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REGULARIZATION OF CAPITAL INVESTMENT IN RAILROADS

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GROSS INVESTMENT in road and equipment of the railroads of the United States is currently shown on the books of the companies as some $29 billion, primarily a valuation in terms of historical cost. About two thirds of this amount is for fixed property, or roadway and structures, and one third is for rolling stock, or equipment. By all odds the biggest single item is that for freight cars, being half as much again as that for locomotives and about the same as the combined items for land and grading for the roadway. Regionally, the distribution of the investment is between $11 billion and $12 billion each in the eastern and western districts and half that amount in the South. In terms of current dollars the gross annual addition to the investment accounts during the 1920's, when this statistic was first compiled, ranged from $430 million to $1.06 billion. In the depression of the 1930's it dropped to $100 million and in the course of the recovery prior to World War II it twice exceeded $500 million. Since that war it has varied from $860 million to $1.4 billion. In real terms the gross annual addition since World War II has fallen considerably below that of the 1920's, since the weighted index of capital goods prices has doubled. Both the functional and the regional distribution of the annual expenditures have shifted noticeably with time. In the 1920's fixed property expenditures were double those for equipment, in the years following World War II the latter became three times the former. In the 1920's the East's expenditures were somewhat more than the West's, and the South's were but half of the West's. In the postwar years the western expenditures exceeded the eastern, and the southern were two thirds of the eastern. These are the over-all accounting summaries of the investment whose stabilization has long been a subject of discussion, though surprisingly little has been achieved.[1]

The life of the capital equipment representing this investment is roughly indicated by the depreciation rates used for accounting purposes, rates based on life studies. The average for all items for

[1] Interstate Commerce Commission, *Statistics of Railways in the U.S.*, 1920-1949, statements 46-47 to 1937, tables 137-139 thereafter.

which depreciation is accrued, which excludes rails, fittings, ties, and ballast, indicates a forty-year life. For the items for which most present-day investment is made, the life ranges from twenty-five to forty years.[2]

From the point of view of regularization, two aspects of the variations in investment may be considered.[3] The first relates to what may be identified as the internal problem of the industry, the problem of why these variations occur; whether they are internal responses to outside changes or responses to purely internal changes such as technical innovations. The second raises questions about the external relationships of the industry's investment with the economy as a whole, which may in turn have feed-back effects on the railroads themselves. The first is relatively the easier aspect to deal with and is the one with which most industry representatives would be content to terminate whatever thinking they do about regularization. The second is nebulous. Railroad influences merge with those of other industries in ways which discourage investigation, and in empirical terms it is difficult to tell which is the cart and which the horse in distinguishing between external relationships and the internal factors. This paper deals primarily with the internal problem.

The Institutional Pattern of Investment Decision Making

Each industry-wide increment to railroad investment in road and equipment is timed and has its magnitude and character determined by decisions made company by company. Thus a general review of the decision-making process based on the author's experience at both staff and director levels, together with a field study of practices of various companies, provides a necessary background for the subsequent consideration of capital expenditures in detail.

Roughly, it appears that investment decisions are primarily the

[2] *ibid.*, 1949, table 96.

[3] Attention should be called to the fact that fluctuation of economic activity in the railroad field involves variations of investment not only in plant but also in both inventory of materials and supplies used currently and maintenance of the plant. The balance sheet figure for the former varied from a peak of $767 million in the 1920's, to $296 million in 1933, to a higher peak of $865 million in 1948. The annual magnitude of the maintenance expenditure ranged around $2.3 billion during the 1920's, dropped to a low of $937 million in the middle thirties, and has more recently been just under $3 billion. *ibid.*, 1949, table 155. These two items involve variations that are important, though proportionately not as great as has been the case with gross investment. Neither of them is considered in this paper.

concern of the directors and top officers of a company. This is not to say that the lower echelons do not make studies and proposals, but rather that the significant decisions, as anyone that has been in the lower levels well knows, rest with the "top brass." Only at this high level are the technical considerations, the appraisal of the future situation, and the financial aspects all brought together. It is also general practice that all but minor proposals be passed upon by the directors, though it is safe to say that in many companies the directors do little but concur in the judgment of the top officers. This is particularly the case with the usual outside director who is connected with nonfinancial business, who is busy with his own affairs, who is not thoroughly versed in railroad affairs, and who must inevitably rely upon his officers for current information. The financially connected director does seem to contribute, for he can advise concerning availability of credit and other financial matters. The officer who is a director is only formally affirming his already formed judgment. Thus, in the main, the top group of officers really make the decisions with such financial advice as may be offered. At the widest limits, this group would include the president and the most directly concerned or most active vice presidents or, where departmental heads are provided with more functional titles, the general manager, general traffic manager, and chief financial officer. In the narrower case, the president would assume the primary role, or possibly two or three dominant members of the group of top officers would be found to be the controlling people.

Whatever combination it may be, its decisions are influenced by, among other things, certain mechanisms and routines that become established in the typical railroad company's organization. While companies have certain common characteristics in these matters, there is a wide variation in how decisions are carried out. Relevant to the problem of regularization, the mechanisms of particular interest range from plans, through annual and monthly budgets, to actual authorizations and orders, and finally to the accounts. Capital plans may be laid out for an indeterminate period or for from one to ten years. These plans vary from an expression of hopes or dreams that everybody recognizes have little chance of fruition, to thoroughly realistic, carefully screened proposals that are to be carried out when circumstances allow. All these plans are recognized as subject to revision as technology, traffic, and other things change. In general these plans perform the function of establishing current priorities among alternative possibilities. In but few cases do they control timing except under most stable circumstances.

As plans come toward the point of being carried out, they are projected into the budget procedure. The capital budget machinery that projects beyond a year is more like planning than like budgeting. The annual budget is, in ordinary times, the first meaningful estimate of expected expenditures; it is a generally respected top limit and a reasonably firm allocation among various possibilities. It reflects previous planning to varying degrees depending upon how serious the top officers are about planning, how much they look to the long run or how easily they are influenced by the vagaries of the moment. There is wide variation among companies in this respect. In some it is part of general policy always to chart the future carefully and stick to the course; in others there is so little aptitude in any area for working toward policy formation that planning is scarcely recognizable as a tool of management. Thus an annual capital budget may represent widely different types of decision making. It should be emphasized that in uncertain times the annual budget may, even under the best of auspices, prove to have little holding power. It can be whittled to pieces in the spring, a few months after being solemnly affirmed, and totally revived again in the fall to the astonishment of all concerned. In the most uncertain times, even the operating budget becomes an unstable thing as it deteriorates from an annual to a monthly or even to a weekly level of commitment, but if the last stage is reached capital expenditure may well have completely disappeared except as required by contractual or legal obligation.

Most frequently, annual capital budget timing has a set place in the calendar, with crystallization and board authorization toward the end of the year, in November or December. This is both because of a cultural mold imposed by the contours of our calendar and because the result of the previous fall's peak is sufficiently relevant, particularly financially, to make it necessary to get an estimate of it before commitments. It is also because outdoor work can be done most efficiently in the summer, and peak loads are to be met in the succeeding fall. Authorization in the previous winter provides the time for plans to be made and orders completed. Sudden national emergencies coming at odd times of the year give rise to marked deviations from this pattern. The normal capital budget machinery can have a substantial element of expenditure commitment, but one must be wary of those companies that give only lip service to the budget, or those times when almost everyone must renege. To the extent that the capital budget is carried out, it does establish a timing of decisions tied to the calendar year.

Capital budgets may move fairly quickly into actual force authorizations, contract signing, and orders for materials and equipment. Board authorization in November or December may result in orders for new cars being placed in December or January, or for new rail in December for deliveries in the following summer. On the other hand, orders may be delayed to await more favorable conditions or to take a last look at trends. Construction work, if done by company forces, may call for early material orders, but labor-force authorization does not come until spring, just before the work is to start. Contract construction work may wait till late, too. In general, the order or contract stage fixes expenditure commitment beyond the company's control, though, again, in hard or uncertain times there has been some reneging. For example, rail ordered for future deliveries has not been accepted, or else the delivery date has been postponed for extended periods.

Once the orders or authorizations have been made and accompanied by expected progress and delivery dates, the basis is laid for the first phase of the accounting department's statements, that is, the estimates of the monthly cash requirements and the estimated accounts for one, two, and three months ahead. The negotiations and detail work for financing are also begun if outside financing is involved, though some preliminary assessment of the problems may well have accompanied the preparation of the annual budget. Subsequently, the estimates of accounts and cash are revised each month until thirty days or more after the end of a given month, the final accounts are presented, still, however, with the estimate of accruals remaining uncertain.

In general, the critical point in capital expenditure appears to be placing the order, making the contract, or signing on the labor force. At that time the investment expenditure is firmly committed, and the expectations of others are definitely established. Thus for the purposes of analysis, the timing of orders is the critical point.

Another variable in the decision-making process, probably more important than this complex of financial studies and statements, is the attitude of the top officers toward capital expenditures, their character, magnitude, and timing. Some officers have a keen interest in all the available improvements, and throughout the organization there is a feeling that capital expenditures get a sympathetic reception and that proposals for expenditure are to be actively developed and passed on up for decision. Other top officers seem more interested in squeezing everything possible out of existing plant; it almost appears that they have to be bludgeoned into making a capital expenditure by competition, group pressure, or a preponderant example of prior advantageous use of facilities by others. A different range of attitudes is evident when it comes to timing. Some of the key group go all out during good times because it is easy to find the needed money or because it is in the air. A few seriously plan for capital expenditure over a long enough period so that the possibility of getting things at lower prices during a contraction may have an appeal and so that even in the trough of business fluctuation there may still appear a reason for improving or expanding facilities in terms of future higher levels of traffic. It would be possible to go on almost indefinitely enumerating various attitudes and providing contrasts. But the key point is that there is this variation and that it provides explanations for some aspects of total industry behavior. This variation also gives grounds for hope that top officers can more generally come to adopt attitudes favorable to regularization of capital expenditures.

The Effect of Profitability on Investment

Before moving into detailed examination of experience with individual classes of capital expenditures, it is of help to review the general types of factors that might be expected to control relevant decisions. The performance and profitability of the past year have already been mentioned as one consideration. The immediate- and near-future month-to-month record and estimates are also watched. The comparative importance of the two varies with the degree of long- or short-range viewing that managements do. Profitability affects both the supply of internal funds for expenditures and the credit position for obtaining external funds. During the 1920's something over one half of the gross investment in road and equipment was paid for out of reservations of profit; the factor of profitability is therefore critical just in terms of sheer mechanics of cash flow. The profit factor is also important in determining ability to borrow, particularly in respect to use of mortgage bonds and stocks as a financing medium. Profitability is of course primarily a reflection of volume of business in conjunction with rates and fares on the one hand, and amounts of labor, fuel, materials, and supplies together with their prices on the other. During the period under consideration these inputs into the railroad business took about 70 per cent of operating revenue in the nonwar years. Interest is another item relevant to profitability. In the 1920's interest paid out amounted to about 9 per cent of revenues; it grew to 14 per cent in 1933, fell back to 9 per cent by 1936, and after 1943 varied from 4 to 5 per cent. What is left to be divided between reinvestment in the property, payment of dividends, and retirement of debt is also affected by taxes that earlier took about 6 per cent and after the war about 10 per cent of revenue.[4] Other smaller items are services purchased, rents, and claims for loss, damage, and injuries. All these items affect profits and therefore affect capital expenditures. Finally, availability of funds for capital expenditure is affected by cash requirements for retirement of debt.

In addition to influence on financial results, expected volume of business affects the amount of capital goods that is seen as necessary to provide transportation service. That is, if at a given point the number of freight cars may not be quite enough to handle existing demands for service and if expectations are that the level of demand will be maintained, there will be pressure to buy more cars. Volume also has its effect on acquisition of capital goods because it enters into the calculation of both the economies from new technical improvements and the effects of variations in labor and materials prices. A new mechanism—for instance, the car retarder for saving brakeman's wages in large yard operation—may have looked like a very desirable investment at 1928 levels of business, but quite unjustified at 1932 levels. Thus, volume of business can operate in both direct and indirect ways to vary the forces leading to investment in capital goods.

A historical review of the fluctuations of the more important of these factors affecting profitability in relation to changes in the rate of capital expenditure may indicate some of the causes of that rate's irregularity. As the previous section emphasized, the placing of orders is the critical point in deciding the timing and magnitude of capital expenditure, so this review will deal with variations in orders. It has also been indicated that authorizations and orders tend to be concentrated in relatively few months just before and after the end of the calendar year. Thus it is necessary that monthly order data, rather than just those for the calendar year, be available for analysis. Furthermore, if the effect of particular major rate and

[4] *ibid.*, 1930, tables XII, XIV; 1949, tables 108, 111, by calculation.

wage decisions that produce lump changes at specific times is to be examined, the same frequent data are needed. Equipment orders are the only capital expenditure items for which monthly data are available over a long period. Of these, freight car orders to builder seem the simplest to discuss because innovation and its timing have less influence on them than on orders for locomotives or passenger cars. Obviously, special considerations that apply to a particular capital item lessen its usefulness for such a review as this, but it must be noted that car expenditures are the largest single item in all the years of major turning points except 1933. Car orders are notorious for being particularly sensitive to changes in influencing factors and so have some special advantage for the purposes of this review. On the other hand, car orders, like all equipment orders, are more dependent than roadway orders on the amount of capital stock or inventory existing at any given time relative to the volume of business, as will be pointed out later. Thus, freight-car orders will form the background of this analysis of the major turning points in railroad capital expenditure.[5]

THE DOWNTURN IN 1920

The year of the first turning point to be considered, 1920, was noted for the number of critical happenings that might have influenced the decisions of railroad companies. At the end of February, Congress passed the Transportation Act of 1920, generally considered to be the first constructive federal legislation concerning the railroads. On March 1 the railroads were returned from government control to private hands. The Labor Board on July 20 awarded a 21 per cent increase in wages retroactive to May 1. Railroad material prices reached peaks during the middle months of the year and softened thereafter. At the end of July a rate increase averaging

[5] Monthly car order data are available in terms of orders to car-building companies from 1920 to date in American Railway Car Institute, *Car Building and Car Repairs*, 1950, p. 60. The other data for the following analysis are to be found in the Annual Statistical Issues and other issues of *Railway Age*; ICC, *op.cit.* and Statement M125, Selected Income and Balance Sheet Items; Association of American Railroads, Bureau of Railway Economics, *A Review of Railroad Operations*; ARCI, *op.cit.* There are some types of differences between the various data that should be noted. Orders close to the end or beginning of a month are not always allocated to the same month. One series includes just orders of railroads, another is for all orders to car builders and excludes orders for cars to be built in carrier shops. The latter is available for the longest period and will therefore be used.

about 33 per cent was announced, to be effective August 26. For the first eight months freight traffic was from 11 to 16 per cent above the previous year, excluding strike periods. September marked a downturn.

In terms of profitability, the result of all these factors was to give a slight net railway operating income (this will hereinafter be abbreviated as n.r.o.i., and is what remains from operating revenue after deducting expenses, taxes, and equipment and joint facility rentals) for the first three months, a deficit for the next five, and a substantial positive amount for the last four. The year's total wound up a mere $17 million for Class I companies. This was a period of difficult readjustment after the war, against which the companies were partly protected for six months following the return to private operation by the government guarantee of income, the amounts for which are not included in the above figure.

There was a serious car shortage through 1920, which reached a peak in September. This receded rapidly thereafter, and a surplus of 200,000 cars was recorded for the end of the year. Freight-car prices reached a peak early in 1920, some three times what they had been in prewar years. Toward the end of the year these prices appeared to be softer. Railroad orders for cars started at 6,000 for January, reached a peak in March at almost 20,000 cars, and dropped to a range of 4,000 to 6,000 from May through the summer and down to between 2,000 and 3,000 in the last three months, which would normally be the beginning of the next season for orders. There was no complete 1919/1920 season under private control. The last four months of the season produced orders for 48,000 cars. The 1920/1921 season's orders were but 15,000.

The high level of traffic, the increasing shortages, and the relief on return to private control appear to be the factors leading to the March 1920 peak. The appearance of n.r.o.i. deficits thereafter, in spite of continued high level of traffic, led to a reduction in orders even though shortages were mounting. July brought knowledge of wage increases accompanied by even greater rate increases, along with softening material prices. Car orders did not increase. In the last months of the year, when orders normally are high, the drop in traffic, reduction in shortages, and falling car prices seemed to outweigh the improved trend in earnings, and orders declined still further.

THE UPTURN IN 1921

The turning point in the latter part of 1921 comes next for attention. Material prices fell sharply in the first half of 1921, generally reaching low points in September. A decision of the Labor Board on June 1 reduced wages roughly 11 per cent, effective July 1. Changes in working conditions also lowered labor costs. In the first half of the year no major rate changes occurred. Traffic started the year some 14 per cent below 1920 levels, the maximum percentage drop below 1920 coming in August with carloadings 16 per cent and ton-miles 29 per cent lower. This represented the greatest decline in business thus far known to the railroads. N.r.o.i. was negative in the first two months of 1921, but was gradually built up through better discipline and lower costs, in spite of the decreased traffic, and from July through October earnings were between 4.5 and 5 per cent of the allowed valuation of the Interstate Commerce Commission (ICC). Car prices seemed still to be declining. In the meantime, large car surpluses, as high as 500,000 in April, were accumulated. These two factors seem to explain why practically no cars were ordered from January to September.

In the month of October 1921, weekly carloading figures turned upward and by the end of October almost reached 1920 levels. The car surplus fell below 100,000. Prices appeared to be leveling off. Cars could be had for roughly a third less than in early 1920. A rate reduction on western grain of one-half the last increase came on November 20, presaging further reductions. The signs of increasing traffic, the decline in car surplus, the favorable nature of the latest monthly earning reports, and the expectation of better car prices would seem to have counterbalanced the negative effect of the rate decrease, and October car orders reached nearly 8,000. December orders exceeded this somewhat, January's were about 15,000, and in March and April orders were between 22,000 and 24,000. The season's total was just over 90,000. Ordering was sustained through the summer. The factors favoring these large orders were strengthening of car prices after February; greater traffic, except in coal, than for any previous year; reappearance of car shortages after May; and improved n.r.o.i.

THE DOWNTURN IN 1929

The next major turn was in 1929. There were no important changes in prices, wages, or rates in that year. Traffic relative to 1928 had increased slowly during the year, so that by the summer of 1929 carloadings were 4 to 6 per cent higher than in 1928. Beginning in the first week of September, loadings fell off; by the first week in October they fell below those of 1928 and by the end of November reached 7 per cent less. N.r.o.i. for the year as a whole was the greatest of any year in the 1920's, though in the latter months it had fallen below the 1928 monthly levels. Freight-car surplus during the summer and in September was less than in 1928, but always above 100,000. The end of October provided a serious psychological shock in the form of the stock market crash. To counteract this, President Hoover on November 19 at a special meeting at the White House asked the railroad companies to maintain capital expenditures and received their pledge to do so. While stock prices had been seriously affected by the turn of late October, bonds held relatively firm, and railroad borrowing remained possible through 1930. Car orders had been high in September 1929—some 16,000; they fell to the 8,000 level for the following two months and to 4,000 for December. January orders of 15,000 appeared to be in response to the presidential exhortation, but only 5,000 were ordered in March and 1,000 in April, and orders for the remaining months of 1930 were a mere trickle. Actually, the 1929/1930 ordering season, if it be extended to include September 1929, produced about the same number of orders as that of 1928/1929, some 56,000.

THE UPTURN OF 1933

The review of the turn of 1933 may best be introduced by noting that railway wage rates were reduced 10 per cent on January 31, 1932, and, as of December 1932, this level was extended for ten more months. Materials continued their downward trend through 1932 and until May 1933. Rates gradually worked their way lower because of competitive cuts. A surcharge of about 2.5 per cent on rates was imposed from January 1932 to October 1933. Traffic in 1932 continued to decline through July, relative to 1931. Thereafter the difference began to decrease. N.r.o.i. for 1932 reached a low of only 26 per cent of that of 1929, and stayed at a low rate for the first four months of 1933. Car orders to builders for the 1932/1933 season were a mere 50. The second week in May 1933 was the first time in years when weekly carloadings exceeded those of the corresponding week of the previous year. By the last week in June, they were 20 per cent over 1932. N.r.o.i. began to recover, but large amounts of unused capacity remained. The car surplus for 1933 averaged over 500,000, though this was some 100,000 less than for 1932. By the fall of 1933, with the opening of the 1933/1934 car order season, carloadings dropped relative to 1932. In October 1933 they were only 4 per cent greater than in 1932, and in December the same. For January 1934, loadings were actually less than for January 1932, but each successive month thereafter through July they gained again. For the first four months of 1934 n.r.o.i. was almost triple what it had been in 1933. Orders to car builders for the 1933/1934 season did not appear until February and March 1934, then totaling only 14,000. With the near impossibility of company borrowing, the government credit arrangements or help under the Public Works Administration (PWA), initiated in late 1933 and effective for the railroads in 1934, made possible these few orders. The latter half of 1934 found the railroads with a 2.8 per cent wage-rate increase, material price increases of some 20 per cent over mid-1933, carloadings generally less than in 1933, and n.r.o.i. 25 per cent below 1933. Not until March 1935 did the ICC decide to allow a rate increase, which amounted to about 3 per cent. Almost simultaneously wage rates rose 8 per cent. The average car surplus for 1934 was 360,000. Practically no cars were ordered in the 1934/1935 season.

THE DOWNTURN OF 1937

The turning point of May 1937 comes next. During the previous year, 1936, wage and freight rates remained level, and material prices turned up in midyear. After March 1936, carloading moved steadily ahead of the 1934 and 1935 levels, by August being 20 per cent higher. N.r.o.i. for the second quarter of 1936 was 24 per cent above the previous year; for the third quarter, 56 per cent; and for the last quarter, 32 per cent. Freight-car surplus, which had started the year at 250,000, by the fall peak was only 110,000, and at the end of the year was 125,000. There had been an unusual nonseasonal bulge in car orders centering on May 1936, totaling 23,000 for the four midyear months. After negligible orders for August through October 1936, the orders to builders rose to 15,000 for December. The elimination of emergency freight charges was announced by the ICC on December 19, 1936. This meant the loss of $112 million in revenue at 1936 traffic levels. Car orders continued at the 15,000 level in January 1937, dropped in February and March, and jumped to 6,000 in April. The 1936/1937 season's railroad orders to builders totaled some 52,000, almost up to the annual average of the last four years of the 1920's.

The year 1937 started with a continuing increase in material prices, wage rates the same as 1936, and lower freight rates. Payroll taxes in connection with retirement and unemployment were added in 1937 to the extent of $92 million. The unions in February voted to demand wage increases, and the railroads at the turn of the year started proceedings before the ICC for higher rates. Carloadings continued their gains over previous years. In April and May 1937 they averaged 15 per cent above the same months in 1936. N.r.o.i. for the first quarter was 38 per cent higher than in 1936. However, beginning with June, carloadings failed to maintain their gains over 1936. Later it became apparent that n.r.o.i. in May was off. June's was better, but July's was even below 1936. Carloadings relative to 1936 continued to decline in July and August. Material prices continued to rise. Through August and October wage rates were increased by 5 to 5.5 cents an hour. On October 19 the ICC granted the first of a series of commodity rate increases calculated to provide $69 million in additional revenue. By August n.r.o.i. was 23 per cent below 1936. Then October saw the beginning of the most rapid drop of traffic known in railroad records, and by the last two weeks of December carloadings were almost at their 1932 level. The year 1937 ended with a car surplus of 280,000. On November 9 the railroads asked for still further rate increases, which were granted on March 8, 1938 and were of a magnitude to provide $175 million in revenue at 1936 traffic levels. N.r.o.i. continued to fall from September till it reached a negative amount in February 1938.

Monthly data for railroad cash deposits were available for the first time in this downturn and are of considerable interest. These had increased with the volume of business through 1935 and 1936, being $210 million on December 31, 1936, or 57 per cent more than on the same date in 1934. In 1937 they continued through March an upward trend relative to 1936. During the next four months the rate of increase declined and by August deposits were the same as in 1936. By the end of September they were $55 million less, for October $92 million, and by the end of the year $197 million. In March 1938 the maximum decline over the corresponding month of the previous year was reached, at $208 million. Near cash items had declined but slightly during this period. Loans and bills payable, representing short-term borrowing, did not change in 1937 and rose but $25 million during January, February, and March 1938. The tremendous pressure to maintain a cash position by not making any capital expenditure commitments is obvious from these figures.

The 1937/1938 season produced but 660 car orders. In the last part of 1937 high wages and material prices, followed by a precipitate drop in business, nullified any effect rate increases had on earnings. Financial adversity, declining business, and mounting car surpluses were a complete deterrent to ordering.

THE UPTURN OF 1938

The 1938 general upturn in economic activity is dated in June in the NBER business cycle chronology. For the railroads, that year began with a general rate increase of about 5 per cent. It was hoped that a wage-rate reduction could be obtained, but none was forthcoming. Prices of railroad material declined some 5 per cent during the year. Carloadings fell off during the first part of the year and were below 1932 levels into May. N.r.o.i., a negative amount in February, staggered along through June at levels lower than in any year of the decade. With an upward tendency in carloadings, second-half n.r.o.i. was $13 million more than that for 1937. It was the same as for 1935, not as much as for 1933. Minimum car surplus was 139,000. In the first quarter of 1939 there were no rate, wage, or price changes, and carloadings improved slightly, though they were still only at 1934 and 1935 levels. The quarter's n.r.o.i. of $85 million was up to the 1935 level but less than that for 1934. Car orders for the 1938/1939 season totaled but 11,000.

THE DOWNTURN OF 1948

Because of the abnormal factors, the war years have been skipped in this discussion. The next and last turning point to be considered affected capital decisions of the winter of 1948-1949. In 1948 there were increases in rates, wages, and material prices. Rates were raised generally in January, May, and again in August, totaling 14 per cent above 1947 levels. A decision handed down at the end of December gave a further increase of some 5 per cent to be effective in the middle of January. On October 1, 1948, operating wages were increased 10 cents an hour and nonoperating 7 cents, with provisions to be effective in September 1949 for putting the latter group on a forty-hour week at no decrease in weekly wages. Railroad material prices pushed upward some 14 per cent through the first nine months of 1948. Carloadings in the first part of the year were below

1947, but for May and June they were the same. A minor decline occurred in the latter part of the year. N.r.o.i. reached new postwar highs beginning in May, and from June through October each month produced over $100 million. By December the carloading decline took on more serious proportions, and n.r.o.i. fell below the previous December's level. For the year it totaled $1,002,000,000, the best non-war year figure since 1929. Car shortages had been serious following the war and continued through 1948, the maximum in the fall peak of 1948 being 22,000, about a half of what it had been in the previous year.

The 1947/1948 car order season accounted for some 50,000 orders, the 1948/1949 for but 11,000, practically all of which came before the turn of the calendar year. Continued decline in carloading through 1949 more than offset two rate increases for the year, and by the third quarter of 1949 n.r.o.i. was but a little over one half of what it had been in 1948. Car orders through the mid-1949 off-season months and the 1949 part of the 1949/1950 order season were under 3,000. At the end of 1948 there had been 64,808 freight cars on order from the builders, while at the end of 1949 there were but 3,760. Decrease in traffic, reduction in shortages, and lowered n.r.o.i. more than made up for the series of rate increases in the balance of the types of factors under discussion.

This terse review of major factors influencing profitability at seven turning points indicates the complex interrelation of the factors as they affect decision making. Favorable general changes in rate level cannot be earmarked as a factor necessarily leading to expanded capital expenditure, since decreases in traffic can overbalance them, as in 1920, 1938, and 1949. The immediate effect of wage increases, if rates and traffic together do not supply corresponding added revenue, can be strongly negative by adversely affecting n.r.o.i. Substantial increases in traffic with a corresponding increase in n.r.o.i., if other things remain equal, can have a buoyant effect as in 1936-1937. Expectations about the price of capital items can, in an extreme situation such as that in 1920, be important. In the item under review, as will be brought out later, the inventory of capital units has an influence in relation to level of traffic. One has the feeling that major changes in traffic volume, with their double influence on need for cars and on n.r.o.i., tend to dominate if the other factors change in only minor ways.

The Effect of Innovation on Investment

Technical advances are another factor leading to investment. Two principal questions arise in connection with innovations, one being whether their timing has any relation to phases of economic fluctuation, the other being whether they can have sufficient influence of a positive sort to override other factors that might time investment demand. It must be recognized at the outset that there are on the one hand the large-scale innovations, some of which are drastic and universal in their impact, such as the diesel electric locomotive; while others are more restricted and less immediately compelling, such as electrification. Then there are innumerable smaller-scale advances, such as improved types of air brakes, better truck frames, mechanical track-maintenance tools, on down to items scarcely recognized as capital, such as tie plates. There is obviously room for detailed analyses of no more than a small sample of these types.

A historical analysis of innovation should begin with the observation that in the early 1900's the possible influence of innovations was overpowered by the great demand for increased capacity. For instance, while new locomotive types were developed and acquired in the early 1900's to increase tonnage of trains and to keep costs down in spite of increasing wage rates, the major pressure was to get enough added hauling capacity to take care of developing increases in business. Not until after the middle of the 1920's can innovation generally be seen to stand out alone as a cause for additional investment to effect economies or to provide improved service. An illustration of this type is the previously mentioned car retarder, which was first introduced in the United States in 1925. Similar in their effect were the several new types of freight steam locomotives brought into wide use about the same time. The streamlined lightweight passenger car, the passenger road diesel, and air conditioning of a later date furnish examples more obvious to the general public. Clearly, the impact of all these innovations on investment is influenced to a substantial degree by economic factors, notably changes in wage rates and in fuel and material prices, and extent of competitive pressure. The steady and almost continuous rise in engine- and train-crew wages from the early 1900's to date has been an active force toward the development and adoption of improvements that would increase train loads. The relatively greater increase over the last decade in the wages of maintenance-of-way, yard, and station employees compared with the wages of train employees has led to emphasis on the labor-saving qualities of work and office mechanical equipment. Certainly, the active competition for long-haul passenger business gave added push to the investment in lightweight, streamlined passenger cars and new types of locomotives with which to haul them.

The first question, whether innovation timing is related to any particular phase of business fluctuation, raises some difficult problems of interpretation. The beginning of the first or experimental stage of an innovation, where and when the original idea or concept appeared, or even what it actually was, is difficult if not impossible to ascertain. The second or developmental stage may be said to start with the experimental model and run through refinement and change leading to a final unit capable of regular operation and ready to be made commercially available. This stage usually is accompanied by some evidence publicly available, and the terminal date is by definition ascertainable. The third phase may be identified as that involving the general adoption of the innovation by many individual companies, accompanied by further refinements and modifications.

The difficulty of identifying what has been designated as the first stage of an innovation is indicated by some of the steps that led to the road diesel-electric locomotive. A substantial number of years before the construction of a diesel-electric locomotive, the electric-traction motors, electric control, truck, and frame elements necessary for such a locomotive were worked out in conjunction with designs for electric locomotives, gas- and electric-rail cars, and street and rapid-transit electric cars. Likewise, the diesel engine itself had been manufactured for various other uses by a number of companies both in the United States and Europe for a number of years before the appearance of the diesel-electric locomotive. Diesel engines were applied to rail cars in 1928.[6] In one of the lines of development of the diesel-electric locomotive, by the Electro Motive Company, the origins were to be found in its manufacture of gas-rail cars. The transition to the locomotive was by substitution of a diesel for a gas engine and enlargement of the motive-power element to a point where the power car no longer could carry passengers or head-end traffic. Another line of development brought together the know-how of the Ingersoll-Rand and McIntosh-Seymor companies as diesel

[6] *Railway Age*, vol. 86, January 5, 1929, p. 110.

engine manufacturers with that of the American Locomotive and General Electric companies as electric locomotive builders. Initially, this combination worked toward a switch engine, but by 1928 it produced a test road locomotive. In neither line was any substantial investment in new plant necessary for construction of initial units because plant used for building preceding types of equipment could be adapted. At just what point in this whole history the road diesel locomotive idea can be said to have first jelled is certainly not clear, and not the least problem is the definition of the unit.

As far as the time span and timing of the second stage of an innovation is concerned, the tabulation of dates in table 1, relating to major innovations since 1920 in the railroad field, provides an opportunity for exploring their relationship to phases of business fluctuation. The earlier date shown is that of the completion of the first actually operable unit incorporating the basic features of what came to be the generally adopted unit. This leaves unidentified earlier experimentation with respect to separate aspects of the final type and to applications in other fields. The second date is that when manufacturing companies had produced the first type of unit that they were ready to make and sell on demand.

The number of these major innovations since 1920 provides such a small sample that it makes definitive conclusions impossible. However, it may be noted that the generally prosperous period between mid-1922 and the latter part of 1929 saw the commercial offering of half of the innovations. The poor times of 1931 to 1935, inclusive, accounted for four out of the ten. In terms of the National Bureau of Economic Research reference cycle chronology, four of the offerings came in the mid-1924–mid-1926 expansion, two in that of 1933–mid-1937, and one in the following expansion. One offering came in the 1926-1927 contraction and two in that of 1929-1932.

If one views the tortuous course taken in the development of some of these innovations, it is small wonder that there seems to be little more than chance occurrence in timing. To take still another example for sake of emphasis, the AB freight brake history could be said to go as far back as an ICC investigation and report in 1924 concerning alleged inadequacies of freight brakes. Existing brakes were subject to stationary test-plant trials in 1926. New types of equipment were supplied for test in 1927 and 1928, and second designs in 1928 and 1929. Road tests were made on the latter in 1929 and 1930. A third refinement of design to meet serious deficiencies appearing in the

TABLE 1

DATES OF DEVELOPMENTAL PHASE OF MAJOR INNOVATIONS

Innovation	*Probable date of first experimental model in U.S.* *(1)*	*First general commercial availability or offering* *(2)*
a. Four-wheel trailing trucks and large fire box for steam locomotive	1919	1925
b. Diesel-electric switcher	1924	1925
c. Diesel-electric road locomotive for passenger trains	1928	1935
d. Diesel-electric road locomotive for freight trains	1925	1940
e. Roller bearing	?	1925
f. Streamlined, light-weight, alloy-steel passenger cars	1932	1933
g. AB freight air brake	1927	1932
h. Air conditioning	1929	1931
i. Car retarders	1923	1925
j. Centalized traffic control	?	1927

Sources:

Innovation	*Column*	
a	1	*Locomotive Cyclopedia*, 10th edn., 1938, p. 103.
	2	*Railway Age*, vol. 78, May 2, 1925, p. 1077.
b	1	*ibid.*, vol. 78, January 3, 1925, p. 41.
	2	*ibid.*, vol. 80, January 2, 1926, p. 72.
c	1	*ibid.*, vol. 86, January 5, 1929, p. 86.
	2	*ibid.*, vol. 98, January 26, 1935, p. 181, insert.
d	1	*ibid.*, vol. 79, October 10, 1925, p. 645.
	2	*ibid.*, vol. 110, February 8, 1941, p. 287.
e	2	*ibid.*, vol. 80, January 2, 1926, advertisements.
f	1	*ibid.*, vol. 94, February 4, 1933, p. 94; vol. 96, January 27, 1934, p. 166.
	2	*ibid.*, vol. 94, February 4, 1933, p. 94; vol. 96, January 27, 1934, p. 166.
g	1	American Railway Association, Division V, *Power Brakes and Appliances*, 1932, p. 5.
	2	*Railway Mechanical Engineer*, vol. 107, March 1933, p. 75.
h	1	*ibid.*, vol. 104, September 1930, p. 508.
	2	Federal Coordinator of Transportation, *Report of Mechanical Advisory Committee*, 1935, p. 638.
i	1	*Railway Age*, vol. 77, November 15, 1924, p. 895.
	2	*ibid.*, vol. 78, May 9, 1925, p. 1145.
j	2	*ibid.*, vol. 83, July 16, 1927, p. 13; August 6, 1927, p. 276; August 20, 1927, p. 325.

road tests was developed in 1930 and tested in 1931.[7] The manufacturers made the commercial offering of the final model in 1932. In 1933 this was adopted by the railroads for compulsory installation on all new cars, and in 1934 a ten-year reconversion program for old cars was agreed upon.[8]

In the third phase of innovation, the using companies make capital expenditure on the new items. The annual rates of installation provide the index of the influence of the innovations on capital expenditure. It appears at once that there is considerable lag between the date of first commercial offering and the beginning of high rates of expenditure. Since most of the innovations so far considered have not run their full course of installation and obsolescence it is necessary to go back in railroad history to earlier innovations to get some idea of the timing over the whole cycle of expenditure. A typical case is that involving the mikado locomotive, a new type first ordered for this country in 1902 and destined to have sufficiently wide use to provide significant data. The mikado, as defined for this analysis, was an eight-driving-wheel freight locomotive with a larger firebox and greater heating surface than had been provided previously, made possible by adding two nondriving trailing wheels to the locomotive wheel arrangement. The combination of two additional trailing wheels and larger fireboxes and heating surfaces was introduced at about the same time on passenger locomotives with the same objective of increasing power. The extra trailing wheels alone had been introduced a decade earlier. In this instance, the innovation appeared when there was a great demand for added hauling capacity because the railroads were being offered increased traffic, a situation that stands in contrast to the circumstances under which some of the more recent innovations have been offered. For a sample of forty major Class I companies, annual orders for the mikado during the twenty-seven years that covered its complete life cycle are estimated in Table 2, along with the year of individual company adoption.

Within the twenty-seven-year cycle for the mikado, the first eight years represented a period of adoption by the few railroads where engineers, well known as leaders with new ideas, headed the

[7] American Railway Association, Division V, *Power Brakes and Appliances*, 1932. (In 1934 the American Railway Association became the Association of American Railroads.)

[8] *Railway Age*, vol. 96, April 21, 1934, p. 579; vol. 97, November 24, 1934, p. 656.

TABLE 2

ADOPTION OF THE MIKADO TYPE LOCOMOTIVE BY FORTY MAJOR U.S. RAILROADS

	Total locomotives ordered by all U.S. railroads and industrials	*Mikados ordered by forty-company sample*	*Railroad companies of sample first ordering mikados in year*[a]	*Cumulative total of companies adopting mikados*	*Railroad companies placing last orders for mikados in year*[a]
1902	4,665	15	AT&SF	1	–
1903	3,283	–	–	1	–
1904	2,538	25	NP	2	–
1905	6,265	90	LV	3	–
1906	5,642	125	–	3	–
1907	3,482	15	–	3	–
1908	1,182	32	V, CMStP&P	5	–
1909	3,350	67	–	5	–
1910	3,787	73	CB&Q	6	–
1911	2,850	*370*[b]	P, W, E, B&O, C&O, S, ACL, MP, IC, GN, UP	17	–
1912	4,515	1,172	R, DL&W, NYC, MKT, CNW, D&RGW, CRI&P	24	V, D&RGW
1913	3,467	482	B&A, SP, C&NW	26	–
1914	1,265	339	L&N, NC&StL, SAL	29	–
1915	1,612	439	NH, CGW	31	NH
1916	2,910	630	NYC&StL	32	R
1917	2,704	661	–	32	–
1918	2,593	99	CofNJ, TP, WP	35	P, T&P
1919	214	915[c]		35	
1920	1,998	166		35	SP, UP
1921	239	29		35	
1922	2,600	1,004	StLSF	36	B&A, E, B&O, CB&Q, CMStP&P, NC&StL
1923	1,944	390		36	DL&W, LV, ACL
1924	1,413	381		36	CofNJ, NYC, W, NYC&StL, MP, IC
1925	1,055	219	FEC	37	C&O, FEC, SAL, NP, C&NW, WP, AT&SF, CRI&P
1926	1,301	166			
1927	734	55			S
1928	603	24			LN
1929	1,212	45			StLSF, GN
1930	440	–			–
Total		8,466			

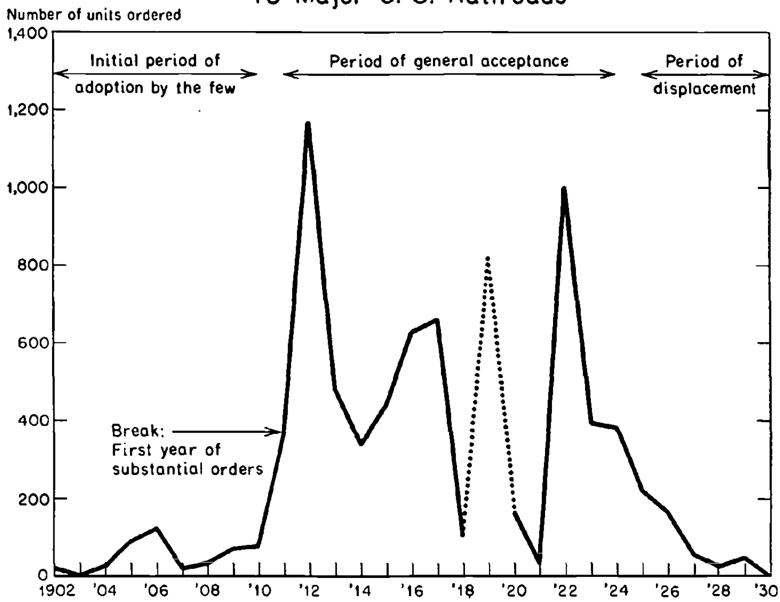
[a] Railroad companies in sample never ordering mikados: B&M, NW, StLSW.

[b] Breaking point.

[c] Federal control occurred in this year. Figure includes locomotives for other than the forty sample companies.

Source: *Railway Age*, Annual Statistical Numbers, 1903-1931. Does not include rebuilt units. *Railway Age* suggests that there may be some inaccuracies in the figures, though not sufficient to invalidate their general import. This comment should be taken to apply to subsequent use of these order data.

Chart 1
Annual Orders for Mikado Type Locomotives
40 Major U. S. Railroads



Source: Table 2.

mechanical departments or probably were important in the technical aspects of decision making.[9] Then in the tenth and eleventh years, the first being a depressed year for orders in general, the great mass of firms "caught on," eighteen out of the forty in the sample. In passing, it might be noted that even as early as the tenth year new alternative designs began to make slight inroads on the supremacy of the mikado type, though, all told, it remained a "best seller" for thirteen years. At the end of that time two new types, the mountain locomotive and the eight-driver four-wheel trailing-truck arrangement, took over.

The history of adoption of most of the new types of steam locomotives introduced from 1900 to 1915 indicates a similar period of lag between first orders for a type and the beginning of heavy capital expenditures for it. Table 3 presents the available data. The prairie type took hold most rapidly, largely because it was the

[9] Such men were Player, of the AT&SF; McHenry, of the NP and later the NH; Barr, of the CMStP; Delano, of the CBQ; and Marshall, of the LSMS (NYC). *Railroad Gazette*, vol. 31, p. 442; vol. 32, pp. 131, 195, 839; vol. 33, pp. 598, 800, 872.

locomotive that was built to increase the capacity of midwestern roads hard-pressed to keep up with rapidly increasing demands of the first decade of the century. The Santa Fe type was the slowest to gain acceptance, thirteen years elapsing before annual orders exceeded 100.

TABLE 3
ADOPTION OF ALL NEW TYPES OF STEAM LOCOMOTIVES
ALL COMPANIES, 1900-1918

	Freight			*Passenger-freight*	*Passenger*	
	Mikado 2-8-2	*Santa Fe 2-10-2*	*Mallet*	*Prairie 2-6-2*	*Pacific 4-6-2*	*Mountain 4-8-2*
Year of first order	1902	1903	1902	1900	1901	1911
Additions, U.S.:						
1902-1903	32			221	35	
1903-1904	0			38	148	
1904-1905	88	86	1	164	119	
1905-1906	56	54	–	78	216	
1906-1907	90	21	26	550	166	
1907-1908	10	–	65	194	149	
1908-1909	7	–	–	131	280	
1909-1910	81	1	108	139	*408*[a]	
1910-1911	*304*[a]	–	235	4	715	2
1911-1912	488	–	99	–	463	1
1912-1913	1,254	32	183	–	653	–
1913-1914	824	–	58	–	520	22
Orders, North American railroads:						
1913	796	–	72	–	566	24
1914	333	63	59	–	174	12
1915	562	75	120	–	102	9
1916	758	*325*[a]	218	–	278	15
1917	834	370	175	–	342	–
Orders, U.S. railroads:						
1918	915	269	145	–	79	50

[a] Breaking point.
Sources: Additions from Interstate Commerce Commission, *Statistics of Railways in the U.S.*, 1902-1914, table entitled "Detailed Classification of Locomotives," by calculation; orders from *Railway Mechanical Engineer*, vol. 91, January 1917, p. 8; vol. 92, January 1918, p. 59.

Another type of early innovation that may be used by way of further illustration is the continuous-track-circuit automatic block signal system. This had its origins as far back as 1872, with the invention of the track circuit. The next thirty-odd years saw the initial development of numerous types of accompanying signal mechanisms. The first continuous installation over a considerable length of line was started in 1890 on the Boston and Albany from Boston to Springfield. Roughly ten years later, the Pennsylvania had finished its installation from Jersey City to Philadelphia, and the Lehigh Valley had equipped its main line from Jersey City to Buffalo.[10] But by the end of 1900 there were only 2,000-odd miles of line with automatic signals.[11] Ten thousand miles had been installed by 1908, 20,000 by 1912, 40,000 by 1923, 60,000 by 1930, and by 1950, 76,000. Though the data prior to 1908 were not gathered on a consistent basis, it would appear that the first year in which anything approaching 1,000 miles of line was equipped came in 1901; 1903 accounted for almost 1,200; 1904 for something over 700.[12] The subsequent annual additions are indicated in table 4.

TABLE 4
INSTALLATION OF TRACK EQUIPPED WITH AUTOMATIC BLOCK SIGNAL

Year	*Net miles*	*Year*	*Net miles*	*Year*	*Net miles*
1905	1,300	1920	575	1935	25
1906	1,700	1921	518	1936	289
1907	*4,000*[a]	1922	1,004	1937	80
1908	1,388	1923	1,471	1938	465
1909	2,047	1924	2,302	1939	593
1910	3,474	1925	1,758	1940	436
1911	2,623	1926	3,868	1941	739
1912	1,884	1927	4,151	1942	864
1913	4,350	1928	2,872	1943	333
1914	3,298	1929	3,673	1944	603
1915	1,079	1930	2,564	1945	1,745
1916	2,012	1931	805	1946	1,620
1917	2,238	1932	–	1947	2,115
1918	1,796	1933	–	1948	1,186
1919	980	1934	–	1949	1,589

[a] Breaking point.
Sources: For years prior to 1912, *Railway Age*, vol. 72, January 7, 1933, p. 138; for 1912-1949, Interstate Commerce Commission, Bureau of Safety, *Annual Reports.*

After the first workable system was installed on the Boston and Albany about fifteen years elapsed before large-scale investment in automatic block signals was begun, in 1907, by the railroads of the United States. This innovation continued to be the basis for sub-

[10] *ibid.*, vol. 22, p. 324; vol. 33, pp. 227, 449. [11] *ibid.*, vol. 33, p. 19.
[12] *ibid.*, vol. 34, p. 88; vol. 35, p. 146; vol. 38, p. 80.

stantial further capital investment for the forty-five years to date, the depression of the 1930's and its aftermath excepted. As many new miles were equipped in the five-year period 1925-1929 as in the great spurt of adoption fifteen years earlier, in 1910-1914.

The history of company adoptions of signaling indicates that a few companies took hold initially at various stages of development and that some others, without markedly different characteristics, waited several decades before seing fit to make use of the innovation.

The causes for the lasting drawing power of this innovation lie in continually increasing emphasis on safety, higher speeds, and heavier trains, and rising unit wage rates for the operators of train-order and manual block systems, together with continued refinements of the equipment. The reasons why complete installations or universal adoption did not come about immediately lay in uncertainty as to just which was the best type and how many improvements would be forthcoming, commitment to earlier manual block systems, lack of conviction on the part of some managements that there were sufficient advantages to justify the expenditure, and lack of financial resources on the part of weaker companies. The installations up to about 1902 were made on sufficiently varying types of lines to indicate that, for managements that were favorably inclined, there was equipment available that might have warranted installation on the main lines of all companies.

The all-steel passenger train car was another innovation of the early twentieth century. It had its origins in steel underframe cars, the first steam railroad use of which appears to have come in 1893, and in rapid-transit type all-steel cars, of which 300 were built for the New York subways in 1904. Sample all-steel cars of heavy steam-railroad design were forthcoming from 1904 through 1906. The New York Central placed the first quantity orders for this type in 1906 in connection with its suburban electrification. Total construction remained at the level of several hundred a year through 1909, when 26 per cent, or just under 500, of the 1,880 cars acquired were all steel.[13] In 1910 some 2,000 all-steel cars were built, and in the three following years some 2,200, 2,100, and 1,800 respectively. In the last year, 1913, the all-steel cars represented 69 per cent of the total.

A final early example of the length and variation in investment effects of innovation is provided by the air brake. This case differs

[13] *Railway Review*, vol. 54, June 6, 1914, p. 822, by calculation.

from the previous cases in that there was strong pressure for 100 per cent adoption to obtain full advantage of the device's contributions. In just its application to freight cars, again after a considerable period of development with a maximum preliminary annual installation of 15,000 in 1884, a definitive type of train brake using compressed air was offered to the market at the end of 1887.[14] Some 28,000 of these units were supplied by the Westinghouse Airbrake Company in 1888, and 24,000 in 1889. The report of this manufacturing firm of its installations as of January 1890 indicated that three companies led in adoptions—the Atchison, Topeka and Santa Fe; Southern Pacific; and Union Pacific—each having purchased over 15,000 units. The Pennsylvania and Northern Pacific were in a second group, with some 8,000 apiece.[15] Again there were a few pioneering firms. In the middle of 1889, 52,000 of the 830,000 railroad-owned freight cars were equipped with some type of continuous air brake. Labor's interest in the safety features of these brakes in contrast to hand braking led to the passage in 1893 of federal legislation calling for complete adoption of air brakes by 1898. The history of the adoption is shown in table 5.

TABLE 5

EQUIPMENT OF FREIGHT SERVICE CARS WITH CONTINUOUS TRAIN BRAKES U.S.

Fiscal year	*Additional cars equipped (thousands)*	*Proportion equipped end of year (per cent)*	*Fiscal year*	*Additional cars equipped (thousands)*	*Proportion equipped end of year (per cent)*
1889/1890	21	9	1900/1901	151	77
1890/1891	36	12	1901/1902	153	78
1891/1892	*65*[a]	18	1902/1903	147	82
1892/1893	37	20	1903/1904	82	85
1893/1894	28	22	1904/1905	81	88
1894/1895	30	25	1905/1906	174	92
1895/1896	84	31	1906/1907	213	96
1896/1897	75	37	1907/1908	142	97
1897/1898	114	46	1908/1909	-	98
1898/1899	163	57	1909/1910	68	99
1899/1900	190	67			

[a] Breaking point.

Source: Interstate Commerce Commission, *Statistics of Railways in the U.S.*, 1889-1910, table entitled "Freight Service Cars Equipped with Train Brakes." The figures for the first four fiscal years are by calculation to include leased and fast freight-line cars.

[14] *Railroad Gazette*, vol. 22, p. 856. [15] *ibid.*, vol. 22, p. 197.

Along with the installation of the brakes, the inventory of all freight service cars was increasing rapidly from 1,014,000 at mid-1890 to 1,366,000 at mid-1900, and 2,135,000 at mid-1910. By 1900 there were as many cars equipped with the brake as there had been cars in 1890. From 1900 on, more than half of the installations of brakes represented those for new cars added to inventory. The rate of equipping old cars was maintained above the 50,000 level until 1907/1908. Annual rates of installation were obviously sensitive to the general level of economic activity. The astonishing part of it is the length of time, twenty-three years, it took to achieve universal application of an innovation with such compelling advantages and with such a low capital expenditure relative to the total amounts being spent by the railroads. The western roads were far ahead of those of the rest of the country at the beginning, with 20 per cent of their freight cars equipped against 4 per cent each for the South and East in mid-1890. By mid-1900 the proportions were 73 per cent, 70 per cent, and 63 per cent respectively.[16] The western roads had been adding freight cars to their inventories faster prior to 1890. Their longer grades may have made the continuous train brake a more valuable piece of equipment to them, though the eastern and southern roads were not without serious grade problems.

It is of interest to note that an improved type of freight brake, the K model, was introduced in 1905, before universal equipment of freight cars had been achieved. This model was to replace the type used initially to equip the country's stock of cars.[17]

Returning to the major innovations of the period particularly under consideration, 1920 to date, the four-wheel trailing-truck type of locomotive provides a more recent illustration of rates of adoption. These locomotives for freight service were the immediate successors to the mikado and its heavier running mate, the Santa Fe type, and for passenger service were the successors to the Pacific and mountain.

Through its increase of firebox capacity, the four-wheel trailing-truck locomotive offered both higher sustained speeds and more economical service for main-line trains than its predecessors. Within five years a third of the companies in the sample had adopted this type for freight service, but fifteen years elapsed before over half the companies had. In passenger service, its potential use was much

[16] ICC, *op.cit.*, 1890, 1900, tables entitled "Freight Cars in Service Equipped with Train Brakes."

[17] *Railroad Gazette*, vol. 40, p. 314.

TABLE 6
ADOPTION OF FOUR-WHEEL TRAILING-TRUCK STEAM (NON-MALLET) FREIGHT AND PASSENGER LOCOMOTIVES BY FORTY MAJOR U.S. RAILROADS

	FOUR-WHEEL TRAILING-TRUCK FREIGHT LOCOMOTIVES (NON-MALLET)			FOUR-WHEEL TRAILING-TRUCK PASSENGER LOCOMOTIVES (NON-MALLET)		
	Locomotives ordered by forty-sample companies	*Sample companies first ordering in year*	*Cumulative total of companies using*	*Units ordered*	*Sample companies first ordering in year*	*Cumulative total of companies using*
1925	35	B&A, T&P	2	–	–	–
1926	70	IC	3	37	AT&SF, NYC, NYC&StL, NP	3
1927	*104*[a]	B&M, E, C&NW, CB&Q	7	64	NYC, DL&W	5
1928	106	DL&W	8	53	CRI&P, D&RG, CN	8
1929	171	W, CRI&P, MP, CGW, AT&SF	13	*186*[a]	C&NW, CB&Q, CMStP&P, SP	12
1930	92	LV, C&O, StLSW	16	47	–	
1931	30	–	16	8	–	
1932	–	–	16	–	–	
1933	–	–	16	10	–	
1934	40	NYC&StL	17	5	LV	13
1935	–	–	17	5	C&O	14
1936	98	CMStP&P, KCS	19	127	NH	15
1937		–	19	34	ACL	16
1938	10	–	19	12	–	16
1939		–	19	15	UP	17
1940		–	19	46	NW, StLSF	19
1941		L&N, NC&StL	21	27[b]	NC&StL	20
1942	172	P, SP, WP, NP, StLSF	26	4[b]	–	20
1943	259	N&W, C&O, UP	29	10	–	20
1944	11	NYC	30	5[b]	–	20
1945	73	V, R	32	13[b]	–	20
1946	40	–	32	–	–	20
1947	–	–	32	10	–	20
1948	32	–	32	–	–	20
1949	3	–	32	3	–	20
1950	–	–	32	–	–	20

[a] Breaking point.
[b] Joint freight-passenger locomotives.
Source: *Railway Age*, Annual Statistical Numbers, 1926-1951.

more restricted and one half of the sample companies never used it. The four-wheel trailing-truck type of locomotive had sufficiently attractive advantages to create some demand during the middle thirties, when practically all of the locomotives ordered were of this type. Its second spurt came primarily for freight service to meet the traffic demands of World War II, at a time when the diesel was just beginning to be accepted.

The diesel-electric switcher carried the burden of introducing the diesel idea. The history of switcher adoption conforms to the general pattern of a long preliminary period of adoption by a few progressive or specially situated companies before general acceptance (table 7).

Many of the early orders for the diesel-electric switchers were influenced by antismoke agreements or ordinances in New York and on the lake front in Chicago that compelled electrification or dieselization, but, all told, the orders did represent the usual pattern of getting the feel of the new item, firm by firm. Not until 1935, ten years after the first commercial availability, did the companies generally begin to "take on" the diesel switcher. Then the acceptance was sufficiently broad and incentive great enough to sustain the level of orders during the 1937-1938 contraction and make the diesel switcher the one innovation among the ten under consideration able to stimulate depression-proof investment demand. By 1940 the level of orders had reached that for steam switchers in the peak years of the 1920's. In some fifteen years the innovation reached its stride in application.

In this instance the long phase of gradual adoption saw a significant shift in relative prices of steam and diesel switchers, part of the refinement process that tends to go on during this phase. In the 1920's and early 1930's diesel switchers of even the smaller horsepowers cost around $100,000, while the larger steam switchers were available for about $50,000. By 1936 and 1937 the smaller, 600-h.p. diesel cost about $65,000, the larger, 1,000-h.p. diesel nearly $100,000, and the large steam switcher $70,000. By 1948 the 1,000-h.p. diesel switcher was still available for about $100,000, but the large steam one had reached $110,000 to $120,000.[18]

The passenger diesel was built on the groundwork of the switcher, but it still took ten years after the former was first offered for half

[18] *Railway Age*, vol. 88, January 4, 1930, p. 75; vol. 90, January 3, 1931, p. 104; vol. 92, January 2, 1932, p. 41; vol. 102, January 2, 1937, p. 44; vol. 104, January 1, 1938, p. 51; vol. 126, January 6, 1949, p. 123.

TABLE 7
ADOPTION OF DIESEL-ELECTRIC SWITCHERS AND ROAD PASSENGER LOCOMOTIVES

	DIESEL-ELECTRIC SWITCHERS[a] (CLASS I LINE HAUL AND TERMINAL RAILROAD COMPANIES)			DIESEL-ELECTRIC ROAD PASSENGER UNITS		
	Number ordered by all U.S. companies	*Companies first ordering in year*	*Cumulative total of companies using*	*Units ordered[b] by all U.S. railroads*	*Companies in forty-road sample first ordering in year*	*Cumulative total of companies using*
1924	1	NYC	1			
1925	11	B&O, CofNJ, C&NW, DL&W, E, LV	7			
1926	8	GN, R, LI	10			
1927	5	–	10			
1928	2	IC	11			
1929	11	CMStP&P	12			
1930	1	–	12			
1931	5	NH, CB&Q, BT	15			
1932	–	–	15			
1933	15	–	15			
1934	21	Blt of Chi, CWI, CGW	18	3	B&O, AT&SF	2
1935	7	AT&SF, PPU	20	–	–	2
1936	52	BLE, RI, BM, CGW, MonC, BS	26	18	CB&Q, (C&NW, UP, SP),[c] CRI&P	4
1937	93	EJE, MP, P	29	20	–	4
1938	110	CEI, GTW, KCT, M&StL, GB&W	34	12	SAL, UP	6
1939	176	ACL, CofG, KCS, LN, PM, SP, TC, W, WP, Sioux, MT	45	30	FEC, ACL, MP, KCS, C&NW	11
1940	255	(Too many com-		83	IC, GN, S	14
1941	583[d]	panies to be listed)		65	NH, P, LN, CMStP&P	18
1942	434			31	B&M	19
1943	434			96	–	19
1944	(Combined road and			131	NYC, W, StLSF	22
1945	switcher models make			95	T&P, MKT	24
1946	figures no longer comparable)			245[d]	DL&W, E, NP, D&RG, WP, SP	30
1947				326	LV, NYC&StL, CGW, C&O	34
1948				211	NC&StL	35
1949				106	StLSW, R	37
1950				215	CofNJ	38

[a] Excluding electric locomotives with diesel auxiliary.
[b] A locomotive may consist of one to four units.
[c] Joint-use equipment. Individual-use orders indicated later.
[d] Breaking point.
Source: *Railway Age*, Annual Statistical Numbers, 1925-1951.

of the forty-company sample to adopt it. The war affected its adoption, and not until 1946 can it be said that the number of orders reached the stride of maximum rates of annual investment. It remains to be seen how long this phase will last.

The adoption of the freight road diesel spread faster than any other of the major innovations except air conditioning, once the inertia of those accustomed to steam was overcome. Table 8 indicates the relevant history:

In four years after its first general use, half of the forty sample roads had ordered units; in eleven years, all but four.[19] Of these four, three were roads over half of whose revenue came from hauling bituminous coal. This rapid spread can be credited basically to the diesel's superlative service and economical characteristics compared with its immediate steam predecessors. Yet it had taken twelve years to move from the first high-speed experimental road unit to a generally marketable one, with the main technical problems to be solved not being difficult. It seems to have taken the entrance of a powerful firm outside the regular locomotive-building field to overcome the inertia of builders and railroads associated with steam.

Of the remaining innovations, data with respect to orders are not compiled, but data for installation and individual-firm adoption, except in two cases, are published and are tabulated below (table 9). The difficulty of identifying streamlined alloy-steel passenger cars and differentiating them from intermediate types prevents tabulation of sufficiently reliable data for this one item.

Car retarders and centralized traffic control (C.T.C.) have been innovations that were slow to take hold, and it is not clear yet what their maximum utilization will be. Retarders were particularly sensitive to the effects of contractions in traffic volume because an individual installation represented a lump investment of millions of dollars. The recent increase in yard costs relative to road costs has added to the retarder's relative drawing power for the future. C.T.C. is unique among the ten innovations mentioned in that it may frequently be capital saving as well as labor saving since it provides increased road capacity without additional track. With growing traffic, multiple track can be avoided; and with declining traffic,

[19] It should be noted that a further refinement in diesel design came in 1948 with the road switchers that could be used in all types of service. This makes the data for specialized types of diesels not fully comparable after 1948 with those for before 1948. It appears that a few late-ordering roads may purchase just the road-switcher type and other roads may turn to it for the majority of their future orders.

TABLE 8

ADOPTION OF DIESEL-ELECTRIC ROAD FREIGHT UNITS

	Units[a] *ordered by Class I railways*	*Companies in forty-road sample first ordering in year*	*Cumulative total of companies using*
1940	8	AT&SF, GN	2
1941	171	B&O, S, SAL, CMStP&P, D&RG, WP, NH	10
1942	*419*[b]	B&M, NYC, ACL, IC, CB&Q, NP, MP	17
1943	270	E, DL&W, LV, R, CRI&P	22
1944	195	StLSW, C&NW	24
1945	323	MKT, KCS	26
1946	484	P, CGW, SP, UP	30
1947	891	StLSF, FEC	32
1948	1,085	CofNJ, LN, TP, W	36
1949	620	–	36
1950	1,492	NC&StL	37

[a] A road locomotive may consist of from two to four units, road switchers not included.

[b] Breaking point.

Source: *Railway Age*, Annual Statistical Numbers, 1941-1951.

third and second tracks can be abandoned. Yet not until thirteen years after the first adoption did this innovation blossom as a major capital item—then primarily in response to the war traffic increases. As in the case of the retarders, the future extent of installation of C.T.C. remains to be seen, but increasing unit labor costs are sure to create strong incentives for its adoption.

Air conditioning and freight brakes represent innovations with unit capital costs smaller than those of the others. In the middle 1930's air conditioning cost around $8,000 per car and freight brakes $160 for conversion and $175 per new car.[20] Air conditioning reflects competitive forces strong enough to condense the initial adoption period tremendously and, in spite of depression conditions, to push to the maximum annual rate of installation within four years of commercial availability. The AB air brake was in marked contrast. In spite of strong technical, trade association, and regulatory pressures for universal application, after six years 107 out of 192 railroad companies had no cars equipped,[21] and nine years elapsed before an annual rate of application was reached that would equip all cars

[20] *Wall Street Journal*, September 25, 1944, p. 4.

[21] *Railway Age*, vol. 106, April 15, 1939, p. 662.

in twenty years. In addition, the rate of application was very sensitive to business fluctuations.

It seems to be possible to make a few generalizations regarding the relation of innovation to investment in road and equipment. There is a considerable lag, to be measured in years, between the commercial availability of an innovation and a high rate of investment in it. Innovations of the type here considered have wide enough appeal so that most companies could find adoption desirable, yet invariably only a small group of companies make expenditures for them in the initial years of adoption. My own observation of a number of roads suggests that this is due to reluctance to give up commitments to old ways and change to new ways of doing things, and to some extent to a desire to wait and get the advantage of refinements upon the original innovation. However, there are some pioneering spirits and some upon whom special pressures for adoption can be brought, who comprise the first few purchasers. They will do the trying out, and if the innovation has something to offer the others will follow. During the years of adoption, improvements will be made and advantages that were not obvious initially will be discovered, both of which help overcome the inertia of the more conservative. It appears that for a substantial number of innovations there is likely to be a sharp break from the initial piecemeal adoption by a few odd companies, with a relatively low level of annual investment, to a subsequent high level, which begins with a large number of potential users rushing to adopt the innovation within a rather brief period. This breaking point is marked in tables for the year in which it occurred. At the breaking point, annual orders or installations treble or increase even more. This higher rate then lasts for a goodly number of years, except when war or general contraction occurs. The longest span in the cases presented has been that for continuous-track-circuit automatic signal systems, the shortest for air conditioning.

There seems to be no evidence that the timing of the appearance of the first commercial offering of an innovation is related to any particular phase of economic fluctuation. Even if there were, it would have little significance in accounting for investment variations because it has been shown that substantial amounts of investment are not made on an innovation until some years after the initial offering.

The timing of the break between the scattered, small-scale investment and the large-scale investment is presented in terms of

TABLE 9

ADOPTION OF AIR CONDITIONING, AB BRAKES, RETARDERS, AND CENTRALIZED TRAFFIC CONTROL

	1. AIR CONDITIONING		2. AB FREIGHT AIR BRAKE (FISCAL YEARS)		3. CAR RETARDERS			4. CENTRALIZED TRAFFIC CONTROL		
	Approximate number of units installed	*Approximate total of cars equipped at end of year*	*Units installed (thousands)*	*Proportion of interchange cars equipped (per cent)*	*Class yard humps equipped*	*Companies first installing in year*	*Cumulative total of companies using*	*Road miles installed*	*Companies first installing in year*	*Cumulative total of companies using*
1925					1	IHB	1			
1926					6	IC, NH	3			
1927					6	B&M, CofNJ, NYC, NW	7	40	NYC	1
1928					3	TP, LV	9	33	PM, B&M	3
1929					10	CO, C&NW, P	12	92	MP, RI, D&RG	6
1930					5	E, RFP	14	213	SP, TP	8
1931	?				2	CB&Q	15	339	B&O, W, CMSP&P	11
1932	?				–	–	15	94		11
1933	?	650			–	–	15	340		11
1934	*1,900*[a]	2,500	17		–	–	15	–	P	12
1935	3,350	5,800	15	1	–	–	15	–	–	12
1936	2,550	8,100	35	3	–	–	15	29	–	12
1937	2,100	11,168	97[a]	8	2	DL&W	17	163	CB&Q	13
1938	650	10,977[b]	79	11	2	BofC	18	73	B&A	14
1939	700	?	43	14	–	–	–	81	C&O, NW	16
1940	500	12,204	92	18	1	LN	19	216	DH	17
1941	600	12,791	143	26	–	–	19	271	E, SAL, NH	20
1942	500	13,320	194	34	4	–	19	*812*[a]	BLE, IC, LN, NKP, V	25
1943	–	13,366	120	40	–	–	19	1,030	StLSF, KCS, NC&StL, UP, NP	30

Table 9 (concluded)

	1. Air conditioning		2. AB freight air brake (fiscal years)		3. Car retarders			4. Centralized traffic control		
	Approximate number of units installed	*Approximate total of cars equipped at end of year*	*Units installed (thousands)*	*Proportion of interchange cars equipped (per cent)*	*Class yard humps equipped*	*Companies first installing in year*	*Cumulative total of companies using*	*Road miles installed*	*Companies first installing in year*	*Cumulative total of companies using*
1944	–	13,392	138	45	2	–	19	1,161	StLSW	31
1945	100	?	180	53	–	–	19	1,330	DSL, WLE, WP	34
1946	700	14,127	178	62	1	–	19	1,018	AT&SF	35
1947	700	14,861	158	70	2	B&O, UP	21	1,319	ACL, CofG, C&EI, DL&W, GM&O, S	41
1948	700	15,552	185	77	6	–	21	1,271	DM&I	42
1949	800	16,314	173	84	6	AT&SF, CRI&P, Mong, SP	25	1,008	C&NW, Clinch, Sioux	45
1950	1,000	17,360	62	89	2	S	26	1,208	PWV	46
1951					1	R	27	1,205	PLE	47

[a] Breaking point.

[b] Adjustment in count.

Sources: (1) *Railway Age*, vol. 102, February 20, 1937, p. 102; vol. 102, June 21, 1937, p. 1040 D24; vol. 104, March 5, 1938, p. 426; vol. 106, February 25, 1939, p. 349–except for approximate total of cars equipped at end of 1948, for which the source is Interstate Commerce Commission, *Statistics of Railways in the U.S.*, 1948, table 29. (2) ICC, Bureau of Safety, *Annual Report*, 1934 to date. (3) *Railway Age*, Annual Statistical Numbers, 1926-1951. (4) *ibid.*, except for mileage after 1930, for which the source is ICC, Bureau of Safety, *op.cit.*

the first year of expanded orders (or acquisition where order data are not available) in table 10. The position of this year relative to the timing of general contraction and expansion is shown also, to find if any relationships might be indicated between expanded investment in innovations and phases of business fluctuations.

Of the seventeen instances of increased rates of orders for capital expenditure two showed no clear break, ten occurred during expansion, five during contraction. In a sense it is surprising that the fifteen that showed a breaking point did not break in periods of expansion, because increased rates of investment in general are thought of as a major element of expansion. In this connection it is of interest to review the position in each phase, contraction or expansion, in which the increase of expenditure for each innovation was decided upon. It would appear that only three—that is, the freight air brake, the mountain passenger locomotive, and air conditioning—moved into high-level investment orders at the beginning of general expansion. Three—automatic signals, four-wheel trailing-truck passenger locomotives, and AB freight brakes—made the step at the end of expansions. The rates of investment orders for these three were immediately curtailed in line with the general contraction. The mikado locomotive and road passenger diesel came forward in the last year of a two-year contraction; the four-wheel trailing-truck freight locomotive in a single year of contraction. The increase in orders for Pacific type passenger locomotives and steel passenger cars occurred in the first year of a two-year contraction, and orders increased still further in the second year. The rest came in the middle years of expansion. The general impression conveyed by all this is that the influence of innovation on increasing rates of investment cannot be demonstrated as being tied to any particular phases, or parts of phases, of business fluctuation. One cannot make a case that these innovations generally led to upturns in railroad investment.

The fact that some innovations, such as the Pacific and mikado locomotives and later the four-wheel trailing-truck freight type, have worked up to a high level of investment during contractions, suggests that highly attractive innovations can break into high rates of adoption and keep up a part of capital expenditure during contraction.

It should be noted that during an expansion, increased investment for any particular type of equipment includes larger expenditures for the tried and tested older types as well as for the recent innova-

TABLE 10
TIMING OF BREAK TO MAXIMUM RATES OF INVESTMENT FOR VARIOUS INNOVATIONS

Innovation	First year of increased rate of orders	First year of increased rate of installation	POSITION OF YEAR OF INCREASED ORDERS RELATIVE TO: NBER reference cycle chronology	Span of particular phase involved
Freight air brakes	–	1891/1892[a]	Orders probably in expansion	First year of 1½ years
Automatic signal system	–	1907	Orders probably in expansion	Last of 2½ years
Pacific locomotive	1910	–	Contraction	First year of 2 years
All-steel passenger cars	1910	–	Contraction	First year of 2 years
Mikado locomotive	1911	–	Contraction	Second year of 2 years
Santa Fe locomotive	1916	–	Expansion	Second year of 3½ years
Mallet locomotive	No break	–	–	–
Mountain passenger locomotive	1922	–	Expansion	First year of 1½ years
Retarders	–	No break	–	–
Four-wheel trailing-truck freight locomotive	1927		Contraction	First year of 1 year
Four-wheel trailing-truck passenger locomotive	1929		Expansion	Last half-year
Air conditioning		1934	Expansion	Orders first year of 4½ years
AB freight air brakes		1937	Orders probably in expansion	Last year of 4½ years
Diesel switcher locomotive	1941		Expansion	Latter years of expansion
Diesel road freight locomotive	1942		Expansion	Latter years of expansion
Centralized traffic control		1942	Expansion	Latter years of expansion
Diesel road passenger locomotive	1946		Contraction	Last of 2 years

[a] Fiscal year.

Sources: Data from previous tables and text, except those for all-steel passenger cars, for which the source is *Railway Review*, vol. 54, p. 822, and mountain type passenger locomotive orders (1918, 53; 1919, 0; 1920, 44; 1921, 26; 1922, 122; 1923, 127; 1924, 52), for which the source is *Railway Age*, Annual Statistical Issues, 1919-1925.

tions. An early instance of this occurs in the locomotive orders of 1911 through 1913. In 1912 and 1913, both years of expansion, orders for the consolidation type of locomotive increased at the same time as orders for its successor, the mikado. Similarly, there were more orders for both the ten-wheel type and the Pacific in 1912 than there had been in 1911. In the case of the consolidation type,

TABLE 11
ORDERS OF SELECT TYPES OF LOCOMOTIVES
NORTH AMERICAN RAILROADS

	Consolidation	*Mikado*	*Ten-wheel*	*Pacific*
1911	577	590	238	486
1912	585	1,309	364	594
1913	823	796	255	566
1914	116	333	148	174

Source: *Railway Mechanical Engineer*, vol. 92, January 1918, p. 59.

orders reached a secondary peak greater in number than that of the mikado in the second year of the expansion, because of the fact that the new mikado type had reached its stride in orders.

In the next decade, a near peak of 1,004 orders (from forty sample companies only) for the mikado came in 1922, during the expansion of 1921-1923, when that type in turn was about to be overtaken by newly developed types. Where it is possible to differentiate clearly between the categories of new and obsolescent items, it appears that large investment in the obsolescent types may be the order of the day during expansion.

Age of Capital Inventory

Obviously, if a railroad company were totally equipped in a single year with completely new and up-to-date locomotives, cars, bridges, rails, and other necessary capital items, and if no traffic changes or innovations were expected, there would be no demand for capital equipment in the following year. A one-year average age of capital items leaves no room for investment expenditure under stable conditions. Such a situation has never occurred, but the concept suggests the possibility that the age of capital items could have something to do with variation in demand for investment expenditure. Unfortunately for ease of empirical analysis, many capital items do not have a single use throughout their life; rather, they usually start in some sort of first-class service, then are transferred to a second, and later to a third and even a lower, status. Most passenger road locomotives and cars have first been put on crack trains, then moved to other main-line services, then to secondary trains and peak-load main-line service, and finally to branch-line trains with still some use in higher grades of service during such peaks as Christmas and Labor Day. Boxcars, with few exceptions, are not tagged for particular trains, but top-condition cars are used for loading freight of exacting types and later are assigned only for rougher types of commodities, finally being used in company service. For locomotives and cars these stages have added up to thirty or forty years of service before retirement. Rail starts its life on tracks carrying fast, heavy traffic, then it is removed and placed in secondary lines, and finally finds its way to yard tracks, branch lines, or some other railroad, possibly seeing service of some sort for as long as forty or fifty years. Even the steel work of bridges has occasionally seen more than one use. Stations and grading represent items that seldom offer the possibility of reuse by railroads.

On an individual railroad it is sometimes possible to trace particular items of the capital inventory through these stages and see the effects of inventory age on particular categories of capital demand, though actual flexibility in use, vagueness of classification, and external forces of change in traffic volume, of competition, and of innovation, even in the simple case, tend to confuse the basic issue.

The history of cars and road locomotives on the New Haven Railroad illustrates what can be deduced from examination of an individual firm. Upon the introduction of the all-steel passenger car, the New Haven ordered 355 steel coaches,[22] from 1913 to 1917. The total inventory of coaches was 1,700, of which over 425 had a wood or steel underframe, having been purchased in the seven years preceding 1913; the remaining 920 were pre-1906. Thus, a little under one half of the coaches in 1917 were less than eleven years old. After the advent of the all-steel car, no other basic innovations in passenger cars appeared for some time. Thirteen years of no purchases elapsed before 100 new coaches were ordered in 1929, these being of the orthodox heavy steel construction but equipped with roller bearings. At this time there were still over 800 non-all-steel coaches on the roster. From 1934 to 1938, 200 of an early type of lightweight, air-conditioned steel coach were ordered. In 1945, 100 of the most advanced, stainless-steel-exterior type were ordered, by which time

[22] Combinations of coach with baggage or mail compartments are included. Electric suburban equipment is excluded.

the 1913-1916 steel cars were in secondary service although some had been air-conditioned. The 300 latest cars, which had an average age of about eight years by the time the last 100 were placed in operation, would appear to have satisfied the current needs of first-line service and some secondary requirements. Barring an upward change in expected traffic or in service standards, there would appear to be no immediate further demand for new passenger coaches.[23]

In the case of boxcars, the New Haven provides, for a single item, the nearest approximation to be found on any railroad of the hypothetical case mentioned at the start of this section. Due to suddenly changed external factors, the New Haven bought some 20,000 boxcars from 1902 to 1912, thus increasing its inventory nearly fourfold. Not another new boxcar was ordered for thirty years, although several thousand were rebuilt to meet changed standards.

The passenger-locomotive history of this railroad shows some possible variations of the influence of inventory age on investment. Starting the century with about 450 steam passenger locomotives, the years 1900-1907 saw 125 more of the then-standard types ordered. In 1906 two innovations made their impress on New Haven locomotive ordering: one was electrification, which accounted for the installation of forty-one passenger locomotives; the other was the two-wheel trailing truck for higher-capacity firebox and boiler design, which led to the ordering initially of forty-two additional steam locomotives. Thirty of the latter were the previously mentioned Pacific type. In 1910, two more were ordered, then fifty-six more in 1912 and 1913, and fifty in 1915, a total of 138 of this type in nine years. Not another steam passenger locomotive was purchased for twenty years, and then only ten of the new four-wheel trailing-truck type in 1936 to haul the heaviest main-line trains. The electric locomotives ordered in 1906 were confined to main-line service and were overtaken by obsolescence as passenger-train weights increased, particularly with the adoption of steel cars. Five of a new electric type, each equivalent to two of the original, were ordered in 1919, followed by twenty-two more of a larger type during the subsequent ten years.

These are examples from an individual firm's history that could be repeated many times over from the histories of other companies. But it does not necessarily follow that the age position of the stock

[23] New York, New Haven and Hartford R.R. Co., Annual Reports, 1912 to date.

of capital of the railroad industry as a whole has such an obvious influence on variations of capital expenditure. The overstocking or understocking of the individual firms might occur at such diverse times that the individual irregularities would fully balance out. Regional differences in traffic variation and profitability, varying degrees of innovation acceptance, and chance changes in managements would be factors tending toward dispersion of individual inventory positions. On the other hand, there are industry-wide influences, principally national variations in level of economic activity, requirements of war, and the most broadly attractive innovations, which would tend to make individual-firm decisions converge. The difficulty of determining the relative strength of these forces in actual practice lies in the fact that they all work simultaneously so that at no time can one or two be isolated for study. If numerical valuation of these forces were possible, multiple regression analysis could extract us from this difficulty, but attractiveness of an innovation and degree of inertia (or progressiveness) clearly defy numerical valuation.

One method of analyzing the performance of groups of companies is to take geographical aggregations of companies, so that the effects of regional variations on inventory and investment would be distinguishable. One of the few compilations of data available for industry-wide analysis that approaches completeness is for locomotives. This was first published with the 1932 statistics of the ICC in the form of a locomotive inventory for Class I railroads, classified by age of building. The following table presents a summary of historical data for acquisition of road freight locomotives, steam and electric, separated as to the three geographical divisions of the country's railroads, with at least thirty companies in each group. The periods taken are of ten-year length, except that 1930 is included with the twenties because the decisions relating to it were associated with that earlier decade.

It will be seen that the eastern railroads acquired the highest proportion of new locomotives from 1910 to 1919 inclusive, relative to rate of growth, while the West acquired the lowest. Although this might suggest that in this period the eastern railroads had overstocked and the western understocked, there was no noticeable effect on acquisition of new locomotives in the following period. The eastern group acquired the same proportion relative to its inventory as did the western, even though there was no traffic increase in the East and a 10 per cent advance in the West. Nor did

TABLE 12

ROAD FREIGHT LOCOMOTIVE INVENTORY AND BUILDING BY DECADES, 1900-1940
CLASS I RAILROADS

	Eastern	*Southern*	*Western*
Number of companies, 1932	53	33	65
Net additions, 1900-1910 inclusive (fiscal years)[a]	5,100	2,000	6,300
Ratio of additions, 1900-1910, to stock, 1905	42%	58%	52%
Change in net ton-miles, 1900-1910 (fiscal years)	+67%	+98%	+92%
Estimated built, 1910-1919 inclusive (fiscal years before, calendar years after, 1916)[b]	6,600	5,900	14,400
Proportion built, 1910-1919, to stock, 1914	39%	36%	28%
Change in net ton-miles, 1911-1919[c]	+32%	+55%	+65%
Built 1920-1930 inclusive[d]	2,841	1,728	2,451
Stock at middle of period, 1925	17,000	6,350	14,750
Proportion built, 1920-1930, to stock, 1925	17%	27%	17%
Change in net ton-miles, 1920-1929	0%	+18%	+10%
Built 1931-1940 inclusive	337	71	230
Stock at middle of period, 1935	11,800	5,100	11,200
Proportion built, 1931-1940, to stock, 1935	2.9%	1.4%	2.0%
Change in net ton-miles, 1929-1940	−21.0%	−7.0%	−16.0%

[a] The number built by districts and for Class I railroads is not available for 1900-1910, so net additions by districts, which are available, are shown as a relative gauge of building.

[b] Estimated from ownership in 1932 of locomotives built in that decade.

[c] Traffic statistics are not comparable by districts before and after 1910, so 1911 data are used for second section. Definition of districts for locomotive data somewhat differed for 1900-1910 period from that for later periods.

[d] Locomotives ordered in each successive period had substantial increases in capacity, from that of 1910-1919 to that of 1920-1930, probably over 50 per cent per unit.

Source: Interstate Commerce Commission, *Statistics of Railways in the U.S.*, particularly statement 8D, 1932, and table 17, 1940, by calculation.

the acquisitions of the prior decade, that is, 1900-1910, suggest for the Eastern roads an earlier deficient program that might have resulted in greater needs from 1910 to 1919. Southern railroad acquisitions in each of the two periods were the greatest relative to inventory, presumably due to greater average rate of traffic growth from 1900 to 1930. In the decade 1931-1940, just before the diesel entered the picture, when all districts showed traffic decreases, the South the least and the East the greatest, the southern railroad acquisitions were at the lowest rate, possibly showing excess purchases earlier. The eastern were the greatest, which did not reflect either decline in traffic or relative weakness financially. The effect of innovation in the East may have been greater with the electrification during this last period of a large section of the Pennsylvania, accounting for the acquisition of 160 electric locomotives.

If this type of analysis is carried on with shorter time periods a somewhat different view develops. The statistics for the decade of the 1920's are broken into two parts in the following table:

TABLE 13
RATIO OF ROAD FREIGHT LOCOMOTIVE ACQUISITIONS TO INVENTORY
1920-1929
(per cent)

	Eastern	*Southern*	*Western*
Proportion built, 1920-1924, to stock, 1925	10	15	11
Proportion built, 1925-1929, to stock, 1925	6	9	4

Source: Interstate Commerce Commission, *Statistics of Railways in the U.S.*, table 8D, 1932, by calculation.

The acquisitions of the first five-year period seem excessive in terms of previous experience adjusted for the declining rates of traffic growth. The much smaller purchases for all districts in the subsequent five years are significant. If the locomotive innovations in the previous section are recalled, one can guess that purchases after 1924 can be attributed largely to the advantages of new types. By the end of 1924 the stock according to the then acceptable technical standards was full, and, with no new developments, locomotive purchases might have dropped far more precipitately than they did. But it must be remembered that, particularly with respect to annual orders, other factors beside age of stock influence orders and acquisitions. The new peaks of freight traffic in several of the years in the early 1920's were an incentive to addition, and after 1922 the improved financial position of the railroads was a significant influence. But after 1926 there was no general increase in traffic. In terms of these periods shorter than decades the effect of age of stock seems more visible.

This suggests that annual acquisitions may be related to the acquisitions of a limited number of immediately previous years, these additions being representative of the first-line inventory rather than of the total. The following table shows annual acquisitions of freight locomotives by districts for all roads and the orders by districts for the earlier mentioned forty-road sample.

Among districts, there were ten district-years (for which figures are italicized) in which orders more than doubled the average of

TABLE 14

FREIGHT LOCOMOTIVE BUILDING FOR CLASS I COMPANIES AND ORDERS FOR FORTY-COMPANY SAMPLE, BY REGIONS, U.S. 1920-1929

	EAST		SOUTH		WEST		TOTAL	
	Ordered	*Built*	*Ordered*	*Built*	*Ordered*	*Built*	*Ordered*	*Built*
1920	232	166	151	97	*525*[a]	*407*[a]	908	670
1921	25	150	15	79	100	218	140	447
1922	546	252	*341*[a]	120	*499*[a]	156	1,386	528
1923	*635*[a]	*935*[a]	207	*440*[a]	206	*677*[a]	1,048	2,052
1924	221	287	229	227	159	218	609	732
1925	161	102	273	131	101	102	535	335
1926	255	245	167	*343*[a]	142	138	564	726
1927	80	142	63	37	94	130	239	309
1928	190	90	24	68	70	70	284	228
1929	245	267	10	25	253	134	508	426
Average	259	264	148	157	215	225	622	645

[a] Years in which orders more than doubled the average.

Sources: Interstate Commerce Commission, *Statistics of Railways in the U.S.*, 1932, table 8D; *Railway Age*, Annual Statistical Issues, 1921-1930, by calculation.

all the years. Surprisingly enough, these peak years were not usually followed immediately by years in which either building or orders were much out of line with the decade's annual averages. Out of the ten cases, the southern peak building of 1926 and the western peak orders of 1920 provided the two exceptions. Excepting a year like 1921, when price expectations controlled decisions, it took the cumulative effect of several years of average and extra-large acquisitions to bring about a substantially below-average year of orders—in the East, it was three years; in the South, five; and in the West, four. In the East, the number built in its series of peak years amounted to 9 per cent of the midperiod inventory; in the South, 20 per cent; and in the West, 10 per cent. It was in the South, with proportionately twice the building of the other sections, that the most drastic cut in orders followed the peak years. For groups of firms, excessive additions for a single year do not appear to have much effect on subsequent ordering, but for several cumulative years seem to be influential.

Regional comparisons are hardly profitable with respect to freight-car inventory and acquisitions. The interest of individual companies is so much influenced by the country-wide car situation because of the free interchange of cars that regional differences are not likely to be significant from the point of view of the question at hand. But it is worth testing some of the conclusions suggested by the locomotive data for car acquisitions for the country as a whole, noting certain basic differences at the start. Rebuilding has been a more general practice with cars than with locomotives. The difficulties of uniform and meaningful definition of rebuilding have prevented collection of adequate data concerning this practice, and its effect on new-car building cannot be ascertained. Innovations have not been as significant a factor in freight cars as in locomotives, though new types of traffic needs have called for the addition of new specialized forms of cars, such as automobile-box and cement-hopper cars, and there has also been pressure to install cars with larger capacity. Table 15 gives the available data on car building and orders for all United States purchasers, railroad and other, for the same ten-year period just presented for locomotives, together with the total figures of the previous decade and indices of demand for and supply of cars.

TABLE 15
ORDERS FOR AND BUILDING OF FREIGHT CARS, U.S.
(thousands of cars)

	Built	*Orders*	*Car loading*	*Car shortage or surplus*
1910-1919	1,118[a]	1,104		
1920	61	80	Highest recorded	Shortage throughout year
1921	40	23	Generally 13.5% lower	Shortage negligible
1922	66	178	Exceeded 1920 by October	Shortage started in May
1923	176	96	Up 10%	Shortage negligible by July
1924	114	147	Down 2%	100-350 surplus
1925	106	87	Up 5%	100-300 surplus
1926	84	62	New high, 6% above 1923	100-250 surplus
1927	63	73	Down 3%	120-460 surplus
1928	43	48	No change	100-450 surplus
1929	82	110	Up 2%	150-430-surplus
Average 1920-1929	89	90		

[a] First three years of decade total include Canadian cars.
Source: *Railway Age*, Annual Statistical Issues, 1921-1930.

By the middle of the decade beginning in 1920, some 2.7 million freight cars were owned in the United States. Some 41 per cent of the cars owned in 1920 had been built in the immediately preceding decade. The depreciation rates indicate an average life of something over thirty years, and inventory studies of 1945 for the 1.8 million Class I cars owned by the railroads indicated that cars were then on the average around twenty years old, with 19 per cent of cars over thirty years of age.[24] This would suggest that in recent years from one thirtieth to one fortieth of the inventory might be normal annual building with minor or no traffic growth and only gradual change in utilization of cars. The 1910-1919 period had represented substantial growth. From 1920 to 1929 there was much less growth, only 8 per cent, and gradually better utilization was obtained. In the latter period, on a thirty-year life basis, 90,000 cars a year, and on a forty-year basis, 67,500 cars would be the limits of building to maintain inventory. A thirty-five year life would give an annual need of 77,000. But here we must note that acquisitions of new cars for 1920, 1921, and 1922 were below normal and that, in the previous decade, 1918 was below with only 67,000. On the 77,000 basis, these four years produced a deficit of 74,000. However, the orders of a single year, 1922, or the building of 1923, more than made up this deficit.

These early years of the decade were years in which other factors than inventory played an important part in purchase decisions. Table 15 shows record peaks of carloadings in 1920 and again in 1923. Severe shortages started in July 1919, continued through 1920, but disappeared in the winter. Large surpluses developed in 1921 with the decline in traffic. The surpluses turned to shortages after July 1922, with traffic increasing and a shopman's strike of that month leading to a rapid rise in unserviceable cars. By July 1923 the shortages had again been worked off, and a large surplus appeared in December. Car prices had been at peak levels in 1920 (three times the prewar basis) but fell rapidly in 1921 and by February 1922 were down 40 per cent. They rose to somewhat higher levels during the rest of the year and early 1923. In 1920 the railroads had had their last year of government control with expenses exceeding revenue for much of the year. By the middle of July 1922 the two were brought into line, and net income was increasingly favorable in 1922 and 1923. For the rest of the decade shortages disappeared, large surpluses were usual, car prices were stable, and net income favorable. There were three successive years of substantially above-normal building from 1923 to 1925.

Beginning in 1926 there were three years of orders below the 77,000 level. The inventory factor was in a position to be the con-

[24] ICC, *op.cit.*, 1940, table 96; American Railway Car Institute, *op.cit.*, 1945, pp. 45-46.

trolling factor. This is again an indication that several years of overbuying are necessary before the inventory position seems to have any effect. But the following year, 1929, found orders again above any of the alternative "normal" requirements. By the end of that year, out of a total stock of about 2,640,000 cars, 32 per cent had been built within ten years and some 74 per cent within twenty years. This does not take into account the improvement of the inventory by a very substantial volume of rebuilding of still older cars. Whether the following years' decline in orders reflects this inventory position more than the falling off of traffic, profits, and credit must remain the "$64 question." The chances are that, even if these last-mentioned factors had remained favorable, the rate of orders would not have remained at 1929 levels for more than a year or so at best.

Even as recently as the years following World War II, short-run overbuying seemed to have preceded a drop in orders though other factors weighed more heavily than in the 1926-1929 period. With something under 1.8 million freight cars owned or leased by Class I railroads each year from 1940 to 1950 and assuming a thirty-five year average life, an even rate of replacement, other things equal, would be some 51,000 cars. New-freight-car acquisitions for the period 1943 to 1946 fell 61,000 short of this. But in 1947, 55,543; in 1948, 95,979; and in 1949, 80,815 cars were acquired, totaling 79,000 in excess of the rate of replacement. In the following year, 1950, only 40,000 cars were acquired. Actual orders (for all owners) had dropped from 120,163 in 1947, to 92,782 in 1948, to 6,223 in 1949. But, as in the early 1920's, inventory position did not operate alone. Beginning in November and December 1948, carloadings tapered off from 1947 levels; in the spring of 1949 they were 10 per cent below the previous year and by the last quarter more than 20 per cent. Net income for 1949 was 37 per cent less than for 1948.[25]

The earlier history of freight-car building provides an unusual opportunity for seeing if large orders in several successive years have any influence at the far end of the life span when the cars so ordered might be expected to come up for retirement. In the three years 1905 through 1907 some 650,000 cars were built, against a stock of railroad and private cars that was on the order of 1.9 million cars at the beginning of the period.[26] Some thirty years later, beginning in about 1935, the need for retiring this great block of cars might have increased the demand for new cars. In 1932 statistics

[25] American Railway Car Institute, *op.cit.*, 1950, pp. 1, 4, 24, 34, 42.
[26] *ibid.*, 1945, p. 4.

of withdrawal of old cars together with installation of newly built cars first became available, and the data are presented in table 16.

TABLE 16
FREIGHT-CAR INVENTORY CHANGES
CLASS I RAILROADS

	Withdrawn from service	*New installations*
1932	65,744	2,815
1933	109,623	1,936
1934	119,740	23,948
1935	109,534	6,987
1936	113,582	37,584
1937	81,451	69,118
1938	60,827	15,213
1939	74,229	23,236
1940	54,846	60,455
1941	26,693	76,392

Source: Interstate Commerce Commission, *Statistics of Railways in the U.S.*, 1941, table 40.

In the first half of the period covered by the table, the car ownership of the railroads was being reduced from 2.3 million to 1.8 million, the latter number being found roughly sufficient to handle even the peak requirements of World War II. The heavy withdrawals of 1933 to 1936 were not matched by new acquisitions in the same years.

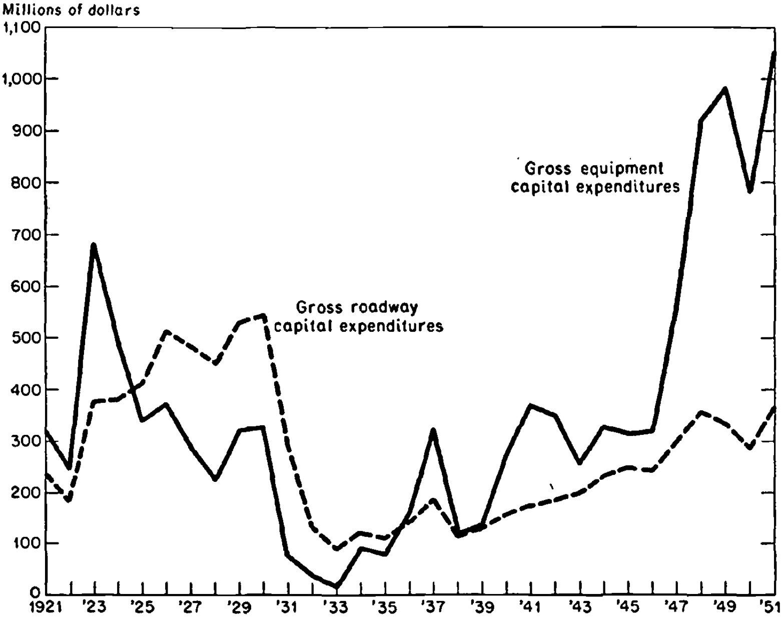
The decline in traffic in the 1930's had more to do with the volume of retirements in that decade than the coming of the end of the life span of the large group of cars acquired thirty years earlier. It is common knowledge that timing of retirement is most likely to be chosen for reasons of financial expediency and effect, rather than because of the age of the units. Also, as has been pointed out earlier, the extent of second- and third-line use is very flexible. There is a wide range within which managerial judgment can decide to rebuild, or replace with modern cars; to continue repairing, or replace with a completely new unit; to meet peak demands with very old cars, or provide new cars so that less old cars are available for peaks. The first alternatives may produce extreme contrasts; for example, one large railroad in its 1945 inventory showed 80 per cent of its hopper cars as being over thirty years old, while another showed substantially none of that age. There was little evidence of a demand for new cars commensurate with any age group calculated to come up for retirement.

By way of summary, in the case of the railroads the stock of capital goods that is involved in the greatest volume of capital expenditures in recent years, equipment, has had an average life of thirty to forty years. This inventory has, to varying degrees, felt the pressure of a succession of innovations. There have been numerous ups and downs in traffic and in financial circumstances. In addition to these variables, the possibility of rebuilding, of improving, and of expanding or contracting repairs, as well as of lower-class use makes the latter years of the life span extremely flexible in response to other influences than just the age of the capital good itself. Such effects of inventory age position as can be seen appear to originate with the status of the beginning part of the life span of the units or, to say it in another way, with the acquisitions of the immediate past few years. At times short-run traffic expectations and immediate financial considerations loom larger in investment decision making than the over-all inventory age position. At other times in the short range, inventory deficits or surfeits of recently built, modern first-line units can have a noticeable influence. From the point of view of regularization this should make the problem somewhat easier and more readily comprehended. It suggests that orders for a year or a relatively short period of years could be judged excessive in terms of some rough proportion of first-class inventory. When orders or acquisitions appear excessive in these terms they can be expected to result in a significant subsequent reduction of capital expenditure, unless very strong contrary factors, like particularly compelling innovations or a war, appear. If an effort to achieve regularization is to be made, the total orders for a year or group of years should be limited to some appropriate proportion of first-line inventory.

Differences among Particular Items of Capital Expenditure

One of the most striking things in analyzing the variations over time of railroad capital expenditures is the difference in the degree of variation among the diverse kinds of capital goods. Since statistics of orders for all roadway expenditures are not available, it is necessary to review these variations in terms of expenditure rather than orders. The first data available for gross capital expenditure item by item are for 1922, but from 1922 to 1928 inclusive, the separately itemized categories are limited in number. These data are summarized in table 17 and the following chart.

Chart 2
Annual Gross Capital Expenditures
Class I Railroads



Source: Bureau of Railway Economics, *Railroad Transportation, A Statistical Record 1911-1951.*

Virtually all the items conform to the direction of change in total expenditure between its troughs and peaks. This is true for the complete list of items through the peak of 1929-1930, the trough of 1933, the peak of 1937, the trough of 1938, the peak of 1941, and then, excluding the war years, the peak of 1948-1949 to the trough of 1950. The only significant exception was in 1950, when the number of locomotives installed was half as many again as the average of 1948-1949, while there was an 18 per cent drop in total expenditure. The exception may be accounted for by the attractiveness of the innovation of the diesel-electric locomotive.

Table 17 shows the difference among items in terms of ratios of peaks to troughs and the reverse. Due to price changes from year to year, these ratios do not indicate the absolute changes over long periods in amounts of physical units added, but the price changes as between items during the short spread of years covered in each column do not vary sufficiently to prevent comparison of one item with another by use of the ratios.

It is at once apparent from table 17 that equipment expenditures fluctuate much more widely than roadway expenditures, except for the effect of diesel-locomotive purchases in 1937 and 1950. Of the equipment items freight cars present the extreme ranges. For roadway the two pairs of items shops and engine houses, and signals and communication are the least stable, and bridges and trestles the most. Heavier rail showed the least decline in the long downturn to 1932, bridges the least in the short one of 1938. Miscellaneous items proved relatively stable among roadway items. Freight cars showed the greatest decline to 1932 and in 1938, but passenger cars fell more in the 1950 dip.

TABLE 17

RELATIONSHIPS OF TROUGHS AND PEAKS OF PARTICULAR ITEMS OF CAPITAL EXPENDITURES

(per cent)

	1933 to average 1929-1930	*1937 to 1933*	*1938 to 1937*	*1941 to 1938*	*1950 to average 1948-1949*[a]
Equipment:					
Locomotives	6	1,180	66	200	150
Freight cars	4	3,100	25	470	50
Passenger cars	6	1,700	74	170	12
Other equipment	6	800	56	250	n.a.
Total equipment	5	2,080	36	320	82
Roadway:					
Additional main track	4(1934)	100(1934)	75	170	n.a.
Yards and sidings	12	200	50	330	n.a.
Heavier rail	26(1932)	240(1932)	59	210	n.a.
Additional ballast	13	240	67	180	n.a.
Shops and engine houses	7	570	55	180	n.a.
Stations and office buildings	12	190	48	140	n.a.
Bridges and trestles	14	210	91	110	n.a.
Signals and communication	7	490	45	290	n.a.
Other roadway	21	230	56	110	n.a.
Total roadway	16	210	60	160	82
Grand total	12	1,190	44	240	82

[a] Figures for locomotives, freight cars, and passenger cars are ratios of units acquired, expenditure data not being available.

n.a.: Not available.

Sources: Two publications of the Association of American Railroads, Bureau of Railway Economics: *A Review of Railway Operations*, 1926 to date; *Railway Supplies and Capital Expenditures*, 1930, p. 20; by calculation.

The important thing in this analysis is not that there are these differences but rather what causes them. There are several technical factors that provide explanation. First, with a drop in traffic a specific part of the stock of equipment is taken out of service and becomes definitely, even visibly, surplus. For instance, by 1932 almost one fifth of the locomotives were stored in serviceable condition, and the proportion of those held awaiting repairs was half again as big as the proportion so held in 1929, making in effect a 30 per cent surplus. In 1932 the average daily surplus of freight cars was almost 700,000 or about one third of the stock. In contrast, roadway and structures are not generally taken out of service for any short-term fluctuation. If only one train is operated each day, the track, bridges, and stations are still used. There is nothing completely idle and no units are specifically surplus. Maintenance, even at greatly reduced levels, still has to be carried on; all facilities must be kept up and operating expenses associated with them must be incurred. Rails are renewed and there is still an incentive to replace with heavier types and so incur capital expenditure. There is hardly any such thing as having a surplus of heavy rail in main-line tracks. Switches still have to be thrown, and the opportunity for saving by installing spring switches, for instance, still exists.

Second, in the case of traffic peaks, equipment lacks are more critical than shortages of roadway facilities. Freight cars are a particularly sensitive item. Their lack when shippers want to load is an obvious and specific deficiency and is a signal for active protest. Serious inadequacy of supply leads to investigation by regulatory agencies and often to vigorous political activity. Inadequacy of other equipment is far less obvious publicly even though it may contribute to car shortage. With roadway, lack of capacity is publicly highlighted still less. It leads to delays, for instance, that are known to shippers and are irritating, but they create direct results less critical than inability to load freight. The tendency then is to remedy insufficiencies of facilities with a speed related to the amount of protest aroused; deficient locomotive stock is therefore subject to less pressure for quick remedy than shortage of freight cars, most types of roadway facilities to less than shortage of locomotives.

Third, there are a number of articles used in maintenance of way that in the course of repairs are almost invariably replaced by improved types. Again, in the case of main-line rail little added work is involved in replacing lighter types with heavier. Thus any rail maintenance is accompanied by complementary capital expenditure. Likewise bridges, up to the advent of the diesel, were invariably made stronger when replaced or rebuilt. In the case of freight cars and locomotives, the majority of part renewals are in kind and so involve no capital investment.

Finally, major roadway and structure projects take longer periods to complete than does the building of equipment. Once undertaken, a project is likely to be carried on to completion. This introduces a certain short-run stability to some of the larger nonequipment expenditures.

From the financial side, the factors operate somewhat differently. Since 1929 very little new financial capital has been raised by mortgage or junior securities. In contrast, equipment-trust and conditional-sales agreements have been a ready means for providing seemingly unlimited funds for equipment except during the very bottom of the 1932 trough. This has meant that capital investment for roadway is more dependent on retained profits than is that for equipment, for which companies put up no more than 20 to 25 per cent cash equity in connection with borrowing. All this has led in recent years to the possibility of greater peaks in equipment expenditure than in roadway expenditure. Whether in the future the high rate of compulsory-retirement provisions of the equipment issues may come to press hard on cash left after expenses so that even less will be left for roadway capital expenditures remains to be seen. If, however, equipment financing is not overdone in expansions its high credit standing should provide a means of facilitating equipment financing through contractions, except those of the most severe type.

Variation among Companies as to Fluctuation of Orders

Granted that innovation, overstocking, war, and other factors may have some effect upon the ups and downs of ordering, it should be valuable to know whether any firms have been able to approach regularity in their rates of ordering and whether there have been others that have concentrated orders very heavily in peak periods. Orders for freight cars are notorious for wide fluctuation, and, since reasonably reliable data are available from 1920 on, these orders make good material for analysis.

The available freight-car inventory data by five-year age groups make possible comparisons with a theoretical uniform purchasing rate. On the assumption that ownership was not changing greatly and that the usual thirty- to thirty-five-year life prevailed for the cars, it would follow that 14 to 17 per cent of cars owned at any given time should be purchased every five years to maintain a uniform rate over time. Examination of the Class I company data for 1945 back to 1915, as indicated in a 1945 inventory,[27] indicates that complete lack of, or only minimal acquisitions by, most companies for the 1931-1935 period not unexpectedly disqualifies them from even coming near to meeting any such test of regularity. The companies most nearly approaching it, however are significant. Out of some 140 (the number varies from year to year) Class I railroads, 8 stand out because their 1931-1935 acquisitions exceeded 4 per cent of inventory. Table 18 indicates the proportion of their 1945 inventory acquired in each of six previous five-year periods. The figures for periods prior to 1925 are somewhat deflated indexes of acquisition because some of the previously purchased cars had begun to be retired by 1945.

As the two averages indicate, the difference between the eight most nearly regular companies and the other Class I companies is very substantial. In both groups the excess proportion purchased in the 1921-1925 period is noticeable and would be explained by industry representatives as due to the run-down condition of the properties after World War I, increases in demand, and the desire to make good this deficiency. In the 1931-1935 period the stable group resisted the trends of the depression astonishingly well, the rest acted in full accord with the feast and famine characterization. That even 8 out of 140 companies can act so differently from the rest should deny the attitude that nothing can be done toward regularization of equipment expenditures.

The annual orders and their relationship to total domestic orders for seven of the eight companies are presented in table 19. The two periods 1916-1920 and 1941-1945 have been omitted because they were influenced by war conditions. The Gulf, Mobile and Ohio has not been tabulated because it is impossible to trace its car ownership. It is made up of several companies whose relationships were reconstituted during the period here considered.

The eight companies that have been the most regular freight-car purchasers appear to be a most diverse group. No particular scale of operation seems to be a requirement for what regularity is achieved, for the country's biggest company as well as two small ones were included. The inclusion of roads with various degrees of financial success, from one of the country's most prosperous to three that succumbed to reorganization, furnishes no evidence that financial stability is a requirement for stable purchases. It should be

[27] *ibid.*, 1945, between pp. 47 and 49. This was the earliest of the Institute's inventories considered reliable.

TABLE 18
AGE DISTRIBUTION OF 1945 CAR INVENTORY OF EIGHT MOST REGULAR PURCHASERS
(per cent)

	P *(1)*	*E* *(2)*	*NYC&StL* *(3)*	*C&O* *(4)*	*GM&O* *(5)*	*SAL* *(6)*	*CGW* *(7)*	*NP* *(8)*	*Average for eight most stable companies* *(9)*	*Average for all other Class I companies* *(10)*
PROPORTION ACQUIRED IN EACH FIVE-YEAR PERIOD										
1945-1941	4	15	29	18	16	14	14	19	11	14
1940-1936	7	9	20	18	26	12	10	13	11	12
1935-1931	4	14	9	14	7	6	52	8	8	1
1930-1926	4	22	5	16	27	34	21	8	10	20
1925-1921	9	13	29	28	21	31	–	26	16	24
1920-1916	16	17	8	5	–	–	–	4	12	15
Pre-1916	55	9	–	–	3	3	3	21		
TREND ON NUMBER OWNED, 1923-1945										
	down slightly	down 50%	down 50%	up	?	steady	down 50%	down 20%		

Sources: Cols. 1-8, American Railway Car Institute, *Car Building and Car Repairs*, 1945 between pp. 47 and 49; cols. 9-10, *ibid.*, by calculation.

TABLE 19
ANNUAL FREIGHT-CAR ORDERS OF THE SEVEN MOST REGULAR COMPANIES AND ALL COMPANIES, 1920-1940

	P	E	NYC&StL	C&O	SAL	CGW	NP	All railroad and private	Seven-road proportion of total (per cent)	NBER reference cycle chronology
	1. *Cars owned at end of year*									
1923	248,000	53,000	22,000	50,000	18,000	9,200	47,000		..	
1930	268,000	44,000	20,000	62,000	21,000	6,200	49,000	2,643,000	18	
1940	232,000	23,000	11,000	63,000	17,000	4,100	37,000	1,935,000	20	
	2. *Freight cars ordered*									
1920	–	2,000	–	2,000	–	–	300	84,000	5	Contraction
1921	–	–	–	–	–	–	–	23,000	0	Contraction
1922	–	–	1,700	5,600	2,700	500	5,800	180,000	9	Expansion
1923	–	4,000	1,500	2,000	2,000	300	–	94,000	10	Last half, contraction
1924	22,000	–	1,500	9,200	1,000	–	1,000	144,000	24	First half, contraction
1925	–	–	–	–	–	–	1,000	93,000	11	Expansion
1926	2,000	–	–	–	3,400	500	1,400	67,000	11	Expansion
1927	–	–	–	900	–	–	700	72,000	2	Contraction
1928	1,000	1,000	–	1,000	200	500	–	51,000	7	Expansion
1929	7,100	2,500	–	3,000	1,000	–	1,300	111,000	13	Last half, contraction
1930	1,700	2,350	–	6,500	2,000[a]	800	1,300	46,000	30	Contraction
1931	–	–	–	–	–	500	2,000	11,000	23	Contraction
1932	1,280	–	–	–	–	–	–	2,000	65	Contraction
1933	–	–	–	–	–	500	–	1,700	29	Expansion
1934	7,000	3,775	1,200	7,810	1,100	500	–	25,000	66	Expansion
1935	10,100	–	–	5,230	–	–[a]	–	19,000	81	Expansion
1936	–	800	777	7,400	1,125	100	1,000	71,000	16	Expansion
1937	2,800	–	1,200	75	225	200	20,200	49,000	13	Last half, contraction
1938	1,000	–[a]	–	25	–	50	–	17,000	6	First half, contraction
1939	2,500	1,500	235	2,500	900	100	1,900	54,000	18	Expansion
1940	2,456	1,525	935	1,100	750	–	2,530	65,000	17	Expansion

[a] Year entering receivership or bankruptcy.

Sources: (1) Interstate Commerce Commission, *Statistics of Railways in the U.S.*, 1923, 1930, 1940. (2) *Railway Age*, Annual Statistical Numbers, 1921-1941. The annual order data substantially agree with acquisition data upon which percentages of previous tables are based. Some of the orders for 1930, 1935, and 1940 were delivered in the following years, because those orders were placed late in the year.

noted that three of the roads—the Erie; New York, Chicago and St. Louis; and Chesapeake and Ohio—were related through Van Sweringen control to the mid-1930's. No data indicating the amount of rebuilding that may have complemented the new acquisitions have been published, though it is known that the Pennsylvania does a lot of rebuilding.

The regular group, accounting for 18 to 20 per cent of total freight cars owned, ordered less than one half of its proportion for all of the expansion years of the 1920's but one, 1924. A more detailed examination of the timing of orders in that year shows that two thirds of the orders of all seven companies came in the first half of that year during the contraction phase. In 1929, on the other hand, most of the orders fell in the expansion part of the year. But in the early contraction years of the 1930's the group always accounted for more than its share. The seven roads played an even greater role in contributing to the first years of the subsequent expansion. Beginning with the fourth year of that expansion and through the fluctuations of 1937-1938, the group fell short of its previous participation. The Chicago Great Western stands out as by all odds the most regular in its purchases. The Kansas City Southern and the Chicago Great Western were the only Class I railroads to order more than sixteen cars in 1933. Furthermore, the Chicago Great Western acted in the early 1930's against a sharply declining inventory.

An interesting side light on ordering in contractions is the degree to which the most regular companies made capital expenditures at reduced prices. The orders of that group were relatively small when prices were high in 1920. They were completely out of the market in 1921 when prices were declining, but placed most of their 1922 orders early while prices were still low. They did not fare so well in 1923. The Chesapeake and Ohio had ordered 1,500 of one type of box cars in April 1922, paying 2.7 cents a pound, f.o.b., for the base car without extras; another 870 cost 3.2 cents in May. The New York, Chicago and St. Louis ordered 1,000 of the same type in June at 3.1 cents, but by October the Chicago Great Western paid 4.0 cents for 500, and in December the Northern Pacific, 3.0 cents for 1,000. By January 1923, the Northern Pacific paid 4.1 cents for 1,000 cars, and in May the Chicago Great Western, 4.5 cents for 300. Waiting until 1924, the Pennsylvania placed its last order, one of the largest ever placed and divided among four manufacturers; this order marked a downward trend in prices.

The next interesting period in the behavior of prices began in

1930, with all but the Chicago Great Western and Northern Pacific ordering too early in the year to get the advantage of the fall price decrease. The Chicago Great Western's 300 hopper cars ordered in November were priced 10 per cent below the going prices in the 1925-1927 period. The 500 box cars ordered in November were priced at the same level, but the following order in 1931 was 30 per cent lower, and that in 1933 lower still. By 1934 the orders of the Chesapeake and Ohio; New York, Chicago and St. Louis; and Chicago Great Western were back to the precontraction price levels.[28]

Equally as interesting as the companies supporting the market during periods of contraction are those showing restrained ordering during expansion. While on a thirty-year life-expectancy basis not more than 17 per cent of the inventory should be acquired within any five-year period, a screening of Class I companies reveals only one road that did not exceed that rate in any of the five-year periods. A more liberal allowance of 22 per cent for the single period and not over 36 per cent for two adjacent periods, after 1920, shows 7 out of about 140 meeting the test. Both the Pennsylvania and the Virginia rebuilt substantial proportions of their cars during this period and so may not have full claim to membership in the group.

The smallness of this group of conservative purchasers suggests that it is as usual to overorder in good times as it is to underorder in slack times. Again rather varied types of companies appear in the group meeting the established standard, but there is more of a tendency than in the previous case for the prosperous roads to be represented. Size seems not to be influential. The fact that all of the group except the Erie had double the country-wide average (excluding the Pennsylvania) of pre-1916 cars raises a suspicion that the earlier heavy purchases may have been a factor.

It appears that even in the case of a capital item that generally has a widely fluctuating annual level of orders, such as freight cars, some companies have for significant periods been able to even out their ordering. The reasons why acquisition of freight cars is likely to vary so widely with contraction and expansion have been indicated earlier in the section. Why then should some companies act contrariwise? The biggest of the more regular companies, the Pennsylvania, has given considerably more thought to long-run planning and to taking advantage of depression prices than has the average

[28] Federal Coordinator of Transportation, Section of Car Pooling, *Freight Train Cars: Original Cost, 1920-1934*, January 22, 1935.

TABLE 20
AGE DISTRIBUTION OF 1945 CAR INVENTORY
OF SEVEN REGULAR PURCHASERS
(per cent)

	PROPORTION ACQUIRED IN EACH FIVE-YEAR PERIOD E	LV	P	V	NC&StL	MStP&SSM	UP	Average, Class I roads	Average, all Class I, except Pennsylvania
1945-1941	15	25	4	19	21	5	13	13	15
1940-1936	9	8	7	8	9	17	19	12	12
1935-1931	14	2	4	1	–	–	–	3	2
1930-1926	22	20	4	–	6	14	7	18	20
1925-1921	12	3	9	16	18	22	16	27	25
1920-1916	17	7	16	15	21	9	10	14	14
Pre-1916	9	35	55	41	26	33	35	19	13

Source: American Railway Car Institute, *Car Building and Repairs*, 1945, between pp. 47 and 49.

road. The three Van Sweringen roads with their joint consideration of equipment problems developed long-range planning attitudes. Beginning in 1929 the Chicago Great Western had as an associate, and after July 1931 as a president, a forceful former executive of the car-building industry, which may have led that road to take advantage of depression buying and to support car building.[29] But beyond these few points picked up out of a sketchy body of common knowledge about company policies, there is nothing in the record to indicate why the few companies stood out among the rest. This points up the great need for research focused on individual decision making, company by company, with a view to ascertaining what has led the few toward some evening out of capital expenditure compared with the great mass who go to the extremes.

What to Do about Regularization

When it comes to discussing possibilities of regularization in light of the factors presented in the foregoing sections, it is necessary to start with certain working assumptions. Certainly it appears that if the railroads were alone in attempting to regularize their capital expenditures there would be little hope that they could do it to a degree that would be significant for the economy as a whole. If other sectors of the economy are to be so operated that the volume of railroad freight traffic could decline 40 per cent in a couple of

[29] *Railway Age*, vol. 110, March 1, 1941, p. 110.

years as it did after 1929, or 28.5 per cent from one spring to the next as it did from 1937 to 1938, then it is hard not to be somewhat of a defeatist within the railroad industry. But without the possibility of a broader interest on the part of business leaders generally, the joint effort represented by this book could hardly have been undertaken. It is not unreasonable, therefore, to assume that other elements of the private sector of the economy are prepared to make some contribution toward the goal of regularization. Also it needs to be pointed out that government in its fiscal and monetary policy must be aiming toward the same objective, if not precisely, at least generally, in the right directions. The final assumptions are that we need not worry about minor fluctuations and that we can take for granted some tendency for things to even out as they go through the different phases of ordering, production, stocking, and delivery.

From the preliminary description of the decision-making process, it seems clear that any effective steps toward regularization must originate with the top officers of the individual firm. These officers must realize the importance of doing something about it and they must feel deeply enough about the matter to be prepared as individuals to consider, long and earnestly, jointly and separately, the possible steps to be taken in the direction of regularization. A real challenge is presented to this group of men, the top officers, in this matter, because certainly one of the strongest threats to continued private operation of railroads would be marked future irregularity. Foreign history has indicated that one of the reasons for nationalization of railroads, particularly in Central Europe, is to make use of their large capital expenditure possibilities as an anti-unemployment device in the hands of the government, and a future tendency for private management to do just the reverse might have far-reaching consequences. But for even this challenge to provide the incentive for the top officers to take the problem really seriously requires the even more basic step of changing their viewpoint from the short to the long run. As has been pointed out earlier, there are wide differences among officers or groups of top officers in the matter of long-range thinking, and the fact that some few really do take the long view gives hope that others can too. In general, however, it must be recognized that such serious projection of capital plans into the future as has been undertaken has been pointed primarily toward technical perfection of properties and not regularization.

Fortunately for the possibility of promoting regularization there is considerable latitude in the decision-making process. It is not a sheer mechanistic affair where all that the officers do is take into account the pertinent variables and come up with an unequivocal, logically determined answer. Personal attitudes do affect decisions in spite of the calculations and conclusions in capital expenditure analyses. Major decisions are frequently made on intuitive bases, probably more so than minor ones. Predilections of the top officers do point decisions one way or the other. All of this provides room for introducing regularization among the values included in the make-up of attitudes and intuition. It could even be introduced in the analyses. This is not to deny that in as tight a financial situation as existed in 1932 there were real limitations on what conscious regularization attitudes might have done. On the other hand, there would seem to have been sufficient latitude for them to have had an effect in the contraction of 1938 or 1950.

Assuming that a real interest in regularization of investment did exist, what are the practical possibilities of doing something about it? What is to be done about the cold, hard fact that the substantial dependence of capital expenditure upon the supply of internal funds places companies in the position of almost immediately curtailing such expenditure the minute weakness in the economy affects traffic volume?

There are basically two ways of circumventing this: first, one can set up in advance, when revenues and net income are good, reserve funds held in government or other readily saleable securities; or, second, one can borrow after the downturn.[30] The setting up of such reserves for future capital expenditure runs into several objections. It may be difficult to convince stockholders that this is to their advantage. They may quite rightfully want dividends high enough to make up for what they missed in the previous contractions. They may prefer to have what cash there is while it is available rather than to leave it lying around, held against uncertain future contingencies and earning low rates of interest. In general, with stock ownership as diffuse as it is in the railroad industry, this type of objection should not be too difficult for managements to deal with. Labor might provide a more serious hazard because the existence of a large cash reserve, no matter how earmarked, could easily be

[30] The effectiveness for stability of either of these operations, for the economy as a whole, would depend also upon from whom money was borrowed, to whom the securities were sold, and how in turn these others acted. For instance, if the reserves were built up by buying securities from banks it would be essential that the banks not invest in other securities so as to provide for expansion elsewhere in the economy.

looked upon as a justification for getting more wages. It is understandable, then, that there has been a tendency for managements, generally those with a real pride in adequate and up-to-date facilities, to make capital improvements with cash when it is available rather than to risk the chance of having it taken away by others and ending up with little improvement of facilities.

On the other hand, for the first time in their history, the railroads during World War II had the experience of building up very large temporary cash investments, though to a substantial extent these were intended to match increasing tax liabilities. With the increases in cash, these investments provided important funds for postwar capital expenditure. War conditions provided the opportunity to accumulate the funds and probably deterred criticism of them. The precedent might indicate the possibility of repeating the process should opportunity arise. However, the last few years have seen happen many of the things that explain why cash is likely not to find its way into such funds. The high rate of capital expenditure has taken more than all the cash that could be made available. Further, high annual borrowing on equipment obligations to provide the extra cash has built up a heavy obligation against future reservations of profits, something on the order of $200 million a year, which might otherwise have been available for a fund. They will not even be available just to keep up the rate of capital expenditure currently. Then there has been competition for cash to provide for retirement of maturing bonds without refunding. It is clear that it would take a strong interest in the possibilities of regularization to make a management try, on the financial side of things alone, to resist all the counterpressures and temptations working against reserve building.

The borrowing alternative runs into obvious difficulty. As traffic turns down, earnings decline, credit standing deteriorates, and borrowing may become difficult if not impossible. That this is not necessarily the case is indicated by the fact that in the contraction year of 1930 the railroads greatly increased their borrowing over the annual rates of the several previous years, managing to increase net funded debt in the hands of the public by over $400 million and short-turn loans by about 50 per cent, or $40 million. Bond prices remained stable until mid-1931. This alternative was not used in the 1937-1938 contraction even though it was clear that the then popular form of debt, the equipment-trust or conditional-sales agreement, could have been sold at favorable interest rates. The availability of borrowing depends in part upon the increase of debt in the prior expansion. If the resultant fixed charges and retirement requirements become high and require for servicing in the following contraction a large share of operating income, the possibility of further debt increase is greatly reduced. The recent very rapid expansion of equipment debt, carrying not only an interest but a high retirement obligation, may prove a case in point. The extent to which debt can be increased during contraction also depends upon favorable external factors, which points up the dependence of the railroads upon action conducive to regularization on the part of financial institutions, monetary authorities, and others. Despite this, the use of debt to continue capital expenditure during contractions seems more feasible than the use of reserve funds.

Separate from the financial problems related to regularized expenditure are those associated with demands for new facilities per se. What can be done to make that demand more uniform? The previous discussion of the inventory position of particular items would suggest that the individual firm could look toward distributing additions to the stock of first-line capital items more evenly over time. If, to use a concrete example, 200 freight locomotives are roughly the needed inventory for a company's first-class main-line locomotives, new replacement units should not be purchased to the full extent of the 200 within the span of just a few years. To suggest this flies in the face of two obviously strong motives for acting to the contrary. First, the large number of added locomotives may appear to be needed to handle anticipated additional business. But since the days of rapid growth of railroad traffic in the early part of the century, increments to traffic relative to total inventory have not been so great as to call for additions of over 10 per cent[31] of the first-class segments of the inventory within a few years. This is said with the fact in mind that there is a large body of second- and third-class inventory that can be called upon and temporarily upgraded for operations from which it had previously been withdrawn. This is not an altogether unusual practice, but to use it as an accepted expedient for the purpose of stabilizing new locomotive purchases does require a new point of view, though not an impossible one if top management takes seriously its long-run responsibility.

If such a policy were followed, some real protection would be

[31] This may not be the exact limit, but at whatever reasonable level it is set, it is far below what has frequently been the practice, instances of 50 per cent or more not being uncommon.

needed against governmental intervention, against administrative regulatory bodies, and, more particularly, against political pressures of the legislative branch. This protection is needed because the users of railroad service may raise trouble over shortages, possibly less than up-to-the-minute levels of equipment, and something less than the best possible service even when these conditions are temporary. As has been indicated earlier, it has been the public's prerogative to protest against inadequacies and to expect governmental response by way of investigation, new laws, and administrative orders. Top management has quite naturally become highly sensitive to this pattern of criticism and has understandingly tended to go all out to avoid being caught in a position that might arouse it. Management must be given some degree of grace if it is to seek more regular acquisitions.

The second strong motive for all-out ordering might arise with the desire to take complete advantage of an innovation. It has been shown that there is usually no industry-wide agreement on just when an innovation becomes advantageous, but the tendency of the majority to decide in its favor more or less at the same time tends to make capital acquisitions of new types of items a problem. The history of the freight locomotive also demonstrates that once a given company decides the new type is advantageous there is an urge to order enough to restock the whole, or a large share, of first-class inventory. From the short-run point of view this is logical, for, if the new type produces favorable unit savings, the more locomotives installed the greater the total savings. Restocking also permits the economies of a minimum number of types of equipment for which to keep repair stocks and train maintenance crews, and it makes possible lower prices when large quantities are ordered. The other side is not so obvious: if, as has happened continuously through the history of railroading, innovations are appearing all the time, the company cannot without high cost keep itself supplied with the latest if it has just put its all into one particular vintage. Histories of individual companies are replete with examples of being caught this way. Some have had sufficient financial resources to buy themselves out, less opulent ones have had to live a decade or more with their particular choice. The history of locomotive orders in 1922 and 1923 bears this out. These years were the tail end of the life cycle of the mikado type. One medium-sized road ordered 100 mikados in a single order in 1922 after having acquired some 200 in the previous ten years. Not another freight locomotive was ordered in thirteen years. Being financially pressed, that road could not afford to forget its 1922 commitment. Had it ordered 25 instead of 100, five years later it might well have purchased some of the subsequent innovations to its real advantage. As it was, it could not begin to get their benefits until 1936. In another instance a large system ordered some 300 mikados from 1922 to 1924 after having acquired almost that many in the previous six years. Being prosperous it could afford a year later, in 1925, to order 100 of a new type replacing the mikados, but it was at a heavy cost. The tendency for these large orders to be made late in the cycle of adoption of an innovation results in not getting the maximum years of its advantages and, except at substantial extra cost, not being prepared to take early advantage of the next innovation. Thus the idea that large orders enable companies to get maximum advantage from innovations is in fact frequently belied. The orders often come long after the innovations are first available and sometimes even after the succeeding innovations are at hand. Furthermore, if a mistake in judgment of new developments is made with a big order it is an inordinately costly mistake, scarcely compensated for by the lower equipment prices because of the size of the order. Even this latter economy may be largely illusory if the large order, as so frequently is the case, is placed at a time when everybody else is making large acquisitions and manufacturers' capacity is overtaxed. Lower prices even on smaller orders would be more likely when the manufacturers are hungry for business. And more recently, with increasing standardization of equipment, the economy of manufacturing for large individual company orders is diminishing. But, again, whether caution is applied toward overstocking to meet sudden traffic demands and whether full advantage is taken of innovations and price fluctuations depend upon having a long-range view at the decision-making level of management.

It seems clear that there are possibilities for regularization and that there are also serious obstacles. It is equally clear that there is considerable latitude within which the decision-making railroad officers can work toward regularization. The critical point is how to spread the gospel—how to get them to make the most of that latitude. Some enthusiastic and persuasive officers could do much. Leaders in the Association of American Railroads and the railroad executive associations could effectively help the cause. The disquieting thing is that it appears easier among these groups to enlist effort to criticize the trucking industry or labor conditions than to consider any such long-range problem as regularization of capital expenditure. This is not to suggest that the former do not need serious consideration, but it should not be to the exclusion of equally earnest study of, and real action on, the regularization problem. It is even likely that the attitude of long-range thinking, which this would engender, would lead to more successful solutions of the truck and labor problems. Finally, a real interest in regularization would in all likelihood develop even greater latitude than there now appears to be within which to operate for regularity.