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Historical analysis of depreciation accounting -- The United States Steel experience

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A HISTORICAL ANALYSIS OF DEPRECIATION ACCOUNTING — THE UNITED STATES STEEL EXPERIENCE

Abstract: This paper examines the magnitude of the reporting bias inherent in the historical cost accounting of a firm's physical capital. Reported depreciation data pertaining to U.S. Steel Corporation (currently USX) between 1939 and 1987 are compared with standardized historical cost figures and replacement cost estimates. The findings suggest that replacement cost depreciation would have provided more information about U.S. Steel's ability to maintain its productive capacity than historical cost depreciation did. Thus, this analysis provides an illustration of one of the primary arguments for replacement cost accounting.

Changing prices have created accounting measurement problems for business enterprises throughout the twentieth century. Paton [1922] noted that in periods of sweeping price changes the accountants' yardstick (money) becomes "an unstable, variable unit; and comparisons of unadjusted accounting statements prepared at intervals are accordingly always more or less unsatisfactory and are often positively misleading . . . When prices on all sides are climbing sharply it seems clear that a mere increase in the number of dollars possessed is not a valid expression of true improvement in economic condition" [pp. 427-428]. In such periods, Paton pointed out that management must be careful not to pursue a dividend policy which threatens "the preservation and expansion of the physical capital of the enterprise" [p. 440].

Paton argued that "by reducing what would otherwise be the net income figure," recognition of replacement cost depre-

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ciation would enforce management's pursuit of a conservative dividend policy, and "undoubtedly tend to prevent the disbursement of capital as dividends" [p. 440]. Paton concluded that replacement cost data would allow users to better judge how successfully management had maintained the existing physical capital.

Even though debate concerning theoretical aspects of replacement cost measurement persisted, physical capital continued to be maintained largely at historical values in financial statements. Finally, in 1979, after considerable discussion and following a period of persistent price increases, the Financial Accounting Standards Board mandated in SFAS 33 that replacement cost information be disclosed.

Subsequent replacement cost disclosures, however, were apparently neglected by statement users. Managers [Madison and Radig, 1983], auditors [Skousen and Albrecht, 1984], and professional analysts [Berliner, 1983] reported that they did not utilize SFAS 33 data when they evaluated past economic events or when they formulated expectations about the future. Recent capital market research studies confirm these survey findings. Researchers found little evidence that a relationship existed between changing price information on a firm level and securities prices [Beaver and Landsman, 1983] or trading volume [Ro, 1981], or that SFAS 33 disclosures could be used to predict unanticipated dividend changes [Schaefer, 1984 and Murdoch, 1986] or takeover targets [Bartley and Boardman, 1983].

This paper uses an alternative approach to assessing the usefulness of replacement cost information. It addresses the questions of (1) whether replacement cost depreciation provides more information about a company's ability to maintain its productive capacity than does historical cost depreciation and (2) whether replacement cost measures enhance a user's capability to perform long-range forecasts and confirm prior expectations.

The annual reports of U.S. Steel Corporation (currently USX) from 1939 through 1987 are used to investigate how certain accounting measurement techniques can bias the financial statement presentation of a firm's physical capital. Specifically, two series that summarize past investing activities are developed. The series are a firm's Net Asset Ratio [(Fixed Assets − Accumulated Depreciation)/Fixed Assets] and a firm's Annual Replacement Index [(Capital Additions − Depreciation)/ Beginning Fixed Assets]. These ratios depict the extent to which a company has been able to maintain its capital base in the past

and provide an indication of the firm's long range competitiveness.

Actual reported data are compared with standardized historical cost and replacement cost estimates for U.S. Steel over a fifty-year period. The comparison highlights the signal differences that can be created by alternative valuation methods. Conceptual implications of the findings also are discussed.

MODEL

"Destruction is the law of nature" [Hatfield, 1909, p. 121]. Yet accounting for the depreciation of fixed capital has not always been so clear cut. In his historical analysis of accounting evolution, Littleton [1966] reported that one of the earliest English references to depreciation was found in *A Brief Instruction* by John Mellis [1588] which suggested a debit entry to the profit-and-loss account and a corresponding credit entry to the "Implements to householde" "for so much lost by decay of household stuff". Similar treatment subsequently was recommended for horses [Stephen Monteage, *Debtor and Creditor Made Easie,* 1683] and ships [William Jackson, *Book-Keeping in the True Italian Form,* 1801]. The asset account was credited at the end of a given period for the current value of the asset in question and any remaining difference needed to close the account was debited to profit-and-loss. Depreciation apparently was not regarded as an expense but was created because of "decay from use" [Littleton, 1966, p. 227].

The systematic recognition of depreciation did not receive much consideration until manufacturing necessitated the purchase of large quantities of plant and equipment and the growth of corporations required that a clear distinction be made between capital and revenue so that net profit could be correctly calculated and capital stock could be protected against impairment from dividends [Littleton, 1966, p. 240]. One of the early authors to apply depreciation to industry was Ewing Matheson in a book entitled *The Depreciation of Factories* [London, 1884].

Since the late 19th century, an argument has persisted concerning whether depreciation should result from a cost allocation process or an asset valuation process. The side taken in this argument can be explained partially by whether one wishes to focus upon measuring a flow or valuing a stock. Ladelle [1890], who favored the flow concept, argued that depreciation should be used to allocate the original cost of an asset to the various periods that will benefit from the stream of

services produced by the machine. Depreciation, in this instance, represents the systematic matching of a historical cost with the revenue that it helps generate [Paton and Littleton, 1940]. Replacement costs are not particularly relevant.

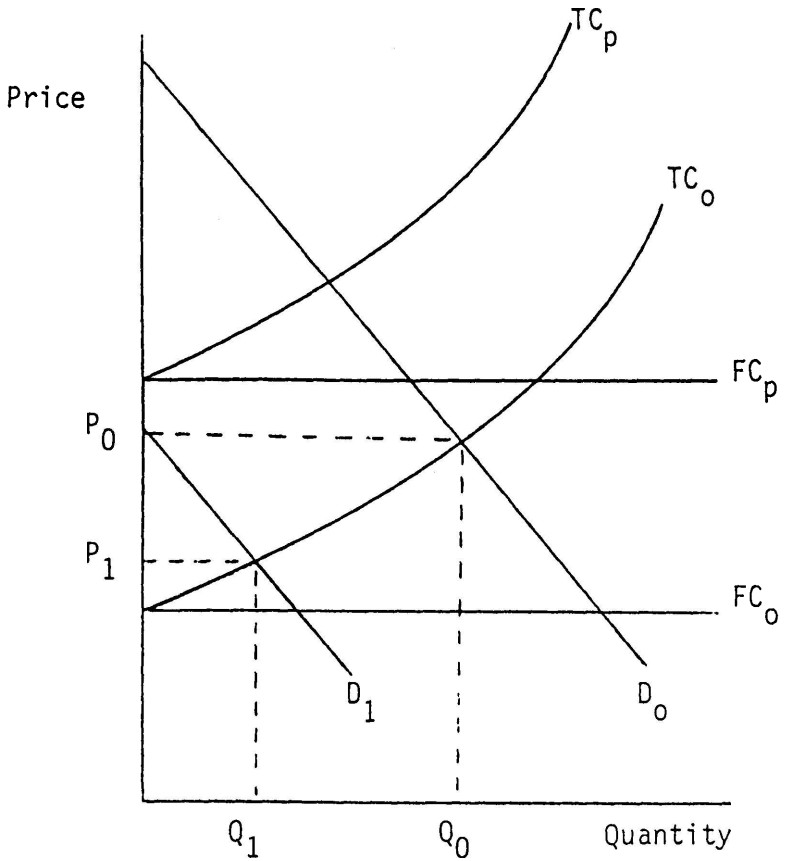
Hotelling [1923], in contrast, employed the stock concept to develop his model of depreciation. He suggested that the value of a machine and the value of a unit of its output are interrelated, and historical costs become irrelevant after an asset has been purchased. According to Hotelling's stock concept, an asset only has value if it can be used in the future. Thus depreciation in a given year reflects the periodic change in the current value of assets that have not yet been sold or discarded [Hicks, 1969]. Replacement costs, in this instance, play an important role in the measuring process.

The stock concept (and thus replacement cost accounting) may provide more information than historical costs about a company's past success in maintaining its productive capacity. Hotelling [1923] argues that a particular capital asset which employs old obsolete technology will be replaced by a new technology machine if management thinks that the present value of the benefits to be derived from the new technology will exceed the cost of purchasing such a machine. If the purchase of new technology cannot be justified economically, however, production will not immediately cease. Old technology firms will continue to profitably produce output with the capital in place as long as the present value of the future net revenues (sales price minus variable costs) exceeds the present value of any positive salvage value to be collected at the termination of the old technology. Variable costs will slowly mount as increasingly more frequent and expensive repairs are required to keep the old technology assets functional.

When an entire plant contains old technology and new technology is not implemented, the time between deciding to terminate old technology operations sometime in the future and the actual closing of the plant doors can span decades. The only signal that such a decision has occurred may be a decline in new capital purchases and a gradual aging in the productive capacity. In this case, replacement costs, not historical costs, provide the best indication that disinvestment is occurring.

Just such an event occurred in the steel industry in the early 1960s. The influx of foreign imports caused the demand curve for the domestic steel industry to shift to the left. This decline in demand (from D_0 to D_1 in Figure 1) caused many domestic steel firms to halt preliminary plans to replace their existing capital

Figure 1
Domestic Steel Industry Supply Curve



D_0 = Old demand for steel products before influx of imports
D_1 = New demand for steel products after influx of imports
FC_0 = Industry fixed costs (old technology)
FC_p = Industry fixed costs (new technology)
TC_0 = Total costs (old technology)
TC_p = Total costs (new technology)
Q_0,P_0 = Quantity and price of domestic steel produced with old technology before influx of imports
Q_1,P_1 = Quantity and price of domestic steel produced with old technology after influx of imports

stock with new technology at a cost of (FC_p), because the present value of the expected future net revenues to be derived from these proposed new investments could no longer be expected to cover the projected initial capital outlays. (See Figure 1.)

CASE DEVELOPMENT

U.S. Steel has been an acknowledged leader in the development of financial reporting.[1] As such, the corporation has been the focus of historical research. Younkins, Flesher and Flesher [1984] utilized the U.S. Steel annual reports issued prior to 1952 to illustrate the historical development of financial reporting during the first half of the twentieth century. Richard Vangermeersch [1971, 1988] utilized the corporate reports to trace the historical development of depreciation and to comment on observed changes in the reporting of tangible fixed assets.

Because United States Steel Corporation is a domestic leader in what has historically been considered a very capital intensive industry, it is also the focus of this study. Throughout the fifty-year period encompassed by this study, U.S. Steel's net tangible assets represented, on the average, over 55 percent of the value of the total reported assets. In such a capital intensive company, depreciation measurement plays an important role in income determination.

United States Steel Corporation also provides an excellent subject for the study of the predictive value of reported physical capacity and related investment numbers, because the company underwent significant restructuring in the early 1980s. In 1979, U.S. Steel began consolidating under-utilized steel production facilities and permanently shutting down obsolete unprofitable plants. This action vastly altered the technological structure of the company. In 1939, 47.8 percent of the revenues generated from the sale of steel products were used to pay employee benefits. By 1981, after the initial plant closings, employee expenditures as a percent of sales had declined to 36.4 percent. In the ensuing six years, additional restructuring enabled U.S. Steel to reduce the number of man-hours required to produce and ship a ton of steel from 10.8 to less than 4.0.

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[1]See *Financial Accounting Milestones in the Annual Reports of United States Steel Corporation: The First Seven Decades*, edited by Richard Vangermeersch, New York: Garland Publishing, Inc. 1986, for extracts of various financial reporting milestones over the period 1902-1968.

Concomitant with the move to eliminate unprofitable steel facilities, U.S. Steel began to funnel available resources away from steel into oil and gas production activities. This change in strategy resulted in the acquisition of Marathon Oil in 1982, the purchase of Husky Oil Company in 1984, and the bringing of Texas Oil and Gas Corporation into the corporate family in 1986.

This case study seeks to identify the point during the fifty-year span when U.S. Steel's strategic plan of retrenchment in steel and expansion into a new industry first could be observed. At what point did it become evident that the company had compromised its ability to retain its historical share of the domestic steel market? Did the reported accounting numbers provide any false or misleading signals of shrinkage or expansion in the company's physical capacity to produce steel?

Measurement of the existing stock (or undepreciated value) of capital assets provides a means of ascertaining if a company has decided not to replace existing capital stock. If the bundle of services embodied in depreciation are not replaced through capital reinvestment then the bundle of services available for future periods identified as net assets will decline. In periods of constant prices, comparison of current capital investments with systematic historical cost depreciation can be utilized to ascertain whether the stock of depreciable assets is increasing or depleting. Such will not be the case, however, when prices change over time. Data that enter the accounting system when assets are originally purchased lose their economic significance as prices change. When prices are not constant the average asset age can only be approximated and disinvestment be uncovered if all assets with older price references are adjusted to reflect the latest prices and technologies. Net asset values and current depreciation must be restated in current prices, which reflect technological change, to estimate the enormity of the problem facing a particular firm to modernize.

Three series of accounting numbers pertaining to the valuation and depreciation of plant assets were developed in this study to examine changes in physical capacity. The first economic series contains actual reported financial data. Information pertaining to U.S. Steel's periodic recognition of expired capital costs in the form of depreciation, as well as information about their annual physical capital acquisitions and disposals, were collected from the annual reports generated by the management of U.S. Steel. Specific segment data derived from the 10-K reports filed with the Securities and Exchange Commis-

sion were utilized to remove oil and gas capital activities where necessary after 1983.

A second economic series eliminated variations in the reported data created by U.S. Steel utilizing different depreciation policies at different points in time. In this series, all assets were valued at historical cost and were assumed to lose their full economic value over a fifteen-year period.[2] Depreciation was assumed to be a linear function of time and was recorded on a straight-line basis.

The beginning balance, on January 1, 1939, in Accumulated Depreciation of $1 billion was revised upward $796 million to reflect the impact of the utilization of a similar fifteen-year life assumption on past depreciation recognition.[3] The net undepreciated balance of $548 million was amortized for case study purposes over the ensuing fourteen years using a sum-of-the-years-digits method.[4] All subsequent purchases of capital assets were assumed to possess a useful economic life of fifteen years. The above assumptions enable uniform depreciation to be recognized on all plant assets acquired by U.S. Steel throughout the entire fifty-year period of the study.

The third economic series generated for this study depicts the impact of increasing replacement costs on U.S. Steel's physical capital investment policies. Historical cost depreciation and net plant assets balances valued in historical costs do not adequately reflect the long-term effect of increasing construction costs on the ability of a company to maintain a certain

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[2]A fifteen-year economic life coincided with the actual replacement cost observed in the Japanese steel industry after World War II and roughly corresponded to the apparent shutdown policy employed by U.S. Steel in the early eighties. If the assumption is made that plant assets become obsolete and are discarded on a first-in-first-out basis, the oldest assets that continued to be operational after the last plant closings were finalized in 1987, must have been purchased no earlier than mid-1969 and thus were less than twenty years old.

[3]Average capital additions during the initial five-year period of the study (1939-1944) totaled $78,250 per year. If additions of a similar magnitude had occurred with similar frequency in the years preceding the start of the period under investigation, it would have taken approximately thirty years to accumulate the gross Fixed Asset balance at January 1, 1939 of $2.3 billion. Based on this assumption and again utilizing a fifteen-year useful economic life, sixteen years of capital additions averaging $78,250 would have been fully depreciated by January 1, 1939, and fourteen years of similar acquisitions would have been partially depreciated.

[4]This amortization reflects the results of the assumption that identical capital additions had been made in each of the years prior to the start of the study and that all capital assets are completely depreciated over a fifteen-year period using a straight-line method.

level of service potential. In a given year, net service potential embodied in current plant additions may not completely replace the service potential consumed through production activities. Yet, because prices have steadily increased over time, the dollars paid for plant additions may greatly exceed the dollar valuation assigned to historical cost depreciation.

To standardize the dollar value assigned to undepreciated plant capacity, all historical costs utilized in the second economic series were restated to reflect current replacement costs. Historical acquisition costs were revised annually to reflect current replacement costs in a given year. An externally generated specific price index was used to perform the conversion as follows:

$$\begin{array}{l}\text{Replacement Cost} \\ \text{in Year } t+n \\ \text{of Acquisition } i \\ \text{Purchased in Year } t\end{array} = \begin{array}{l}\text{Historical} \\ \text{Cost of} \\ \text{Acquisition } i \\ \text{Purchased in Year } t\end{array} \times \frac{\begin{array}{l}\text{Current Index} \\ \text{in Year } t+n\end{array}}{\begin{array}{l}\text{Historical Index} \\ \text{in Year } t\end{array}}$$

The ENGINEERING NEWS-RECORD (ENR) construction cost index was utilized to convert historical cost dollars to replacement cost dollars. The ENR construction cost index was created in 1921 to diagnose price changes that occurred during and immediately following World War I and to evaluate their effect on construction costs. The index, which is composed of constant quantities of structural steel, portland cement, lumber, and common labor, is designed to measure the effects of wage rate and materials price trends.

The ENR construction cost index was selected over the producer's price index (PPI) for three reasons. (1) The PPI does not include labor, which is a vital part of the construction business. (2) The PPI includes many items such as food which are unrelated to the construction business. (3) The ENR construction cost index is less volatile and better reflects changes in capital spending. Table 1 contains a summary of the ENR construction cost index for the years 1939 through 1987.

COMPARISON OF DEPRECIATION RECOGNITION

Actual Reported Depreciation

One of the goals of depreciation accounting is to distribute the cost of a capital asset over the estimated period that the unit will provide economic usefulness to the firm so that the periodic expiration is systematically and rationally matched against the

Table 1
Engineering News Record Construction Cost Index
1939-1987

Years	Index Range		Average Annual Change
	From	To	
1939-1947	236	413	9.37%
1948-1957	413	724	7.53%
1958-1967	724	1070	4.78%
1968-1977	1070	2577	14.08%
1978-1987	2577	4401	7.08%

periodic revenue generated by the asset. Physical factors such as wear and tear from operation, the action of time and other elements, and deterioration and decay, as well as functional factors such as obsolescence and supersession, place limits on the economic usefulness of an operational asset and ideally will be reflected in the periodic apportionment of asset cost.

Table 2 summarizes the various methods employed by U.S. Steel to record depreciation expense throughout the fifty-year period.

Examination of the various depreciation policies followed by U.S. Steel over the past fifty years suggest that the vagarities of the current income tax law, not changes in plant capacity utilization, governed the periodic corporate recognition of depreciation.[5] Emergency facilities constructed during World War II and the Korean Conflict costing $186,544,000 and $812,854,000, respectively, were rapidly amortized over five-year periods. Later, in 1962, the IRS Revenue Procedure 62-21 allowed U.S. Steel to inaugurate the use of an accelerated method of recognizing depreciation on its assets for tax purposes. Management decided "after careful study of the new procedure as applied to its own properties", to base "its determination of the wear and exhaustion of facilities on the guideline procedure" [U.S. Steel, 1962, p. 5]. This move increased depreciation which reduced accounting profits available for distribution as dividends. The 20 percent double-the-declining-balance method was utilized for the next six years.

[5]Vangermeersch [1971, p.70] came to the same conclusion. He noted, "As tax accounting depreciation methods and the replacement-cost and accelerated methods became the financial accounting depreciation methods for U.S. Steel, the yearly depreciation amount became more and more the result of an arbitrary and inflexible formula geared not to production but to tax and other considerations."

Table 2
Summary of Depreciation Expense Recorded by U.S. Steel 1939-1987

Period	Depreciation Total	Depreciation Average	Depreciation % of Beg. Fixed Assets	Description
1939-1940	$ 136,015	$ 68,007	2.9%	Straight-line (SL) Depreciation
1941-1945	608,451	121,690	5.1%	SL Depreciation plus amortization of emergency facilities totaling $186,544,000
1946	71,401	71,401	3.0%	SL Depreciation
1947	114,462	114,462	4.5%	SL Depreciation plus $26,300,000 extra which represents 30% of original cost (Attempt to reflect replacement cost)
1948-1950	415,003	138,334	4.8%	SL Depreciation plus annual accelerated amount of 10% of cost when purchased and 10% in succeeding year (Total extra = $112,899,000)
1951-1952	346,107	173,053	5.2%	SL Depreciation plus annual accelerated amount ($62,004,000) plus amortization of emergency facilities certified by Defense Production Administration as essential at 20% per year ($59,014,000)
1953-1961	2,190,838	243,426	4.9%	SL Depreciation plus amortization of emergency facilities ($753,840,000)
1962-1967	1,961,700	326,950	4.7%	20% Double Declining Balance under IRS Revenue Procedure 62-21 plus 7% investment tax credit ($101,500,000)
1968-1969	533,700	276,850	3.3%	SL Depreciation with revised asset lives Buildings 40 yrs.; Machinery 18 yrs., Mining 10.5 yrs., and Chemical 11 yrs. plus 7% investment tax credit ($73,900,000)
1970-1978	3,112,900	345,878	3.3%	SL Depreciation adjusted downward in some years due to lower operations
1979-1987	4,555,300	506,144	3.7%	SL Depreciation adjusted for level of production. Minimum of 80% at capacity ≤ 50%; 100% at capacity of 85%; 130% maximum at capacity of 100%. Depreciable lives changed to 15 yrs. - Machinery; 9.5 yrs. - Chemicals; and 10 yrs. - Mining.

In 1968, "to enhance the comparability of financial statements in the steel industry" [U.S. Steel, 1968, p. 4], U.S. Steel revised the lives of certain properties and returned to a straight-line method of recording depreciation. Current tax law again played a role in the magnitude of the periodic charge. The midpoint lives provided by the IRS Asset Depreciation Range System served as the range over which depreciation was to be recognized for a particular asset. Depreciable lives remained unchanged until 1979 when most were reduced. This revision of economic lives, however, could be labeled, "Too little, too late." In the fourth quarter of 1979, U.S. Steel announced the permanent shutdown of several steel and nonsteel plants and wrote down depreciable assets a total of $218.7 million to their estimated recoverable value. Sales revenues from these operations amounted to only about 5 percent of total sales, but the plant closings impacted more than 11,000 employees.

The 1979 downward adjustment was followed by four similar announcements over the next seven years. In 1981, management suggested that the facility shutdowns were only temporary, and were caused by "a recession compounded by excessive steel imports" [U.S. Steel, 1981, p. 3].

However, by 1982, the production suspensions were no longer considered temporary. Management blamed "sagging demand" and a company desire to "reduce costs and improve operating efficiencies, quality control and customer service" for the realignment of and curtailment of a number of plants [U.S. Steel, 1982, p. 4]. The next series of plant shutdowns occurred in 1983. Management reported, "In December we moved to preserve the best and most modern of our tools of production, to close or downsize certain operations and to consolidate others. And we struck a balance between products for the capital goods market and those for consumer-oriented markets, shifting our emphasis to flat rolled steels for automobiles and appliances, seamless pipe for the oil and gas industries and heavy plates and beams for construction" [U.S. Steel, 1983, p. 2].

In 1987, at the end of a six-month strike, U.S. Steel announced that it would not restart most of the facilities at Baytown, Texas and Provo, Utah. "We are not giving up any capacity to put product in the marketplace from where we were before the strike" [Wall Street Journal, February 5, 1987, p. 4].

The total recognition of the presence of obsolete, worn out, and unneeded physical capacity ultimately amounted to $1,347 billion dollars. This succession of chargeoffs eliminated over 10 percent of the gross carrying value of the physical assets re-

ported at the beginning of 1979 and reduced capacity almost 50 percent.

Statement users were forewarned that problems were mounting. Throughout the forty-year period leading up to the series of write-downs, U.S. Steel management persistently admonished readers in the annual reports that allowable depreciation charges were inadequate, effective tax rates too high, and that company resources were simply not available to maintain a modern physical plant. (See Appendix 1 for excerpts of management comments).

U.S. Steel's accompanying financial statements, however, provided inadequate numerical signals of the extent to which obsolescence was eroding their physical capital base. Comparison of annual capital additions with the concurrent depreciation charges, graphically depicted in Figure 2, might erroneously suggest that U.S. Steel maintained an expanding productive capital posture throughout the post World War II era. Apparent declines in productive capacity were only portrayed in periods when emergency facilities were being amortized (1941-1945 and 1954-1956) or in the initial stages of the recognition of accelerated depreciation (1962-1965).

By 1967, the accounting numbers suggested that the company had begun to rapidly expand its productive capacity. Three years later management sought to confirm this image with the following comments:

> "Although it will be another year or two before some major units are fully operational, almost every area of our steel operations has now been substantially upgraded . . . Our job now is to obtain the volume required to utilize the full productive capabilities of all our facilities by participating fully in the growing markets for steel" [U.S. Steel, 1970, p. 2].

However, closer analysis of Figure 2 shows that the shift in the reported accounting numbers was due, in part, to the change in depreciation methods. In 1968, the straight-line method reduced depreciation charges by $94.0 million.[6] If the losses associated with the plant closures are ignored, U.S. Steel expended almost twice as many funds for plant additions ($11.2 billion) as they expensed as depreciation ($5.8 billion) during the sixteen-year period that followed the change in depreciation methods.

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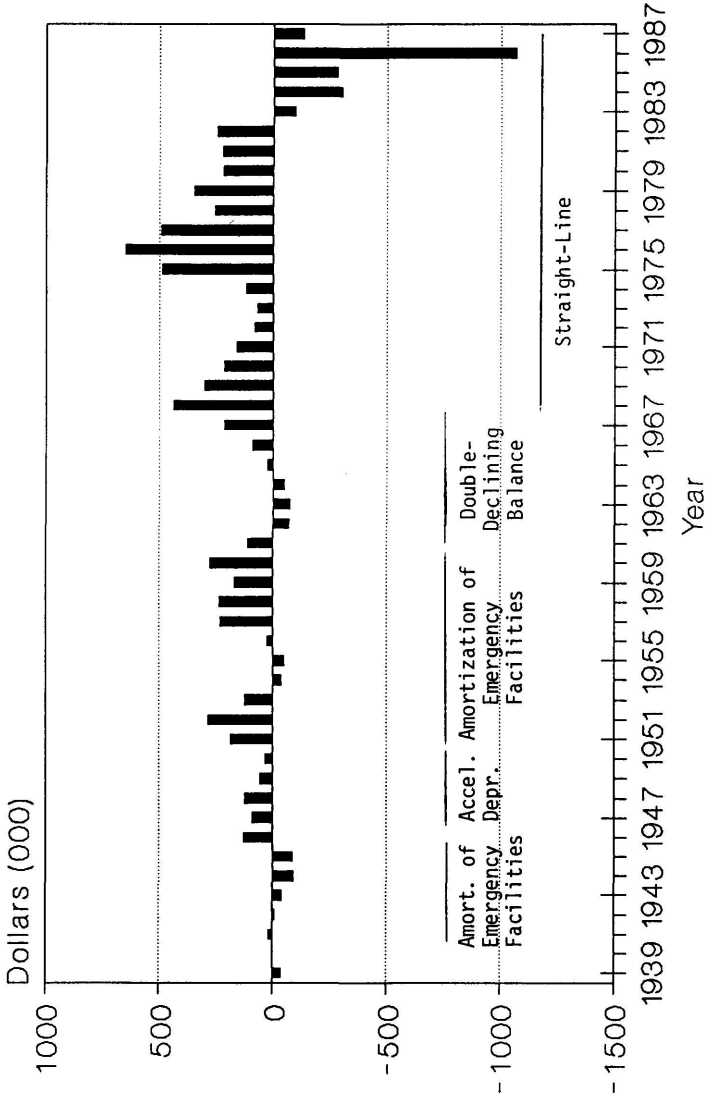
[6]No cumulative catchup adjustment was shown on the income statement. APB #20 which would have required disclosure was not implement until 1971.

Figure 2
Capital Additions minus Depreciation
Actual Reported Numbers



Not only did U.S. Steel extend the useful life of its assets, but throughout the 1970s, the company also periodically recognized depreciation that was below the amount which would have been required had production been maintained at the presumed ideal level of 85 percent of capacity. The company's depreciation policy assumed that physical factors such as wear and tear resulting from the operation of the assets, should be the major limiting factor in determining depreciation. In reality, economic factors such as technological obsolescence might have provided a better prediction of the rate at which an asset was losing its service potential.

U.S. Steel's financial statements did not reflect the contraction and retrenchment that were occurring in plant capacity until 1984 after the bulk of the plant closings had been consummated. At that time, plant additions declined drastically and remained insignificant thereafter. (See Appendix 2 for a brief discussion of the factors cited by U.S. Steel as causing the company's loss of its historical share of the global steel market.)

Historical Cost — Uniform Useful Economic Life Assumption

Existing plant assets will become outmoded as improved, more efficient machines or processes become available. To remain competitive, a company must constantly replace old physical assets with new technologies, well before the replaced assets reach the end of their physical lives. In a highly industrialized, technology-oriented economy, technological impairment will be steady and very persistent. The systematic periodic recognition of a uniform amount of depreciation regardless of the actual physical decline that an asset might actually suffer offers an indication of the process by which a company's plant capacity becomes outmoded.

Table 3 compares actual depreciation with standardized depreciation to show the effect of a uniform depreciation policy. It gives some indication of the bias generated when either the depreciation method or useful life assumption is altered. The impact on the financial statements of not maintaining a consistent depreciation policy is graphically presented in Figure 3, which depicts the cumulative difference between recorded depreciation plus the actual write-offs and depreciation charges based on a fifteen-year life straight-line assumption.

From the outbreak of World War II through 1957, U.S. Steel appears to have recognized excess depreciation charges (compared to the standardized series) in the financial statements.

Table 3
Comparison of Actual Depreciation
With a Fifteen-Year Life Assumption
Straight-Line Depreciation

Years	Reported Depreciation	Fifteen-Year Assumption	Actual Over<Under> Standardized	
			Period	Cumulative
1939-1947	$ 930,329	$ 716,157	$ 214,172	$ 214,172
1948-1957	2,119,816	1,685,872	433,944	648,116
1958-1967	2,793,832	3,264,519	(470,687)	177,429
1968-1977	3,199,500	4,437,863	(1,238,363)	(1,060,934)
1978-1987	6,369,600*	6,505,999	(136,399)	(1,197,333)

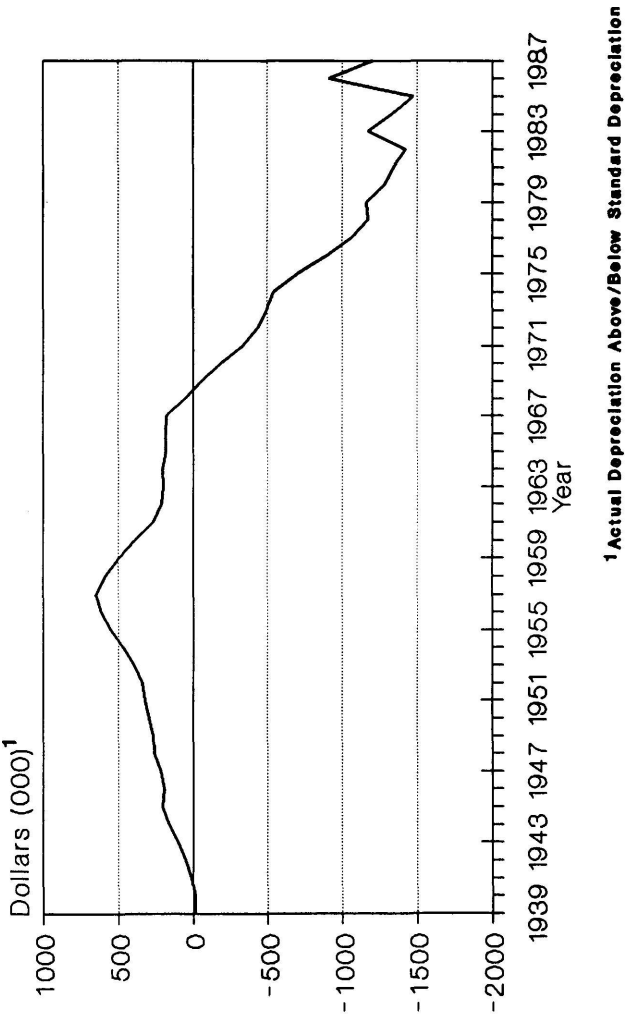
* Includes major write-offs

During this period the company utilized various accelerated methods to amortize the emergency facilities constructed for World War II and the Korean Conflict. From 1963 through 1967, financial statement recognition of a 7 percent investment tax credit and the 20 percent double-declining-balance depreciation allowed under IRS Revenue Procedure 61-21 caused reported depreciation and standardized depreciation to be quite similar. (The five-year difference was only $31,138,000.) In 1968, however, U.S. Steel returned to reporting straight-line depreciation; thereafter, the company consistently underestimated depreciation expense. By 1978, just prior to the initial announcement of a major plant closing, cumulative underestimates exceeded $1 billion. From 1979 through the end of the study in 1987, asset write-downs and reported depreciation roughly equaled estimated straight-line fifteen-year estimated depreciation, but individual years were markedly different.

Replacement Cost — Uniform Useful Life Assumption

The final economic series utilized to depict depreciation expense not only assumes that all property, plant, and equipment is depreciated over a uniform fifteen-year life, but further standardizes the write-off of the service potential inherent in such assets by restating historical costs to replacement costs. The revision of property, plant, and equipment to reflect the estimated costs that would be incurred if assets with similar service potential were purchased at current prices, allows the reader to more accurately estimate any remaining productive

Figure 3
Cumulative Difference Between Actual Depreciation plus Writeoffs and Straight-line (15 yr. Assumption)



capacity, because fully depreciated assets (formerly reported at low historical costs) are weighted identically after restatement to recent purchases (at higher prices) of productive assets.[7] Table 4 summarizes historical cost fifteen-year life assumption depreciation expense restated in current prices (regular depreciation) and current year changes in replacement costs of previously depreciated service potential (catchup depreciation).

Table 4
Summary of Replacement Cost Depreciation

Years	Replacement Cost Depreciation		Catchup as Percentage of Regular Depreciation
	Regular	Catchup	
1939-1947	$ 958,985	$ 1,886,052	196.7%
1948-1957	2,423,510	3,121,072	128.8%
1958-1967	4,381,298	3,720,838	84.9%
1968-1977	7,199,059	15,071,021	209.3%
1978-1987	10,969,516	14,633,148	133.4%

Old (totally depreciated) assets will require the recognition of significant amounts of catchup depreciation, particularly in periods of increasing costs, as evidenced in this case by increases in the ENR Construction Cost Index. Estimates of such changes in the probable future sacrifices, which would be required to replenish current operating capacity of fully depreciated assets, are not readily available when such assets are only measured in the original prices incurred to construct the assets. These valuation problems become more pronounced as assets age and the percentage of fully depreciated capacity becomes significant relative to total capacity.

From 1968 when U.S. Steel began utilizing straight-line depreciation through 1983 when the fourth round of permanent plant shutdowns was consummated, annual catchp depreciation was, on the average, twice as large (201.5%) as regular replacement cost depreciation. After this point in time, annual catchup depreciation dropped dramatically in importance to be considerably smaller (28.5%) than regular depreciation. These numbers offer a striking contrast to the image of a rapidly expanding physical capacity as depicted in the historical cost depreciation series. Between 1968 and 1983, U.S. Steel reported that capital additions were $4,240 million in excess of actual recorded historical cost depreciation (see Figure 2 and Table 2).

[7]See Appendix 1 for further explanation.

When asset life is held constant, only changes in the amounts needed to replace productive capacity will cause replacement cost depreciation to differ from historical cost depreciation. Figure 4, which graphically overlays the ENR Construction Cost Index on the annual restatement of depreciation in current costs, portrays the impact of changing construction costs on depreciation recognition.

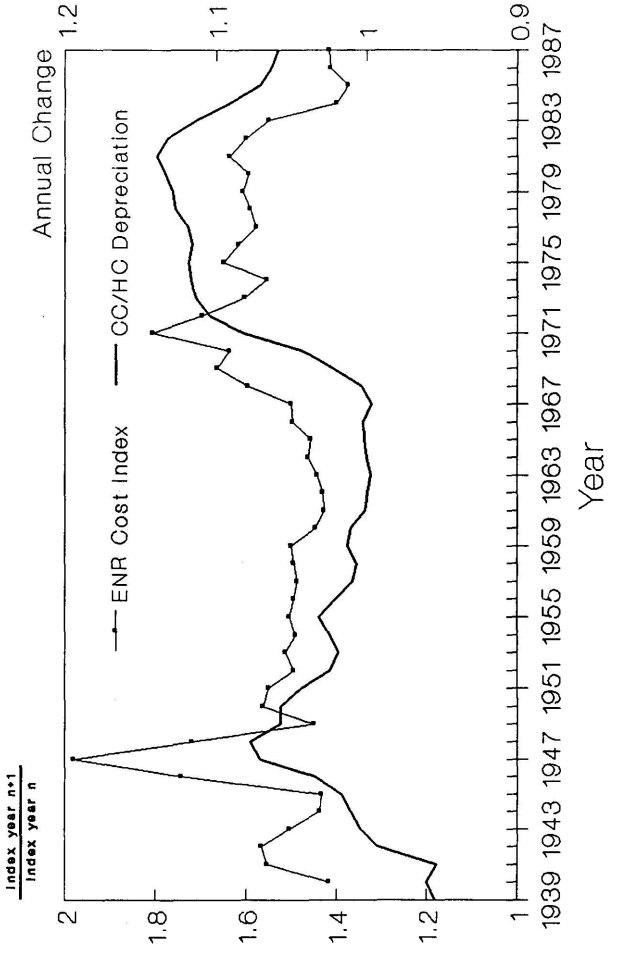
In general, changes in construction costs varied directly with the variance in replacement cost and historical cost depreciation under a fifteen-year asset life assumption. Two significant increases in the costs of construction — one immediately following the end of World War II and the second during the build-up and fighting in Vietnam — were followed in the subsequent years by a widening of the gap between replacement cost and historical cost depreciation. In the years between World War II and Vietnam, the steel industry experienced relatively small changes in the cost of construction. In particular, the U.S. Steel fixed asset accounts reflected few changes in depreciation expense restated for the fifteen-year life assumption. The two series converged only during one period. In 1972, spiraling construction costs began to abate. Yet replacement cost depreciation as a percentage of historical cost depreciation continued to widen for ten years. This ratio only began to improve in 1984, when construction cost changes began a sharp decline.

Which method of recording depreciation best reflects changes that have occurred in current productive capacity? The impact of the three alternative methods of valuing depreciation are discussed in the next section to highlight the effectiveness of each in linking capital values to prediction of future cash flows.

COMPARISON OF REPORTED INVESTING ACTIVITIES

Iron Age [January 30, 1964] asked the following question: "Is the steel industry being too cautious in its capital speeding?" They answered their own question by saying: "Steel spending is high. But it still just about equals depreciation." From 1939 through 1987, U.S. Steel recorded a five-fold increase in the value of its capital assets and capital additions were approximately $4 billion more than depreciation changes. This would suggest that U.S. Steel had been able to expand its productive capacity. Yet capacity during this same period declined from a reported high in 1959 of 41.9 million to 19.2 million tons in 1987. Was the decline in physical capacity as abrupt as historical cost

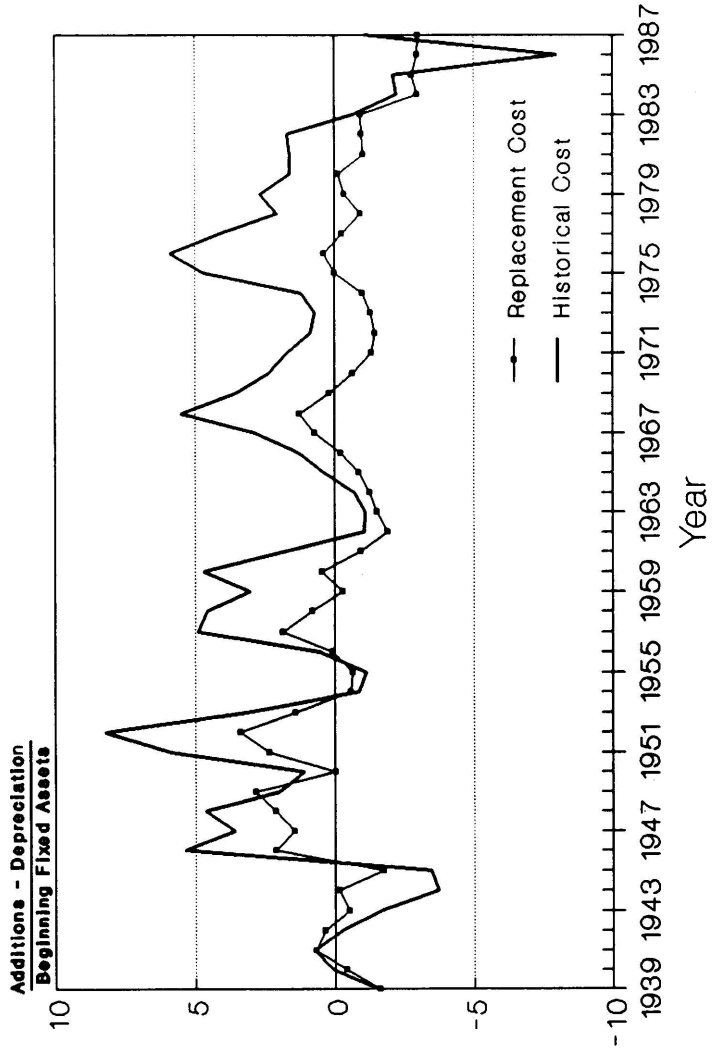
Figure 4
Comparison Of Change In ENR Construction Cost Index With CC Depreciation/HC Depreciation (15 yr.)[1]



[1]Left axis applies to change in ENR construction cost index and right axis applies to change in CC/HC depreciation.

figures would suggest, or did a gradual aging process occur? Which depreciation valuation method provides the clearest signals that productive capacity was being eroded? Figure 5 pictorially compares Annual Replacement Indexes measured in historical costs with those calculated with replacement costs.

Figure 5
Annual Replacement Indexes
1939-1987



From the end of World War II until 1983 when U.S. Steel was involved extensively in the plant shutdown program, the reported historical cost numbers presented a persistent pattern of annual new capital expenditures being well in excess of the annual recognition of facility wear and tear. Only for two short periods (1954-1955 and 1962-1964) did capital additions fail to exceed depreciation charges. The first disruption of apparent steady expansion occurred immediately following the Korean War after an extensive program of modernization and expansion was completed. Tax savings, precipitated by the accelerated write-off of these emergency facilities, aided in the financing of the construction.

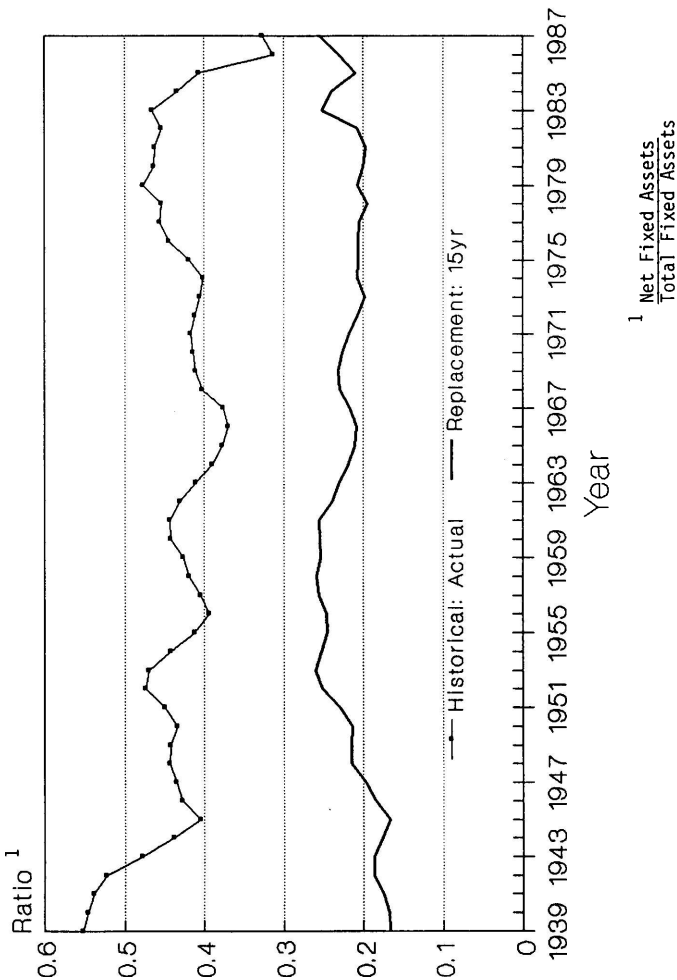
The years 1963 through 1965 marked the second period when construction expenditures did not outpace historical cost depreciation. Shifts in demand from heavy to light products were occurring, and domestic steel producers were starting to feel pressure from foreign imports. During this period, new facilities authorizations began to reflect a change in emphasis at U.S. Steel toward light, flat rolled steels. This shift culminated in August, 1965, when an enlarged $1.8 billion facilities program was announced. For the next seventeen years capital expenditures completely outpaced recognition of wear and tear. Yet productive capacity declined from approximately 42 to 31 million tons.

The Annual Replacement Indexes revalued in current replacement costs provide a different picture of capacity expansion and contraction at U.S. Steel. With historical costs, capacity expansion did not appear to cease until 1983. In contrast, a bleak picture begins to emerge as early as 1961 when replacement costs are utilized. Thereafter, current capital expenditures are greater than depreciation charges, valued also in current costs, only in 1967-1969 and again briefly in 1976.

Comparison of the reported historical cost Net Asset Ratios with the replacement cost Net Asset Ratios (Figure 6) provides confirmatory evidence of the signal differences obtained from the two economic series. Undepreciated assets as a percentage of total assets give some indication of the age of the physical plant. Again historical costs ratios offer a much more positive image of the company's ability to maintain physical capacity over the years than does the alternative measure. Historical cost data suggest that U.S. Steel was able to modernize the plant between 1965 and 1980 (Net Asset Ratios increased from 37.7 to 46.3). Using replacement costs, one could at best only infer that U.S. Steel was holding its own. (The ratio declined slightly from 21.1 to 20.1). In 1983, historical cost Net Asset Ratios abruptly began

deteriorating from a high of 46.5 to 32.7 in 1987. Such rapid swings are not observed in the replacement cost numbers for this period. (Comparable Net Asset Ratios were 25.6 and 25.8, respectively.)

Figure 6
Net Asset Ratios
1939-1987



Figures 7 and 8 provide additional information pertaining to the annual changes in the reported historical cost and replacement cost Net Asset Ratios.

Figure 7
Annual Change in Net Fixed Assets/Gross Fixed Assets
Historical Cost — Actual Depreciation

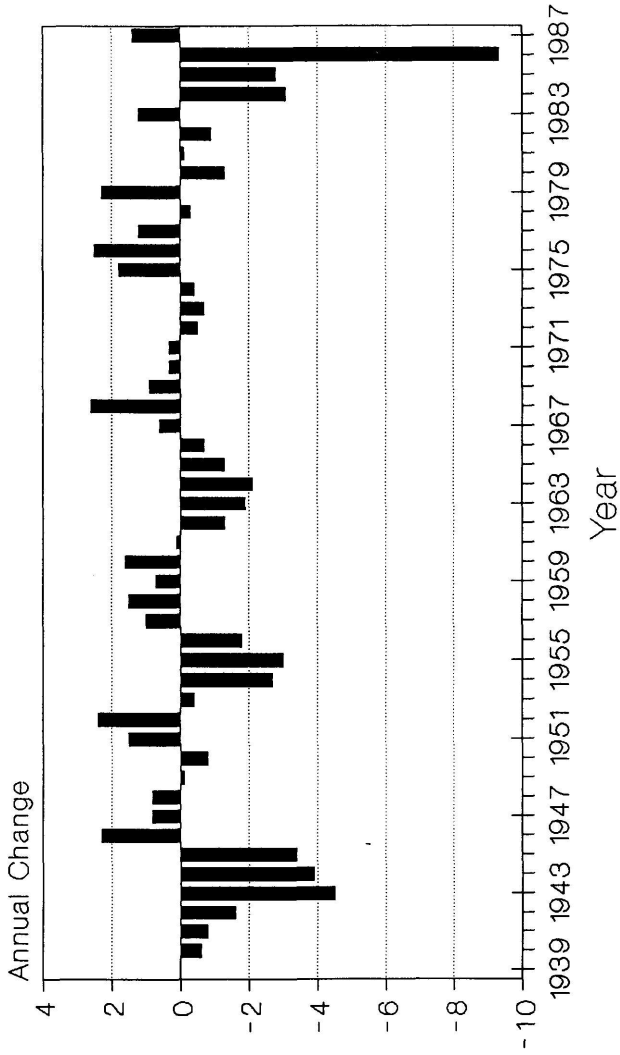
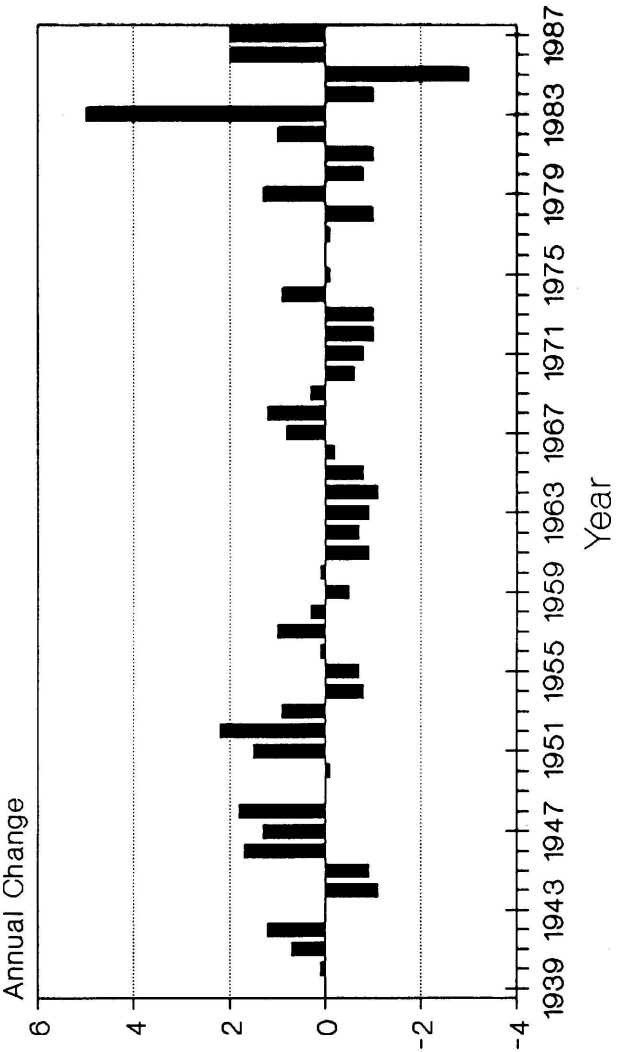


Figure 8
Annual Change in Net Fixed Assets/Gross Fixed Assets
Replacement Cost — 15 yr. Assumption



Net Asset Ratios calculated with reported financial statement numbers suggested that U.S. Steel experienced from time to time fairly large changes in the average age of the physical plant. Significant ratio declines occurred twice — once during World War II and then again during the Korean Conflict — before the plant shutdowns commenced in the 1980s. The early "plant agings" simply reflected changes in the company's depreciation policy. The latter decline arose because previously underdepreciated assets were being abandoned. When replacement costs were utilized to develop the Net Asset Ratios, similar large negative shifts did not arise. Asset aging, particularly for the two decades beginning in 1960, appeared to be more gradual and more persistent.

One profitability measure — Return on Net Fixed Assets — was calculated to provide some indication of the bias inherent in the reported financial statements concerning management's effectiveness in using company plant assets to generate net income. Figure 9 contrasts U.S. Steel's reported historical cost return on investment with indexes computed on a replacement cost basis.

Historical cost indexes paint quite a different picture of long-term company performance than do numbers adjusted for replacement costs. U.S. Steel's reported financial statements created an illusion of prosperity. The company's "maintenance" investment policy maximized short-term profits; but, by the end of the period, U.S. Steel had completely lost its competitive advantage. The existing financial reporting system encouraged this orderly liquidation.

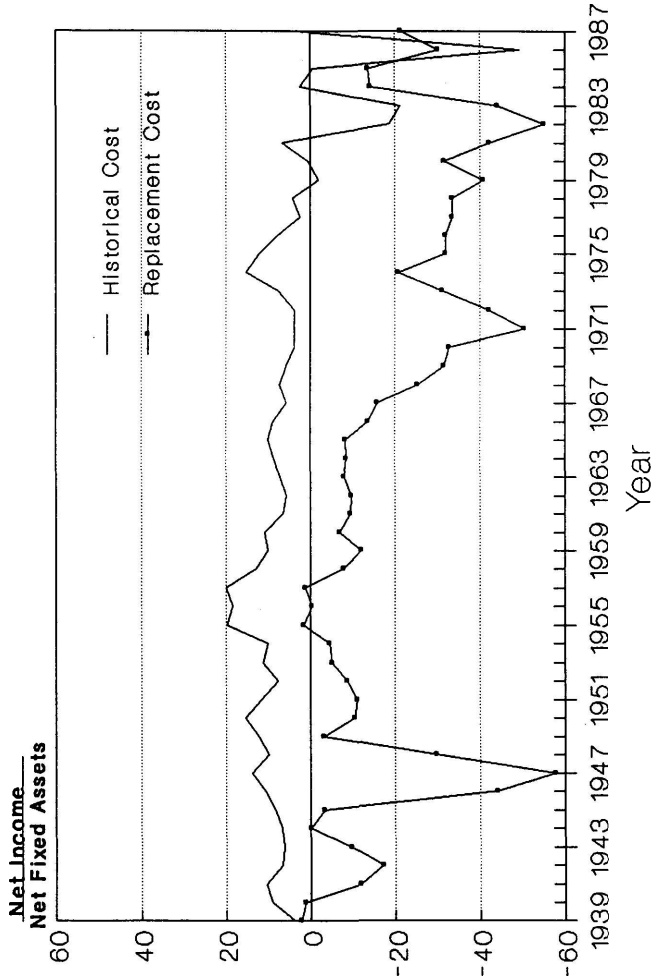
CONCLUSIONS

This paper examined the extant accounting practices for depreciation over a fifty-year span as conveyed through the financial statements of one company — U.S. Steel. Several conclusions, which deal in general with the accounting for depreciation and specifically with the information communicated by U.S. Steel, are offered.

General Conclusions:

1) Altering the accounting techniques used to convey information about an economic series can alter the picture conveyed to the statement user.
2) When prices are changing and/or new technology emerges, the use of replacement cost numbers to value current services

Figure 9
Return On Investment
1939-1987



obtained from property, plant and equipment and to estimate any remaining future service potential will more rapidly convey subtle changes in productive physical capacity and more accurately predict future reductions in acknowledged physical capacity.

Specific Conclusions Relating to U.S. Steel:

1) In the past fifty years, recorded depreciation has not resulted entirely from a cost allocation process whereby the cost of an asset was systematically allocated to the periods during which it would be used. Economic factors not related to matching revenues with related expenses had a significant impact on the annual depreciation charge recorded by U.S. Steel.
2) Current tax law, not changes in plant capacity utilization or concern with matching the periodic expiration of physical plant service potential with the periodic revenue generated by the company assets, governed the corporate recognition of depreciation.
3) Depreciation can be standardized so that the original cost is systematically allocated over a predetermined number of periods. Yet changing prices, particularly those incurred for the construction or purchase of long-lived assets, cause allocations of past costs to be poor predictors of future cash inflows from the sale of goods or future cash outflows for the purchase of new technology.
4) Recognition of the cost of replacing productive assets in the cost allocation process, provides the clearest signal of gradual changes which are occurring in a company's ability to maintain or even enhance its physical capacity to produce future goods or services.
5) Examination of replacement cost numbers suggest that U.S. Steel made a decision about 1960 to not commit itself to a total conversion or recapitalization in the technology newly emerging at that time. Current and anticipated resources simply were not available. U.S. Steel alternatively initiated a smaller, and thus less risky, program of partial conversion to the new technology. Concurrently, the old technology plants continued to profitably produce output (at least in historical cost terms) with the capital in place. Variable costs (particularly labor) gradually increased over time without a concomitant improvement in output per man-hour. Finally, two decades later, the price of the output being created with

the old technology could not offset current cash outlays for variable costs and U.S. Steel could no longer economically justify maintaining operations. In 1978, U.S. Steel initiated a program which ultimately resulted in the permanent closing of almost 50 percent of its reported capacity.

Webster's Ninth New Collegiate Dictionary (1985) defines a language as being any "systematic means of communicating ideas or feelings by the use of conventionalized signs, sounds, gestures, or marks having understood meanings." Accounting represents a language whereby ideas are conveyed with numbers. U.S. Steel, through its annual financial statements, imparted information to its statement users both with numbers (in the actual financial statements) and with words (in the management comments attached to the financial statements). One conveyed a message of ongoing prosperity. The other conveyed a message of impending doom. The negative message ultimately proved to be the correct one. Yet there is little indication that it was heeded by those who could have altered the path that U.S. Steel followed.

The experiences of U.S. Steel bring three questions to mind. Was the verbal message repeatedly given by company management ignored because the accounting message being transmitted offered too different a picture? Could the accounting message have been couched in different terms which would have added emphasis to U.S. Steel management's verbal warnings? Are other similar warnings going unheeded today because historical cost numbers simply do not accurately reflect the underlying economic events? Additional research into this area certainly seems advisable.

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APPENDIX 1
Excerpts from Annual Reports of U.S. Steel

1939 — "[D]epreciation and depletion of property is an inescapable cost element in production and, unless an adequate sum can be currently set aside to cover these unseen costs, the corporation might at some future time find that its facilities had been worn out or depleted and that provision for their replacement has not been made" [p. 12].

1947 — "It is a simple fact that to buy similar tools of production takes many more dollars today than formerly; to count as profits, rather than as

cost, the added sums required merely to sustain production is to retreat from reality into self-deception" [p. 14].

1954 — "Depreciation amounts as ordinarily calculated and recognized in tax laws ... have failed to perform their vital revolving-fund function of maintaining the supply and modernness of the tools of production. The reason for this: The total number of dollars that can be recovered in depreciation over the life of a given facility is limited to the number of dollars originally expended for the facility. But the buying power of the dollar has not remained at all stable ... If depreciation cost is understated in current buying power, then income is correspondingly overstated ... This is unfair and unfortunate because it results in the taxation of capital" [pp. 23-24].

1956 — "[The current Federal taxation system] may be regarded as the hidden taxation of capital as it turns over through depreciation or, alternatively, as a hidden increase in the tax rate on true income ... The prospect is that the portion of reported income that must be regarded as "phantom" income, because it is required to maintain the business under conditions of continuing inflation, will increase ... As basic costs continue to be forced upward, and as the depreciation deficiency widens, management's problem of finding the dollars required to maintain the business becomes more acute" [pp. 27-28].

1960 — "The part that government can constructively play in promoting the growth process is strictly limited, but the part it can play in preventing growth is virtually unlimited ... [The government's] tax and regulatory powers can be used to destory utterly the incentive and ability to save and productively invest that are essential to growth. [Under the current tax code, the calculation of depreciation] must be based on the prices paid years ago — twenty-five years or more in the case of U.S. Steel ... The deficiency amount which should realistically be regarded as depreciation is thus treated as income and on that pretense over half of it is taxed away. This is more than inimical to growth; it puts a tax on just staying even" [pp. 26-28].

1966 — "Capital is, in a word, tools — everything invested to further production ... Facility modernization and product innovations blur, even obliterate, the line of distinction between replacement and expansion of capacity ... The financing of replacement should be covered by adequate depreciation ... There is thus need for realistic depreciation allowances, geared to both the acceleration of obsolescence and to the inflationary erosion of the dollar" [pp. 33-38].

1969 — "The current tax formula is based on charges for depreciation of dollars invested in the past. But because of inflation, these dollars have less buying power today, and thus the depreciation allowed is too small even to maintain existing investment ... As the widening gap between return of capital needed and that allowed is taxed as profits, the real tax rate rises and the incentive to invest falls" [pp. 37-38].

1976 — "Because of the long lives over which our investment in facilities is required to be recovered, inflation exacts a heavy toll. The purchasing power of the dollars recovered through depreciation, therefore, is but a fraction of the amount actually needed to replace the equipment" [p. 5].

1980 — "Present tax laws limit depreciation to the original cost of facilities ... [This] means that only part of the cost of replacing worn out facilities can be recovered as a cost of doing business ... Confiscation of private property was never contemplated by Congress. Yet, confiscation is

occurring at an accelerated pace. Inflation, when combined with our existing tax laws, is the cause. Tax reform to alleviate the effects of inflation — through faster write-off of plant and equipment — is no longer simply desirable, it is imperative" [pp. 33-34].

APPENDIX 2
Discussion of Factors Cited by U.S. Steel

U.S. Steel cited three factors, beyond the Federal tax policy, as exacerbating their ability to retain their historical share of the global steel market. The company faced intense pressures internally from labor and the Federal government and externally from foreign steel producers. Management suggested that these pressures ultimately played an important role in U.S. Steel's decision to reduce its steel-making operations.

Union Pressure

U.S. Steel experienced persistent union pressure for increased wages and benefits. During the 1950s, a cycle of union demands which were not subject to "dickering or compromise," strikes, and compromises brought successively larger wage increases, insurance and pension benefits, vacation pay and automatic cost of living adjustments to the worker.

In 1956 the Company noted, "For the best part of two decades, U.S. Steel's employment cost per employee hour . . . [has] advanced at a rate, compounded annually, averaging 8.1% . . . [T]he vast power of industry-wide labor unions in compelling annual increases in employment costs far beyond increases in productivity is automatically compelling inflation" [p. 25]. And, in 1959, "The long-term increase in output/man-hour (since 1940) has been equivalent to only a little over 2% per annum" [p. 29].

Even though the frequency of extended work stoppages declined in the subsequent years, wages continued to rise, but productivity did not improve. U.S. Steel warned in 1979.

> "Labor cost must be competitive. Higher labor rates can be justified only if that labor is more productive and can provide a product or service which is competitive . . . No nation or company can long survive if the price and productivity of its labor is noncompetitive . . . Since the early seventies, there has been little productivity improvement in steel . . . For the coming decade, it is quite clear that collective bargaining improvements must be earned by improved productivity" [p. 14].

And again in 1982.

> "The only alternative to the permanent loss of both steel mills and steelworker jobs was a moderation in labor costs to bring them more into line with those of other manufacturing workers" [p. 3].

The escalation in hourly wage costs did not subside until 1983 after steel plants had begun to be permanently idled. In 1982, the average hourly wage of steelworkers was $21.61, which represented a 1,579 percent increase over the 1945 average hourly wage of $1.287. The Consumer Price Index during this same period increased only 436 percent.

A significant wage reduction was finally achieved in 1986, after steel plants had been idled by a six-month strike.

"We were determined to get a competitive labor settlement which would give our steel business a fighting chance to survive in a tough marketplace. Although we had to endure a six-month strike, we attained our objective" [p. 4].

Government Pressure

Throughout the fifty years of the study, the Federal government also applied extensive pressure on U.S. Steel; first, to hold down prices, and later, to comply with environmental standards. Several company comments relating to government pressure follow.

Price Controls:

1945 — "Price controls in peacetime is a simple denial to customers of their right to bring about and to support production of the goods and services they want . . . Price and cost changes that significantly narrow profit margins inevitably repel investment and employment in additional production" [p. 24].

1952 — "[Since the start of World War II, one of the] principal devices employed to undermine the profit incentive has been the virtually continuous direct or indirect imposition of ceilings on steel product prices during a period when Federal fiscal and monetary policies were debasing the buying power of everybody's dollars" [p. 24].

1958 — "He who would squeeze income reinvested to increase wages, taxes or other costs, or to reduce prices, would be squeezing out . . . the most immediate and direct means that exists of financing and expanding industrial capacity, important in peacetime and essential in wartime" [p. 29].

1964 — "Steel prices are virtually the same as six years earlier" [p. 5].

1973 — "On January 25, 1974, the Cost of Living Council granted what was for U.S. Steel a very nominal increase in pricing authority on steel products against the substantial cost increase incurred since 1972" [p. 2].

Environmental Regulations:

1973 — "We believe the time has come when environmentalists at all levels must carefully weigh the full costs of further pollution abatement against the probable benefits, particularly where elimination of the final insignificant percentage of contaminants may be several times as costly and use many times as much energy as eliminating the first 99%" [p. 16].

1975 — "In today's climate, some governmental regulations are so restrictive and so costly to apply that it may be impossible to add the needed new capacity and thus provide additional job opportunities . . . It is not technologically or economically feasible to operate many facilities for the production of steel . . . with no emissions" [p. 6].

1977 — "A factor significantly restricting the Corporation's ability to invest in job-producing tools for the future is the mounting pressure for retrofitting of older facilities with sophisticated and highly expensive environmental control facilities . . . The economics of

[capital investments to comply with the implementation of environmental laws] may, at the time they are to be made, dictate that certain facilities be abandoned instead of modified to comply with the requirements" [p. 21].

In 1979, the company noted that it had invested $2.1 billion in the past five years in investments to reduce steelworking costs and $.6 billion for nonincome producing environmental facilities.

Foreign Pressure

In the late 1950s, U.S. Steel began to experience pressure from abroad as well as at home, as foreign steel at extremely competitive prices began to enter the country. At its peak, in 1984, imports comprised 26.4 percent of the domestic market.

Company management described this problem in the following ways.

1959 — "There is increasing competition from other steel producers, both in the U.S. and in foreign countries, from other materials such as aluminum and plastics, and from technological advances which affect materials requirements throughout industry" [pp. 11-12].

1961 — "Foreign producers with recreated modern capacities are increasingly able to compete with American producers in international markets ... America is costing itself out of foreign markets, and out of the jobs of producing for them, while foreign producers are invading our domestic markets ... [If] the cost inflation remains unhalted, it seems quite clear that we will not be able to balance what we buy or give abroad with what we sell or get from abroad" [p. 29].

1964 — "For the first six decades of the 20th century, the U.S. economy was an exporter of steel mill products. Starting in 1959 and in every year since, imports of steel mill products have exceeded exports ... Much of the steel imported from foreign countries into this country has been sold at prices substantially below those prevailing both in their own domestic markets and in the U.S. markets" [p. 37].

1967 — "Prices of foreign steel sold in the United States are substantially below U.S. domestic prices. Limited data available indicate that price differences arise primarily because of the large cost advantage — principally employment costs — enjoyed by foreign steelmakers [p. 18] ... Many foreign producers have an added advantage because the installed costs of new facilities abroad are far less than in the United States. (Due to pollution control equipment requirements) [p. 20] ... U.S. import vulnerability inceases when and where low foreign wages are accompanied by productive capability and capital availability" [p. 35].

1978 — "Many of these imports were dumped here at ... prices below their costs, or below what they sell the same products for in their own countries. Dumping hurts the domestic steel industry and the American economy through lost jobs, sales and profits ... Today, the U.S. is the only industrialized nation unable to supply its own steel needs. If solutions are not found, we will become even more dependent on foreign sources of supply" [p. 6].

Summary

U.S. Steel was unable to find any workable solution to the wage-price squeeze on profits. This, coupled with the fact that their capital base was deteriorating, caused the company to become increasingly noncompetitive in the international market. After several decades of warnings, U.S. Steel finally in the early 1980s began to search for alternative investments.

1984 — "A New U.S. Steel came into its own in 1984 . . . Today our Oil and Gas segment is now our major line of business in terms of both revenues and earnings" [p. 2].