THE IMPACT OF TECHNOLOGY ON EMPLOYMENT IN THE RAILROAD INDUSTRY

by

CLAUDE RICKARD NEILL

B. A., Friends University, 1967

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1970

Approved by:

Elgin S. Bagley

Major Professor

TABLE OF CONTENTS

THIS BOOK CONTAINS NUMEROUS PAGES WITH THE ORIGINAL PRINTING ON THE PAGE CROOKED THIS IS THE BEST IMAGE AVAILABLE

LIST OF TABLES

INTRODUCTION

On May 10, 1869, the East and West was linked by rail at Promontory Sumit, Utah. The success was due mainly to human muscle and endurance. Those who laid the first transcontinental railroad used tools that are crude when compared with modern machinery. Looking back, it becomes apparent that many technological advances have been made since that historic day. At the same time, the position of the railroads within the transportation industry has shifted. Many of the more significant changes have occurred in the last twenty to twenty-five years, and the result is a decreasing demand for railway labor.

PURPOSE AND METHOD

C. Glyn Williams, Assistant Professor of Economics, Indiana University, estimates, "Upwards of 80 percent of railroad employment decline in this period (1946-1963) was brought about by technological change."[1] The purpose of this paper is to review the effects of technological advancement on employment in the railroad industry, and it will endeavor to support the claim that technology has been the most important cause of employment declines. The paper is limited to a discussion of technological advances and their influence on industry-wide employment and productivity.

---

[1]C. Glyn Williams, "Changes in the Skill Mix and Their Effect on the Railroad Industry's Wage Level," Industrial and Labor Relations Review, Vol. 20, No. 1 (October, 1966), 89.

The time period considered is 1947 to the present; however, most statistics are available only through 1968. Due to the abnormal situation existing during World War II, 1947 was arbitrarily chosen as the base year. Also, most of the major changes that will be discussed in this report were initiated during the postwar period. Most of the productivity figures presented were calculated by the writer from the original sources. This was necessary because productivity statistics were not readily available, and when found, were usually not comparable because of different measuring techniques. The technique used in developing the productivity indicators was modified from one found in a paper by Richard J. Barber, Associate Professor of Law, Southern Methodist University.[2]

Unless otherwise noted, all of the data presented is for Class I Railroads in the United States. Effective January 1, 1965, the Interstate Commerce Commission defined Class I Railroads as those having annual operating revenues of more than $5,000,000. Even though the definition of Class I has been revised periodically, the Association of American Railroads (AAR) states, "These differences in classification do not affect significantly the comparability of statistics from year to year."[3]

---

[2]Richard J. Barber, "Technological Change in American Transportation: The Role of Government Action," Virginia Law Review, Vol. 50, No. 5 (June, 1964), 824-826.

[3]Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition (Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1970), 3.

INDUSTRY TRENDS

The railroad industry is changing; it is no longer a monopoly. Its share of intercity passenger traffic has been cut to about 1% by automobiles, buses and airplanes. The rails' share of intercity passenger traffic was over 75% in 1944[4] and about 85% in 1920. In 1920, the railroad's share of intercity freight traffic was 84%; now it is about 40%. Even though the share of freight decreased, the volume of freight has increased.[5] Consequently, if the state of technology were the same today as twenty-five years ago, the impact on railway employment resulting from changes in the transportation industry would probably be minor. This takes into account passenger service declines because passenger service is such a small portion of the overall service offered by the railroads.

However, the impact has not been minor. In 1947, Class I railroads employed an average of 1,351,961 persons. In 1969, the figure was 578,302, which is the lowest number during this century. Since 1951, employment has declined annually and has reached a cumulative decrease of 57% since 1947. Wage and salary outlays have not kept pace with declining employment.

---

[4]Thomas M. Goodfellow, Background on Passenger Train Service Pertinent to Hearings of Subcommittee on Surface Transportation of the Senate Commerce Committee, Sept. 23-25, 1969 (Washington, D.C.: Association of American Railroads, Public Relations Department, 1969).

[5]Dudley F. Pegrum, Transportation: Economics and Public Policy (Homewood, Illinois: Richard D. Irwin, Inc., 1963), 31.

In 1951, the total payroll was $5,336,198,000. In 1969, it was $5,362,757,000.[6]

Table 1 shows that the weighted output per man-hour has increased at an average annual rate of 8.9%. To determine the weight output, revenue freight-ton miles and revenue passenger-miles are weighted by the ratio of total average revenue per ton-mile to total average revenue per passenger-mile for the period, 1947 to 1969. In this case, revenue freight-ton miles is multiplied by one, and revenue passenger-miles is multiplied by 2.13 (30.95 to 66.06 = 1 to 2.13), and the results for each year are summed to give the weighted output for that year. Then 1947 is used as the base year, and the weighted output for each year is converted to an index number. The index number is divided by the man-hours index to determine the index of output per man-hour. The average annual change in output per man-hour is calculated by dividing the index of output per man-hour by the number of years since 1947.

Since the transportation services supplied by the railroads are not homogeneous, a weighted output index is necessary to determine a meaningful productivity figure. Harold Barger, Columbia University, presents the rationale for an index similar to the one used in this paper. Barger states:

> The use of market values, or prices, as weights in computing the output index was suggested above primarily as a means of avoiding the need for arbitrary decisions.

---

[6]Association of American Railroads, 78-80.

Table 1

OUTPUT, EMPLOYMENT, PRODUCTIVITY, 1947-1969

Year	(1) Revenue Freight Ton-Miles (billions)	(2) Average Revenue Per Ton-Mile (dollars)	(3) Revenue Passenger-Miles (billions)	(4) Average Revenue Per Passenger-Mile (dollars)
1969	768[g]	1.35[g]	12[g]	3.60[g]
1968	744	1.31	13	3.39
1967	719	1.27	15	3.20
1966	738	1.26	17	3.18
1965	698	1.27	17	3.18
1964	659[h]	1.28[h]	18[h]	3.17[h]
1963	622	1.31	18	3.18
1962	593	1.35	20	3.11
1961	563	1.37	20	3.08
1960	572	1.40	21	3.01
1959	576	1.45	22	2.95
1958	552	1.46	23	2.90
1957	618	1.45	26	2.84
1956	647	1.38	28	2.68
1955	624	1.37	29	2.60
1954	549	1.42	29	2.62
1953	606	1.48	32	2.66
1952	615	1.43	34	2.66
1951	647	1.34	35	2.60
1950	589	1.33	32	2.56
1949	527	1.34	35	2.45
1948	638	1.25	41	2.34
1947	655	1.08	46	2.10
Total		30.95		66.06

[g]Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition (Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1970), 35, 37, 39, 40, 78.

[h]Association of American Railroads, Railroad Transportation, A Statistical Record, 1921-1963 (Washington, D.C.: Association of American Railroads, Bureau of Railway Economics, 1965), 22, 24, 28, 29.

Table 1--Continued

Year	(5) Weighted Output Index[a] (1947=100)	(6) Employment[b]	(7) Index of Employment[d] (1947=100)	(8) Man-hours[c] (millions)
1969	105	578,302[g] [1]	43	f[1]
1968	103	590,536	44	1,201
1967	100	610,191	45	1,225
1966	103	630,895	47	1,295
1965	97	639,961	47	1,320
1964	93	665,034	49	1,385
1963	88	680,039	50	1,399
1962	84	700,146	52	1,430
1961	80	717,543	53	1,453
1960	82	780,494	58	1,587
1959	83	815,474	60	1,669
1958	80	840,575	62	1,712
1957	89	986,001	73	2,019
1956	94	1,042,664	77	2,161
1955	91	1,058,216	78	2,203
1954	81	1,064,705	79	2,178
1953	90	1,206,312	89	2,510
1952	91	1,226,663	91	2,577
1951	96	1,276,000	94	2,709
1950	87	1,220,784	90	2,614
1949	80	1,191,444	88	2,743
1948	96	1,326,906	98	3,253
1947	100	1,351,961	100	3,323

[a]The weighted output is derived by determining the ratio between the totals of columns 2 and 4. The ratio is 1:2.13. Each figure in column 1 is multiplied by 1, and the figures in column 3 are multiplied by 2.13. The weighted output figures for freight and passenger service are added for each year and expressed in column 5 as an index with 1947=100.

[b]Average number of employees during the year.

[c]Man-hours represents a total of "straight time actually worked" plus "overtime hours paid for." The latter includes pay for some hours not actually worked. Where source gives only figures for "days," each day is multiplied by eight to give hours worked.

[d]Calculated from data in relevant preceding column.

[f]Necessary detailed man-hour data for 1969 are not available.

[1]Interstate Commerce Commission, Wage Statistics for Class I Railroads in the United States, Prepared by the Bureau of Accounts, Statement No. A-300 (formerly M-300), Calender Years 1947-1968.

Table 1--Continued

Year	(9) Index of Man-hour[d] (1947=100)	(10) Index of Output Per Man-hour[e] (1947=100)	(11) Average Annual Change in Output Per Man-hour (1947-1969)
1969			
1968	36	286	8.9
1967	37	270	8.5
1966	39	264	8.6
1965	40	243	7.9
1964	42	221	7.1
1963	42	211	6.9
1962	43	195	6.3
1961	44	182	5.9
1960	48	172	5.5
1959	50	166	5.5
1958	52	154	4.9
1957	61	146	4.6
1956	65	145	5.0
1955	66	138	4.8
1954	66	123	3.3
1953	76	118	3.0
1952	78	117	3.4
1951	82	117	4.3
1950	79	110	3.3
1949	83	96	-2.0
1948	98	98	-2.0
1947	100	100	

[e]Column 5 divided by column 9.

> Since the market regards a dollar's worth of apples and a dollar's worth of oranges as equivalent or interchangeable, therefore—so the argument ran—we may regard them as equal physical quantities. What this leads to in practice is the aggregation of dollar volumes of different commodities at fixed prices per ton, per yard, or other commercial unit. By this procedure, the universal measure of physical output, applicable to all commodities without exception, becomes the dollar's worth—measured at the base date or over the base period.[7]

Barger's method differs from the one used because it weights the output by the prices during the base period. In this paper the weights are influenced by the price during every year under consideration.

Credit for the 8.9% average annual productivity increase cannot be attributed to any single invention or event, but some technological advances are more important than others. Note again that technology cannot be given all the credit for the gains. Some of the increase is probably the benefit of using old equipment more efficiently, work-rule changes and novel marketing schemes. The remainder of this report is devoted to an examination of some of the major technological advances and the changing productivity of several groups of railway labor.

DIESELIZATION

The most important technological advancement in the railroad industry is the diesel-electric locomotive. Its influence

---

[7]Harold Barger, "Appendix A—On the Measurement of the Physical Output of Public Utilities," The Transportation Industries, 1889-1946, A Study of Output, Employment, and Productivity (New York: National Bureau of Economic Research, Inc., 1951), 171.

is far-reaching and not yet fully felt. The conversion from steam to diesel-electric tractive power was no accident. It occurred because the diesel unit is by far the most economical to operate. Smaller crews are possible. Maintenance and fuel costs are less. Track maintenance costs are also less because diesel-electric locomotives are not as hard on the tracks. Longer, heavier loads can be pulled faster and with fewer locomotive units. These changes have in turn promoted technological advancements in the areas of track construction and maintenance, shop maintenance procedures, traffic control and the rolling stock itself.

On December 31, 1947, there were 41,719 locomotives in service. Of that total 5,772 were diesel-electric units, 35,108 were steam, 821 were electric and 18 were classified as "other". At the end of 1969, there were only an estimated 27,040 locomotives in service. Twenty-one were steam, 26,722 were diesel-electric, 276 were electric and twenty-one were classified as "other".[8] "Other" locomotives include diesel-hydraulic units, which are used successfully in West Germany and Great Britain.[9] Table 2 shows the number of locomotive units in service on December 31, 1947, 1951, 1955-1969. The ICC defines the term "unit" as "the least number wheel bases together with super-

---

[8]Association of American Railroads, 68.

[9]Ray McBrian, "New Motive Power Technology," Technological Change and the Future of the Railways, Selected papers presented at a three-day conference conducted by the Transportation Center, Northwestern University (Evanston, Illinois: Northwestern University, 1961), 211.

Table 2

LOCOMOTIVES IN SERVICE, DECEMBER 31, 1947, 1951, 1955-1969[a]

December 31	Total	Diesel-electric Units	Steam	Electric Units	Other
1969	27,040	26,722	21	276	21
1968	27,376	27,017	21	305	33
1967	27,687	27,309	21	321	36
1966	27,886	27,481	25	344	36
1965	27,816	27,389	29	362	36
1964	28,300	27,837	34	393	36
1963	28,449	27,945	36	429	39
1962	28,639	28,104	51	434	50
1961	28,815	28,169	112	478	56
1960	29,080	28,278	261	492	49
1959	28,493	28,163	754	539	37
1958	29,513	27,575	1,350	556	32
1957	30,248	27,186	2,447	585	30
1956	30,433	26,081	3,714	606	32
1955	31,429	24,786	5,982	627	34
1951	40,036	17,493	21,747	780	16
1947	41,719	5,772	35,108	821	18

[a]Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition, 68.

structures capable of independent propulsion, but not necessarily equipped with an independent control."[10]

Before the diesel-electric locomotive, a definition of "unit" was not necessary because even if the units were combined, each unit still required a crew to operate it. Diesel units can be combined and operated with a single crew. This means that

[10]Interstate Commerce Commission, Statistics of Railways in the United States for the Year Ended December 31, 1952, Prepared by the Bureau of Transport Economics and Statistics (Washington: United States Government Printing Office, 1955), 13.

the same manpower can move longer, heavier trains. The Report of the Presidential Railroad Commission states, "Potentially, diesel power meant that a single crew could handle a 300-car train, whereas previously, it might have taken four crews to handle four 75-car trains."[11]

Dieselization also precipitated certain changes in the "anatomy" of the freight train. Due to the increased tractive power of diesel locomotives, the average freight train load has increased about 50% in the last twenty years. The average number of cars in a freight train increased from 52.2 in 1947 to 70.0 in 1969. Although the total number of freight cars has been decreasing, the total capacity of all the cars has been increasing. In 1947, the average freight car capacity was 51.5 tons. In 1969, the capacity was estimated to be 65.6 tons. The average speed of freight trains was 16.0 miles per hour in 1947; in 1969, it was 20.1 miles per hour.[12]

Motive power technological change did not end with the process of dieselization. The original diesel-electric locomotives were 1200 to 1500 hp. Second generation diesels are now replacing the original ones. Several years ago, units of 3000 to 3600 hp. were considered large. Today the large diesels produce 5000 to 6600 hp., and it is not unreasonable to expect

---

[11]U.S. Presidential Railroad Commission, Report of the Presidential Railroad Commission (Washington, D.C.: U.S. Government Printing Office, 1962), 69.

[12]Association of American Railroads, 49-52, 66.

8000 hp. locomotives in the future. The large locomotives can pull longer, heavier loads and require less maintenance. It is estimated that 14,500 new diesels could replace 30,000 of the old units and still handle the same volume of traffic.[13] The biggest locomotives in the world are owned by the Union Pacific. In 1969, it took delivery on the first of twenty-five 6600 hp. units. UP's new locomotives have been built so that a complete overhaul can be made in twenty-four hours, and they will be capable of going 1,400 miles between service stops. The UP found that it costs $7,000 a year to service any locomotive. Therefore, if fewer units can be used while maintaining the same capacity, total expenses will be less.[14] Although not all roads are purchasing the giant locomotives, the trend is to fewer diesel units with increased tractive power. Table 3 shows the trends in diesel-electric tractive power. If the average tractive effort were the same in 1967 as in 1947, 31,490 units would be required instead of 27,309 to make up the same total tractive effort. This is an increase of almost 15% over the level in 1967.

From 1947 to 1969, train and engine employment decreased 43%. The largest portion of this decrease resulted from fewer job assignments, and fewer job assignments were the result of

---

[13] U.S. Bureau of Labor Statistics, "Railroads," Technological Trends in Major American Industries, Bulletin No. 1474 (Washington, D.C.: U.S. Department of Labor, 1966), 197.

[14] Tom Shedd, "Three-fourths of a Billion for New Equipment," Modern Railroads, Vol. 24, No. 5 (May, 1969), 91-92.

Table 3

DIESEL-ELECTRIC LOCOMOTIVES: NUMBER AND TRACTIVE EFFORT

December 31	(1) Number	(2) Total Tractive Effort (thousands)	(3) Average Tractive Effort[a] (pounds)
1969	26,722[b]	[c]	
1968	27,017[d]	48,380,077 hp.[d]	
1967	27,309	1,779,965	65,883
1966	27,481	1,748,077	63,610
1965	27,389	1,725,079	62,984
1964	27,837	1,731,471	62,200
1963	27,945	1,716,139	61,426
1962	28,104[e]	1,723,424[e]	61,323
1961	28,169	1,741,656	61,829
1960	28,278	1,728,407	61,122
1959	28,163	1,715,445	60,911
1958	27,575	1,670,849	60,593
1957	27,186	1,644,176	60,479
1956	26,081	1,577,620	60,489
1955	24,786	1,488,694	60,062
1954	23,531	1,404,606	59,692
1953	22,503	1,336,529	59,393
1952	20,492	1,207,349	58,918
1951	17,493	1,018,119	58,202
1950	14,047	807,523	57,487
1949	10,888	617,506	56,714
1948	8,089	455,287	56,285
1947	5,722	326,255	56,524

[a]Column 1 divided by column 2.

[b]Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition, 68.

[c]Not available.

[d]Interstate Commerce Commission, Transport Statistics in the United States for the Years Ended December 31, 1957, 1962 Part 1, Railroads, Prepared by the Bureau of Accounts (Washington, D.C.: United States Government Printing Office), Table 16.

[e]Interstate Commerce Commission, Transport Statistics in the United States for the Years Ended December 31, 1962-1968, Tables 18, 163.

fewer freight and passenger trains. Even though traffic volume increased, the number of freights decreased because of the increased load pulling capacity of diesel locomotives. The number of passenger trains decreased because of declining demand. In considering the productivity increase of train and engine employees, a comparison of a physical output index with the weighted output index is useful. This should help overcome the possibility of drawing false conclusions from a single set of statistics. Gross ton-miles in road services, excluding locomotives and tenders, were selected for the physical output index. Table 4 reveals that the average annual output per man-hour increased 5.2% when based on the weighted output index. Table 5 shows that the increase was 5.7% when based on gross-ton miles.

CONSIST OF CREWS ISSUE[15]

If job assignment reductions were the only problems faced by operating employees,[16] adjustment to dieselization would have been much smoother. The diesel-electric locomotive can be operated by an engineer, whereas the steam locomotive required an engineer and a fireman-helper. By the middle of the 1950's,

---

[15]"Consist of Crews" is defined as the composition of the crew. (U.S. Presidential Railroad Commission, 23.)

[16]"Operating employees," typically work either in engine service, as engineers, firemen-helpers, or hostlers and hostler helpers (the latter group moves locomotives to and from roundhouses and ready tracks); or in train service, as conductors, brakemen, baggagemen and switchtenders. (U.S. Presidential Railroad Commission, 26.)

Table 4

WEIGHTED OUTPUT INDEX, TRAIN AND ENGINE EMPLOYMENT, PRODUCTIVITY, 1947-1969

Year	(1) Weighted Output Index[a] (1947=100)	(2) Employment	(3) Index of Employment[b] (1947=100)	(4) Man-hours[c] (millions)
1969	105	166,298[e]	57	[f]
1968	103	165,446[g]	57	333[g]
1967	100	167,532	58	333
1966	103	170,707	59	348
1965	97	171,411	59	350
1964	93	179,975	62	371
1963	88	185,788	64	378
1962	84	187,979	65	376
1961	80	187,847	65	373
1960	82	199,522	69	398
1959	83	204,166	70	410
1958	80	206,219	71	410
1957	89	233,075	80	472
1956	94	242,068	83	503
1955	91	235,541	81	501
1954	81	230,729	80	472
1953	90	251,487	87	532
1952	91	255,009	88	552
1951	96	263,921	91	591
1950	87	252,056	87	575
1949	80	251,250	87	557
1948	96	282,179	97	663
1947	100	290,020	100	686

[a]Taken from Table 1, column 5.

[b]Calculated from data in relevant preceding column.

[c]Man-hours represents a total of "straight time actually worked" plus "overtime hours paid for." The latter includes pay for some hours not actually worked.

[e]Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition, 82.

[f]Not available.

[g]Interstate Commerce Commission, Wage Statistics of Class 1 Railroads in the United States.

Table 4--Continued

Year	(5) Index of Man-hours[b] (1947=100)	(6) Index of Output Per Man-hour[d] (1947=100)	(7) Average Annual Change in Output Per Man-hour (1947-1968)
1969			
1968	49	210	5.2
1967	49	204	5.2
1966	51	202	5.4
1965	51	190	5.0
1964	54	172	4.2
1963	55	160	3.8
1962	55	153	3.5
1961	54	148	3.4
1960	58	141	3.2
1959	60	139	3.3
1958	60	133	3.0
1957	69	129	2.9
1956	73	129	3.2
1955	73	125	3.1
1954	69	117	2.4
1953	78	115	2.5
1952	80	114	2.8
1951	86	112	3.0
1950	84	105	1.7
1949	81	99	- .5
1948	97	99	-1.0
1947	100	100	

[d]Column 1 divided by column 5.

Table 5

GROSS TON-MILES (EXCLUDING LOCOMOTIVES AND TENDERS), TRAIN AND ENGINE EMPLOYMENT MAN-HOUR INDEX, PRODUCTIVITY, 1947-1968

Year	Gross Ton-miles in Road Service (millions)	Index of Gross Ton-miles[a] (1947=100)	Index of Man-hours[b] (1947=100)	Index of Output Per Man-hour[c] (1947=100)	Average Annual Change in Output Per Man-hour (1947-1968)
1968	1,884[d]	108	49	220	5.7
1967	1,866	107	49	218	5.9
1966	1,913	110	51	216	6.1
1965	1,836	106	51	208	6.0
1964	1,784	103	54	191	5.4
1963	1,721[e]	99	55	180	5.0
1962	1,460	84	55	153	3.5
1961	1,413	81	54	150	3.6
1960	1,450	83	58	143	3.3
1959	1,468	84	60	140	3.3
1958	1,433	82	60	137	3.4
1957	1,587	91	69	132	3.2
1956	1,654	95	73	130	3.3
1955	1,625	93	73	127	3.4
1954	1,497	86	69	125	3.6
1953	1,621	93	78	119	3.2
1952	1,643	94	80	118	3.6
1951	1,681	97	86	113	3.3
1950	1,588	91	84	108	2.7
1949	1,487	85	81	105	2.5
1948	1,701	98	97	101	1.0
1947	1,740	100	100	100	

[a]Calculated from relevant data in preceding column.

[b]Taken from Table 4, column 5.

[c]Column 2 divided by column 3.

[d]Interstate Commerce Commission, <u>Transport Statistics in the United States for the Years Ended December 31, 1957, 1962</u>, Table 43.

[e]Interstate Commerce Commission, <u>Transport Statistics in the United States for the Years Ended December 31, 1963-1968</u>, Table 162.

dieselization was all but complete. Tractive power technological efficiency had been achieved, but a massive problem of manpower inefficiency had developed because of the unions' refusal to allow job reductions.[17] The firemen-helper issue has been discussed for twenty-years, and at the present time labor and management are still trying to resolve it. In 1963, compulsory arbitration under Public Law No. 88-108 allowed the carriers to eliminate 18,000 firemen jobs (between 1959 and 1967), and everyone thought the problem was solved. However, when the law expired in 1966, the unions began bargaining for the restoration of all the jobs. The use of firemen on passenger trains has never been disputed, but because of declining passenger traffic, the number of jobs available in this category has been dwindling. This has contributed to job reductions in addition to the ones eliminated by arbitration.[18] Since labor relations are beyond the scope of this paper, discussion of the firemen-helper issue will be limited to facts and figures on employment.

Table 6 shows firemen-helper employment from 1947 to 1968.

At the time of the Presidential Railroad Commission Hearings, the normal crew consist of a freight train included the engineer, a fireman, a conductor and two trainmen. (The terms

---

[17] "Viewpoint—On Getting Ahead—and Staying There," Railway Age, Vol. 162, No. 22 (June 5, 1967), 38.

[18] Nancy Ford, "Labor Outlook: Trouble, Then a Breakthrough," Modern Railroads, Vol. 24, No. 1 (January, 1969), 72-74.

Table 6

FIREMEN-HELPER EMPLOYMENT,
1947-1968

Year	Employment[a]	Index of Employment[b]
1968	17,985	30
1967	19,229	32
1966	19,635	32
1965	21,768	36
1964	29,964	50
1963	35,869	59
1962	36,522	60
1961	36,616	61
1960	38,765	64
1959	39,920	66
1958	40,135	66
1957	45,050	75
1956	46,630	77
1955	45,443	75
1954	44,636	74
1953	49,009	81
1952	50,081	83
1951	53,274	88
1950	51,175	85
1949	51,399	85
1948	58,082	96
1947	60,447	100

[a]Interstate Commerce Commission, Wage Statistics of Class I Railroads in the United States.

[b]Calculated from relevant data in preceding column.

trainman, brakeman and flagman designate the same type of work.) In some cases the consist included three or four trainmen. One trainman (the head-end brakeman) rides in the cab with the engineer and fireman. The conductor and other trainmen ride in the caboose. The main duties of the crew are to signal the engineer when stopping and starting and when setting out cars and to watch the rolling stock when the train is in motion. In yard service, the consist included a foreman (the conductor) and two to four helpers (trainmen). Usually, there were only two helpers.[19]

In testimony before the Presidential Railroad Commission, the railroads argued in favor of cutting crew sizes on a job-by-job basis. They wanted to analyze the work load of each crew and adjust the size accordingly. The railroads felt that this position was justified because the work load was not as great as it once had been. In road service, the amount of switching to set out cars was drastically reduced by the disappearance of l.c.l. (less-than-carload-lot) freight. At the same time, the use of radio-telephones made possible more effective communication between the engineer and the crew in both yard and road service. The use of modern classification yards reduced the amount of labor required to identify and switch cars during the make up of trains. Likewise, the amount of paper work required of both yard and road crews has been reduced. In road service, the "watching" function of trainmen has become partially obsolete. Modern technology has reduced the need to watch for "hotboxes" and other equipment failures during train movement. Stronger steel wheels have almost completely replaced

[19]U.S. Presidential Railroad Commission, 57.

the less dependable cast iron ones. The use of roller bearings and modern lubricant pads have greatly reduced the incidence of hotboxes. Previously, solid bearings were used.[20] The number of hotbox setouts has been reduced from one every 200,000 car miles to one every 1.8 million car miles.[21] Also, the use of hotbox detectors are much more effective than the human eye. There are about 1,500 detectors placed along the tracks of U.S. and Canadian railroads.[22] In opposition to the companies, the unions argued that the "job content" was greater because of longer trains. Also, they argued that safety would be impaired if crew sizes were cut.[23]

Besides arbitrating the firemen-helpers issue, the special board set up under Public Law No. 88-108 heard arguments on the size of crews. The special arbitration board decided crew consist conflicts on a job-by-job basis. The arbitration award authorized the elimination of 8,500 trainmen jobs. This was less than half the number of jobs the carriers indicated they wanted to eliminate. However, for some reason, the carriers actually used one-and-one crews on only 4,500 of the 8,500 consists on which they were authorized. (One-and-one crews have a head-end brakeman and a conductor in the caboose.) When

---

[20] U.S. Presidential Railroad Commission, 56.

[21] Edward T. Myers, "AAR Research Tackles New Problems," Modern Railroads, Vol. 23, No. 6 (June, 1968), 72.

[22] "Hotbox Sleuths Map New Strategy," Railway Age, Vol. 167, No. 11 (September 15/22, 1969), 83.

[23] U.S. Presidential Railroad Commission, 56.

Public Law No. 88-108 expired, the unions began pressing for reinstatement of many of the jobs eliminated by the arbitration award.[24] In many cases, they have successfully reinstated full crews. The settlement in June, 1969 between the Louisville and Nashville Railroad and the United Transportation Union is typical of the unions' success. The following statement issued jointly by L & N President W. H. Kendall and UTU Vice-President J. P. Saunders outlines that agreement:

> The railroad has agreed that all road crews will consist of not less than two trainmen and a conductor and all yard crews will consist of not less than a foreman and two switchmen except where specific agreements have been reached to use crews with only one trainman or switchman. Agreed-upon exceptions to the three-man crew rule include eight road crews and forty-five yard crews. The union had agreed that trainmen who are provided with portable radios will use them in conformity with rules and instructions of the company and the Federal Communications Commission. An extra pay allowance of $1.50 a trip or tour of duty will be extended to all trainmen for use of radio set and the allowance for coupling air hose will be increased from forty to sixty-five cents for each shift worked.[25]

MAINTENANCE OF EQUIPMENT

Operating employees have not been the only ones affected by technology. Shopcraft employment has been reduced because of a smaller, more modern fleet of equipment and improved maintenance equipment and procedures. One of the reasons why the

---

[24] Ford, 72-74.

[25] "L & N and UTU Reach 'Final Agreement' on Crew Consist," Railway Age, Vol. 166, No. 21 (June 9/16, 1969), 30.

diesel-electric locomotive replaced the steam locomotive was its low maintenance cost. A steam locomotive requires regular service every 100 to 150 miles. Diesels require it every 350 to 450 miles, and even then, it costs less. Major repair is also required less frequently on diesel units. They average over 250,000 miles in freight service between major repairs, whereas steam locomotives averaged only 80,000 miles. Diesel repair is cheaper because repair parts are standardized and can be purchased from the factory. In the days of steam, the railroads had to make almost every repair part because two steam locomotives were rarely built with the same specifications. The average shop time for diesel locomotives is five days, compared with eighteen days for steam locomotives. Compare the average shop time with the time (24 hours) it takes to completely overhaul one of the Union Pacific's new 6600 hp. units mentioned earlier. Besides requiring less costly service, there are fewer diesel-electric locomotives to service. The use of modern materials in the construction of freight cars has again decreased the need for maintenance. Also, declining passenger traffic has eliminated many jobs associated solely with this service.[26]

---

[26] Economics and Research Branch, Canada Department of Labor, Technological Changes in the Railway Industry: Employment Effects and Adjustment Process, CPR Angus Workshop, Montreal (Ottawa, Canada: Queen's Printer and Controller of Stationary, 1967), 7-31.

The factors mentioned above offer a sufficient explanation for reduced shop employment, but job reductions did not end there. The railroads centralized maintenance work and shifted from labor intensive to capital intensive methods. Assembly line techniques and modern machinery have reduced the number of men needed to perform most repairs. Just one example of how modern machinery saves labor is the use of electric or air hoists in the Canadian Pacific Railroad's Angus Workshops. Working with hand chain blocks, it took four men two man-hours (about thirty minutes) to fit the main drums on a locomotive carriage. Now it takes them one quarter of a man-hour (about four minutes).[27]

Man-hour productivity in equipment maintenance has increased at an average annual rate of 12.1% (Table 7). This figure is based on the weighted output index used earlier. Table 8 is included so the reader can compare the decreasing employment with the smaller inventory of rolling stock.

MAINTENANCE OF WAY AND STRUCTURES

Aside from dieselization, no technological factor has had a greater impact on the demand for labor than mechanization of maintenance of way and structures (M/W) work. The AAR reports that there was an average of 87,616 M/W workers in 1969.[28]

---

[27]Economics and Research Branch, Canada Department of Labor, 25-26.

[28]Association of American Railroads, 82.

Table 7

WEIGHTED OUTPUT INDEX, MAINTENANCE OF EQUIPMENT AND STORES MAN-HOURS, PRODUCTIVITY, 1947-1968

Year	(1) Weighted Output Index[a] (1947=100)	(2) Man-hours[b,c] (millions)	(3) Index of Man-hours[d] (1947=100)	(4) Index of Output Per Man-hour[e] (1947=100)	(5) Average Annual Change in Output Per Man-hour (1947-1968)
1968	103	265	29	355	12.1
1967	100	272	29	345	12.3
1966	103	292	32	322	11.7
1965	97	298	32	303	11.3
1964	93	313	34	274	10.2
1963	88	313	34	259	9.9
1962	84	321	35	240	9.3
1961	80	324	35	229	9.2
1960	82	363	39	210	8.5
1959	83	388	42	198	8.2
1958	80	389	42	190	8.2
1957	89	490	53	168	6.8
1956	94	533	58	162	6.9
1955	91	548	59	154	6.8
1954	81	545	59	137	5.3
1953	90	677	73	123	3.8
1952	91	701	76	120	4.0
1951	96	753	81	119	4.8
1950	87	720	78	112	4.0
1949	80	738	80	100	-0-
1948	96	908	98	98	-2.0
1947	100	924	100	100	

[a]Taken from Table 1, column 5.

[b]Interstate Commerce Commission, Wage Statistics of Class I Railroads in the United States.

[c]Man-hours represents a total of "straight time actually worked" plus "overtime hours paid for."

[d]Calculated from relevant data in preceding column.

[e]Column 1 divided by column 3.

Table 8

MAINTENANCE OF EQUIPMENT AND STORES EMPLOYMENT, NUMBER OF LOCOMOTIVES, FREIGHT-TRAIN CARS, PASSENGER-TRAIN CARS, 1947-1969

Year	(1) Employment	(2) Index of Employment[a]	(3) Number of Locomotives	(4) Index of Locomotives[a]
1969	127,122[b]	34	27,040est.[b]	65
1968	132,114[c]	36	27,376	66
1967	138,488	37	27,687	66
1966	145,628	39	27,886	67
1965	148,425	40	27,816	67
1964	154,652	42	28,300	68
1963	156,895	42	28,449	68
1962	161,080	44	28,639	69
1961	164,085	44	28,815	69
1960	184,006	50	29,080	70
1959	194,500	53	29,493	71
1958	196,594	53	29,513	71
1957	246,358	66	30,248[d]	73
1956	265,684	72	30,433	73
1955	273,155	74	31,429	75
1954	275,150	74	32,872	79
1953	335,993	91	35,009	84
1952	345,531	94	37,343	90
1951	369,073	100	40,036	96
1950	348,181	94	40,494	97
1949	320,782	87	40,691	98
1948	365,142	99	41,851	100
1947	370,287	100	41,719	100

[a]Calculated from relevant data in preceding column.

[b]Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition, 63, 68, 82.

[c]Interstate Commerce Commission, Wage Statistics of Class I Railroads in the United States.

[d]Interstate Commerce Commission, Transport Statistics in the United States for the Year Ended December 31, 1957, Tables 14, 26, 32.

Table 8--Continued

Year	(5) Number of Freight-Train Cars	(6) Index of Freight-Train Cars[a]	(7) Number of Passenger-Train Cars	(8) Index of Passenger-Train Cars[a]
1969	Missing		12,800est.[b]	29
1968	1,453,883[e]	84	15,384[e]	34
1967	1,477,166	85	18,610	42
1966	1,488,115	86	20,016	45
1965	1,478,005	85	21,327	48
1964	1,488,385	86	23,057	51
1963	1,512,306	87	24,602	55
1962	1,550,067	89	25,566	57
1961	1,604,241	93	26,705	60
1960	1,658,292	96	28,305	63
1959	1,676,386	97	30,096	67
1958	1,724,228[d]	99	31,922[d]	71
1957	1,745,706	101	33,443	75
1956	1,706,828	98	34,981	78
1955	1,698,791	98	36,871	82
1954	1,736,022	100	37,768	84
1953	1,776,781	102	39,532	88
1952	1,758,933	101	41,011	91
1951	1,752,391	101	42,406	95
1950	1,721,231	99	Missing	--
1949	1,753,728	101	Missing	--
1948	1,759,523	101	Missing	--
1947	1,734,191	100	44,841	100

[e]Association of American Railroads, Statistics of Railroads of Class I in the United States, Years 1958 to 1968, Statistical Summary No. 53 (Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1969), 9-10.

This is a 67% decrease from the 1947 level of 264,816 (Table 9). As with dieselization, mechanization of M/W was initiated to cut costs. As labor costs increased, management turned to machinery to do the work that was formerly done by men with picks and shovels. Professor William Haber, University of Michigan, attributes mechanization of M/W to the forty-hour week. In his paper presented to the Conference on Technological Change and the Future of the Railways at Northwestern University in 1961, he states:

> Mechanization of the maintenance-of-way on U.S. railroads was in part stimulated by increasing hourly rates, but advanced most rapidly when the 40-hour week was introduced about 10 years ago (1951). It became worthwhile to seek ways and means to employ fewer men on the tracks; it became profitable to develop technical and mechanical methods and to displace "pick and shovel" men....By improving their economic position, the unions stimulate the technological changes necessary to keep unit costs down, to avoid price increases, and to meet foreign competition. The short-run consequences of such technological changes may often result in substantial labor displacement.[29]

Manpower productivity in M/W work has shown a phenomenal increase. Measurements of productivity are questionable but will be presented anyway. Based on the weighted output index, productivity increased 12.8% annually from 1947 to 1968 (Table 9). Using miles of track operated as an output base reveals a 10.7% annual increase (Table 10). These statistics are question-

---

[29]William Haber, "Technological Innovation and Labor in the Railway Industry," Technological Change and the Future of the Railways, Selected papers presented at a three-day conference conducted by the Transportation Center, Northwestern University (Evanston, Illinois: Northwestern University, 1961), 102.

Table 9

WEIGHTED OUTPUT INDEX, MAINTENANCE OF WAY AND STRUCTURES EMPLOYMENT, PRODUCTIVITY, 1947-1969

Year	(1) Weighted Output Index[a] (1947=100)	(2) Employment	(3) Index of Employment[c] (1947=100)	(4) Man-hours[b] (millions)
1969	105	87,616[e]	33	f
1968	103	88,916[g]	34	182[g]
1967	100	90,462	34	183
1966	103	94,098	35	192
1965	97	94,633	36	195
1964	93	98,615	37	204
1963	88	99,393	37	203
1962	84	102,274	38	207
1961	80	105,476	40	211
1960	82	118,516	45	238
1959	83	126,999	48	256
1958	80	134,122	51	268
1957	89	170,766	65	342
1956	94	185,571	70	374
1955	91	196,980	74	396
1954	81	199,102	75	398
1953	90	240,696	91	487
1952	91	242,122	91	493
1951	96	251,150	95	514
1950	87	237,887	90	483
1949	80	235,051	89	533
1948	96	266,959	101	647
1947	100	264,816	100	641

[a]Taken from Table 1, column 5.

[b]Man-hours represents a total of "straight time actually worked" plus "overtime paid for." The latter includes pay for some hours not actually worked. Where the source gives only figures for "days," each day is multiplied by eight to give hours worked. This results in an understatement of total hours from 1947 to 1951 because the workday was usually ten hours.

[c]Calculated from relevant data in preceding column.

[e]Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition, 82.

[f]Not available.

[g]Interstate Commerce Commission, Wage Statistics of Class I Railroads in the United States.

Table 9--Continued

Year	(5) Index of Man-hours[c] (1947=100)	(6) Index of Output Per Man-hour[d] (1947=100)	(7) Average Annual Change in Output Per Man-hour (1947-1968)
1969			
1968	28	368	12.8
1967	29	345	12.3
1966	30	343	12.8
1965	30	323	12.4
1964	32	291	11.2
1963	32	275	10.9
1962	32	263	10.9
1961	33	242	10.1
1960	37	222	9.4
1959	40	209	9.1
1958	42	190	8.2
1957	53	168	6.8
1956	58	163	7.0
1955	62	147	5.9
1954	62	131	4.4
1953	76	118	3.0
1952	77	118	3.6
1951	80	120	5.0
1950	75	116	5.3
1949	83	96	-2.0
1948	101	95	-5.0
1947	100	100	

[d]Column 1 divided by column 5.

Table 10

MILES OF TRACK OPERATED, MAINTENANCE OF WAY AND STRUCTURES MAN-HOUR INDEX, PRODUCTIVITY, 1947-1968

Year	(1) Miles of Track Operated	(2) Index of Miles of Track Operated[a] (1947=100)	(3) Index of Man-hours[b] (1947=100)	(4) Index of Output Per Man-hour[c] (1947=100)	(5) Average Annua Change in Outp Per Man-hour (1947-1968)
1968	322,394[d]	91	28	325	10.7
1967	322,855	91	29	314	10.7
1966	323,600	91	30	303	10.7
1965	324,788	92	30	307	11.5
1964	330,616	93	32	291	11.2
1963	332,971	94	32	294	12.1
1962	335,055[e]	94	32	294	12.9
1961	338,416	95	33	288	13.4
1960	340,779	96	37	259	12.2
1959	342,566	97	40	243	11.9
1958	344,477	97	42	231	11.9
1957	345,832	97	53	183	8.3
1956	347,928	98	58	169	7.7
1955	350,217	99	62	160	7.5
1954	352,085	99	62	160	8.6
1953	353,075	99	76	130	5.0
1952	353,878	100	77	130	6.0
1951	354,546	100	80	125	6.3
1950	354,775	100	75	133	11.0
1949	355,449	100	83	120	10.0
1948	355,484	100	101	99	-1.0
1947	355,227	100	100	100	

[a]Calculated from relevant data in preceding column.

[b]Taken from Table 9, column 5.

[c]Column 2 divided by column 3.

[d]Interstate Commerce Commission, Transport Statistics in the United States for the Years Ended December 31, 1963-1968, Table 1.

[e]Interstate Commerce Commission, Transport Statistics in the United States for the Years Ended December 31, 1947, 1962, Table 1B.

able because of the current controversy over the quality of maintenance. If maintenance quality has remained the same or increased, then these figures are valid. Union spokesmen testifying before the Kansas Corporation Commission in June, 1970 indicated, "that some railroads appear to be more concerned with quantity of maintenance than quality." One union representative said his railroad has "too few section workers to handle track assigned to them for maintenance."[30] A look at the facts reveals that about one-third of the train derailments can be traced to track conditions.[31]

Gus Welty, Senior Editor of Railway Age, argues that maintenance has improved:

> It is a fact that railroads today employ fewer M/W people. It is not a fact that maintenance necessarily suffers. Machines do a better job and a faster one than manual labor can do. Machines, in a real sense, have made possible a higher level of property maintenance—because (1) at the going rate of pay, no railroad could afford to employ the old army of M/W workers, and (2) even if the army could be afforded, many railroads would find it impossible to locate and hire the sheer volume of bodies which would be required.[32]

Another questionable aspect of the productivity statistics is the trend toward having maintenance performed under contract

---

[30]"Railroads Called Indifferent to Track-Maintenance Job," The Wichita Eagle, Vol. 98, No. 155 (June 4, 1970), 1A.

[31]Merwin H. Dick, "Pressures Intensify for Higher Track Standards," Railway Age, Vol. 168, No. 6 (April 13, 1970), 59.

[32]Gus Welty, "Lines on Labor," Railway Age, Vol. 167, No. 2 (July 14, 1969), 12.

by outside firms.[33] When the work is performed by contractors, the man-hours are not included in the railway labor statistics. In the opinion of the writer, contracting is not yet extensive enough to materially affect the validity of the tables. Also, in all probability, maintenance quality has not yet decreased significantly, but the track has proved to be inadequate because of the longer, heavier loads being moved. Although the exact productivity statistics are subject to review, the fact that M/W labor is more productive now than in 1947 is beyond question.

Increased productivity is the result of mechanization of tasks formerly done by men with hand tools. Today, tamping ballasts, removing and driving spikes, tightening bolts, lining track, laying rail, raising track and applying anchors are all performed by machines of various types requiring one operator and few, if any, helpers.[34]

Not all of the productivity increase can be attributed to machines. The diesel-electric locomotive is not as hard on the tracks as was the steam locomotive. Technology has provided longer lasting materials with which to build and repair the track. Ties are treated with preservatives and are expected to last up to fifty years. The use of continuous weld or ribbon

---

[33]Merwin H. Dick, "M/W Work Will Get More Attention in 1970," Railway Age, Vol. 168, No. 2 (January 19, 1970), 41.

[34]H. C. Crotty, "The Need for Greater Employee Safety on Railroads," Labor Today, Vol. 5, No. 1 (February/March, 1966), 20.

rail has increased rail life as much as 50%, from 20 years to 30 years. Rail life is extended because the first part of a rail to wear out is the joint. When ribbon rail is used, there is no crack for the wheels to pound against. The standard rail length is 39 feet. Therefore ribbon rail must be welded by the user. Most roads that use ribbon rail have one or two centrally located shops where the 39 foot lengths are welded into about 1,400 foot lengths. The length of the ribbon rail varies according to the specifications of the individual roads. After welding, a special train takes the rails to the location where they are to be used. This special train requires six men to help unload it plus the engine crew. Recently, much research has been done to developed a process so the ends of the ribbon rail lengths can be welded in the field. Field welding would also allow repair of continuous weld track without using joints. Other developments include the use of hardened rails on curves. The Sante Fe believes that hardened rails will last three to five times longer on curves. Because of the heavier loads being pulled, heavier track is required. Most new rail going into busy mainline operations weighs more than 130 pounds per yard. Lighter rail is used on branch lines, but even there, the weight is increasing.[35] In 1920, the average weight per yard of rail was 82.2 pounds, and in 1968, it was 107.9 pounds.[36]

---

[35]Edward T. Myers, "Engineering Skills Build Quality Plant," Modern Railroads, Vol. 23, No. 12 (December, 1968), 55-58.

[36]Association of American Railroads, 62.

Maintenance of way employment requirements have decreased in all occupational groups except portable equipment operators and helpers. The average number of equipment operators and helpers has increased from 5,567 in 1947[37] to 9,351 in 1968.[38] The occupations hit the hardest are section-men and extra gang (transient) laborers. The following discussion is devoted to the impact of change on employment in the two groups. Much of the information is from an interview with R. E. Catlett, Staff Engineer, St. Louis-San Francisco Railway Company. He spent several hours explaining the changes that have taken place in M/W over the last twenty years, and his assistance is deeply appreciated.

Section gangs have been replaced by district gangs. Section gangs included one foreman and two or three laborers. They were responsible for the day-to-day maintenance of approximately six miles of track. Their equipment included motorized cars and hand tools. Their duties included repairing the fence and cutting the grass along the right-of-way, maintaining road crossings and roadway signs and replacing spikes and an occasional tie or broken rail. The modern district gang (still called

---

[37]Edward B. Jakabauskas, "Technological Change and Recent Trends in the Composition of Railroad Employment," Quarterly Review of Economics and Business, Vol. 2, No. 4 (November, 1962), 86.

[38]Association of American Railroads, Statistics of Railroads of Class I in the United States, Years 1958 to 1968, Statistical Summary No. 53 (Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1969), 4.

section gangs by some roads) includes one foreman and six to eight men. They are responsible for fifty to sixty miles of track. Their duties are essentially the same as the smaller section gangs except they do not cut the grass. It is sprayed with chemicals by special crews, or the spraying is done by a contractor. The district gang travels in highway vehicles. The motorized car is almost a thing of the past. The gangs are equipped with small power tools to do the routine work. The men are also trained to use tie saws and handlers, spot tampers, switch tampers and liners so they can perform most of the repair work in their district.[39]

Major maintenance work is performed by transient gangs. If the rail is to be replaced, the rail-laying gang does this. Twenty years ago there were about 100 men in a rail-laying gang. Now the average is about sixty-five. The following is a list of the machines used to replace the rails:

1. 2-Spike pullers
2. 2-Cranes
3. 1-Machine to clean out ballast
4. 1-Air compressor with dual spike drivers
5. 2-Anchor machines
6. 1-Bolt machine
7. 1-Welding unit
8. 1-Adzer
9. 1-Hydraulic Spiker[40]

The work done by most of these machines was previously done by men with hand tools.

---

[39] Interview with R. E. Catlett, Staff Engineer, St. Louis-San Francisco Railway Company, Springfield, Missouri, July 8, 1969.

[40] Interview.

The tie injector gang follows, and they replace old or broken ties. The gang includes a minimum of twenty-one men and a maximum of forty. There are about 3,250 ties per mile, but only 500 or 600 are scheduled for replacement at one time. This replacement work must be done every four to seven years depending on the use of the track. To replace a tie, the spikes are first removed by a mechanical spike puller. Formerly, this was done by men with hand tools; now it is done by one or two machines. The tie is now cut into three pieces, and the center section is automatically placed on the shoulder by the machine. Then a machine pushes the two ends from under the rails and onto their respective shoulders. It also prepares the bed for the new tie. One or two cranes follow. One stacks the old ties, and the other positions the new ties for insertion. (Machines are available that push the entire tie out to one side, but the overall process is essentially the same.) The tie injector then picks up the tie and pushes it under the rails and into place. Prior to development of the tie remover, the ties were dug out with picks and shovels. Tie insertion was also a manual process. As a matter of fact, it was the slowest and most difficult job in a tie gang. With a tie injector, a new tie can be put in place every fifteen seconds. Next, a laborer cleans the ballast and dirt from between the rail and the new tie so that a spot tamper can pack the ballast firmly under the tie. Then a rail lifter raises each rail sufficiently above the new tie to allow a laborer to slide a tie plate under the rail. A spike driver secures the rail to the tie, and a machine reinstalls the anchors. (Anchors help control expansion and contraction of the rails.) Before mechanization, tamping was done by men with shovels, the rails were lifted by rail jacks, and men with mauls drove the spikes and replaced the anchors. Mechanization has made the job of tie replacement much easier, and it has eliminated many jobs in the process.[41]

The last gang to work on the track is the track-surfacing gang, but before it begins, new ballast (rock) is put on the roadbed, if it is needed. The surfacing gang tamps, regulates the ballast and lines the track. Tamping raises the level of the track from 1½ to 5 inches by working the new ballast under the ties. The purpose of this process is to cushion the track to obtain a smoother ride. Regulating the ballast means that the excess rock is removed from between and beside the rails so that the ballast is level with the top of the ties. Lining adjusts the entire track to make both rails level or to produce the proper incline on curves. Twenty years ago the surfacing gang did most of its work with hand tools. Tracing the development of the modern machines is quite interesting. Originally, tamping was accomplished by six men raising the track with jacks so that another six men could work the ballast under the ties with shovels. The first change occurred with generators mounted

---

[41]Edward T. Myers, "New Machines Speed Tie Work," Modern Railroads, Vol. 22, No. 8 (August, 1967), 108-110.

on push carts powered vibrators to replace the shovels. Then a multiple tamper was developed. Its hand-like claws vibrated in the ballast. Even though six men were still needed to jack the tracks, the multiple tamper was beneficial because it required only one operator. Finally, a tamper was developed that could both tamp and jack, and the six jackers were out of work. The ballast regulator follows the tamper. Of course, this job was once done by hand. Then the liner lines the track. The use of liners with light beams represents a great advance beyond the days when men did it with levels.[42]

From the previous paragraph one would think that the ultimate in track-surfacing technology had been reached, but this was not the case. With the machines described above, a track-surfacing gang was usually comprised of two multiple tampers, a tamping jack (tamper that jacks and tamps), a track liner and a ballast regulator. Each of the five machines required an operator. Five laborers plus a foreman were also required. Within the last several years a sophisticated machine was developed that can tamp, raise the track and line it all in one process. A ballast regulator is the only other machine that needs to be used with it. The result is a track-surfacing gang comprised of two equipment operators, three laborers and a foreman.[43] It should be noted that a mechanic is assigned to

---

[42]Interview.

[43]"Track Machines Pay Big Dividends," Railway Age, Vol. 165, No. 15 (October 14, 1968), 20-21.

each gang to keep the machinery operating. As the machines become more complicated, the mechanic's job becomes more important. It is important that the machinery be kept operational because the on-track working time is only about four hours per eight-hour shift. The actual working time is so short because the gangs must clear the tracks to allow trains to pass.[44]

THE APPLICATION OF ELECTRONICS

The Hump Yard

Modern electronics and communication systems are offering the railroads an opportunity to solve one of their most perplexing problems—terminal congestion. Cars simply do not move through the terminals fast enough, and there are too many terminals.[45] The result is underutilization of equipment—particularly the freight cars that sit idle in freight yards a good deal of the time. The hump yard or electronic classification yard represents a major contribution to the solution of this problem. What are the benefits of converting a conventional flat yard into a hump yard? An important benefit is a reduction in the number of employees required to handle a given volume of switching. The hump yard is the nearest thing to complete automation in the railroad industry. The occupational groups

---

[44]Interview.

[45]"Problem-Solving in the Terminals," Railway Age, Vol. 166, No. 23 (June 30, 1969), 27-29, 68.

affected most are the operating employees working in the yards, yardmasters, assistant yardmasters and switch-tenders. Besides requiring fewer employees, a hump yard saves valuable land space and reduces the number of locomotives and miles of track needed. Generally, a hump yard combines the operations of several smaller yards, resulting in more efficient use of the land. In large cities where property values and taxes are high, this is particularly important. The number of locomotives required may be cut as much as 60%. Also, car and freight damage is much less because the speed of the car is controlled by a retarder, and when it hits the next car, it is slow enough to avoid damage. Perhaps the most important benefit of the hump yard is the fact that it cuts delays. Switching is faster; the time required to make up a train may be cut as much as 75%. Since the average car spends only an estimated 10% of its serviceable life in road movement, anything that cuts delays and increases car utilization is beneficial to the railroads.[46] Productivity increases due to the implementation of hump yards cannot be calculated from statistics generally available. In order to get meaningful figures, a detailed study before and after installing the hump yard would be necessary.

How does the hump yard operate? A switching locomotive pushes a series of cars from the receiving tracks to the crest

---

[46]Phillip Cohen, "New Technologies and Changing Manpower Requirements in Canadian Railroads," <u>Labor Law Journal</u>, Vol. 14, No. 8 (August, 1963), 687-688.

of the hump. The first car to be released is identified either by a switchman or the new Automatic Car Identification (ACI) system. (ACI will be discussed later.) If the switchman identifies the car, he radios the information to the yardmaster in the tower. The yardmaster determines the destination of the car and pushes the button so that it will go to the proper classification track. From this point on, the process is entirely automatic. The car is automatically uncoupled and allowed to coast down the hump. As the car reaches the bowl (the bottom of the incline), it is weighed in motion, and its speed is determined by radar. Its rolling characteristics are determined by computer, and the correct retarder pressure is automatically applied to the wheels so the car will be slowed down enough that no damage is done when it bumps the car ahead of it. The entire operation from the time the destination track is selected until the car reaches that track is controlled by an analogue computer. Human participation is limited to monitoring the operation, but if necessary, the automatic system can be overridden by manual controls.[47]

Hump yards vary in size from nine classification tracks to two sets of 48 to 60 tracks. When two humps are used, one handles traffic going in one direction, and the other handles

---

[47] Peter B. Wilson, "The Possibilities of Automation in the Railroad Industry," Technological Change and the Future of the Railways, Selected papers presented at a three-day conference conducted by the Transportation Center, Northwestern University. (Evanston, Illinois: Northwestern University, 1961), 144.

traffic going in the opposite direction. The smaller yards are usually semi-automatic, whereas the larger yards are fully automatic. A very interesting example of a small hump yard is the Northern Pacific's Missoula, Montana, yard. It has nine classification tracks and can classify over 500 cars daily. The benefits of the Missoula yard are fewer delays and reduced manpower requirements. When it was a flat, medium-sized yard, the average carload of lumber stayed in the yard two days. Now, that average has been cut to 0.6 days. Because the Missoula yard is more efficient, it does a more thorough job of arranging the cars. Therefore the road crews can set out the proper cars as the train passes through the flat yards to the east. Previously, the job was so complicated that it had to be done by the switching crews. Since the Missoula yard now does its own weighing, there is no need for the cars to stop at Livingston, Montana, to be weighed. The biggest manpower cuts have occurred at the Helena and Livingston yards. They need only one shift each day because their volume has decreased. The impact on employment from this small yard is indicative of the much greater impact of larger hump yards.[48]

Computers

Almost 85% of the nation's railroads make use of computers. The sixty-two roads use 243 computers in a variety of ways. The

---

[48] Edward T. Myers, "NP's Small Yard 'Thinks Big'," Modern Railroads, Vol. 23, No. 10 (October, 1968), 66-68.

Information Letter from the Association of American Railroads states,

> They (computers) are used in freight classification yards and to improve car utilization and service reliability. They're used to plot lines for new track and to diagnose derailments. These industry applications, of course, are in addition to such normal uses as cost accounting, freight billing, record-keeping and payroll preparation.[49]

Industry-wide information systems rely on computers to link the railroads with the Association of American Railroads Data Center in Washington, D.C. ACI (Automatic Car Identification), TRAIN (Tele-Rail Automated Information Network) and UMLER (Universal Machine Language Equipment Register) are industry-wide programs for automation of freight car distribution information. ACI provides electronic identification of all cars used in interchange service. By June 1, 1970 (the earlier target date was January 1), all cars used in interchange service were to be marked with a multicolored retroreflective tape label. A scanner placed at the side of the track is capable of reading the label, even as the car passes at very high speeds, and also if the label is dirty. The scanner transmits the car's initial and number to the railroad's computer center. In January, 1970, thirty-three scanners had been installed, and nearly 200 were scheduled for installation during the year. The system began operation in 1969 and will

---

[49]"Computerization on Railroads Is Increasing, Survey Shows," Information Letter, Association of American Railroads, No. 1908 (April 1, 1970), 3.

become fully operational during 1970. The computers of the individual roads are linked with the computer at the AAR's Data Center. TRAIN is the name of this system which will provide accurate information on car supply and car flow. Hopefully, with this information more readily available, freight car utilization can be improved. UMLER is a complete official registry file of the characteristics of all cars used in interchange service in the United States and Canada. This system also became operational in 1969.[50]

The following is a list of the benefits which Robert Roberts, Eastern Editor of Modern Railroads foresees from the use of the nation-wide computer network:

1. $13 million can be saved by ACI in reduction of human error in car movement records...
2. $2.7 billion can be saved in capital outlays for equipment that does not have to be made as a result of a 10% increase in car utilization...
3. Improved locomotive utilization.
4. Improved per diem accounting.
5. Faster, more accurate production of train and yard lists.
6. Better utilization of train crews.
7. ACI coupled with weigh-in-motion scales.
8. ACI coupled with hotbox detectors, dragging equipment detectors and related devices.
9. Automation of hump yards.[51]

Every one of the benefits mentioned by Roberts will undoubtedly reduce the demand for human services, but at this time it

---

[50] Association of American Railroads, Railroad Review and Outlook (Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1969), 17-18; and (1970), 14-15.

[51] Robert Roberts, "ACI is Key to Penn-Central In-Motion Car Weighing," Modern Railroads, Vol. 23, No. 3 (March, 1968), 97.

is too early to determine the impact. Perhaps the brunt of the employment cuts will be borne by clerical workers. However, the impact on the demand for yard and operating personnel will be substantial. At the same time, the demand for computer programmers and key punch operators will probably increase. This will be a switch for the railroad industry.

Centralized Traffic Control

Centralized Traffic Control (CTC) is not a new development. It was first installed in the United States in 1927. The AAR estimates that there were 41,300 miles of road under CTC in 1969.[52] This is about one-third of mainline mileage. CTC allows a single operator to simultaneously control the movement of all trains within the hundreds of miles of track under his control. Sitting at an electronic console, the train dispatcher follows the progress of each train and controls the switches and signals to give each train the right to proceed or stop on a siding. Because of the system's flexibility, trains no longer need to follow strict schedules, there are fewer delays, higher average speeds are attainable and safety is improved. Other benefits include a reduction in the number of miles of double track needed because CTC increases the capacity of single track.

---

[52] Association of American Railroads, Yearbook of Railroad Facts, 1970 Edition, 62.

Capacity can be increased even more by the use of a computer to program train movements. The cost of maintaining single track is less, and so are the taxes.[53] The productivity of dispatchers increased at an average annual rate of 0.8% between 1947 and 1968 (Table 11). Since the work load of the dispatchers is a function of the miles of track operated and the number of train-miles, the physical output index is derived from a combination of the two measures. Because of a lack of sufficient evidence for doing otherwise, train-miles and miles of track operated are given equal weights in determining the output index. (The calculations include all track because the employment figures include all dispatchers, not just those working in CTC.) In 1947, there was an average of 4,356 chief train dispatchers, train dispatchers and train directors. In 1968, there were 3,422, which is a decrease of only 21%. This is much less than the average employment decline of 57% for the industry.

THE FUTURE

Even if all of the manpower adjustment problems associated with technological advancement were miraculously solved overnight, future technological developments would make the solution obsolete the next night. Dieselization was described as "the single most important technological advancement in the railroad

---

[53] U.S. Bureau of Labor Statistics, 198-199.

Table 11

TRAIN-MILES, MILES OF TRACK INDEX, DISPATCHER EMPLOYMENT[a], PRODUCTIVITY, 1947-1968

Year	(1) Train Miles (millions)	(2) Index of Train Miles[b] (1947=100)	(3) Index of Miles of Track[c] (1947=100)	(4) Average Index[d] (1947=100)
1968	552[h]	54	91	73
1967	570	55	91	73
1966	602	58	91	75
1965	593	58	92	75
1964	598	58	93	76
1963	589	57	94	76
1962	587[i]	57	94	76
1961	585	57	95	76
1960	614	60	96	78
1959	639	62	97	80
1958	647	63	97	80
1957	722	70	97	84
1956	765	74	98	86
1955	775	75	99	87
1954	764	74	99	87
1953	826	80	99	90
1952	847	82	100	91
1951	884	86	100	93
1950	873	85	100	93
1949	879	85	100	93
1948	992	96	100	98
1947	1,031	100	100	100

[a]Dispatchers include chief train dispatchers, train dispatchers and train directors.

[b]Calculated from relevant data in preceding column.

[c]Taken from Table 10, column 2.

[d]Column 2 plus column 3. The sum is divided by 2 to obtain an equally weighted index.

[h]Association of American Railroads, Statistics of Railroads of Class I in the United States, 11.

[i]Interstate Commerce Commission, Transport Statistics in the United States for the Years Ended December 31, 1957, 1962, Table 53.

Table 11--Continued

Year	(5) Employment[e]	(6) Index of Employment[b] (1947=100)	(7) Man-hours[e,f] (thousands)	(8) Index of Man-hours[b] (1947=100)
1968	3,422	79	7,158	63
1967	3,423	79	7,136	62
1966	3,475	80	7,387	65
1965	3,484	80	7,606	67
1964	3,504	80	7,640	67
1963	Missing	--	7,711	67
1962	3,617	83	7,828	69
1961	3,686	85	7,962	70
1960	3,907	90	8,546	75
1959	3,962	91	8,785	77
1958	4,063	93	9,134	80
1957	4,430	102	9,785	86
1956	4,530	104	9,943	87
1955	4,409	101	9,623	84
1954	4,510	104	9,847	86
1953	4,632	106	10,158	89
1952	4,654	107	10,347	91
1951	4,706	108	10,523	92
1950	4,503	103	10,395	91
1949	4,260	98	10,785	94
1948	4,306	99	11,360	99
1947	4,356	100	11,424	100

[e]Interstate Commerce Commission, Wage Statistics of Class I Railroads in the United States.

[f]Table 1, footnote c.

Table 11--Continued

Year	(9) Index of Output Per Man-hour[g] (1947=100)	(10) Average Annual Change in Output Per Man-hour (1947-1968)
1968	116	.8
1967	118	.9
1966	115	.8
1965	112	.7
1964	113	.8
1963	113	.8
1962	110	.7
1961	109	.6
1960	104	.3
1959	104	.3
1958	100	-0-
1957	98	-.2
1956	99	-.1
1955	104	.5
1954	101	.1
1953	101	.2
1952	100	-0-
1951	101	.3
1950	102	.7
1949	99	-.5
1948	99	-1.0
1947	100	

[g]Column 4 divided by column 8.

industry." Already, many persons in the industry are toying with the idea of converting to other forms of motive power. One railroad is experimenting with twenty-one diesel-hydraulic units. Another is attempting to adapt a 1500 hp. jet engine to a locomotive. Perhaps the next big change in motive power will be conversion to atomic power.[54] Several roads are

[54]U.S. Bureau of Labor Statistics, 197.

studying the possibility of converting to electric power. Benjamin F. Biaggini, President of the Southern Pacific, stated,

> We must not try to spend expensive time in warming over old ideas when we should be moving ahead with our best thinking on new concepts for future railroads. It is time to be looking at all kinds of advanced power systems—linear induction motors, air-cushion vehicles, magnetic suspension, fuel cells and electrification—either from conventional or nuclear power plants.[55]

The Department of Transportation is experimenting with a passenger-carrying tracked air cushion vehicle, and it might be in operation in late 1972.[56] The Canadian National Railways has been testing a Turbo Train for several years.[57] Ray McBrian, Director of Research, The Denver and Rio Grande Western Railroad, summarizes the situation very well: "So far every revolutionary change which has been developed in the motive power field, occurred because of economics, improved service, availability, lower maintenance costs, less damage to track structure, higher horsepower per unit weight, better adhesion and speed possibilities."[58]

Crewless trains are feasible with existing technology. Automatic trains were successfully tested on a ten mile stretch

---

[55]Fred N. Houser, "70,000 cars in '70...Plus 1,300 locomotives," Railway Age, Vol. 168, No. 2 (January 19, 1970), 34.

[56]"Air Cushion Vehicle May Be Ready by '72," Information Letter, Association of American Railroads, No. 1918 (June 10, 1970), 2.

[57]"CN Resumes Cold Weather Testing of Its Turbo Train," Information Letter, Association of American Railroads, No. 1897 (January 14, 1970), 2.

[58]McBrian, 206.

of track in France in 1955.[59] In 1960, the Canadian National Railways successfully tested 35 and 76-car automatic trains over a ten mile mainline section. San Francisco's new rapid transit system, scheduled for completion in 1970-71, will have automatically controlled trains.[60] In 1969, the Muskingum Electric Railroad, a privately owned coal hauler, began hauling coal automatically over the 15½ miles from the mine to an Ohio Power Co. generating station. This was the first fully automatic train in the United States, and it was accomplished not by a railroad, but by a public utility.[61] When labor costs and problems become so great that the capital outlay for Automatic Train Operation (ATO) is practical, the carriers will move in that direction. The biggest obstacle to the initiation of ATO at the present time is the costly labor conflicts that it would create.

CONCLUSION

The impact of technology on employment in the railroad industry has not been minor. Employment decreased 57% between 1947 and 1969, and there is no indication that this is the extent of the reductions. Every technological advancement mentioned in this paper was implemented to cut costs, and gener-

---

[59] Wilson, 145-147.

[60] U.S. Bureau of Labor Statistics, 200.

[61] Fred N. Houser, "Muskingum: Test-Tube for Future?" <u>Railway Age</u>, Vol. 166, No. 21 (June 9/16, 1969), 16-19.

ally labor costs were the most significant ones to be cut. As long as labor costs continue to rise, management will be enticed to substitute capital for labor. Consequently, this writer sees no possibility for railroad employment to long remain at its current level. It will probably creep continually downward unless something happens to break the trend. One thing that could change the trend is a dramatic breakthrough in motive power technology (as mentioned in the previous section) or an end to the work-rules disputes that have plagued the industry for years. If something like this occurs, employment could tumble rapidly. On the other hand, if the demand for rail services increases because of increasing population pressures, then in the opinion of the writer, railroad employment may stabilize or even increase slightly. But, an employment increase is unlikely because of the continually advancing state of technology. In the long run it will be impossible for rail employment to fall to zero unless the railroads vanish, which is an unlikely possibility. However, if some of the possibilities mentioned above occur, employment could easily drop to a fraction of its current level, and the 12% increase in average annual output of some job classifications would be relatively insignificant.

BIBLIOGRAPHY

Articles

"Air Cushion Vehicle May Be Ready by '72," Information Letter, Association of American Railroads, No. 1918 (June 10, 1970), 2.

Barber, Richard J. "Technological Change in American Transportation: The Role of Government Action," Virginia Law Review, Vol. 50, No. 5 (June, 1964), 824-895.

"CN Resumes Cold Weather Testing of Its Turbo Train," Information Letter, Association of American Railroads, No. 1897 (January 14, 1970), 2.

Cohen, Phillip. "New Technologies and Changing Manpower Requirements in Canadian Railroads," Labor Law Journal, Vol. 14, No. 8 (August, 1963), 685-693.

"Computerization on Railroads Is Increasing, Survey Shows," Information Letter, Association of American Railroads, No. 1908 (April 1, 1970), 3.

Crotty, H. C. "The Need for Greater Employee Safety on Railroads," Labor Today, Vol. 5, No. 1 (February/March, 1966), 20-21, 27.

Dick, Merwin H. "M/W Work Will Get More Attention in 1970," Railway Age, Vol. 168, No. 2 (January 19, 1970), 39-41.

Dick, Merwin H. "Pressures Intensify for Higher Track Standards," Railway Age, Vol. 168, No. 6 (April 13, 1970), 58-62.

Ford, Nancy. "Labor Outlook: Trouble, Then a Breakthrough," Modern Railroads, Vol. 24, No. 1 (January, 1969), 72-74.

"Hotbox Sleuths Map New Strategy," Railway Age, Vol. 167, No. 11 (September 15/22, 1969), 83-84.

Houser, Fred N. "Muskingum: Test-Tube for Future?" Railway Age, Vol. 166, No. 21 (June 9/16, 1969), 16-19.

Houser, Fred N. "70,000 cars in 1970...Plus 1,300 locomotives," Railway Age, Vol. 168, No. 2 (January 19, 1970), 33-38, 92.

Jakabauskas, Edward B. "Technological Change and Recent Trends in the Composition of Railroad Employment," Quarterly Review of Economics and Business, Vol. 2, No. 4 (November, 1962), 81-90.

"L & N and UTU Reach 'Final Agreement' On Crew Consist," Railway Age, Vol. 166, No. 21 (June 9/16, 1969), 30.

Myers, Edward T. "AAR Research Tackles New Problems," Modern Railroads, Vol. 23, No. 6 (June, 1968), 72-73.

Myers, Edward T. "Engineering Skills Build Quality Plant," Modern Railroads, Vol. 23, No. 12 (December, 1968), 55-58.

Myers, Edward T. "New Machines Speed Tie Work," Modern Railroads, Vol. 22, No. 8 (August, 1967), 108-110.

Myers, Edward T. "NP's Small Yard 'Thinks' Big," Modern Railroads, Vol. 23, No. 10 (October, 1968), 66-68.

"Problem-Solving in the Terminals," Railway Age, Vol. 166, No. 23 (June 30, 1969), 27-29, 68.

"Railroads Called Indifferent to Track-Maintenance Job," The Wichita Eagle, Vol. 98, No. 155 (June 4, 1970), 1A.

Roberts, Robert. "ACI is Key to Penn-Central In-Motion Car Weighing," Modern Railroads, Vol. 23, No. 3 (March, 1968), 97-100.

Shedd, Tom. "Three-fourths of a Billion for New Equipment," Modern Railroads, Vol. 24, No. 5 (May, 1969), 91-92.

"Track Machines Pay Big Dividends," Railway Age, Vol. 165, No. 15 (October 14, 1968), 20-21.

"Viewpoint—On Getting Ahead—and Staying There," Railway Age, Vol. 162, No. 22 (June 5, 1967), 38.

Welty, Gus. "Lines on Labor," Railway Age, Vol. 167, No. 2 (July 14, 1969), 12.

Williams, C. Glyn. "Changes in the Skill Mix and Their Effect on the Railroad Industry's Wage Level," Industrial and Labor Relations Review, Vol. 20, No. 1 (October, 1966), 88-91.

Books

Barger, Harold. "Appendix A—On the Measurement of the Physical Output of Public Utilities," Transportation Industries, 1889-1946, A Study of Output, Employment, and Productivity. New York: National Bureau of Economic Research, Inc., 1951, 163-182.

Haber, William. "Technological Innovation and Labor in the Railway Industry," Technological Change and the Future of the Railways, Selected papers presented at a three-day conference conducted by the Transportation Center, Northwestern University. Evanston, Illinois: Northwestern University, 1961, 98-113.

McBrian, Ray. "New Motive Power Technology," Technological Change and the Future of the Railways, Selected papers presented at a three-day conference conducted by the Transportation Center, Northwestern University. Evanston, Illinois: Northwestern University, 1961, 206-220.

Pegrum, Dudley F. Transportation: Economics and Public Policy. Homewood, Illinois: Richard D. Irwin, Inc., 1963.

Wilson, Peter B. "The Possibilities of Automation in the Railroad Industry," Technological Change and the Future of the Railways, Selected papers presented at a three-day conference conducted by the Transportation Center, Northwestern University. Evanston, Illinois: Northwestern University, 1961, 141-154.

Periodicals

Association of American Railroads. Railroad Review and Outlook. Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1969.

Association of American Railroads. Railroad Review and Outlook. Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1970.

Association of American Railroads. Railroad Transportation, A Statistical Record, 1921-1963. Washington, D.C.: Association of American Railroads, Bureau of Railway Economics, 1965.

Association of American Railroads. Statistics of Railroads of Class I in the United States, Years 1958 to 1968, Statistical Summary No. 53. Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1969.

Association of American Railroads. Yearbook of Railroad Facts, 1970 Edition. Washington, D.C.: Association of American Railroads, Economics and Finance Department, 1970.

Interstate Commerce Commission, Wage Statistics of Class I Railroads in the United States. Prepared by the Bureau of Accounts. Statement No. A-300 (formerly M-300), Calendar Years 1947-1968.

Interstate Commerce Commission. Statistics of Railways in the United States for the Year Ended December 31, 1952. Prepared by the Bureau of Transport Economics and Statistics. Washington: United States Government Printing Office, 1955.

Interstate Commerce Commission. Transport Statistics in the United States for the Years Ended December 31, 1954-1968, Part I, Railroads. Prepared by the Bureau of Accounts. Washington, D.C.: United States Government Printing Office.

Public Documents

Economics and Research Branch, Canada Department of Labor, Technological Changes in the Railway Industry: Employment Effects and Adjustment Process, CPR Angus Workshop, Montreal. Ottawa, Canada: Queen's Printer and Controller of Stationary, 1967.

U.S. Bureau of Labor Statistics, "Railroads," Technological Trends in Major American Industries, Bulletin No. 1474. Washington, D.C.: U.S. Department of Labor, 1966, 196-202.

U.S. Presidential Railroad Commission. Report of the Presidential Railroad Commission. Washington, D.C.: U.S. Government Printing Office, 1962.

Other Sources

Goodfellow, Thomas M. Background on Passenger Train Service Pertinent to Hearings of Subcommittee on Surface Transportation of the Senate Commerce Committee, Sept. 23-25, 1969. Washington, D.C.: Association of American Railroads, Public Relations Department, 1969.

____. Interview with R. E. Catlett, Staff Engineer, St. Louis-San Francisco Railway Company, Springfield, Missouri, July 8, 1969.

THE IMPACT OF TECHNOLOGY ON EMPLOYMENT IN THE RAILROAD INDUSTRY

by

CLAUDE RICKARD NEILL

B. A., Friends University, 1967

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1970

Employment in the railroad industry declined 57% between 1947 and 1969. The purpose of this report was to examine the impact of technology on the demand for railway labor. Although employment declines are partially the result of a reduction in some rail services (especially passenger service), technology has played a major role in reducing employment. Exhaustive research in trade and professional journals often produced incomplete facts and statistics. Consequently, the writer developed his own productivity tables. The most interesting source of information was a personal interview with a staff engineer at a railway's office.

Productivity was measured by a weighted output index derived by weighting revenue freight ton-miles and revenue passenger-miles by the ratio of the totals of their average revenues between 1947 and 1969. Between 1947 and 1968, output per man-hour increased at an average annual rate of 8.9%. The weighted output index was 105 in 1969, and employment was down 57% from 1947. Consequently, railway labor is more productive, and technological advancement is the major reason. However, a portion of the employment declines are the result of the changing nature of rail services. The volume of freight traffic has increased while passenger traffic has declined to a fraction of its former level and l.c.l. freight has all but disappeared.

The most obvious change was the conversion from steam to diesel-electric tractive power. Diesel locomotives can pull longer, heavier loads with a smaller crew, require less maintenance and are easier on the tracks than steam locomotives. Between 1947 and 1969, train and engine employment decreased 43%, and the average output per man-hour based on the weighted output index increased at an average annual rate of 5.2% between 1947 and 1968. Using gross ton-miles as a physical output measure reveals an increase of 5.7%.

The impact of dieselization was not limited to train and engine employment. Maintenance of equipment and stores employment was immediately upset becaus there were fewer diesel locomotives requiring less maintenance. The introduction of power tools and assembly line techniques further reduced the demand for shop labor. Between 1947 and 1968, the average annual increase in output per man-hour was 12.1%, and employment declines reached 66% in 1969. Likewise, mechanization of maintenance of way and structures adversely affected the number employed. Between 1947 and 1969, average employment declined 67%. Weighted output per man-hour increased at an average annual rate of 12.8% between 1947 and 1968. If miles of track operated is used as a measure of physical output, the increase is 10.7% annually.

Modern electronic equipment has reduced the need for human services throughout the railroad industry. Where the hump yard has been installed, it has almost completely automated the process of classifying trains. Centralized traffic control utilizes electronic equipment to improve safety and track utilization. Computers are reducing the human effort required to dispatch trains, trace cars and bill customers. With present technological capabilities, completely automated trains are possible.

As long as technological advancements offer the railroads an opportunity to reduce costs, they will take advantage of future changes, and the effect on employment will be much the same as in the past. However, a dramatic breakthrough in motive power or work rule changes could cause massive employment cutbacks. Without the technological advances of the past, railway employees would be extremely inefficient, and their industry would be unable to keep pace with the modern economy.