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EFFICIENCY

AS A BASIS FOR

OPERATION AND WAGES

BY
HARRINGTON EMERSON

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INTRODUCTION

WORKS MANAGEMENT, that is, the process of directing the great forces of manufacturing to the best advantage in economy, has progressed very rapidly during the past few years from the condition of a scarcely formulated practice to that of a rapidly materializing science. The rate of progress in this change has not been uniform. As usual in such phenomena, it has been marked by continuous and rapid acceleration, notably stimulated at certain points by the publication of the work of great investigators, thinkers, or practitioners in the field. An early impetus of this character was given by Mr. H. F. L. Orcutt's papers on machine-shop management which appeared in *The Engineering Magazine* in 1899. Another phase was inaugurated by Mr. Carpenter's two series on profit-making management, also published in this Magazine. One of the greatest of all, though in a more specialized direction, was influenced by Mr. F. W. Taylor's deeply scientific analysis of the times of operations, followed by his world-famed study of the art of cutting metals. Mr. H. L. Gantt's development of the bonus system, and Mr. F. A. Halsey's promulgation of the premium plan, marked other notable epochs in the growth of the new applied science. Mr. Emerson's development of the efficiency system is another such extension, later, but perhaps larger—large enough to form the basis of a philosophy and hopeful enough to have won the designation of "a gospel."

The methods advocated have already found application in some of the largest manufacturing and operating institutions in the United States. This first complete demonstration and explanation of them appeared originally as a series of articles in *The Engineering Magazine* from July, 1908, to March, 1909. They took place at once as one of the classics of the literature of industrial engineering, and the continued demand for them in permanent form has more than confirmed the original purpose held by the author and *The Engineering Magazine*, to republish them complete in a single volume. They have been thoroughly revised, in great part rewritten, and much amplified, so that even those who read them as they appeared from month to month will find a new and a fuller interest in the chapters of the book.

THE EDITOR.

PREFACE

The Spanish island, Guam, was a closed port previous to 1898. No foreign or merchant vessel was allowed to visit it. The inhabitants lived happily and lazily, in entire forgetfulness of the ten commandments and of all the maxims of Poor Richard. After it was ceded to the United States, Captain Leary was made commandant and the shiftless happiness of the natives vexed his American soul, so among other reforms he ordained clothes and work and marriage, and forbade cock-fighting, gambling, and promiscuity.

Perhaps never before were men and women in a primitive stage of social and industrial evolution brought so suddenly face to face with the deepest modern problems.

The Guamanese, having few wants, and these lavishly supplied by prodigal Nature, worked little. Captain Leary voiced the spirit of American activity by determining that they ought to work. Assuming that his premise, the obligation to work, is correct, should they work efficiently for themselves, individually creating advance supplies for wants hereafter to be developed; should they work for themselves collectively, building roads and planting parks, erecting pavilions, learning to play brass bands, etc.; should they work for posterity, building docks and public edifices, making other improvements, valuable for the future rather than for the present generation; or should they be given *corvée* tasks, as are the natives of Java by the Dutch, each worker under obligation to deliver plantation, forest, and sea fruits at an arbitrary low value, the profit being appropriated by those more intelligent and masterful? Had I been one of the younger and progressive Guamanese, I should have been willing to develop new wants and been willing to work for them, I should have been willing to work a little for the collective interest, I should have been willing to work a little for posterity, and I should have not minded giving part of the proceeds of my labor to those who could intelligently organize and direct; but I should have objected to regulation of dress, amusement, and personal habits.

It would have seemed to me rational that whether I worked an hour a day, or twelve hours a day— whether, according to individual proclivity I worked for myself, for the community, or for posterity, that I should work efficiently; but if I worked for a task master, the shorter the hours, the less per hour, the more inefficiently I worked, the better for me.

In a civilized country the problem is even more simple than it was at Guam. With exceptions so few as not to count, modern workers (as also wild animals) work for themselves and their immediate posterity. Slave labor no longer exists; labor for the community is no longer undertaken for moral and emotional rewards, as in crusades and pilgrimages. We have no Samurai class, men who were no more acquainted with money than a modern clubman with a shoemaker's or tailor's tools. We have no unpaid House of Commons and House of Lords. Our executives, our judiciary, our legislature, our army and navy, receive salaries; our physicians, our lawyers, our clergymen receive fees. There is everywhere a pecuniary reward for the time and service given.

There is today a more direct connection than ever before between individual, corporate, and national efficiency, and individual, family, and social well being, and this is the inspiration and the justification of these essays.

HARRINGTON EMERSON.

May, 1909.

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Chapter I

TYPICAL INEFFICIENCIES AND THEIR SIGNIFICANCE

NATURE'S operations are characterized by marvelous efficiency and by lavish prodigality. Man is a child of Nature as to prodigality, but not as to efficiency. If it had happened the other way—if he had followed Nature's lead as to efficiency, but had taken up parsimony as a distinctly human virtue—the human race would have been wealthy beyond conception.

Most political economists have preached parsimony, not efficiency. As parsimony is not one of Nature's teachings and as efficiency is, it would be better to aim at efficiency first and leave parsimony to the generations to follow, who will be forced to make a virtue of necessity.

The efficiency of Nature's operations is seen on every side.

There is Nature's pump, which draws up the water from the surface of the ocean to a vast height, carries it thousands of miles, and deposits it on mountain tops and over plains. No reciprocating parts, no valve slip, no lost motion, no frictional resistance, no pipe lines. Prodigal in the amount of water sucked up, prodigal in the height to which it is lifted, prodigal as to distance transported, the operation shows the 100 per cent efficiency of a perfect heat cycle.

There is Nature's storage battery in muscular reserve. A salmon will enter the Rhine from the sea, cease feeding after entering fresh water; he will swim up-stream 500 miles, in exceptional cases stay at the headwaters for 17 months, and then, not having lost much weight, will swim to sea again.

An oil engine may reach 30 per cent thermal efficiency, but the salmon, assuming his whole weight to be pure oil, without consuming it, uses up several times more energy than is yielded by an equal weight of oil in combustion.

The salmon uses atomic, not thermal, energy.

The fire-fly, the glow-worm, the phosphorescent jelly-fish, show a far higher light efficiency than has ever been reached even by vacuum lamps.

A heavier-than-air flight has very recently been attained by man; but most of Nature's visible creatures, from the midge to the heavy swan, revel in mechanical flight. From swans to humming birds, innumerable feathered creatures fly every spring from the tropics to the Arctic circle, every autumn from Arctic circle back to tropics, while some of them fly from Arctic to Antarctic.

To attain the high efficiency of the atomic energy of the fish, the high mechanical efficiency of the bird, the high lighting efficiency of the fire-fly, is not an ethical or financial or social problem, but an engineering problem; and to the engineering profession, rather than to any other, must we look for salvation from our distinctly human ills, so grievously and pathetically great.

Inefficiency, principally of administration, is alone responsible for the long bread line of able-bodied men, which continuously for nearly two years has disgraced New York City. Inefficiency, principally of administration, is alone responsible for the 700 starving children, fed at the East Side schools in New York.

For every mouth that comes into the world, there are two hands, two feet; and if each set of hands and feet does not have an organizing brain to direct it, there are occasionally great creative and organizing minds, whose province is to forestall bread lines and infant starvation by wisely directing willing hands and feet but weak heads.

When one considers such products of modern engineering knowledge and skill as an ocean steamer, the perfection of design, the perfection of machinery, the perfection of line and staff organization; or when one considers a modern New York office building, the Hudson Terminal for instance, where one finds, without any futile or inept talk, discussion, or legislation, a harmonious and smooth-working combination and aggregation of intense individualism, intense socialism, intense communism—and even intense anarchy, since all the tenants come and go as they please—one realizes that it is to engineering knowledge and practice one must look for redemption from existing evils. Men, women and children starve, not because there is not abundance and plenty, not because the few have appropriated the portion of the many, but because there is unnecessary waste. The actual and potential wastes in each year amount to as much as the total accumulations of wealth, and if all the possessors of accumulations were left in undisturbed possession, and the wastes of current production and use eliminated and the gain equitably apportioned according to meed and deed, no woman or child would need to do mill or factory, store or office work, no superannuated man or woman need toil, no young man need delay marriage, nor any head of a family be torn by anxiety as to the feeding, the clothing, or the housing of his dependents.

It is distinctly the business of the engineer to lessen waste—wastes of material, wastes of friction, wastes of design, wastes of effort, wastes due to crude organization and administration—in a word, wastes due to inefficiency. The field is the largest and richest to which any worker was ever turned.

Progress—absolute, not temporary and time-serving—will be made slowly or rapidly in proportion as ideals and standards are low or high.

The field is large and rich because so little is being done, because there is so much to do.

Very few, outside of those who have made special investigations, realize how very low the average efficiency of endeavor is, even in a highly civilized country like the United States. Everywhere we see brilliant results; rarely can anyone follow the losses between result and initial supply.

A filament, enclosed in a glass bulb, is heated to incandescence by an electric current and we use the glow for illumination. It takes a definite voltage and a certain number of amperes to heat a given filament to and keep it at the required brilliancy. There is frictional loss between lamp and dynamo, loss in the dynamo, losses in the steam engine driving the dynamo, losses in the boiler, in the furnace, in the transportation and mining of the coal.

Man wastes three-quarters of the coal in the ground, brings the remaining quarter to the surface by inefficient labor and appliances, doubles, trebles, or quadruples its cost by transportation charges to furnace door. Rarely is as much as 10 per cent of the energy of the coal transformed into electrical energy, and of this only 5 per cent can appear as light. Ten to twenty times as much light is provided as necessary on a writing table, because of the distance of the bulbs from the place where the light is needed. The light itself glows continuously, not only during intermittent work but often several hours before and after it is needed. Out of ten thousand B. t. u. in the coal mine we use in necessary light the equivalent of about six.

The fire-fly converts the hydrocarbons of its food into light with an efficiency of 40 per cent. It flashes its light at intervals, thus making it most effective by contrast with the surrounding darkness, and it emits no more light than is necessary for its purpose.

In production the fire-fly is about seven hundred and fifty times as efficient, in volume use ten times as economical, in time use twice as economical. The fire-fly is fifteen thousand times as efficient as his human rival.

If any human activity is followed out from initial reservoirs to final attainments, a similar sequence of losses will be found—losses gauged not by any ideal or unattainable standard, but by what is being continuously accomplished all around us. Even if, as yet, some of the high efficiencies seen in Nature are beyond reach, it is a greater reason for eliminating those wastes which are avoidable and which are primarily responsible for the starvation of men, women and children.

Not only are occurring wastes more flagrant than is generally admitted, but it is also not realized that very hard and extremely exhausting work is not an evidence of efficiency.

The fire-fly works comfortably; the miner and furnace stoker do not. Recently on the first of the hot summer days, on the charging floor of an iron foundry in the middle West, in a foundry far-famed for its advanced methods, three men, weary, haggard, worn to the limit of human endurance, were throwing the pig, scrap, and coke into the cupola; yet in spite of their exertions they were working with only 33 per cent efficiency. At another foundry, two men, with less fatigue and effort, charge regularly a cupola twice as large. What caused the 67 per cent drop in efficiency of the three men? The tracks for the cars bringing up the supplies of pig, scrap, and coke, were so located as to the single cupola door, that three men were necessary to handle the materials, pig, scrap, coke. One lifted a pig from the car, passed it to his companion, who swung it to the third man, who threw it into the cupola. This had been going on for twenty years. At the other foundry there were two cupola doors; the car came up so that each man unloaded, with minimum of effort, directly from car into cupola.

That men should work very hard for 9 or 10 hours per day is not a hardship if they are interested in their work, or if, in the larger interest of the community, they work efficiently; but to work desperately hard for many hours at dirty, hot and rough work, yet waste 67 per cent of the time and effort, is unpardonable. What could have resulted from an elimination of this waste?

1.—The product could have been cheapened.

2.—The men could have worked one-third the time and have accomplished as much.

3.—One man could have done all the work and have earned three times as much.

The benefits should however be distributed in all three directions. Fewer men should work less hard, receive higher wages, and deliver a cheaper product.

The inefficiency on the charging floor pervaded the whole of this foundry although it stands exceedingly high in its class. The proof of the general inefficiency is evidenced by the fact that the other foundry turns out its finished castings for less than half as much per 100 pounds, labor, materials, overhead charges included.

It is not because men do not work hard, but because they are poorly directed and work under adverse conditions, that their efficiency is low.

At a southern foundry the work of unloading pig iron from box cars was done by negroes. The current wage rate was $0.16 per hour, the performance about 2 tons per hour per man. It was resolved by the management to increase the speed of work, to lessen its cost, and to add to the earning power of the laborers. Conditions were standardized, so that each worker could unload directly from car to pile. The speed of work was standardized at 7 tons an hour. The average distance each pig had to be moved was less than 10 feet, the total horizontal load movement 140,000 pound feet, or 26 pounds one mile in one hour. To lift 14,000 pounds 3 feet vertically in one hour requires $\frac{1}{47}$ part of a horse power. Analyzed in this way, the task appears reasonable. Wages were set at \$0.027 per ton, or, on the basis of 7 tons an hour, at \$0.19 per hour. The men actually and continuously unloaded 10 tons an hour and earned \$0.27 per hour, an increase in output of 500 per cent, an increase in wages of 69 per cent. The increase in tons above 7 per hour was wholly voluntary, a reflex response to the extra pay.

Railroad repair shops throughout the country do not show 50 per cent efficiency on an average as regards either materials or labor. A case observed was as follows:

A foundry made, for a railroad shop, big cylinder bushings. These, after being machined in the railroad shop, weighed about 375 pounds, but the orginal casting weighed 1,780 pounds. It took three days to remove 1,405 pounds of cast iron. It should have taken less than one day if the rough bushing had weighed only 600 pounds. The difference in result is reduced to financial expression in the following table:

COMPARISON OF COSTS.

	As made.	Standard.
Weight, rough	1,780	600
Cost per pound	$0.04	$0.04
Total cost	$71.20	$24.00
Labor	3 days	1 day
Cost of labor, $3.00 per day	$9.00	$3.00
Machine charge, $2.00 per day	$6.00	$2.00
Overhead charges, $2.00 per day	$6.00	$2.00
Total cost	$92.20	$31.00

In this same shop the most efficient men were checked up and found to average only 60 per cent in actual output, compared to realizable standards. At the end of two years of persistent effort many of the best men were brought up to 110 per cent efficiency, but there were still men as low as 10 per cent as to actual output compared to reasonable standard—the same standard on which others realized 110 per cent.

In another big locomotive shop, a careful study of the machines which had been in operation for 20 years showed that the location of 75 per cent of them would have to be changed, so as to facilitate the orderly, effective, and economical progress of work from one to the other. This and other eliminations of wastes doubled the output, with less labor costs.

In consequence of general shop inefficiency and operation inefficiency due to similar causes, locomotive repair costs, on western railroads, run from $0.08 to $0.12 a mile; yet a most efficient superintendent of motive power on a large transcontinental road succeeded in dropping to $0.05 and had only touched the high spots, his well considered opinion being that $0.04 was reasonably attainable. On another transcontinental road, repair costs per mile were dropped from $0.1374 to $0.08 by persistent effort, but when the efforts were relaxed expenses immediately rose to $0.17. They should have come down to $0.06. Eastern and southern roads, with their small engines, better coals, and better waters, are not to imagine that they show any higher efficiency. They are on the whole worse.

A leading eastern road established piece rates in its car shops and then limited the earning power of the men. When there was a sudden demand for increased car repairs, the limit was taken off and the men doubled their earnings. Then the limit was put back. The large eastern roads have signally failed in attempts to increase the efficiency of their repair shops.

In a leading southern shop many men were receiving 12-hours pay for 3-hours work.

Coal wastes on railroads are almost as bad as labor and material wastes. On a very large railroad system, fuel charged per 1,000 tons of train weight per mile averaged 260 pounds; yet actual tests where all coal used was weighed, showed a consumption between terminals of only 80 pounds. This actual consumption could be doubled, be made 160 pounds, yet this standard be only 60 per cent of the coal paid for.

The total amount of preventable material and labor wastes and losses in American railroad operation and maintenance approximates $300,000,000 a year—not less real, but more easily preventable, than the $600,000,000 of fire losses and fire-department expenses, which actually occur in the United States. This inefficiency of effort pervades to a greater or less degree all American activities.

Mr. F. W. Taylor, who has given twenty-five years to the minute and scientific study of efficiency, and who as an incidental consequence developed high-speed steels, thus speaks of it.

> That the first-class man can do in most cases from two to four times as much as is done on an average is known to but few and is fully realized by those only who have made a thorough and scientific study of the possibilities of men.
>
> This enormous difference exists in all of the trades and branches of labor investigated, and this covers a large field, as the writer together with several of his friends have been engaged, with more than usual opportunities, for twenty years past, in carefully and systematically studying this subject. It must be distinctly understood that in referring to possibilities, the writer does not mean what a first-class man can do on a spurt or when overexerting himself, but what a good man can keep up for a long term of years without injury to his health, and become happier and thrive under.

Inefficiency similar to that in the manufacturing shops exists in all building operations to the same or even greater extent. Mr. Taylor found a labor efficiency of only 28 per cent in the rough labor employed in the Bethlehem Steel Company's yards. The writer, by time studies, determined an efficiency of only 18 per cent in a gang of laborers excavating a foundation, and even less on some construction work in the erection of the large office buildings in New York.

When brick-laying conditions are standardized, bricks have been laid in inside walls at the rate of

20 a minute. Three-quarter inch rivets in structural iron work have also been driven at the rate of 20 a minute, but with a continual regular performance of 3,000 in 10 hours. Bricks are usually laid at the rate of 800 to 1,000 per day, and rivets driven at similar rate.

The United States and State agricultural bureaus have determined like inefficiencies in farming operations. The land was there, the effort was there; but owing to poor preparation of soil, poor planting, poor cultivation, the net results in such great staples as cotton, wheat, and corn, have been less than half of what proper methods, with the same climatic conditions, land and men, have since realized.

The agricultural stations and Mr. Luther Burbank, combined, have been doing for agriculture what Mr. Taylor and his disciples have been doing for the machine shops.

In our whole educational system there is the same inefficiency. Years are given to study, yet better results have been attained in months. In American schools the two main objects of education, amenities and discipline, are largely neglected; and instead an immense amount of time is consumed acquiring quantities of information of very low absolute or ultimate value.

Inefficiency is not a local evil. It extends through the whole of American life—extends through the whole industrial life of the world. The Chinese coolie, who as a daily task carries 100 pounds 27 miles for $0.27, is industrious and hardworking, but not more inefficient than the

American railroad which moves a freight car an average of 23 miles a day, the cars at best averaging only half loads per mile.

By a very inefficient use of his brain and muscles, the coolie carries the maximum load a maximum distance for a minimum price. The American railroad, by the most advanced engineering and industrial methods, carries an absurdly small net load for an absurdly small distance at an unnecessarily high cost.

Prevailing inefficiency is not a lapse from former virtue. We cannot praise "the good old times" when everything was done better. The coolie in spite of his many virtues is not better than the railroad whose charges per ton mile average only one-thirtieth those of the coolie. The difference is, however, that elementary though his methods are, the coolie has high standards, evolved during many centuries, but in Europe and America the railroad and the modern shop, using methods of great promise, have as yet no standards.

In tabulating inefficiencies it is not assumed that it is a human ideal to work hard all the time and spend nothing.

The unit is the man. If he elects and can manage it, he can live in a tub, bask in the sun, and curtail his efforts and wants to a minimum. If he elects, he can work hard for days, weeks, or months, and in short and riotous extravagance spend all he has accumulated. The fire-fly probably is chargeable with both extremes, but what is expected is that the man shall emulate the fire-fly in working efficiently when he does work, whether the total time given to work be long or short.

Chapter II

NATIONAL EFFICIENCIES; THEIR TENDENCIES AND INFLUENCE

INEFFICIENCY is a form of waste, of loss; it lurks everywhere—in processes, in materials, in individuals and in nations. There is, however, a difference in kind between the two forms of inefficiency, one manifest in processes and materials and the other manifest in individual or nation. To the efficiency of a process or in the use of a material there is a clearly ascertainable maximum, and when it is exceeded the material gives way, as in the Quebec bridge; but to the efficiency of an individual or of a nation there is no predeterminable limitation. In the passion for modern scientific accuracy it has proved more interesting, and more has been done, to solve the lesser problem of efficiency in process or material, almost wholly ignoring the larger problem of individual or national efficiency.

Men are quick to catch and appropriate the ideas of other designers as to bicycles, steam engines, gas engines, automobiles, so that the same standard designs and performances ultimately occur in widely scattered countries; but individuals and nations differ fundamentally not nearly so much in the degree as in the nature of their characteristics. They differ not as one coal from another, but as sulphur, carbon, hydrogen, and radium differ. The analogy of fuels is illuminating and may further a better understanding of the whole question of efficiencies. If a coal yields 13,000 B. t. u., the combustion problem is to utilize as large a percentage of them as possible. Other elements in combustion with oxygen may evolve only 4,000 B. t. u. per pound, as sulphur, or 60,000 as hydrogen; or radium, without troubling to combine with oxygen, will evolve per pound 210,000,000,000 B. t. u. or thereabouts.

It is the province of the chemist to determine the actual number of heat units in any element or combination, so that we have, for each, a theoretical maximum. It is the task of the combustion engineer to devise apparatus which will utilize the largest percentage of the heat units in the fuel; but the more difficult problem of the economic engineer is to select the fuel and burn it so as to secure the desired result at lowest cost.

It is more difficult to select intelligently, between the limits of a drift-wood burning furnace and a Diesel crude-oil motor, the power installation for a tug boat than it is to design and secure good furnaces, good boilers, or good engines. A very elementary furnace and boiler will yield 50 per cent efficiency; the best boiler and furnace, and then only under exceptional test conditions, may yield as much as 85 per cent; and no increase of expenditure, no increase of designing skill, have thus far realized 90 per cent. When, however, one passes from sulphur to carbon, from carbon to hydrogen, from hydrogen to radium, the progression is not one of 80 per cent improvement between best and poorest, but the best, radium, is fifty million times better than the poorest, sulphur.

Applying the analogy of fuels to individuals and nations, we have as yet no analysis of humanity which will enable anyone to determine their capabilities. We do know how the best individual will react against some definite mechanical proposition; we do know the best record as to running or swimming or any other athletic or manual performance, with the certainty that it will never be appreciably bettered; but even this knowledge has as yet been utilized to very small extent, outside of sport, to increase individual efficiency in a particular task. Our manipulators of human material are constantly using human radium on a grate intended for lignite coal, very much as the early engineers in the natural gas fields used natural gas expansively to drive engines originally built for steam.

The difference between sulphur and radium as evolvers of heat is fully paralleled in the difference between the Italian immigrant (who, with wheelbarrow, works at less than 20 per cent efficiency on the railroad dump), and the Corsican, of poverty-stricken antecedents, who in early manhood pushed the whole of Western Europe and also the two Americas a hundred years forwards. It is not assumed that every immigrant boy is an embryo Napoleon; but from John Jacob Astor on, foreign immigrants who would have remained peasants in their own country have become dynamic forces in the New World, simply because, to these radium individuals, opportunity occurred.

As to any man, and as to any nation, the as yet unsolved problems of efficiency are: (1), to enable each to accomplish the uttermost in reaction with the task set, average present efficiencies being about 60 per cent; and (2), to set each at the highest task of which it is capable, present average efficiencies being so much below one per cent of the best as not to warrant an estimate.

The differences between coal and coal are molecular; the differences between sulphur and radium are atomic. The differences between the speed of one runner and another, the natural resources of one nation and another, are physical; the differences between the spirit of Diogenes and the spirit of Napoleon, between the spirit of the Papuan and the spirit of the American, are psychical.

Inherited wealth and inherited power have rarely made men great, although when young heirs first come into their inheritance they may for a short time dazzle by their prodigality. Great natural resources will not in the long run maintain nations, although during the period of reckless squandering they may seem prosperous to themselves and to others. For the past 10,000 years Central Africa has teemed with natural resources, but it was the Vikings of bleak Norway who conquered the European and Mediterranean littoral, incidentally also taking possession of Iceland, Greenland, and visiting the northeast coast of America.

Alaska is a more favored region than either Norway or Switzerland. It has 100,000 square miles of agricultural land, the best coal in North America, lead, copper, silver and gold mines, vast forests, rich fisheries, a great fur trade, and 20,000 miles of ice-free sea coast, harbor-indented, along the great Pacific highway between all Asiatic and all North American ports. The Eskimo, Aleuts, Indians, and mongrels of Alaska, surrounded by unparalleled natural resources, have accomplished little, although their supineness has been no greater drawback than the stupendous ignorance, neglect, and corruption to which this empire of the future (if men are forthcoming) has been subjected by some of the departments at Washington. The Swiss, for whom nature has done so little, have, individually and nationally, developed high efficiency. When Alaska, the relatively richer country of the two, has as many inhabitants as Switzerland in proportion to its area, it will be a nation of 120,000,000. No wonder the Canadians, with nearly six times the area of Alaska, have hopes of repeating in America the polar drift of empire so manifest in Europe, Asia, Africa, South America, and Australasia.

Between one civilized country and another there are extremes of variation in natural resources, yet all are prospering. The efficiency of the workers in all of them is low, yet each country is growing rapidly in wealth. The cause of prosperity cannot lie in natural resources, since some of the countries with the most resources are most backward and others with the poorest resources are most forward. The cause of prosperity cannot lie in the ability or fidelity of the workers, since all of them, when checked up, are found to be of low average efficiency. The cause of success must therefore lie either in some common trait which all possess, or in the exploitation of some different trait in each. The only common trait is ambition, the desire for success and wealth; but the gratification of ambition, the attainment of material success, has each time been due to a different psychical instinct. In Alaska the eagle, the seal, and the bear all grow fat by feeding on salmon. The food is common to all three, but the method of appropriation is different. The eagle descends from the air, and lifts the salmon out of the sea; the seal pursues and seizes the salmon in the water of the sea; and the bear scoops him out with his paw when he finds him in the shallow brooks. The British, French, Germans, hunt success along lines as different as those of the eagle, the seal and bear. It is easier to describe the psychical differences between eagle, seal and bear than to describe the psychical differences between the great industrial nations. Nevertheless the differences exist, and the causes of the respective successes cannot be understood unless the reaction of success of these psychical traits is apprehended; and, what is more important, that nation will in the long run reach a higher level which is able not only to appropriate the best designs and processes of its rivals but, what is immeasurably more important, to appropriate also and possibly to improve their psychical inspirations.

The English, the French, the Germans, the Japanese, the Americans, are not great because they all have schools and seaports and coal, but because schools and seaports and coal mines have fed wholly different natural characteristics. To discover these different national characteristics it is necessary to back off, both in space and time, so as to lose details and see only the governing traits. No nation can be reduced to a formula, but an attempt will be made to separate out, for a number of leading industrial nations, traits of which they more or less seem to possess a monopoly, and which for that very reason merit careful analysis by their rivals.

In recent centuries Great Britain has been easily the leader both commercially and industrially. The English also were up and doing before daybreak in other directions, and by the time the other nations woke up, either yawningly or to the sound of some revolutionary alarum, the English were anywhere from several decades to several centuries on their way. They limited the power of kings, 1215 A. D.; they abolished divine right in 1649, selected by vote their own sovereign in 1689. The American colonists woke up in 1776, the French in 1789, the Germans in 1871. During the period when other nations were pulling each other down in continental Europe, the English were appropriating large parts of Asia, America, and Africa as well as the continental islands. When other nations were using wood and developing charcoal burners, the British were opening coal mines. When other nations were building post roads, the British were stringing iron rail; when the Americans were building the best and fastest wooden clipper sailing ships, the British were not only building iron steamers, but they were also calmly taking possession of all the strategic points of the seven seas. While other nations were stretching wires on poles along railroad rights of way within their own boundaries, the British were enmeshing the globe with submarine cables. It is not because the British are the greatest shipbuilders that they control the sea, but they incidentally build ships and a few other things because at least 100 years before any one else realized its importance, they made the unclaimed empire of salt water their own. For any other power at this late date to aspire to rivalry on the sea is futile—is laughable.

Consider the North Sea. Sweden, Russia, Germany, Holland and Belgium, all the immense maritime trade of Northern Europe, goes to and comes from the Atlantic Ocean and all there is beyond, through what the English proudly call the English Channel, with the cliffs of Dover at one end and on one side and the Channel Islands at the other end on the other side. Consider the Mediterranean, bottled up at one end at Gibraltar and at the other by the French-conceived, designed, and dug, but at present English-owned Suez Canal, with Malta conveniently and centrally located in the waist, with Cyprus watching the egress from the Black Sea of both Turk and Russ. The only nations in Europe who can go to sea without British consent are the Norwegians, the French, the Spanish and the Portuguese. Consider the Atlantic Ocean, north and south, studded with British mainland ports and island outposts along all its four sides, and up and down through the middle. Consider the Indian Ocean—Cape Colony at the western southern end, Australia at the eastern southern end, the western northern entrance blocked at Aden, the eastern northern entrance blocked at Singapore, with Mauritius, Ceylon and sundry other islands scattered centrally around, very useful for all sorts of purposes, coaling and repair stations, landings for submarine cables, shores for space telegraph installations. Consider the Pacific Ocean—not quite so completely a British sea, but nevertheless even in it they would be first in length of sea coast were it not for Alaska's indented mainland and islands. Although second, as to mere length of shore line, they have, both on American and Asiatic side, strategically a greater number of important posts, not counting Australia and New Zealand to the South, than any other power, and when the all-British cable was laid from Vancouver to Australia and New Zealand, as many British islands as were needed turned up conveniently for mid-ocean stations.

Not content with commanding the European Mediterranean, they also command the American Mediterranean, with the counterpart of the Suez Canal in the St. Lawrence River, the deep-water channel between the Great Lakes and the Atlantic. They also control one side of the water passage from Lake Erie to Lake Ontario, from Lake Huron to Lake Erie, from Lake Superior to Lake Huron. On the Pacific side of North America it is the same. There is another though smaller inland sea there, the matchless Puget Sound; but, in spite of 49 degrees north, the treaty boundary line, the British not only reserved their own independent sea outlet north of Vancouver Island, but they established another Gibraltar at Esquimalt, on the north side of the Fuca Straits, only entrance to the largest and most important American harbor on the west coast, but commanded by British guns.

Although the United States at last controls Panama, during the whole of the last century it was not any American statesman who foresaw the importance of this control, nor was it any American ambition that dared attempt the task of breaking the Isthmus.

Two hundred years ago the British appropriated a complete chain of islands cutting off both Gulf of Mexico and Caribbean Sea from the Atlantic Ocean; in 1827 Goethe, in a masterly discussion of the importance of the Isthmian Canal said: "I would be surprised, if the United States would miss the chance to get such a work into her own hands. It is entirely indispensable for the United States to make the passage to the Pacific Ocean, and I am certain that she will accomplish it." It was however not the near-by United States that first undertook the work, but the distant French.

So early and so persistent was the British instinct of sea control that surprise is caused, not that the British have so much, but that they let so much of value slip through their fingers.

By right of exploration they might have taken possession of the whole of equatorial Africa; they might, without anyone making protest, have annexed both sides of the Straits of Magellan; they might have seized on both the Diomede Islands in the middle of Bering Straits, and it is incredible that after discovering the Hawaiian Islands they should have let them go.

For the British these islands have strategic location and value because the only direct sea route on which they are situated is the one between Vancouver and New Zealand. They are of no value strategically to the United States, as they lie at least 1,000 miles south of any direct route from the United States to Asia, lie 1,000 miles out of the course of steamers making the run from Panama to Singapore, and the attempt to magnify them as an important sea possession of the United States merely accentuates the difference between the deep-set purpose of the English and a fatuous impulse.

So sensitive are the British as to anything that appertains to the control of the sea that they get into a panic at the mere suggestion of tunneling the English Channel, or flying an ærodrome across the Channel; and when the Germans built the fastest steamers for the Atlantic trade, the English did not rest until they had evolved a new form of steam engine, a new form of screw propeller, had built larger boats than any other flag possessed, and with the combination, regained the lost blue ribbon of the sea. Similarly, as soon as the French, Germans, Americans laid a few straggling sub-oceanic cables, the British at once set up space-telegraph stations so that soon no British steamer anywhere need be beyond call from British land.

This persistent far-sight, this stubborn holding on to an ideal, characterizes the British bull-dog in all things, although illustrated above only as to sea power; and it is perhaps well for the rest of the world that on the whole the Briton is good-natured and that he does not have too many ideas.

The predominant characteristics of the French are quite different; none the less admirable—in fact, more progressive. The French are brilliant innovators and as a nation they think logically and execute artistically. Their revolution had its inception in the work of the encyclopedists, and its culmination in the Code Napoleon. In the Theatre Français the prices of the seats are cut into the solid marble, but the monogram of the government is detachable, because forms of government are the accident of the moment but the principles of art are eternal. The English follow up persistently a few all-important matters. The French evolve brilliantly along entirely new lines. The French were the first to ascend into the air in balloons, the French invented and made practical the bicycle, and France still holds all the official records for all sorts of heavier-than-air flight. The French started both the gas engine and the automobile; they first used rapid-fire machine guns, the mitrailleuse; their passenger locomotives make the fastest regular runs in the world; they developed compound locomotives, and also, the most powerful freight locomotive, the Mallet articulated, is of French design. To the French we owe the first successful submarines; to a Frenchman, Daguerre, we owe photography, and to another, pyrometry which has placed metallurgy on a scientific basis. The French invented and put into effect the decimal system, which has been universally adopted for money (except by the insular British) and the French also established and maintained bi-metallism, without a hitch, for 70 years, although in that period the greatest fluctuations that the world has ever experienced occurred in the relative production of gold and silver. The French have always had the intelligence to avoid the financial panics that have disgraced Great Britain, Germany, and the United States. The French dug the Suez Canal and also started the work at Panama. Most appropriately, we owe to the French modern stearine candles, the Argand burner, and the brilliant use of the electric current for light. Storage batteries of both types were discovered in France, as also plate glass, rolled glass, and wire glass. A Frenchman first deciphered the hieroglyphics of Egypt; another Frenchman, Pasteur, expanded and made rational the practice of inoculation; another one, Berthelot, developed modern chemistry, and to the French we owe artificial silk.

It was because the French teem with revolutionary ideas that Franklin's ability received from them more immediate and cordial recognition than from either Americans or British.

The characteristic trait of the French is brilliant innovation carried out in an orderly, logical, and artistic manner.

Germany is one of the world's greatest industrial powers—so menacing, in fact, that the eyes of the industrial and commercial world are turned apprehensively in her direction. Until recently, however, she has always been bringing up the rear, the slow but sure turtle among the nations. When France, Spain, and England were parts of the Roman Empire, assimilating Roman civilization, Germany was a storm center of savage ferment. Italy officially adopted Christianity in the fourth century, France became Christian in the fifth century, but it was not until the ninth century that Charlemagne gave the Saxons their baptism of blood. When the French and English were evolving parliaments and courtly manners, the Germans were engaged in their thirty-years' war. It is characteristic that the renascence in Italy and France took the form of a revival of classic art, literature, and culture; in Spain and England took the form of over-sea adventure; but in Germany the form of religious revival and reform. It is also not less characteristic that while other nations have made progress through revolution and violence, the Germans are rapidly overtaking them through peaceful evolution.

American wooden clipper vessels were the queens of the sea from 1800 until the introduction of steam. Previous to 1870 the only German shipbuilding was in the Baltic yards where American clipper models were imitated, but shortly after 1870 Germany "resolved" to build ocean steamers and in 25 years her ocean liners, German-designed, German-built, German-manned, officered, became the fastest and finest vessels afloat. It required extraordinary effort on the part of the English to regain the lead. America has built more locomotives and owned more miles of railroad, many times over, than Germany, but in this year of Grace 1908 it is the German principle of superheating that is being applied to American locomotives.

Germany succumbed helplessly before the genius of Napoleon in 1806, but less than two generations later Von Moltke had remodeled the oldest of all organization—military—by adding to line organization the principle of developed staff organization, and it is staff organization that has made Germany during the last 40 years easily the pre-eminent military power in the world.

An English authority on iron and steel has recently shown that in spite of adverse natural and economic conditions which make the average production cost of German pig iron 50 per cent higher than the average cost of British warrants, yet owing solely to better organization and more advanced industrial discipline, German exports of iron and steel increased 350 per cent in the decade from 1897 to 1906–7 while the British increase in the same period was only 10 per cent.

This habit of the Germans of "resolving" that they will accomplish certain results, and then forthwith succeeding, is exceedingly disconcerting to commercial and industrial rivals. Whether the subject be military organization, the designing of ocean steamers or of locomotives, technical or industrial training, industrial and commercial expansion, all the German needs to do is to desire to surpass—and he succeeds, not by far-sighted annexation of a field not yet taken, not by brilliant creation of a new field, but by patient improvement on the model supplied. "*Billig und schlecht!*" said Prof. Reuleaux of the German exhibits at the Centennial in 1876; "made in Germany," the legislative badge of inferiority in 1880; but today German products are no longer "*Billig und schlecht*" and, in many lines "made in Germany" is a label of highest excellence.

It is fortunate for their rivals that German efforts are so often indiscriminate, that they will elaborate mathematically the theory of the Dutch windmill and overlook the sirocco blower, that they perfect staff organization in the army and that they have failed to apply it to their shops, being in this respect far behind the best American developments!

Americans have little of the persistence of the English, little of the brilliancy of the French, and not any of the patient science of the Germans. The immigrants or adventurers who of their own choice, full of faith and hope, came to the land of sunshine and opportunity, were the restless daring spirits of all the nations of Europe; first the Spaniards, then the French, later the English, and more recently the Irish, the Germans, the Scandinavians, the Russians and the Italians. For all these the past held but light ties; they came to stay, and the little they did bring of mental or material equipment proved of scant value. There has been in all of them, of whatever decade or nationality, the common restlessness, the common eagerness to make good. Before them stretched out the promised land, forest and plains, farms and urban sites, transportation monopolies, minerals. The gold-seeker in California, equipped with elementary courage and pick and shovel, exhausting the shallow placers, spending the proceeds in individual aggrandizement; such is the true type of the American, whether he be named Astor or Vanderbilt, Rockefeller or Morgan, Jas. J. Hill or Harriman, Carnegie or Guggenheim. Because there were no traditions to hamper, because those prospered most who acted most energetically, American enterprises have been characterized by spasmodic and disconnected impulses, very different from the dogged pluck of the English or the logical development of the French or the studied results of the Germans. In America personality has been everything—personality inbred until often in one generation it becomes sterile from lack of cross fertilization. Because of different personality, not because of different problems or different opportunity, the New York Central Railroad and the Pennsylvania Railroad have grown and prospered, but the Erie Railroad, between the same terminals, has always been in difficulties; and because of varying personality, far more than varying conditions, such railroads as the Union Pacific, the Northern Pacific, have swung up and down and then up again between extremes of inflation and depression. In the United States whether in religion, politics, transportation, commerce or industry there is no persistence nor clear thought nor profound preparation.

An agent of Lloyd's visiting the Altantic Coast shipyards of the United States reported that American materials were fully as cheap as English materials, that American wages were no higher than British wages, but that the very greatly increased cost of American-built ships was due wholly to the enormous inefficiency of organization and performance. There are instances in an American shipyard of several hundred mechanics, lolling, sleeping, smoking, in the double bottom of a battleship under construction, drawing pay but doing no work whatever. Yet, when the mood takes the American, creations more stupendous, more beautiful than the world had ever dreamed of, suddenly spring from nothing, as in the filmy beauty and sublimity of the World's Fair grounds and buildings at Chicago, yet as suddenly these creations fade back into nothingness leaving only a memory; while Stonehenge, the pyramids, the Parthenon, Notre Dame, St. Peters, endure.

The American, whether at Chicago in 1903, or on the Alaskan White Pass in 1899, crowds the progress of 2,000 years into a single year; but to mark the milestones of time, he leaves neither tombs, cathedrals, palaces nor anything else that holds out a promise of secular endurance. Individuality has been supreme, it has accomplished so much. There have been great inventors—Franklin, Howe, Maxim, Edison, Westinghouse, F. W. Taylor—but what they have created has rapidly become the property of all mankind. When lavish opportunity no longer exists, when invention becomes less the inspiration of the moment and more the result of patient research, how then will it fare with the American in the cosmopolitan struggle for first place?

Latest of the civilized nations are the Japanese. The occidental world was opened to them by Perry in 1853 and as late as 1867 they were still using bows and arrows, two-handed swords and chain armor. The Germans and the Japanese (not counting oriental Europe) emerged latest from feudalism and rose into world prominence about the same date, and for that reason both have proved dangerous, because both were compelled to absorb so much from others, and yet were able to supplement it with their own virile special virtues. The Japanese, with an open-mindedness unparalleled in the history of the world, sent forth their brightest young men to England, to France, to Germany, to the United States; they adopted eclectically all that was best, adapted to their own needs what they had selected, and soon they became adepts. They have sat at the feet of the English in all matters appertaining to the sea, from shipyard to ship officers, from ship models to ship insurance; they have sat at the feet of the Germans in all matters appertaining to military organization, and, as the expedition to Pekin and the Russian war showed, improved on their models; they are as logical as the French and more progressive than the Americans.

Ascribing to the English the efficiency of wise anticipation and continuous persistence, to the French the efficiency due to their innovations of supreme value and merit, to the Germans the efficiency due to their perfection of organization, discipline, and scientific minuteness, to the Japanese the efficiency due to open-mindedness and marvelous power of assimilation, to the Americans the efficiency due to individuality—it cannot be doubted that it would be more desirable and produce better results to graft on the individualism of the United States persistence, clear habits of thought, scientific patience and open-mindedness, than to let loose intense individuality among the English, French, Germans and Japanese. The trouble with the American is that as yet he is provincial, skeptical as to the value of anything outside his own limited experience, a trait amusingly illustrated in the way he takes for granted that millions of foreigners shall cheerfully give up their allegiance for the sake of American citizenship, but is indignantly surprised when any American seeks naturalization in Europe, irritatingly illustrated by the way he repels criticism by the childish claim that his conditions are peculiar.

The boundless natural resources of America are being exhausted. Will the American forever be able to maintain a lead through intense individuality alone, or will he industrially as a nation recede before the German, even as native American names have disappeared from Broadway, New York, and been replaced by miles of German names? Will mere resourcefulness suffice in the future? Because he is resourceful, because he is adaptable, because he has always delighted to force the game to the uttermost, it may be that all he needs is a set of higher standards, and that if they are supplied he will realize them sooner than any competitor.

Standards except as to a few performances are as yet undetermined in the industrial world. If the American sets them high, he may attain them, and the prevalent democracy may make it easier for each worker to rise to the limit of his capacity.

CHAPTER III

THE STRENGTH AND WEAKNESS OF EXISTING SYSTEMS OF ORGANIZATION

IT is notorious that great aggregations of wealth and power usually do not operate as efficiently as smaller concerns. Nothing in the United States is so gigantically inefficient in proportion to its power and opportunities as the United States Government, equally in what it attempts and in what it fails to attempt.

The great industrial and transportation corporations are often very efficient in manipulation, but content with low efficiency of operation, although there are notable exceptions. The great ocean shipbuilding yards from Maine to Virginia, from Puget Sound to the Bay of San Francisco, depend not at all on the internal efficiency, (which enables the International Harvester Company, although a thousand miles inland, to export in competition with the whole world) but solely on absolute prohibition of competitoin and on lavish government appropriations. It is the little American plant manufacturing automobiles, motor boats, or bicycles, making locomotive repair parts, or some other specialty, that defies the competition of the world.

The ten-million-dollar and upwards company ought to be able to supplement every dollar-a-day worker with a two-hundred-thousand-dollars-a-year staff of assistants, thereby making the worker four times as effective and gaining a crushing advantage over the smaller concern which cannot afford the same aggregation of specialized knowledge. The great concerns, however, have conspicuously failed to develop this advantage, even if they do have a large staff of experts—a very different thing from a staff organization which gives the least worker the needed direction, stimulus and advice. A two-hundred-thousand-dollar staff for a dollar-a-day man is neither utopian nor expensive. On the contrary it is to the highest degree economical, if almost infinitesimal attention from a very high-priced man will make, as to his specialty, one thousand or twenty thousand low-priced men four times as effective.

To preserve the adult individual, Nature uses staff organization; to preserve the race, Nature uses line organization. Both are necessary, and they may operate separately, they may alternate, they may work in parallel; but always and everywhere it is one or the other or a blending of both. Man, the individual, is fitted out with a number of aids, each far superior to him, each knowing what to do and how to do it, knowing how to respond to his every call to the extent of its ability. His lungs, his heart, his stomach, his nervous system, how instantaneously they come to his rescue in an emergency! On the other hand, a father is succeeded in time by his son, one generation gives way to another; "the king is dead, long live the king!" This is line organization.

The strength of line organization lies in its indestructibility. A company cannot be destroyed as long as two men are left. The captain is succeeded by the lieutenant, and if this one falls, a petty officer takes command. There is always some one in authority. The weakness of line organization is that no one man knows much more than any other, that promotion is by seniority and not by merit. If a company loses its way in the woods it is all lost together. The captain has no special knowledge to meet the emergency. The weakness of staff organization is that if one member of the staff collapses, the whole organization goes to pieces, as when the heart stops beating or the lungs fail to find air. The strength of staff organization lies in its ability to multiply many-fold the effectiveness of other staff members, all coöperating to make possible such a wonderful thing as a man, a humming bird, a midge, or a yellow-fever microbe.

Organization may be conscious or unconscious. The authority in charge, whether individual or intangible, whether one or many, may know how to do the work or may not know how to do it. In the first case performance may be delegated to subordinates; in the second case it must be, if the work is to be well done, the actual worker, as far as the work is concerned, being a subordinated superior. The most perfectly organized entity in the universe is the living thing. There is an unconscious, unseen authority over it, not in the theological sense, but in the instincts with which it is endowed.

Passing from the single body to a community or family, we find similar organization, a central authority supported and supplemented by special staffs. Isms fail—individualism, communism, socialism, despotism—not because there is not serviceable value in each, but because form of organization counts for more than theoretical ism, and the highest organization relies on and utilizes all. Institutions have evolved from the primitive family and tribal life of birds and mammals, and birds and mammals, notably man, have evolved, molded by forms of organization.

There is always line and staff in organic nature. Line organization developed in its specially human form not in the family or tribe, but when men gathered in bands, generally for mischief or damage either to animals or to others of their own kind. The experienced hunter led a band on a hunting expedition or the fisher led a company to fish. As the hunters developed into maurauders, as the fishermen developed into buccaneers, there was pure line organization and very little, if any, staff. The hunter and war captain had himself been hunter and warrior, the captain of the boat had been fisher and fighter. Because he was older and stronger or more experienced, he commanded other men, none of whom knew more than he did. When the medicine man or priest accepted a disciple there was even less chance for staff, since the adept knew far more than the neophyte. Thus all through the development of army, of navy, of church, we find line organization, whose unit is the company, headed by a captain. This kind of organization is at the opposite extreme from pure staff organization found in the living body, and it is also distinct from the mixed line and staff found in primitive family life. The shops and schools adopted line organization almost without modification. There was indeed subdivision of labor, since all foremen did not direct similar activities nor all teachers teach the same branches, but these differentiations were not into staff functions.

Some modern organizations of tremendous strength are those in which staff alternates with line, as in a base-ball team. The ins play in line organization, all subject to the captain, each passing through exactly the same round, since a part of the play, as to its entirety, is handled by each. The outs, also subject to the captain, play distinctly in staff organization, the pitcher, singly, doing all the pitching against each of the ins, the catcher, singly, doing all the catching against each of the ins. The whole inning is played by each. It is because the staff specialists, the pitcher, the catcher, etc., are superior to the average skill of the ins and combine against each one separately, that in the best games there is no score.

In all organizations line and staff have their place. Organization has always been a means to an end, and it has therefore always been an evolution rather than a creation, generally lagging behind requirements. Long after the time when staff should have come to the rescue of line, line traditions and line prejudices have continued to prevail, each line officer trying to create a staff of his own. In the navy a strong staff has by a process of compulsion been added to the line. Supreme as he was, no sea captain quite dared to claim that he knew all about furnaces and boilers, engines and propellers, refrigerating and illuminating accessories, so there have been developed in marine organization very strong staffs. There was not the same compulsion in the army. It is von Moltke's greatest claim to fame that he perceived the deficiency of line organization in the army and supplemented it with the general staff which made the Prussian army the marvelously supreme organization it became shortly after 1860. The theory of a general staff is that each topic that may be of use to an army shall be studied to perfection by a separate specialist, and that the combined wisdom of these specialists shall emanate from a supreme staff. The specialist knows more about his one subject than all the rest of the army put together, but the whole army is to profit by his knowledge. One man may be the authority on military maps, another on balloons, another on roads and road making, another on sanitation, another on explosives or rapid-fire guns, an ever widening list. Nothing is to be left to chance, or to individual ignorance or brilliancy.

The North Germans were not more courageous, not better individual fighters than the South Germans, the Austrians, the Hungarians or the French. Napoleon in 1806 had no difficulty in defeating the military organization of Prussia, inherited from Frederick the Great, and it took nearly ten years of European coalition, all of Russia, all of Austria, all of Germany, all of Great Britain, to overthrow the French. The Prussian army in the decade 1860–70 became what it was, not on account of men or arms, but through the supreme genius of one man whose creation, the general staff, used the line organization as one of the means or implements to the all-important end.

If a man has special military aptitudes, special genius, the staff is the place for its opportunity and development. In the line special genius only makes trouble. Grant deprived General Butler of his command because Butler did not know how to obey. Nominally, under von Moltke's plan, the line remained supreme, the highest command being vested in the King of Prussia, though he was merely the spokesman for staff plans, even as in England the monarchical line is supreme with its personal staff of earl marshals, etc., yet all the real power lies with the cabinet, a staff organization. It was owing to staff knowledge and staff plans that in 1866, the Prussian army, two weeks after the outbreak of hostilities, overthrew the combined armies of Austria and of South Germany. It was owing to staff organization that the united German army of 1870 on September 2 at Sedan decided the war against France, declared July 14. The French plans for mobilization required 19 days, but von Moltke's plan for German mobilization required 18 days, and it was strictly carried out in neither more nor less days than the 18. The French mobilization took 21 days and this delay placed the seat of war in France instead of along the frontier or in Germany. French officers were not even provided with maps of French territory. The French plan of campaign failed before it was even tried, because of the fatal 3-days delay. On August 6, only 23 days after the outbreak of hostilities, one of the bloodiest battles of the war occurred.

Napoleon I was a marvelous genius, but he worked with line organization against line organization; he had to get rid of all his rivals, make himself ruler, dictator, emperor, before he could carry out his plans. Von Moltke left the line undisturbed, gathered his eminent military contemporaries into the general staff with him, and through the staff gave his king, the head of the line, an organization before which all the military power of Europe crumbled. It was King William's great merit that he had the good sense to listen to the staff advice of such specialists as von Moltke for war, Bismarck for diplomacy. The Japanese, seeking the best there was in Western organization, adopted and perfected in their army the Prussian staff system. At the relief of Pekin they proved themselves in all staff matters superior to any of the allies, the Germans included. Their maps, their Red Cross, their commissariat, their discipline, their humanity were all better. The superiority of the Japanese, both before and during the war with Russia, was due even more to Japanese staff knowledge and staff skill than to the high ideals and bravery of the individual soldiers and sailors that brought about the final victory.

Yet even von Moltke's marvelous combination of old line and modern staff could not be adapted without change to railroad or manufacturing activities. Its deficiency lies in the fact that the members of the line, who are many, are excluded from intimate relations with the staff, which is numerically so weak. When the line is supreme there is a great deficiency of special knowledge. When the staff is supreme there is a great deficiency of personal fructifying experience. In last analysis the man in the line, the man down at the bottom of the line, meets with difficulties, and he is the one who most needs staff assistance for his special case. He is the one who should be able to call on the very hightest special talent to solve his ten-cent difficulty. He finds this assistance outside of his daily work far more than within its limits. If, for instance, in New York city he wishes to transport himself from the north end of the city to the south end, he offers a five-cent piece and finds at his disposal a fifty-million-dollar subway. In his daily work, however, there is no assistance. For his bread-and-butter task, which alone makes him of value to others, there is little assistance of this kind.

What is needed in organization is complete parallelism between line and staff, so that every member of the line can at any time have the benefit of staff knowledge and staff assistance. This kind of organization does not exist in perfected form to-day. Modern organizations are defective because they individualize instead of generalize their staffs. The president of a railroad or of a manufacturing plant apportions duties among several vice-presidents, each one of whom takes up a line of duties. This is necessary, but in the old days in the palace of Pharaoh it is not stated that the chief butler organized a staff with a head baker or that the chief baker organized a staff with a head butler. Each vice-president of course requires a staff of his own for his special line of duties, but there are general needs which are the very fundamentals of strong organization and these needs should be under general staff officers, all of whose aggregated wisdom should be available to guide, not only the president and the vice-president, but also each subordinate official down to the lowest man in the line. Because there is no general staff of this kind, each official down to the worker attempts, more or less awkwardly, to create his own general, as well as his particular, staff. There is specialization of line activity, which is always advantageous, but there is also multiplicity of different kinds of general control, which is wholly bad. Imagine an army to which each soldier came with his own individual rifle and ammunition and kit, in which each captain had his own system of tactics, in which each general had his own special plan of campaign! Yet this is virtually the condition of railroad and manufacturing-plant organization to-day. Much of the time and energy of each official is taken up with keeping in order and adjusting to the whole his unregulated staff activities and eccentricities. One of the defects of this kind of organization is that the staffs of the different officials are not correlated. It makes no difference whether the head of a company is an individual or a commission, the organization is that of the line, the old military line, which at best has progressed as far as monarchy with a monarch's staff.

CHAPTER IV

LINE AND STAFF ORGANIZATION IN INDUSTRIAL CONCERNS

WITH full understanding of the strength of line organization, of staff organization, and of their reciprocal advantage to each other, and with a general comprehension of what both have accomplished in the past, it becomes possible to devise and outline a modern line and staff organization suited to the largest industrial concerns. The task would be hopeless if it were necessary to displace or even to modify existing line organization, since scarcely anything is as tenacious of life as institutions. But happily this is not necessary. Von Moltke added staff to line without a jar. A perfect staff could be added to modern line and be self-supporting from its inception without a jar.

A modern company, whether railroad or industrial, is organized for a specific purpose which is realized by an interplay of men, machines, materials, and methods. The specific purpose is the end in view, but the interplay is the all-important means. Whatever the vice-president's department, he has men, equipment, supplies and conditions to deal with. Whatever the manager's duties, he also has men, equipment, materials, and conditions to adjust to one another. Whatever the superintendent's duties he also is confronted with the same general problems as to men, equipment and tools, materials, and methods. The foreman meets the same problems of men, materials, machines, and methods, and even the individual worker has also his problems of man, of machine, of materials, and of methods. It is evident that the most philosophic way to meet general and universal problems is by general and universal solution. That is the solution offered by Nature. We have hands, feet, a head, and various other bodily parts, each doing various work, but there is only one heart, one set of lungs, one stomach, one telephone system, each doing specific work. The general problems, therefore, appertaining to men, to materials, to machines or equipment, and to methods or conditions, can be initially divided into four groups. All four groups, which more or less interweave, should come under one chief of staff. Under him should be various heads of staff. The subdivisions of the staff depend on the particular business, but a general scheme, modified to meet special conditions, would be that of the four groups mentioned.

As to Men.

1.—A head of staff to plan, direct, and advise as to everything appertaining to the well-being of the employees. This is in itself a very extensive and important department of staff activity. Men should not be able to connect themselves with a company except after examination as to their moral, physical, and professional fitness. Everybody knows that one quality of steel will cut four or five times faster than some other quality, and a modern tool is selected not because it has the shape of a drill but because it is of a composition that can be made into a good drill or into any other good tool.

Men are still selected not on account of qualities that would make them good in any particular direction, but because at the moment they call themselves this or that.

The line organization of a staff head in charge of welfare must extend down to where it is available with advice and help to the humblest worker. There is no reason, for instance, why a watchman, whose business is to look for bad conditions, should not combine the duties of a watchman with those of welfare work and advice. He would meet special cases that would otherwise escape observation and report, and carry them up to his staff superiors, but he would also have been instructed by his staff superiors and given standards by them as to all usual conditions, so that he would have at his fingers' ends standards for the use of the workers, standards evolved and determined by specialists of the highest rank.

It ought to be as difficult to enter the service of a great corporation as to pass an entrance examination to West Point; but once in, it ought to be a catastrophe for a man to be forced to leave, because the company provides so much that he cannot provide himself for his physical, financial, and professional welfare, because it rewards individual efficiency.

As to Equipment.

2.—A head of staff to plan, direct and advise as to everything appertaining to the adjustment of structures, machines, tools and other equipment to the work in hand. There is very little difference between good handling of equipment and good handling of men. The rules that apply to the one case will generally apply to the other. Much has been learned about the proper care of men from methods evolved for the care of equipment, and much has to be learned about the care of equipment from methods evolved for the guidance of men. It is not to be forgotten that in the human organism the whole is incapacitated by a seemingly slight injury to a single part. No man will work efficiently with a cinder in his eye, or a splinter under his nail. Neither will a plant work efficiently if little things go wrong. Single items of equipment are often of very great perfection, whether a Corliss engine or a twist drill, but from twist drill to general design and equipment of plant everything is usually wholly out of relation and balance. Recently, in consequence of staff organization, it was found necessary to relocate over three-quarters of all the machines in two large and fairly modern plants. Each machine had been doing good work by itself, and no one looked further; but the moment its relation to other machines or to the progress of the work was investigated, the conditions at once appeared impossible and unbearable. This relocation of machines, together with other staff reforms, has resulted in an increase of output of 40 per cent without additional men for equipment. The high officials of every railroad point out the glaring defects of early location or equipment—the fact, for instance, that among 1600 locomotives owned by one road there were 250 different types, instead of 6. The earlier builders had no staff advice.

This staff line in charge of the use of equipment also extends down until it is within reach of the worker. An example will show both the nature and the effects of staff organization. A staff was organized on a transcontinental railroad to advise generally as to the care and operation of shop machinery and tools. The duties of the staff, which extended from the vice-president's office downwards, were:

a. To secure suitable machines and equipment.

b. To give them the best possible care.

c. To give the workers advice and directions as to how to use the equipment most efficiently.

The expense of maintaining shop machinery and tools on this railroad, for the year 1903–4, was $487,171; the unit cost in relation to output was $10.31. On a competing and largely parallel railroad, working under similar conditions, the cost in the same year was $487,150, and the unit cost, $9.55. As a result of staff activity and control on the first road, by the year 1906–7 total costs had fallen to $315,844, and unit costs to $4.89, but on the other road, where line organization was not supplemented by staff organization, the total costs rose to $638,193, unit costs remaining virtually constant at $9.81. This saving in expenses of

$322,000 was brought about by a staff costing less than $10,000, and the $10,000 is included in the $315,844.

One subdivision of this maintenance problem was the care of belting. This had cost (for maintenance and renewals) at one of the main shops about $12,000 a year, and it was so poorly installed and supervised that there was an average of twelve breakdowns every working day, each involving more or less disorganization of the plant in its parts or as a whole. With the authority of the vice-president and in conjunction with the general purchasing agent, the whole subject of belting was taken up. A few general rules were laid down:

a. That there should be accurate and continuous records of installation, repairs, and breakdowns.

b. That the installation and care should be delegated to one trained specialist with full authority and responsibility.

c. That the quality of the installation and operation should be very high.

The worker in actual charge of belts, a promoted day laborer, was given standards, and took his directions from a special staff foreman, only one of whose duties was knowledge as to belts. The foreman had received his knowledge and ideals from the general chief of staff, who had made belts a special study, and this general chief of staff had been inspired and directed by a man who had made a nine years' special study of belts and who was the greatest authority in the world on the subject. The belt foreman had as much of this knowledge at his call as he could absorb, but he in turn was in immediate contact with each individual belt, with the machine it was on and with the worker using the machine. The chief of staff learned as much from the belt foreman as the belt foreman learned from the chief of staff. The belt foreman learned as much from the machinists as they learned from him. The cost of maintaining belts fell from $1,000 a month to $300 a month, the number of breakdowns declined from twelve each working day to an average of two a day, not one of them serious, and even the few breakdowns were due almost wholly to originally defective installations, such as narrow pulleys, which it was impossible to remedy without unjustifiable expense.

As to Materials.

3.—A head of staff as to materials, their purchase, custody, issue and handling. Subsidiary materials are only too often purchased on the basis of price per pound rather than on basis of cost per unit. This is inevitable, since no one is able to give the purchasing agent any standard as to cost per unit. After materials are purchased, they are frequently given such poor custody that they deteriorate or disappear before being used. They are still more often issued for extravagant and wasteful use. The economical handling of materials is a special art.

In a large steel plant, staff control of handling material reduced the cost of handling per ton from $0.072 to $0.033, and increased the number of tons handled per man per day from 16 to 57. Here again was the same kind of staff organization, calling down from the top all the most valuable knowledge in the world as to this one subject, working up from the bottom from actual daily contact with changing conditions.

There is no logical difference between money spent on materials and money spent for labor. A brick wall is a combination of labor and of material. Every issue of material, every issue of labor, should be standardized in advance and checked; the same system of accounting and distribution should be used for both labor and material.

As to Methods and Conditions.

4.—A staff head as to conditions and methods, including standards, records, and accounting. It has been found practically impossible to maintain either standards or records unless they are tied into the accounting. This is because there are standards as to money entries and none as to times or performances. This does not imply that records or standards shall be an outgrowth of accounting. Either is quite as important as accounting, and if a choice had to be made between good accounting coupled with bad practice and good practice coupled wth bad accounting, most practical men would choose good practice. It is because at the present time good accounting is unrelated to good practice that extensive accounting is viewed with such extreme disfavor by the practical man. Standards are wholly distinct from accounting, records are wholly distinct from accounting, but all three gain greatly when tied in together. It is impossible to maintain records unless there are standards of performance, but these can never be evolved from either records or accounting. The determination and establishment of standards is a peculiar art, yet one of fundamental importance, for, without a mean sea-level from which to start there is no measuring of mountains or of absolute heights. Railroads and industrial plants have systems of accounting based on the same general plan, but their records are often not of the same facts, so that it is difficult, if not impossible, to compare performances on one railroad with those on another railroad. There are certain records at the top, there is occasionally a certain semblance of a record at the bottom, but between the bottom record, on which, after all, everything rests, and the top record which is supposed to reveal the condition of the company, everything is vague and disconnected. It is astonishing, almost pathetic, that presidents' reports and Wall Street publications solemnly print costs per locomotive mile or cost of fuel per 1,000 ton miles, when the initial records out of which the final reports are built up are wholly unstandardized.

With a staff specialist on records, with record specialists under him reaching down into intimate, hourly and departmental touch with the worker, every gang boss, every worker could confide to him his desires and his needs. A good record may increase the output of a machinist quite as effectively as a good belt or tool, as good material; and when the worker needs help of this kind he should have it at hand. I knew a worker on time allowance for every job. The company was satisfied with 100 per cent efficiency, but this particular worker had set himself a standard of 120 per cent, his earnings depending on his monthly efficiency. To attain this he could not afford to lose track as to any single day; he had to know, in fact, how he stood as to every job during the day. He therefore needed a record of both his standard and actual time. An ambition of this kind is of extreme value to the company, not only because it decreases the cost and increases the output and reliability of the man, but because of its effect on all the other workers. This man made out his own records, on awkward and unsuitable blanks, and they were kept in such a way as not to fit in with or be of any value to the general scheme. Here was a case where the desire of the worker could well have been assisted by the skill of the specialist, each learning much from the other and together evolving a form of record of universal, optional use. Had any question come up beyond the skill or the authority of the local record man, he could have taken it up with his superiors until it had met, and been solved by, the grade of talent required.

Standards of performance are not less of a general character than records. In railroad operation the only work which is accomplished in a definite predetermined time is the running of the passenger trains. The Pennsylvania Railroad, for instance, reports that it ran its 18-hour train from New York to Chicago 312 days out of 366 exactly on time, an arrival efficiency of 85.24 per cent. In April, 1908, the Chicago train arrived in New York 28 days out of 30, or 93.33 per cent on time, being on one of the two days only 1 minute late.

Probably this train runs with a time accuracy of 99.9 per cent if one should add up all the standard-time minutes in the year and divide by the actual time taken. Perhaps the Pennsylvania Railroad keeps similar efficiency check on other passenger trains, but how about all its other items of expense incurred for either material or time? Do they also show 99 per cent efficiency or would they show about 60 per cent efficiency? If standards were established, if records were kept, it would be possible soon to attain almost automatically the same high efficiency as is now shown in the 18-hour train. It has cost money, a great deal of money, to run the 18-hour train as efficiently as it runs. It would save money, a great deal of money, to run other operations on a 100 per cent schedule.

Both accounting and records are very greatly simplified when connected up with standards. When the housewife buys a pound of tea or of meat she hands over the money and she receives in return a definite and agreed-upon equivalent in weight. This is exactly what the railroad company or the manufacturing concern does not do when it pays for services. The company does not even know what it ought to receive as service in return for the money paid, and so it accepts, not what it ought to receive, but what the payee gives, generally much less than it is entitled to.

The result of perfected staff organization is that everything is well and quickly done when and where wanted, that all costs are predetermined, that the responsibility for any deviation is immediately located, that the heads of both line and staff can direct far better than they are now able to, that costs of performance decrease, and that output from the same equipment and men increases. The staff is to the line what the good road is to the automobile. Without it neither speed nor smooth running nor economy is attainable.

Chapter V

STANDARDS; THEIR RELATIONS TO ORGANIZATION AND TO RESULTS

PRESERVATION and perpetuation are two of Nature's most important laws; therefore line organization, which is self-perpetuating, is essential, it being unimportant whether the chief and officers of the line are individuals or commissions or a semi-staff. Line organization, from its nature, will always be mediocre and inefficient unless handled by an extraordinary genius like Napoleon. The mediocrity is not one of individuality but of organization. Promotion is not by merit, since this would destroy the essential feature of line (its property of self-perpetuation), but advancement is by seniority. The youngest member is as capable potentially as the highest, and whether he rises to supreme command in five years or in forty-five depends on opportunity. When he has reached the age of retirement he gives way to a junior as one day gives way to another. There was nothing worth preserving, and the elimination of the temporary head produces a desirable wriggle of life all the way down the line.

Line organization needs few standards, usually crude and often fictitious. Seniority or precedence is one of its standards, and closely interwoven is the fundamental standard of immediate and unquestioning obedience almost as automatic as the obedience of sheep to the leader. This simplicity of standards eliminates mental, moral, and physical perplexity. A chief of line may have many personal standards. He may not permit men to be recruited for his guard unless seven feet tall, the idiosyncrasy of the first king of Prussia, or he may uniform them in tall beavers and scarlet coats, or he may dress them like cowboys, and call them rough riders, or as in the German and French and Russian armies there may be most punctilious standards imposed as to dueling.

Line organization can be defined as a self-perpetuation of a good average with the one standard of obedience.

Because it is the exact opposite, staff is a strengthener to line. It is not self-perpetuating, but distinctly selective. The youngest captain in the German army assigned for staff duty is perhaps the highest special authority on aeroplanes. Promotion is not upwards but outwards, just as the Wright brothers, who began by specializing on aeroplanes in their home field in Ohio, are now the recognized authorities in the United States, France, England and Germany—in aeroplanes, but in nothing else.

Instead of there being one main standard, obedience, causing no perplexity—instead of subsidiary fanciful standards—there is an unlimited multiplication of scientific standards, higher than all personality. The member of the line, whether in church, state, army or navy, must obey blindly and implicitly. The staff expert receives from his chief principles which are higher than the chief, since they are part of the eternal laws of the universe. The bookkeeper's standard is that two and two are four, not three nor five, and no command of chief justifies him in departing from this standard. His chief may tell him that a pound of carbon burned to CO_2 evolves 14,500 B. t. u., or that the mechanical equivalent of heat is 772 foot pounds or 778 foot pounds. He may by his own experiments determine the former at 14,146 and the latter for his own latitude at 777, and it is the duty of the chief to accept the new standard if verified. The line has always justified its standard of obedience to human authority by attempting to derive the human authority from Heaven—the divine right of kings, the keys of heaven and hell entrusted to St. Peter, the inspired Scriptures.

Staff standards are based on specific human authority only until new facts substitute better authority. The chief of staff furnishes general and approximate standards, a subordinate staff specialist establishes closer and more accurate standards.

Staff standards are not theological abstractions, but scientific approximations, and are evolved for the use of the line, the sole justification of the standards being that they will make line work more efficient. Staff standards being for the benefit of the line and often entrusted to line officials, must be put in the form of permanent instructions so that all may understand what is being aimed at, and deviations by the line be noted and reprimanded.

During the Cuban campaign, in a road over which many hundred army wagons were to pass, there was a mud hole. The first transport wagon, obeying the command to proceed to destination, floundered into the hole, had to be unloaded, dragged out, and reloaded. The crew had neither authority, skill, nor equipment to mend roads, so they passed on. Also there were no written staff instructions as to what a line official should do when he found the road impassable, so the second wagon coming along a few hours later, plunged into the same hole and experienced the same delay and trouble. In turn each of the several hundred wagons repeated the same performance, and although this road was in constant use for several months no attempt was made to mend it, Had there been as much sense of staff as in ant-hill activities, the first wagon would not have passed on without bettering the conditions for those who follow, instead of leaving them worse; had there been even elementary staff, one wagon only would have gone into the hole, which would then as a matter of course have been eliminated. Had there been perfected staff, even the first wagon would not have passed over the road until it had been put in condition.

A sign post definitely stating distance, character of road, steepness of grades, to next town, is not in any way an imposition on or an impediment to the wayfarer, whether on foot or in automobile, but is a valuable help. The sign post is a staff, without authority, except as imposed on the line by a line officer, a staff without value except as to its own special and limited information.

Staff standards are infinite and ever changing. The best practice of yesterday is the laughing stock of today. The work of the expert is never done. The aeroplane flight of 6 miles last year becomes 60 miles this month, 600 miles next year. The chief of staff, who is to inspire the search for higher standards, who is to handle them with common sense, must himself be governed by elemental natural truths—his standards, used as a test for all the others—and these highest standards are psychical and physiological rather than physical. The four psychological requisites for a chief of staff are: (a) Faith, in men, in equipment, in methods, and in standards, (b) an enthusiasm that inspires and creates confidence, (c) ultimate highest ideals, (d) very great rapidity of action.

Faith in men, faith in equipment, faith in methods, faith in standards, must be so great as to inspire a contagious enthusiasm not only in the junior staff members but also in all the members of the line from commander-in-chief down to private. No man is fit to be a member of a staff who does not delight in his work, who does not consider it the keystone of the arch, who does not bend it wholly to the interests of the line, so that the line will recognize that through staff presence and staff endeavor, line work is made safer, higher, more pleasurable and more profitable.

The chief of staff must believe that the great majority of employees, nine-tenths, at least, can be easily influenced to do what is right, and prefer to do what is right, and that if the right course is made easy, it will be automatically followed, just as most people naturally keep to the sidewalk, although there are no rules ordering them to do so. Policemen are armed with clubs not to intimidate the well-behaved many but to terrorize the exceptional few. After the first prejudice against any innovation is overcome, staff standards must continually appeal to those for whom they are set up.

The chief of staff must assume, until the contrary is proved, that existing equipment and existing facilities utilized to fullest efficiency can meet most requirements; that it is better to improve than to substitute; that Goliath can be slain with a sling, and that the western road to India can be discovered with a caravel.

No man is fit to be either chief of staff or staff junior who does not have and adhere to high ideal standards. This fidelity to principles is necessarily foreign to the line. A type setter is a member of the line. He achieves, obediently following the manuscript; but the proofreader is a member of the staff and maintains standards. Between them perfect work is turned out.

The chief of staff and all his juniors must be alive to the value of rapidity of action. Seconds, minutes, hours and days are to the staff what hours, days, months and years are to the line. Staff ideals of the value of rapidity are found in the instantaneous action of a boxer or fencer, where delay of the hundredth part of a second to meet an expected condition may result in death; are found in the activities of the weather service, which receives reports from territory 6,000,000 miles in extent, compiles and digests the information, and publishes tomorrow's weather before noon today, to all the world over, land and sea; a delay of a few hours would make the whole work valueless. Staff ideals of speed reacting on all the line are found in the work of a daily paper, which collects the news of the whole world until the night is half gone, goes to press at two in the morning, and reaches distant customers at 6 a.m.

A proposition was made to the line officers of a large corporation to reduce expenses $2,000,000 per annum. Whatever the time required to accomplish this, every day's delay caused an irretrievable loss of $6,666; yet details that ought to have been decided in 8 minutes were allowed to wait for 8 months. Line traditions vitiated staff ideals, and as the line lasts forever it is not imbued with speed ideals. It was quite in accordance with line tradition that the wars between France and England lasted 100 years, that the religious wars in Germany lasted 30 years, that the wars of Frederick the Great lasted 7 years, that the French European wars lasted 26 years, that the war of the American revolution lasted 7 years, the war of the Rebellion 4 years—but that the staff-prepared war of von Moltke's Prussian army against twice as strong a territorial and numerical coalition lasted 2 weeks, and von Moltke's staff-prepared war of Germany against France captured the French emperor and the French armies and ended the French empire in 7 weeks after outbreak.

In line, there is very little planning but a great deal of organization; in staff, it is all planning and very little organization.

Owing to absence of staff as part of their own organization, lines, all over the world, have been forced to depend on outside staffs, whose inspiration was generally tinged with pecuniary self-interest, so that the great shops and railroads and other industrial concerns have been as to men, machines, materials, and methods over-supplied and over-equipped, as when a $100,000 saw mill is erected to handle a $50,000 lumber tract. Many hundred million dollars have been spent in the last decade on fanciful betterments, when greater returns could have been obtained by standardizing what was.

In marked contrast to the lavish expenditure for inadequate returns from improvements in industrial and transportation concerns is the small expenditure and enormous return brought about in agriculture. The present depression in the great industrial division of American activity and the almost giddy prosperity of the agricultural division at once illustrate the fundamental difference in results and in methods obtained from line and staff activities respectively. The farmer is not lazy, he is not troubled by union limitations, and he has the enormous spur of direct and personal increase of reward for increased or more intelligent effort; he has moreover been at his business from birth; but the average result in crops is only about 30 per cent of what it ought to be.

There is no reason for assuming that industrial activities, entrusted to men whose interest goes no further than their daily wage, who were not born to the business, will average any higher in efficiency than the farming class, and in fact there is just as much difference between the average crop and the expert's crop as there is between the average output of a man and machine and the expert's output from the same man and machine. Two different influences are revolutionizing agriculture—the isolated special genius, and the staff adviser. The industrial field has had the isolated special genius but as yet very little staff assistance.

Because these essays on efficiency are applicable particularly to shops and railroads it is better to use illustrations from agriculture, since it is much easier to see the mote in the brother's eye than the beam in our own. Therefore the yield of potatoes will be used in illustration. What is the limit of yield of potatoes from an acre of ground in the United States? The average yield per acre over a series of years is 96 bushels. Shall we therefore set 100 bushels as standard 100 per cent efficiency?

The lowest average in 1907, 65 bushels, occurred in the great agricultural State of Kansas; the highest average was in the desert State of Wyoming, 200 bushels to the acre. The highest average in Wyoming is due to one man, who issued a challenge of $1,000 open to all the potato growers of Colorado, that he would raise on his Wyoming farm more potatoes per acre than any one could raise in Colorado, provided further that if he won the contest yet failed to raise 1,000 bushels per acre, he would forfeit the whole of the stakes, $2,000 to charity.

It is psychology, not soil or climate, that enables a man to raise five times as many potatoes per acre as the average of his own State, ten times as many per acre as the average of the United States, thirteen times as many as the average in the better soil and climate of Kansas. An easily attainable standard of potato raising is therefore not 100 bushels but 500 bushels, which can be called 100 per cent efficiency.

On this basis the average of the United States is 19 per cent, the average of Kansas 12 per cent, the production of the Wyoming champion 200 per cent efficiency. If the United States attained as to potato raising an average efficiency of 50 per cent, the increased value of the crop in one year would be sufficient to pay for the Panama Canal; or, the acreage and labor devoted to potatoes could be reduced to 40 per cent of what it now is, and still yield as many potatoes.

Undoubtedly the potato champion, in a more favorable climate, where, with irrigation, three crops are possible, as in the Yaqui Valley in Mexico, would raise 3,000 bushels per year per acre. They would cost him more per acre but less per bushel than any other potatoes in the world.

Individuals of this kind have inspired the Agricultural Department at Washington, working in conjunction with State agricultural staffs, to standardize conditions for all staple agricultural products.

It has recently been asserted that with selected seed a standard attainable yield of wheat is 50 bushels per acre per year. The actual yield is 14 bushels; the total 650,000,000, when it ought to be 2,500,000,000 bushels—yet there are charity bread lines in New York.

With a standard of 50 bushels per acre the efficiency average of the United States is only 28 per cent, the money loss at constant price over $1,000,000,000 per year.

The staff experts of the Agricultural Department have enabled Texas cotton growers to raise one bale per acre. Selected seed, suitable fertilizer, systematic cultivation are all that is required. The acreage of cotton is 32,000,000, the production only 12,000,000 bales; the efficiency is 17.5 per cent and the annual loss due to inefficiency about $1,000,000,000.

Italian bees in California raise twice as much honey as they do in Italy. The California bees do not work as hard; they live longer because most of the disagreeable work is eliminated. The staff experts advising the bees are men who standardize bee work both simply and effectively. The bees make honey instead of wasting time on hives, on foundations, on comb, and on long journeys to semi-barren flower fields.

The potato expert increased the efficiency of his fields to ten times the average; the corn and cotton staff experts have through their advice enabled whole counties of farmers to double the average yield of corn and cotton; the making of better conditions has increased the average yield of honey 100 per cent.

If we could put ourselves in touch with the feelings of plants we should probably find that there was much more enjoyment to potatoes in growing 1,000 bushels to the acre than in growing 67 to the acre. Intensity of production does not mean physical exhaustion, but favorable conditions. Similarly, intensity of human production does not legitimately mean, and ought never to mean, the physical exhaustion of an over-worked victim, but should be due to the joyous stimulus of perfectly standardized conditions.

Examples from agriculture have been selected because far more has been done to establish standards of attainable production in agriculture than to establish standards in factories, shops, and mechanical trades. The plant also will always do the best that circumstances permit, and the circumstances are largely controllable. A man will rarely do his best, even if circumstances are favorable; but as an offset it is more easy to control factory, transportation, shop, and handwork conditions than to control seasons, climates, diseases, and insect pests. On the whole, the efficiencies of industrial organizations are no higher than those of farming activities, and as staff standards indicate possible increases of 200 per cent in agricultural yields, so staff standards and staff assistance will bring about 200 per cent increased efficiency in materials and services in industrial organizations, including railroads. Tests show that this can be done.

The standardizing of belt practice by staff study has increased the average life of belting more than six-fold, has reduced belt failures to one-sixth of what they were, has decreased annual cost to less than one-seventh.

The discovery and perfection of high-speed steels did not originate in any shop, but was exclusively developed by men whose ideals and practices were those of the staff, and high-speed steel accomplishes four or five times as much as the old carbon steel.

Staff-selected and designed abrasive wheels cut four times as fast as the old grindstones, and every grade needed can be made to order, standardized for each different kind of work; files that are standardized as to quality last five times as long as the usual good commercial files and cut much faster.

Wherever the staff expert turns, he finds that standard time and cost for some units of work can be reduced to one-half, for other units to one-quarter, occasionally to one-tenth of the average time for the unstandardized work.

Railroad practice has many standards, chiefly those of specification, of construction, and of times for passenger trains. No railroad has ever determined any cost standards either for maintenance or operation of equipment, maintenance of way, or consumption of fuel; yet there is no railroad in the country on which each one of these cost standards could not be determined in a very short time and with very close accuracy, at a cost equal to the saving effected in a single month.

When each unit of locomotive repair is standardized, the sum of the units shows a cost between $0.03 and $0.06 a mile for maintenance. The actual average costs on the railroads are between $0.06 and $0.12—therefore twice what they ought to be. The standardized cost of maintaining freight cars is as low as $30 per annum. Actual average costs run from $45 on some roads to over $100 on others. Standards of maintenance of way vary, but innumerable assays of actual work show a maintenance-of-way labor efficiency of scarcely more than 30 per cent.

Staff determinations with a dynamo car showed that 1,000,000 B. t. u. in the coal were amply sufficient to furnish power to move a 1,000-ton train one mile. The actual coal charged to locomotives always contained more than twice as many, often three times as many, B. t. u.

The average mileage of the locomotives of the United States is close to 30,000 per year, about 82 miles per day. Average mileage of a freight car is about 25 miles per day. Staff standardization in locomotive repairs not only decreases the cost to one-half as much per mile, but also increases the mileage at least 33 per cent.

Locomotive repairs cost twice what they should, not because men in charge are not of the highest ability and experience, but because these men are so hampered by line organization that it is almost impossible for them to evolve standards or to maintain standards when evolved. Standards are always of the microscope, of the assayer's balance, of infinite patience applied to the smallest of details. It is not important that absolute zero is at — 273 degrees and that the highest temperature in the sun is 10,000 degrees, but it is important that human life is snuffed out if the temperature of the body rises 5 degrees centigrade.

It is not important that space is so vast that it takes hundreds of light years for the light of distant stars to reach us—wireless telegraphy on a stupendous scale—but it is important that the yellow-fever bacillus may lurk in the saliva of a mosquito, so small that the microscope has scarcely yet discovered it.

It is not important that pressure varies from nothing in vacuo to so much at the deepest spots in the sea that an air bubble taken down there becomes heavier than water and cannot rise to the surface, to so much at the earth's center, even if there were free opening to the surface, that the air would be heavier than gold, harder than titanium, so that a needle could not be driven into it, yet if in it, would slowly move surfacewards until specific gravity of air and needle were the same. These facts, interesting though they are, do not concern us as much as the fact that men cannot work on high mountains without danger nor in caissons without risk of the "bends," and that half the power put into air compression is lost in pipe leaks.

The staff chief and his assistants in search of standards are not using bolometers to measure the ten-thousandth part of a degree, nor the spectroscope to measure the speed of advance or recession of the fixed stars, nor ruling diffraction gratings 900,000 lines to an inch, nor are they interested in either the North Pole or the transit of Venus; but they are searching for common, every-day, practical and attainable standards of which astounding few have been determined.

Time is infinite, but that does not concern us so much as that five minutes of suspension of breathing or heart beating carries us over the boundary that separates life from death.

Congress has determined that a dollar (not now coined) shall consist of 25.8 grains of gold nine-tenths fine, but it may be a shock to learn that Congress has never determined the grain or any other standard of weight or of length or of time. The United States Treasury Department has adopted a gallon and a bushel, but neither is in accordance with the legal standards of Great Britain. They not only differ from the present standards of Great Britain, being respectively 17 per cent and 3 per cent smaller, but they also always differed from the discarded English standards from which they were derived.

On April 15, 1903, the Superintendent of Weights and Measures, not Congress, directed that the international metre and kilogramme should be in the future regarded as fundamental for metric and customary weights and measures. Congress, which has failed to legalize standards either of weight or of length or of capacity, has however standardized the spelling of Porto Rico and the motto "In God We Trust" on the dollar, and it is safe to say that Congress has concerned itself more with this motto than with the fact that all the thousands of millions of dollars of railroad and industrial shares sank in October, 1907, 33 per cent in value in a few weeks, and that the earning power of hundreds of thousands of men, eager to work, fell from an average of $2.00 per day to nothing.

In Germany in the polytechnic schools as late as 1875 and perhaps now, mediæval standards of proper procedure in all matters appertaining to students' duels were more definite, punctilious, important, than surprisingly lacking modern standards of scientific accuracy.

These examples of American legislative and German scholastic insistence in the puerile and neglect of the all-important almost give the dignity of natural law to the statement that in standards insistence and excitement are in inverse proportion to practical every-day importance, and with such high examples as Congress and German Universities it is not surprising that in the line organization of American industrial enterprises there is more sensitiveness about prerogative than in Congress itself, more alertness to take offence at the unimportant than in the German student.

The difficulties blocking the path of the radical improvement that would immediately result from supplementing the line with staff and standards, are the sensitiveness and apprehension of the line that, in some way it cannot explain, staff activity and application of standards will reflect on line ability, as if in the round-the-world automobile race, the benefits of good roads from Berlin to Paris, and the speed made over the good roads, reflected on the capacity of the automobile drivers who made slow yet astonishing progress through Siberia.

Chapter VI

THE REALIZATION OF STANDARDS IN PRACTICE

THE five preceding chapters are general in character, showing that inefficiency is almost universal, that each nation has to some extent offset general inefficiency by good qualities of its own, differing from the good qualities of other nations, that American advantages in the past lay in great natural resources and in wonderful opportunities, pursued by keenly adaptable rather than specially skilled men.

Inefficiencies everywhere were ascribed to the primitive and elementary character of the directing organization, which has progressed very little beyond the military line evolved centuries ago, continuing unchanged even in armies until the latter half of the nineteenth century. To lessen inefficiency, not *less* of military line but *more* of supplementary staff was urged, and a specialized staff was indicated as the logical and inevitable forward step. It is the business of the staff, not to accomplish work, but to set up standards and ideals, so that the line may work more efficiently.

In attempting to better and strengthen great American repair and manufacturing plants, it was found necessary to use the perseverance of the British, the innovating logic of the French, the staff was the general auditor, on the president's staff; under him were the division auditors, mechanical accountants, shop accountants, down to the time keepers and pay-roll distributors.

The accounting staff, fully organized and capable, proved of the greatest assistance as a type on which to model other staffs.

Before beginning standardizing work a number of surveys were run through the shop to ascertain what was not covered by the existing line and accounting organizations. The first survey was to ascertain whether materials were being properly handled and checked; the second survey covered the condition of the machines and tools; in the third survey a number of labor essays or audits determined the relation between what men were actually doing and what they should do; the fourth survey showed as to a few operations the relation between current costs and standard costs, and the fifth survey the speed of movement of work through the shop. It does not follow because a shop is lax in one of these directions, that it is equally lax in others; it does not follow that being excellent in one direction it will be excellent in the others. Good work had always been an ideal in this shop, also a large output; but neither costs nor speed had been ideals.

The preliminary investigations revealed certain organic weaknesses of operation, due to the absence of ideals or standards and to the absence of a staff organization able to create and realize standards. To eliminate these weaknesses a staff was gradually created supplementary to the line. This staff organization would not have had necessary powers unless it had started very high up, the chief of staff in charge of standardizing and efficiency methods being on the staff of the vice-president, without whose support in many an hour of need nothing could have been accomplished.

Under the chief of staff were various specialists, selected or promoted for their demonstrated experience, each one of these specialists becoming the head of a special staff line. The staff, in fact, was evolved not theoretically but in direct response to necessity.

The five different lines of preliminary survey were each made permanent fields of investigation and control.

A staff specialist was put in charge of everything appertaining to materials, his duties being to evolve methods which would always supply the right material at the right place, at the right time, in the required quality, minimum necessary quantity, and at lowest cost. Another specialist was put in charge of all matters appertaining to the maintenance and operation of machines and tools. A third and most important organization of specialists was given the duty of standardizing every task as to time; a fourth specialist took up the matters of standard costs, and a fifth specialist provided methods by which all work could be dispatched through the shop even more carefully and accurately than trains are dispatched on a railroad.

Although in this particular shop—a repair shop for a large corporation—costs had never been considered of commercial importance, it was found staff was the general auditor, on the president's staff; under him were the division auditors, mechanical accountants, shop accountants, down to the time keepers and pay-roll distributors.

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Although in this particular shop—a repair shop for a large corporation—costs had never been considered of commercial importance, it was found absolutely necessary to provide a standard method of determining costs, applicable equally to the five-minute task of a single worker or to a month's output of the whole shop.

Costs can be subdivided into three divisions: (1) material costs, (2) direct-labor costs, and (3) indirect or overhead or surcharge costs, this last division embracing everything that is not material or direct labor. Indirect charges (3) were subdivided into four classes: (1) power, (2) maintenance, (3) rent, (4) administration. As a general production proposition, there is no difference between a man and a machine, the mere fact that the man is paid wages and the machine is virtually a slave (in which capital is invested, which has to be maintained and which in time perishes) being a financial and not a productive difference. Therefore all the expenses of power, maintenance, rent, and administration were subdivided partly to men and partly to machines, thus giving the foundation for a standard cost of any operation for any unit of time. Each of the four subdivisions of overhead or burden was put under the care of a staff specialist.

When a simple system of stating all costs—whether for a single task for man or machine, or for all a man's work for any period, or for all the work of a gang or department, or for a whole plant—is available; when this system permits parallel statement of actual and standard costs—then the whole problem is well-nigh solved, patience, persistence, fidelity, and high ideals accomplishing the results, through the use of staff specialists.

The system under which costs were standardized will be elucidated in another chapter, it being first more important to see the results of this system, when applied to a single department of a great works, than to understand the system in its details.

DEPARTMENT F.

Statement of Condition for 12 Months Preceding June 30 on Basis of Standard Volume of Output.

Costs per Hour.

	Actual.	Standard.	Waste.	Attainable Reduction.
Direct wages.......	$ 36.93	$27.77	$ 9.16	25 per cent
Overhead expense ..	18.98	11.11	7.87	41.5 per cent
Machine expenses ..	48.94	29.17	19.77	40 per cent
	$104.85	$68.05	$36.80	35.1 per cent

If this shop averaged 2,700 hours in the year the total expense would be $283,095, the preventable waste $99,360.

This statement shows that whereas the actual cost per hour for a given output averaged over a period of 12 months had been $104.85, it was determined by the staff officials that it should cost only $68.05, a reduction of 35.1 per cent.

This statement is remarkable. The actual expenses were those of the preceding twelve months. The standard expenses are theoretically predetermined by standardizing *not* the cost of work, but the efficiency of men, of machines and of methods.

The standard costs were those possible at the date the work was undertaken. By the time actual costs are reduced to $68.05 per hour new standards will have come into existence, making the standard costs as low, perhaps, as $60 per hour, so that the standard is always elusively ahead of the actual

The president of the company does not need to see each month much more than this one statement (prepared however in the form of a flowing record) so that, at a glance, he can see the trend of progress. In this particular case a time limit was set within which the reduction was to be accomplished.

That the reduction from $104.85 per hour cannot be effected in a single month is obvious, and equally so that it ought not to take ten years. Whether it is to take a year or two years or four years depends solely on the willingness of the management. The shaded area in the diagram measures the exact cost of taking two years instead of one, and it amounts to about $100,000.

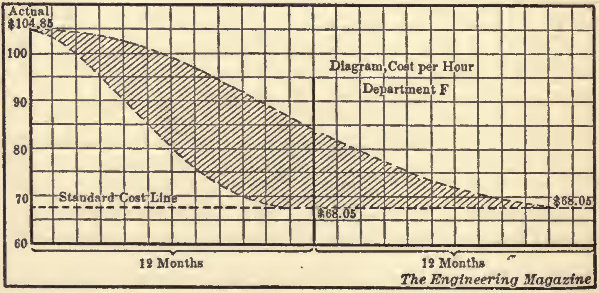


DIAGRAM SHOWING COST OF DELAY IN REDUCING COSTS TO STANDARD.

This epitomized statement of standard hourly cost is for a definite number of standard cost units, so that whatever fluctuations in kind or volume of work occur from month to month, standard comparisons hold good. The assumptions on which standard costs are based for a Department, F, were as follows:—

Standard annual hours per machine	2,400
Standard annual hours of shop work	2,700
Standard value of equipment	$200,000
Standardized overhead charges	$100,000

SUBDIVISION OF INDIRECT CHARGES.

	Actual.	Standard.	Reduction.
Power	$26,100	$13,000	50 per cent.
Maintenance	96,618	48,000	50 per cent.
Rent	14,587	12,000	17 per cent.
Administration:			
Direct	9,870	12,000	21.5 inc.
Indirect	21,550	15,000	30 per cent.
Total	$168,725	$100,000	40.8 per cent

In pursuing the location of responsibility the indirect charges were apportioned partly to machines and partly to men.

	Actual.	Standard.	Reduction.
Overhead charges:.			
Assessed to machines	$117,470	$70,000	40.4 per cent.
Assessed to men	51,255	30,000	41.2 per cent.
Total	$168,725	$100,000	40.8 per cent.
Direct pay roll	99,794	75,000	25 per cent.
Total	$268,519	$175,000	35.1 per cent.

Standard practice propositions are generally wrecked on the fact that to secure a net reduction of 40 per cent as to the whole, the cost of direct supervision is increased.

Managers are reluctant to incur an increased cost for direct supervision (in this case of 2.1 per cent or $2,130) to effect the 40 per cent net reduction amounting to $68,725, because they find it impossible to believe that so great a gain is attainable, especially as it is not made the first month. They are certain that the very extensive staff organization must necessarily cause an unbearable increase in indirect expenses. This is not the case for three reasons:

1.—A portion of the expense, the preliminary studies and investigations, are properly charged to capital investment as they have lasting value—as much as drawings or patterns, more than machines.

2.—When the output of a plant aggregates $15,000,000 a year, with a pay roll of $3,000,000, the pro rata expenses of the general staff officials prorated to a department shop whose direct and indirect roll is only $150,000 a year are only 5 per cent of the total, so that if the general staff cost $40,000, the assessment to Department F would be only $2,000.

3.—All the particular staff expenses are charged directly to the account benefited. If a staff advisor for, or a designer of, tools is employed his expenses are charged directly to the maintenance account.

The employment of so complete a staff will necessarily highly specialize operations, and economies result, not from an effort to secure them, but from an effort to do everything in a standard practical manner. Standard power conditions mean the same power with less coal and less power for the same output. As power happens to be one of the subdivisions of burden, the burden per unit is reduced without any thought or worry as to whether it is related to direct-labor increases or decreases.

Standard maintenance conditions mean far better tools for less cost, greater output from the same machines; and as maintenance is one of the surcharge accounts, when it decreases the maintenance surcharge per unit decreases. In Department F, actual expenses for power were $26,100; predetermined standard power expenses were placed at $13,000. This astonishing reduction was realized in practice and was effected in the following manner: A power specialist is made responsible for the production of power. If the actual expense is $60 a year per horse power of 3,000 hours, every item of expense is analyzed, and it is ascertained that under standardized conditions the expense should not exceed $45, so this standard cost is set up for the man in charge of power production to aim at. On the other hand, the foreman of the department uses power, it being entirely beyond his control whether the rate to him is $60 a year or $45; but wasteful use of power is not beyond his control, so another staff expert scrutinizes every item of power use, ascertains that by the elimination of destructive frictions, leaks, and wastes of various kinds, the total annual consumption of power can be reduced from 435 to 300 horse power; 435 horse power at $60 amounts to $26,100, but 300 horse power at $43.33 amounts only to $13,000. No one acquainted with the scandalous inefficiencies of the average factory power plant, consuming from 5 to 7 pounds of coal per horse power per hour, will question the ability to lower costs 28 per cent, and no one acquainted with the leaks of air and steam and water, leaks of light and heat, all the frictional losses due to lack of alinement, too tight belts, etc., will question the possibility of reducing power consumption 30 to 33 per cent.

The standards of $43.33 per horse power per year, and of 300 horse power for the department, are by no means final. As long as it pays to follow them, further reductions are in order until standard minimum practice is attained. The essential of the system is that the item of power, as to production, distribution, and use, is set up monthly in two parallel columns, one showing actual, the other standard results, and the chief of staff in conjunction with chief of line combine their efforts until facts and theory coalesce—until the victory is won, a victory not less inspiring because it is bloodless.

The item of maintenance is treated in exactly the same way. There must be a general supervisor of maintenance who standardizes the quality, custody, and issue of small tools, who remodels the larger machines, who anticipates breakdowns or repairs them so that the same collapse will never occur again. There is in addition all the economy that results from the careful and checked use of machines and tools. On even a larger scale than the one now being discussed, my own staff assistant, in charge of maintenance of shop machinery and tools, effected the following results:

Year.	Output.	Expense.	Unit Cost.
1905....................	47,854	$486,620	$10.16
1906....................	57,760	376,106	6.51
1907....................	64,628	315,844	4.89
1908....................	64,326	290,832	4.52

The reduction in unit cost is more than 50 per cent, the economy on a unit basis is $362,798.

In connection with this account the experience was amusing. The general superintendent was so alarmed at the direct staff expenses and the expenses of the improvements recommended by the staff, that he ordered a special account to be opened, in which they were all entered, so that at the end of the year he might point to this account as the cause of the, to him, inevitable and abhorrent increase. After absorbing all these special expenses, the actual net saving in money at the end of the year was $110,514, for a 20 per cent greater output.

It is unnecessary to discuss "rent" in detail. Standard expenses show slight reductions below actual owing to standardization of repairs, better custody of buildings, etc. There are occasions when rent can be very greatly reduced, by increased use of old instead of building new buildings, or the double-shifting of a shop. Using the building 20 hours a day instead of 10 hours will very greatly reduce rent per unit of output. The actual result of standardizing the legitimate cost of all these different items of burden is to reduce general expenses per unit or per hour about 40 per cent.

The method has been more fruitful than the usual methods of effecting economies in shop operation because an ideal standard cost is ascertained at which to aim, and realization is facilitated not by sub-dividing expenses to departments, thus frittering away responsibility, but by grouping all expenses under a few heads and putting each group in charge of a specialist, whose ideal is not to reduce cost of specific output but to standardize operations.

The problem of standardizing direct pay roll is much more difficult, as it involves the determination of a standard time and costs for every task. For every work order issued to employees there is a determinable standard time. This time must be ascertained by the Taylor system of time studies. The specialist at the head of time-study work must be able at a moment's notice to state, before the work is begun, what the standard time is. The determination of standard time is a profession in itself at which specialists become very expert, so that on the average their determinations will not vary more than 1 or 2 per cent from ideal standards. Standard times may be anywhere from 10 per cent to 90 per cent less than actual times.

Standard time is a reasonable time for a good worker to accomplish the task set. The worker is limited by conditions as they are; but as conditions change, standard times will be revised in such a way as not to interfere with the personal efficiency of the worker.

It must be made pleasanter and more agreeable for the worker to attain standard output or to surpass it than to fall below it. His coöperation is secured by appealing to some of the strongest human instincts—some urging him forward, as ambition and hope, an increased wage rate set by himself, pleasure in the work; others impelling him from behind, as apprehension of discharge.

The result of standard efficiency in workers, coupled with standard other conditions, was to reduce direct-labor costs 25 per cent, an unusually small reduction.

I do not lay much stress on names or forms. I have been in shops of very high efficiency whose managers would not have understood the meaning of the word *staff*. Yet staff talent and staff activity were in full swing, the manager by natural intuition having selected foremen who had the double gift of line and staff ability. I also recognize that Mr. F. W. Taylor's shop organization based on functional foremanship is but another way of securing staff results, through staff specialists.

COST AND PROFIT PER PIECE AND PER DAY OF VARIOUS EFFICIENCIES.

	33 p.c.	50 p.c.	66.7 p.c.	100 p.c.	133 p.c.
Pieces per day..........	1	1.5	2	3	4
Total costs per day.....	$150	$165	$165	$186	$212
Net cost per piece.......	150	110	82	62	53
Selling price............	100	100	100	100	100
Loss per piece..........	48	10			
Profit per piece.........			18	38	47
Loss per day...........	48	15			
Profit per day..........			36	114	188

Whatever the names given to the line foreman or the staff specialist, it has been demonstrated over and over again, and on the largest scale, that staff investigation will show standard costs to be far below actual costs, and that predetermined standard costs can be attained through the direct and indirect assistance given to the line by the staff. The possible volume of the economy depends solely on the magnitude of the business; the rapidity with which economy can be effected, solely on the courage and thoroughness with which the work is prosecuted. The labor difficulties are virtually nil,

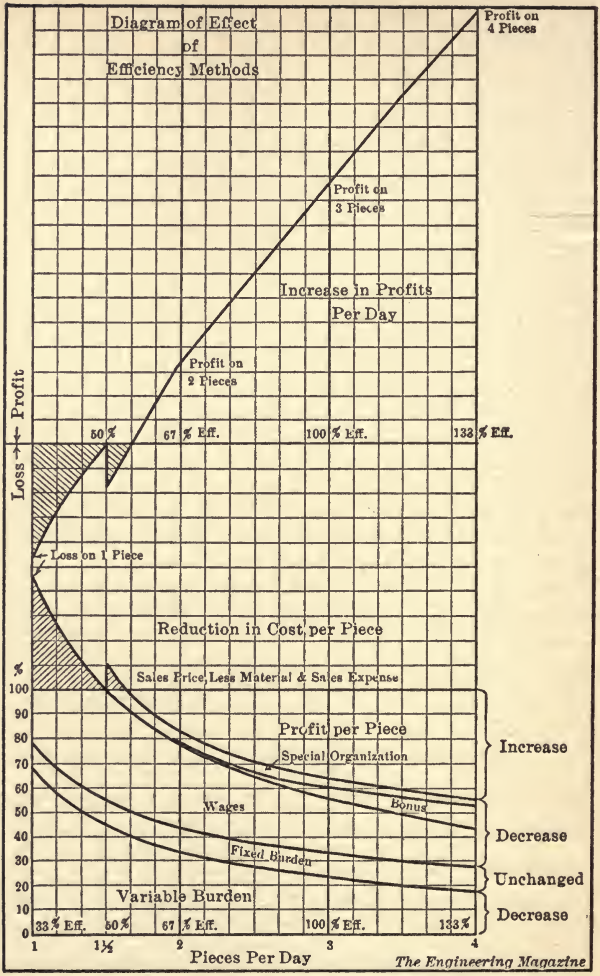


DIAGRAM OF EFFECT OF EFFICIENCY METHODS.

if there is persistent and conscientious effort to give the worker a square deal. The greatest impediment is the reluctance of the line to accept staff assistance, methods, and standards, including equity towards employees.

The diagram illustrates graphically and theoretically the effect on costs and profits of an increased output due to staff stimulus and bonus to the line.

CHAPTER VII

THE MODERN THEORY OF COST ACCOUNTING

THERE are two radically different methods of ascertaining costs: the first method, to ascertain them after the work is completed; the second method, to ascertain them before the work is undertaken. The first method is the old one, still used in most manufacturing and maintenance undertakings; the second method is the new one, beginning to be used in some very large plants, where its feasibility and practical value have already been demonstrated.

The objections to the old method are not only that it delays information until little value is left in it, but that it is wholly and absolutely incorrect, mixing up with costs incidents that do not have the remotest direct connection with them, so that analysis of cost statements, as, for instance, repair costs per locomotive mile, does not lead to elimination of wastes. The advantages of the second method are not only that costs must be ascertained before the work is begun, but that the costs as finally tabulated are the real costs divided as to each unit, whether a single element or aggregated out of a million separate elements (1) into standard expense and (2) into avoidable loss. An analysis of costs so stated facilitates an almost inexorable elimination of inefficient conditions of all kinds, standard expenses being constantly standardized at new levels—wastes, the excess above standard cost, being constantly removed.

The general method of anticipation as opposed to the method of retrospect is not a new one, and has already largely made its way in other lines of human activity. The old method was to call out the priests and tom-toms when an eclipse was occurring and thus drive away the devil who was eating the sun. The modern method is to predict the eclipses decades or centuries in advance, and check up our clocks, watches, and calendars by the actual occurrence. Under the old method the farmer planted what seed he had, fertilized it with any available manure, and trusted to nature to do the rest. The modern farmer predetermines conditions, selects and tests in advance special seed, feeds the soil with chemically adjusted fertilizer, irrigates scientifically, and trusts as little as possible to nature. In California he forces the lemon trees to bear for the Fourth of July and the orange trees to bear for Christmas. In hygiene, the old method is to wait until the whole community is infected with yellow fever or bubonic plague and then to quarantine and use chloride of lime; the newer method is to prevent the mosquitoes potentially capable of carrying the germs of yellow fever from ever being born, and to kill off the rats and ground squirrels that carry the fleas whose saliva infects the human body with bubos. In travel, the old method was to start an ox team from St. Joseph for California and to arrive somewhere between six months and a year after the start. The new method is to leave San Francisco on the minute, and to arrive in New York on the Century Limited also on the minute. That precision and exactness are more largely due to organization than to conditions is proved by the fact that the pony express of fifty years ago which made its runs between Sacramento and St. Joseph, a distance of nearly 2,000 miles, under unparalleledly adverse conditions of Indian hostility and climatic accident, adhered more closely to time schedule than many a modern railroad. In ocean travel the old method was to sail at some indefinite date from Europe and to arrive at a more indefinite date in America, much as Columbus did on his first voyage, an uncertainty of a couple of months not mattering; but the modern method is to build vessels whose exact speed is predetermined before the keel is laid, as for the Lusitania and Mauretania, which leave port on the minute and arrive almost on the hour.

Predetermination of results is the main characteristic of the modern method. The acceptance of the hap-hazard is the main characteristic of the old method, still in full and orthodox standing in cost accounting. Predetermination of results is based on scientific certainties modified by experience. It ought not to be necessary to prove that retrospect costs based on servile record of the hap-hazard cannot be of value, but actual illustrations from actual practice of their unreliability may hasten the conversion of those who are still skeptical.

Two closely similar types of locomotives were operating on a great railroad, one type in the east, the other in the west, both doing virtually the same work. The vice-president of the road desired to order a large number of new locomotives of the general type in question. He called for the records of the two classes and found that the locomotives operating in the west cost $0.14 per mile for maintenance, but that the locomotives in the east cost $0.10 per mile for maintenance. With these records before him he felt inclined to order the type costing for repairs $0.10 per mile. The facts were, however, that the western round-houses and repair shops were operating at 50 per cent efficiency and the eastern shops and round-houses at 80 per cent efficiency, so that the real respective costs of the locomotives were for the western $0.07 per mile and for the eastern $0.08 per mile. In this case so-called actual costs would have been expensively misleading.

A large manufacturing plant turned out forty special machines at a hap-hazard labor cost of $400,000, or $10,000 each, but after they were completed and the costs tabulated, the manager declared that if he were given another similar lot, the labor cost would not exceed $5,000 each. Was the $200,000 extra cost of the first lot real cost, or was it the cost of inefficiency due to unstandardized operations?

A waiter bringing in an expensive dinner to a guest at a hotel stumbles and crashes dinner and dishes to ruin. Shall the guest, besides being put to the annoyance of waiting another half hour, be charged not only double price for his dinner, but also for the broken dishes, or is the expense of the accident to be charged to inefficiency, a general overhead burden on all dining-room operations, taken care of in the standardized cost of each dish, without reference to specific accident?

There was a railroad shop in which charges were distributed with such painful care that the shop sweepers subdivided their time to the various locomotives around which they loitered. But locomotives, as well as men, can loiter, and one of the locomotives stood in this shop three months waiting for a steel deck plate. Being familiar with its number, the workers charged all the time they could not readily account for to this locomotive, so that at the end of three months the total amounted to more than $5,000. The fictitious accuracy as to the sweepers' time made more glaring the gross falsity of the locomotive charge. In principle there is no difference between charging an hour of wholly wasted time to a locomotive and charging it with two hours of time when one hour should have accomplished the work. The moment specific wastes of any kind are charged to a definite order instead of being charged to some inefficiency account, real costs are vitiated.

Assuming, under the old method, an elaborately carried out cost system, there may be put up to the superintendent in tabulated form comparative records covering many thousand different operations, from one to two months after they are completed. The superintendent does not have any time himself to examine all these different records, so he entrusts the work to a clerk, often without shop experience, instructing him to specify those records that require investigation. The clerk who has learned to apply "the method of exceptions" passes over as satisfactory those costs that show slight change from previous records, and notes down for action those that show great variations. Because costs are not standardized, the variations due to inefficiency under identical conditions are in the records either increased or lessened by the much larger variations due to change of conditions. It is evident that a job done one month under 100 per cent conditions, but with 60 per cent labor efficiency, may equal in cost the same job done another month under 60 per cent conditions but 100 per cent labor efficiency. The tabulated costs of this job show no variation and are consequently passed as satisfactory, although in both cases as to the total elements the expense is 25 per cent too high. In another case, perhaps, the clerk notes that one month the surfacing of a slide valve is reported to have cost \$37.00 and in another month to have cost \$3.65. Having found, as it seems to him, a variation worth following up, he begins an interminable and irritating investigation. The foreman in whose department the discrepancy occurred denies it, claiming that the accounting department is in error. If the time and cost accounting is so accurately looked after that it can be demonstrated that the first order was done by an expensive man on a big slow machine, with a very high hour rate, but that the cheaper second order was done by a low-priced man, on a small quick machine, with a low hourly rate, then as to this six-weeks-old occurrence the foreman advances plausible excuses—the little suitable machine was otherwise employed—the expensive man was out of work—it was in any case an emergency job and the customer had to pay for it—so the investigation results in naught in the way of cost reduction, but the whole system is discredited both in the opinion of the foreman and of the superintendent, and the cost clerk soon ceases to take more than perfunctory interest in his duties.

The human mind is curiously irrational and perverse. The Chinese are more interested in their ancestors than in their children, and other individuals besides the Chinese are more interested in tracing their descent to the 1024th part, even on the wrong side of the blanket, of some rascally nobleman, than in training their own children in paths of righteousness. If the object of cost accounting is to record fictitious and valueless genealogies, then the old methods should be given Godspeed; but if the object of cost accounting is to record accurately present facts and facilitate future improvements, then the new method alone is suitable. The old system of cost accounting is deficient firstly, because it looks backwards instead of forwards, and it is even more deficient because it has failed to recognize the difference between exchange and equivalency. A birthright may be sold for a mess of pottage. This is exchange without equivalence. When 100,000 bushels of wheat of certified grade are exchanged for dollars at the market quotation, there is both exchange and equivalence, the operation being reversible, as the money can be immediately reconverted into wheat with only a small frictional loss. In this operation of exchange with equivalence the Government not only standardizes the dollar, but it puts its stamp on the standard dollar—the grade of the wheat is certified to by qualified and approved inspectors—the scales on which wheat is weighed are inspected as to accuracy.

It is, however, only recently that Governments have furnished the standard dollars now used by exchange. When studying commercial practices at a German commercial school, most of my time, that might have been better employed, was wasted in learning to value and reduce to a common denominator the various coins of brass, tin, copper, silver, gold and platinum which were currently used to settle balances. Before Napoleon made a cleaning up in Germany there were some three-hundred independent States, each with its own rights of coinage and money issue. Many of these issues were still current in 1870, and without an assay and metal-market quotations as to value, there was nothing definite in a safe full of alleged money. The *thaler* or *gulden* was indeed standardized at so many grains of silver, but many of the current coins were not *thalers* or *guldens* and had first to be reduced to *thaler* or *gulden* values. Similarly today in operating concerns there are many expressions, as "a day's work," "a pound of material," "the performance of a machine"; but exactly what constitutes a fair day's work, how far a pound of material should go, and what a machine should do per hour, have only in a few cases been determined. They should be predetermined in all cases.

The modern method of cost accounting anticipates standard expenses because it first determines equivalency between dollars spent and standard service. In the mining of precious metals, as also in the German banker's assay of the strange coins he handled, there has always been this determination of equivalency. An ounce of pure gold is worth $20.67; an ounce of alloyed and impure gold is worth $20.67 multiplied by an efficiency figure which may be anything from 99.99 per cent down to a fraction of 1 per cent. Whatever the mixture, whatever the ore or coins, sample and assay determine the value per ounce, thus determining the efficiency coefficient. As in mining and in former coin assays, so also in modern cost accounting there must be initial determination of equivalency, standard equivalency consisting, for dollars paid out, of actual costs multiplied by current coefficient of efficiency. In present commercial transactions the old-time slugs and base coins of every kind, country, and date have been eliminated. Dollars, francs, sovereigns, and marks, all definitely and precisely related to one another, constitute the common standards of the commercial world, but in industrial equivalency we are still in the dark ages.

It is the function of the efficiency engineer to give the industrial and operating world:

1.—Standards as definite as the dollar, franc, sovereign, or mark, for all services, materials, or equipment operations.

2.—To make assays, as definite and reliable as the assayer's determination of bullion values, of all current operations, thus establishing current efficiency.

3.—To provide remedies which will bring current efficiency (often, one might say usually, only 50 per cent of what it should be) up to 100 per cent.

It is the function of the comptroller, auditor, accountant, to locate and record all expenditures, to locate and record all receipts.

Both comptroller or auditor and efficiency engineer are staff officers, the work of each of whom is supplementary to that of the other, and both together supply the line officers with the tools and the methods needed to carry on operations with exact knowledge as to cost and efficiency.

Because efficiency is the most important item in modern costs, the modern comptroller and the efficiency engineer must affiliate, associate, so that they may jointly solve the problem, the efficiency engineer being deprived of his most powerful instrument of determination and betterment if the comptroller does not supply him with the necessary current and correct records which he needs. The effect of association of comptroller and efficiency engineer on costs will be illustrated for a specific case of railroad operation, any other possible case being capable of similar solution, the illustration being used, not to show the results of efficiency, but to show how the auditor and the efficiency engineer, before any current work is begun, can predetermine standard costs and current efficiency, ultimately making the latter 100 per cent.

It is evident, when the efficiency engineer predetermines standard costs, that the difference between standard costs and actual costs is the volume of the loss due to inefficiency. It is also evident that if by assays the efficiency engineer assertains current wastes, he is able to determine standard costs by deducting the wastes from actual costs.

When standard costs are adopted the efficiency engineer is pledged to supply methods which will eliminate the wasteful difference between standard and actual costs, and from time to time, as this work of elimination progresses, standard costs will themselves be revised, sometimes upwards, sometimes downwards, since the basic elements of costs, materials, services, and operations are not constant in value.

A certain railroad operates 1,000 locomotives. Test questions put by bankers, investors, officials are: What is the cost of locomotive repairs per mile? What should be the cost of locomotive repairs per mile? The auditor answers the first question, the efficiency engineer answers the second question; and only where they have worked in harmony are the two answers the same. The staff officer in charge of the accounts, whatever his title —comptroller, general auditor or vice-president— carries his organization as to methods of accounting and checking down to the minutest details. The efficiency engineer's work runs parallel with the auditor's from top to bottom, but on a wholly different line, much as telegraph lines run parallel to railroad lines, each having relations to the same operation, train movement, at every station. In accounting the auditor is responsible for correct cost statements as to every item of expense, and the efficiency engineer is responsible for correct cost attainments—namely, 100 per cent efficiency, as to every service, material issue, or equipment operation.

As a preliminary to coöperation, the efficiency engineer learns that the mileage of locomotives is approximately known, because engineers and firemen are paid on the mileage basis, and that the total annual mileage for the 1,000 locomotives is 30,000,000 miles; that under the Interstate Commerce provisions, all costs of labor and material for locomotive repairs have been charged to one given account whose total for the previous fiscal year was $3,000,000. This works out to a mile cost for repairs of $0.10. The efficiency engineer then goes over the road, makes numerous assay tests of service, of material used, of equipment operation, and while there is great variation in individual assays, some running as low as 5 per cent and others as high as 100 per cent, it is his opinion that the assays of the road as to this account show 60 per cent of the standard; that costs are therefore 67 per cent higher than they ought to be. The accountant thereupon divides his estimate for the coming year into two parts and adopts (on the recommendation of the efficiency engineer) $0.06 as standard average repair cost per mile, and he adopts 60 per cent as the current efficiency factor, carrying the remaining charge of $0.04 to a preventable waste account. Until further notice any average expense for repairs above $0.06 is considered preventable loss.

It is the business of the efficiency engineer to eliminate wastes, and it is the business of the auditor to carry the accounts in such a manner as to record the results of the efforts of the efficiency engineer. The initial 60 per cent efficiency should gradually increase to 100 per cent and the auditor is to record the increase. The president of the company is advised by the auditor that repair costs as standardized by the efficiency engineer are $0.06 per mile, and that preventable losses amount to $0.04 per mile. The proportionate loss due to inefficiency is 40 per cent, and if current yearly mileage is to be 36,000,000 miles (on basis of current wastes) the loss will be $1,440,000, which loss, if his original assay is correct, it is the task of the efficiency engineer attaining 100 per cent to eliminate, just as certainly as the Century Limited can make the Chicago-New York run in 18 hours.

The president need not look deeper than the standard of $0.06 per average mile, and the efficiency for the total account of 60 per cent. The standard will not be changed for a year—although ultimately it might be made $0.055 or even $0.05, standards being wholly distinct from efficiency—but from month to month the president will watch the efficiency factor and expect to see it rise from the initial 60 per cent to a final 100 per cent, actual costs per mile correspondingly dropping from $0.10 to $0.06. It is, however, not the cost per mile but the *efficiency* which is important. A severe winter might occur, greatly adding to repair costs; a roundhouse might burn down and damage many locomotives. If all the necessary repairs are made at 100 per cent efficiency, officers and shareholders will have to be content, even though the standard cost has to be advanced, after all consideration and for sufficient reason, to $0.10 a mile. On the other hand, extraordinarily favorable conditions may drive the actual costs down to $0.05, but if average efficiency in details is only 50 per cent, officers and shareholders know that $0.05 is not low but twice what it ought to be. In the effort for economy many railroads have been making records of low cost which are wholly fictitious, since necessary work has not been done, standards are not maintained, and inefficiency as shown by the labor and operation assay is even greater than usual.

To attain 100 per cent efficiency—$0.06 a mile—and to record the downward progress from $0.10, are respective duties of the two staff officers, efficiency engineer and auditor. The latter meets the former's needs in the way of records and accounts. As the largest operating units are the divisions of the road, and as locomotive operation is about 30 per cent of the total road-operating expense, the efficiency engineer asks the auditor to subdivide operations, all the expenses for services, for materials, and for equipment operation (as to locomotive repair accounts):

1.—To separate locomotives.

2.—To the respective divisions.

3.—To the kind of work done, as tire turning, flue welding, etc.

From these records it will be possible to tell not only what each separate locomotive costs per year, but also what each class of work costs. On many roads, charges are already subdivided to respective divisions; on others, even to separate locomotives, although not in such a way as to be of any practical use, but it has not been usual to classify as to operations because this has hitherto served no purpose from an exclusively accounting point of view.

Necessary records being available, the efficiency engineer investigates divisions, shops, round-houses, locomotives, and operations. He finds that shop conditions on one division are only 50 per cent, on another 70 per cent, and he forthwith adopts such remedies as will most rapidly bring up the inefficient divisions. He may find, for instance, that lighting and heating or other elementary sanitary conditions on a division are so poor that the men, even with best intentions, lose 25 per cent of their time. Some of this can be remedied, often in a surprisingly easy manner, or work can be diverted to the more efficient shops. The policy of concentration of work at efficient points is steadily pursued. In a given distance, a boiler-shop punch made by day work at an outlying shop cost for labor $6.00, the same punch made on an automatic machine at a central shop costing for labor $0.06.

When it is stated that an efficiency engineer brings about improvements it is to be remembered that he is a staff officer—that he merely provides standards for the officials to follow—that he may indeed establish a standard of 60 per cent efficiency below which no man ought to be permanently retained in the service of the company, but being a staff officer he will not directly discharge an employee, although the efficiency standing is only 10 per cent. Discharge is the prerogative of the line officer. As a staff officer, the accountant may report that a given locomotive costs \$0.20 a mile to maintain, while another locomotive on the same kind of work costs only \$0.08; as a staff officer the efficiency engineer may report that \$0.20 a mile is 100 per cent performance while the \$0.08 is only 80 per cent performance; but neither the auditor nor the efficiency engineer has the right to order the uneconomical locomotive out of service.

High cost and inefficiency are not identical. High cost may occur with high efficiency, low cost may occur with low efficiency. The Indian who carried 250 pounds on his back over Chilkoot Pass in Alaska at the time of the Yukon gold rush was tremendously efficient, but the method was costly, rates being \$0.60 a pound. This is an illustration of high cost and high efficiency. The Alaskan locomotive which today hauls freight over the neighboring White Pass may be very inefficient, only able to drag half a normal load, yet the rate is down to \$0.02 a pound. This is relatively low cost combined with low efficiency. The railroads of the United States carry freight at lower rates than any other railroads—cost of service is relatively low. Many of the operating and maintenance methods are extremely wasteful, at least 51 per cent above reasonable standard, therefore efficiency is very low, but the low costs of service are not the result of inefficiency.

Just as the shops are each separately investigated in the pursuance of the work, so the conditions as to locomotive operation are investigated as to each division. Surprising troubles are often revealed. One railroad on which efficiency work was undertaken had neither turn-tables nor round-houses large enough to turn certain new locomotives; on another road some of the curves were so sharp that decapod locomotives could not back over them. In another case the tracks leading to the main round-house were so easily blocked that it was almost impossible to move locomotives in or out. An engineer experienced in detecting inefficiencies will discover a vast number of conditions that are not standard, but which can be easily improved by the line officers, and which when improved will bring up the efficiency factor of the division. No divisional factor can increase without bettering the system factor. If for instance the system factor is 60 per cent, the division one-tenth of the system, when the divisional factor is advanced from 65 per cent to 75 per cent, the system factor will advance to 61 per cent.

Records being available for each separate locomotive, each is investigated both as to performance and as to cost of maintenance. The efficiency engineer establishes new measures, new methods of comparison unknown either to operating officials or to accountants. He knows that repair costs per locomotive mile are, from an efficiency point of view, meaningless. One locomotive weighs 400,000 pounds, another only 40,000; one locomotive operates on 3 per cent grades, another on level track. He therefore uses such measures as the tractive-weight mile, which compensates for weight and also, fairly well, for the difference between freight and passenger locomotives. He establishes a standard allowance of $1.00 of repairs per ton of coal burned, and on the basis of grade and service he establishes a standard of fuel allowance.

The measuring appliances and methods of the standard-practice engineer, innumerable in their variety, are invented and applied so as to test and gauge efficiency. As to all his own measures he seeks the co-operation of the accountant, without whose figures it is impossible to record definitely and reliably the progress made, or the reverse. As a general proposition those tabulated records, which involve, directly or indirectly, equivalency in money will be maintained by the auditor; those records which involve other equivalents, foreign to the auditor's experience (as pressures or temperatures, or chemical analysis) will not be looked after by him.

The measures and methods of the efficiency engineer can be divided into two main classes, those that affect general conditions, and those that secure special results. General conditions are those that affect the good and the bad alike, as good equipment, good operating conditions and administration. Special results are secured only through high individual performance, whether the individual is a person, a machine, a material issue, or an operation however complicated. The next chapter will outline the specific methods and records evolved and used jointly by auditing and efficiency engineers to locate and eliminate wastes.

Chapter VIII

THE LOCATION AND ELIMINATION OF WASTES

MODERN efficiency cost accounting and expense statements consider separately *total expenses,* which concern chiefly the comptroller, *standard* or *efficiency costs,* which concern alone the efficiency engineer, and *current wastes,* which concern both comptroller and efficiency engineer. Total expenses need no definition. Efficiency costs are predetermined costs. It is part of the duty of an efficiency engineer to predetermine standard costs either by using existing standards or by a series of assays.

Current wastes are predetermined by assuming that they will be relatively of the same percentage as for an immediately preceding period. The period may be either short or long—a week, a month, a quarter, a year, or a longer term. The more rapidly changes occur, the shorter should be the term, but when operations are well standardized and standards regularly attained the term may be longer. Total costs are based on two predetermined items, standard costs and current percentage of waste.

Standard costs are the mariner's compass of a business enterprise, showing as they do from month to month the proper course of the business ship. Predetermined total costs, which include prevailing waste, are knowledge of the latitude and longitude of the location of the ship. Predetermined costs, although of immense practical value, are subject to one slight disadvantage, more theoretical than actual, which nevertheless may prejudice adherents of the old school against the new methods. The drawback is that predetermined total costs do not agree with actual expenses over the same period. Let it be remembered, however, that this lack of agreement is no more important than is the lack of agreement (except at two moments of the year) between siderial time and sun time, the lack of agreement between standard railroad time and local clock time, the non-agreement between magnetic north and true north, the non-agreement of the Pole Star with the true north, or the non-existence of any constant true north, since even the axis of the earth wabbles.

The efficiency engineer uses statements of standard costs, of current wastes, and of predetermined total costs. Without them he is in the position of a driver who is trying to develop a trotting horse without the advantage of a measured course or of a time-piece. The driver would accomplish something, he might indeed force the horse to the limit, but he would never know whether he really had the best horse, or whether some change of harness, shoes, sulky, or track was a betterment or a detriment. The efficiency engineer knows that only by the rarest accident will actual costs correspond with total predetermined costs, which are the sum of standard cost and previous waste percentage. He will never attain exact correspondence between allotment and performance. The comptroller's problem is to reconcile the actual expenses, for whose correct statement he alone is responsible, with the valuable and useful total predetermined costs which he and the efficiency engineer have jointly elaborated and accepted; it is also his task either to maintain for the efficiency engineer, or to assist him in securing, records showing the discrepancies between predetermined and actual costs. He can of course adjust predetermined costs to actual expenses, or he can adjust actual expenses to predetermined costs. It is more desirable to do the latter, because in no other way is the attention of all concerned continually called to the important facts of standards and of wastes. A railroad which reports locomotive repair costs of $0.16 per mile, a fact whose importance escapes all but a very few experts, would not be so indifferent to this very great waste if it had to report in the form illustrated at the top of the next page:—

DIAGRAM OF EFFECT OF EFFICIENCY METHODS

Miles run	30,000,000
Standard cost for repairs per mile	$0.06
Total standard cost	$1,800,000
Preventable waste and repair cost per mile	$0.10
Total cost of preventable waste	$3,000,000
Total actual expense per mile	$0.16
Total actual expense	$4,800,000

Efficiency engineers have also found to their sorrow that unless predetermined costs are tied in to current costs by the comptroller it is impossible to attain accuracy in their statement, and there is also no available proof to convince those whose support is essential that the methods used are really producing the results promised. In scanning the accounts of one firm the efficiency engineer discovered that payment for a cow accidentally killed has been charged to the tool-maintenance account, not for the purpose of perpetrating a fraud but simply to close out an omitted item. When the tool account was put on standard allowance, items of this kind sought refuge elsewhere, and the expenses reported were those actually incurred. The old ideals of close time accuracy in the statement of costs are not to be lightly disregarded, but hitherto they have resulted in obscuring the importance, and causing the neglect, of items more important from the profit and loss, from the efficiency, aspect. If a worker is overpaid through an error in his rate, if he draws pay for a day on which he is not present, there is quite proper alarm and no hesitancy is shown in correcting the error during the next pay period; but if the same workman destroys valuable material or continuously kills time, no one except perhaps his foreman takes any cognizance of the resulting loss, which in the aggregate probably exceeds a thousandfold the loss due to accounting carelessness. Inaccuracies in money should not receive less attention than hitherto, but efficiency losses should receive more. If a slight time inaccuracy in expense statement results in very great efficiency and other gain, knowing full well what the inaccuracy is, its amount, and why it has occurred, we can accept it just as we accept the magnetic compass or the pole star as preferable to the imaginary true north, or standardized sidereal time as preferable to the practically impossible sun time. There is the great gain in continuous efficiency statement, in anticipation of all cost records, so that the cost of any particular operation, however extensive or minute, is known in advance with greater real accuracy as to single items than in the system of accidental costs, and with very small inaccuracy as to the total aggregated expenses of a year. To illustrate by a concrete example. It is better for a monthly or yearly report to state that total predetermined costs for repairs to locomotive per mile traveled are \$0.07 when in reality they are \$0.0696, than to state them accurately as \$0.101, when no one has any idea how to reduce them.

The double problem and its solution by comptroller and by efficiency engineer will be shown by an actual practical example. On a great railroad system current actual costs of one of the items of locomotive repair were about \$0.10 per unit. A reduction of this account was planned in June, 1904. It was definitely ascertained from the official records:—

1.—That actual expenses for the preceding year had been \$487,171.

2.—That actual expenses per unit were \$0.1031.

It was definitely stated by the efficiency engineers:—

1.—That standard costs per unit should not exceed \$0.06.

2.—That current losses and wastes per unit were at least \$0.04.

3.—That on the basis of same volume of business, actual expenses should be reduced to \$287,000.

4.—That the actual annual saving should be $200,000.

The double problem was to eliminate the inefficiency costs which amounted to 40 per cent of the whole expenses, and to reconcile predetermined costs with actual costs. The tables on page 127 illustrate the progress of the work from year to year, although actually the corrections would be made and standards revised from month to month, thus minimizing differences.

In the year 1903–4, before efficiency work was begun, the actual costs were $487,171, but predetermined on a basis of $0.10 they would have been $472,500. The difference between these two amounts could be either cleared at the end of the fiscal year, or, preferably from the efficiency standpoint, carried in the statement of the lapsed year 1903–4 to "Accounts Receivable" or to "Advances on Work not yet Performed" or to some other suitable caption; but at the beginning of the ensuing fiscal year the amount is charged immediately or in monthly instalments to the maintenance account under consideration. If this is done, in the year 1904–5 the predetermined expenses appear as $478,540 but actually amount to $486,620 expended through the year, to which must be added the item of $14,671 brought forward as a charge from the preceding year. The deficit of $22,751 at the end of this year is closed out as before and is carried as an initial charge into the year 1905–6. For 1905–6 the standard cost is continued at $0.06 but, owing to the improvements already effected, wastes are predetermined at $0.01, making a total allotted cost of $0.07 per unit. This totals to $404,320 but actual expenses are only $376,106, or $28,214 less than the predetermination. The deficit at the beginning of the year was $22,751, from which we subtract the credit of $28,214, leaving a credit of $5,463 to be carried into the year 1906–7. For this year the standard cost was reduced from $0.06 to $0.05 per unit, and no allowance being made for wastes, which by this time were eliminated, the predetermination was also reduced to $0.05. The total of predetermined allowance was $323,140, the actual expenses were only $315,844, the credit being $7,296; the forward credit was $5,463, making a total credit of $12,759 which at the end of the year 1905–6 can be reported under "Accounts Payable," or "Due for Work Already Done," or any other way.

It is much to have reduced the total actual cost from $487,171 to $315,844, but the real results attained are shown more clearly in the unit cost statements. Not only was a standard of $0.06, 40 per cent lower than current practice, adopted, but in the fourth year the standard was revised and a new standard of $0.05 adopted, which was more than attained in the following year. Not only was a waste of $0.04 predetermined, but a waste of $0.052 per unit was actually eliminated. The unit expense was reduced more than one-half and the end of improvement was not yet reached. In the fiscal year 1907–8 a unit cost of $0.0452 was attained, total actual expenses being $290,832; and in the calendar year 1908 the unit expense sank to $0.0373, the total being $223,541.

PREDETERMINED COSTS AND ACTUAL COSTS AND THEIR RECONCILIATION.

	1903–4.	1904–5.	1905–6.	1906–7.
Total units.........	4,725,000	4,785,400	5,776,000	6,462,800
Predetermined unit standard costs....	$0.06	$0.06	$0.06	$0.05
Predetermined unit wastes...........	0.04	0.04	0.01	.....
Predetermined total unit costs........	$0.10	$0.10	$0.07	$0.05
Actual unit costs...	0.1031	0.1017	0.065	0.049
Predetermined standard costs....	$283,500	$287,124	$346,560	$323,140
Predetermined wastes...........	189,000	191,416	57,760	....
Predetermined total costs............	$472,500	$478,540	$404,320	$323,140
Actual costs from President's annual report...........	487,171	486,620	376,106	315,844
Credit to Efficiency account..........	....	....	$28,214	$7,296
Debit to Efficiency account..........	$14,671	$8,080	....	....
Credit carried from preceding year ...	....	....	....	$5,463
Debit carried from preceding year....	....	$14,671	$22,751	....
Credit to carry to following year......	....	....	$5,463	$12,759
Debit to carry to following year....	$14,671	$22,751	....	....

The handling of this account on an efficiency basis of predetermined costs yielded many other instructive experiences. The initial plans for reduction were made in June, 1904, but July, August and part of September were allowed to slip by before work was seriously taken up. By this time the monthly expenses had risen to $45,129, the unit cost approximating $0.114. There were no sub-records of details available, so that the efficiency staff did not know where to begin its work, and the process of betterment required large initial outlays for better facilities, tools, and equipment. The cost of making up a complete set of sub-records was considerable. As a consequence the first half of the fiscal year 1904–5 cost $256,891, the unit cost being $0.1073, or considerably more than the total expense for the whole year 1908 with 23 per cent more units. The detailed records for each month show the tremendous efforts made to stem the rising tide of waste during this first year, but the annual record does not show this internal struggle. Possibly some will claim that the reduction of expense was not due to efficiency standards and efficiency methods. Perhaps not; but the diagnosis of inefficiency was made before beginning any work, standards of cost and waste were established before beginning any work, a large staff using drastic modern methods was exceedingly busy trying to produce results through every means known to efficiency engineers, and where this staff was most active the greatest improvement was attained. On a similar and parallel road, all conditions being closely identical, except efficiency staff, actual costs hovered around the unit cost of $0.10.

	A.—Using Efficiency Staff Organization.			B.—Without Efficiency Staff Organization.		
Year.	Output.	Expense.	Unit Cost.	Output.	Expense.	Unit Cost.
1903–4..	47,250	$487,171	$10.31	51,003	$487,150	$9.55
1904–5..	47,854	486,620	10.16	52,037	567,161	10.90
1905–6..	57,760	376,106	6.51	57,034	537,318	9.42
1906–7..	64,628	315,844	4.89	65,076	638,193	9.81
1907–8..	64,326	290,832	4.52			
1908 ..	57,777	223,541	3.73			

In modern railroad operation an account aggregating less than $500,000 is not of highest importance. The example given has been selected to illustrate methods rather than the results in details. During the same period on the same railroad and in wholly similar manner another account was standardized and reduced as follows:—

	1904–5.	1905–6.	1906–7.
Total units....................	47,854	57,760	64,628
Standard labor cost per unit...	$30.	$31.35*	$32.10*
Standard waste per unit........	40.	20.	10.
Predetermined cost per unit....	$70.00	$51.35	$42.10
Actual expenses per unit.......	70.15	48.57	43.32

*The weight of units increased.

As to this account the reduction in waste attained on a unit basis amounted to $1,731,030. Smaller accounts were even more successfully handled. In one case the total actual expenses dropped from $12,000 to $600 with the same amount of work.

There are five trunk railroads operating between New York and a western point. Taking the locomotive mileage as a unit, they maintain their locomotives in repair approximately as follows:—

	A	B	C	D	E
Repair cost per locomotive mile....................	$0.04	$0.08	$0.10	$0.12	$0.16

Those intimately familiar with conditions on D and E know that locomotives on these roads can be maintained in first-class repair for $0.06 per unit. Railroad D has a locomotive mileage of about 20,000,000, so that its excess of expenses owing to its inefficiency as to this one item is not less than $1,200,000 per annum. Railroad E has a locomotive mileage of 30,000,000 and its excess of expenses owing to its inefficiency as to this one item is not less than $3,000,000 per annum. The total locomotive mileage of all the railroads in the United States is about 200,000,000, and a saving of $0.04 per mile is possible on all but a very few. Hence the total waste per annum is about $80,000,000, or about the same as the total annual gold production in the United States—a waste and loss that a change from accounting by retrospect to accounting by anticipation would do very much to correct.

Accountants will understand that so vague and unscientific a unit as "locomotive mile" has been used in the above example solely to illustrate a principle. The real standard unit of cost for any operation is the cost per unit of time, to which in certain cases material costs are added. It costs so much a year to operate an industrial plant or a railroad; the year is subdivided into working hours which may vary in different departments. Every ordinary operation can be reduced to time at a definite cost per hour. The efficiency of any man, any machine, any department, any shop or division, or any plant or railroad, can be determined by standard time and rate and the addition of the wastes which previous experience reveals. The cost of repairing a particular locomotive for a particular mile run never has been, never can be, ascertained, but the rate of pay for a man for a given hour and his speed of work can be as definitely determined as the length of a race track and the time required by a horse to go around it. It is absurd to standardize the output of a locomotive plant at fifty locomotives a month when the standard labor on one locomotive amounts to 20,000 hours a month and on another locomotive to 5,000 hours. When, however, standard hours of labor for each item of each locomotive are summed into a total of standard hours for each type, then, if the limit does not lie in the machines, the number of men required (with allotted waste added) can be predetermined; or, if the limit of the machines determines the number of men, then the number of hours available fixes the volume of output, which may be high one month at forty locomotives and low another month at sixty of a different type. Costs of locomotives or of locomotive miles, or of track maintenance, or of anything else, will take care of themselves when the unit hours of each man and machine are operating at highest efficiency for standard cost, and there is no other way to save millions of dollars than to avoid spending dimes without equivalency.

An American railroad running westward from New York, although under strictest instruction to economize, spends per unit $0.16, a total of $4,-800,000, while another railroad, with a well deserved reputation for good management, maintains better conditions for $0.05 per unit. Assuming the efficiency of this railroad as to this item of expenditure to be 100 per cent, then the other railroad is operating at 31.2 per cent efficiency.

Because of the great inefficiency and wastes occurring in private and corporate businesses, many assume that Government management and control would result in less waste. This is not the case. Work of certain kinds undertaken by the Government, as building warships, reclaiming arid lands, digging canals, is expensive because Governments do not legitimately exist for activities of this kind, which can be carried on better, more cheaply and expeditiously, by private or corporate endeavor. The legitimate business of the Government is not to compete with individuals and corporations, but to supply the staff knowledge needed by individuals and corporations, to develop great national efficiencies which are beyond the power of the short-lived. Astronomical researches, tide and weather observations, geodetic, coast, and geological surveys—these are some of the staff duties of a Government; sanitary, financial and other general protection are the co-operative assistance we expect from Government. No individual has the same extensive and continuous opportunity as the Government to sound the deep seas, to map their shores, to explore the heavens; no individual has the power to determine a continuing equivalency between a commodity and money; but there are thousands of individuals who know more about digging dirt and rock than does the Government, and therefore when the Government undertakes work of this kind, the inefficiencies revealed transcend those found in railroad shops.

In one of the largest operations conducted by the United States Government, the following assays were obtained:—

	Standard Cost.	Waste.	Actual Expense.
1.	$1.95	$29.65	$31.60
2.	2.60	13.65	16.25
3	6.50	39.00	45.50
4.	1.30	14.95	16.25
5.	3.90	35.10	39.00
6.	13.00	85.00	98.00
Totals.	$29.25	$217.35	$246.60

Efficiency per cent, 11.86.

Assays of this kind if numerous, are quite as reliable as assays of ore on the dump.

With test assays (on a very limited scale, it is true) showing only 13 per cent efficiency, is the Canal Commission with its *un*limited inexperience and its *un*limited money, to be put in the same class as the most highly organized and efficient railroad, or in the same class as the railroad showing 31.2 per cent?

The distance from the United States, the novelty of the climatic and other conditions, the absence of competition, the lack of economical incentive, the known absence of all business efficiency standards in all departments of the United States Government, even at Washington, and especially in the Army and Navy, whose ideals are the greatest amount of destruction in the shortest time, without regard to cost), the failure to employ any of the modern methods of standardized unit costs and their realization—all these conditions combined necessarily result in the low efficiency. Therefore the low work efficiency attained for dollars spent is due to initial errors of judgment as to organization and methods, errors necessarily resulting in incompetencies of operation.

In comparison with standardized and attainable unit costs, the United States will probably waste not less than $180,000,000 in building the Panama Canal. The estimated cost is $360,000,000, and on a basis of fifty per cent efficiency the waste will be $180,000,000.

What is meant by fifty per cent efficiency is not that some other type of canal should be built, or that less dirt should be excavated, or that sanitation should be curtailed, but that for the same canal, for the same volume and quality of work, the expense should be one-half of what it is.

To assume that the efficiency will be higher is to assume that in the first year of this work in the Canal Zone the Government can show a higher efficiency than that developed on a carefully managed railroad at the end of forty years of experience.

CHAPTER IX

THE EFFICIENCY SYSTEM IN OPERATION

IN the preceding chapter the method of reconciling predetermined allotted costs with actual expenses was outlined as to actual cases, in which efficiency methods reduced unit costs from $10.31 to $3.73 in four years and a half, in a subsidiary account, effecting a saving of $379,017—reduced unit costs as to a main account from $70.15 per unit to $43.32, effecting a saving of $1,731,030.

Other instances were given in which an analysis of a railroad repair account for a single year showed it to be $3,000,000 too high, and the Panama actual expenses will consist in about $180,000,000 of standard unit costs and in about $180,000,000 of preventable waste, the waste being due to low efficiency in units.

The reduction of cost is an efficiency result compared to which the method of stating it in the accounts is unimportant, but the ability to follow efficiency methods and to convince others of their value and effect depends largely on clear and easily understood statements, and these statements are difficult to obtain and do not carry weight unless at some point they are certified by the accountants and thus tied into the official expense reports. Efficiency records and accounting records can coincide only at one point—namely, where the same equivalents are used. All the expenses of the year appertaining to a unit, divided by all the units for the year, can be used by both efficiency engineer and by accountant, but in this case no statement of efficiency and expense will coincide for a shorter period or for a smaller number of units. If at the other end—the single unit for the smallest time—cost-accountant and efficiency engineer agree as to a method of stating cost for the single unit of work, then the records built up from this base will diverge immediately, as efficiency corrections are not identical with expense corrections. It is however very important that both efficiency statements and cost statements keep close together, that both should use the same unit, that both should use equivalency (standard cost) and that expense shall be stated in two terms: Standard Cost and Waste. It will prove convenient for the accountant to standardize from previous records both the current percentage of waste and the general burden resulting from indirect expense, rather than to carry into the daily operative expense statement the actual but partly accidental waste and the actual fluctuating burden, especially as the standardization of waste permits a very close prestatement of cost which is always of advantage, and also brings back forcibly to the accountant the great purpose for which accounts were originally evolved and developed—namely, to locate and eliminate wastes. Whether efficiency records receive the assistance of accounting statements or not, the methods of attaining efficiency are as follows:

The volume of work to be done is carefully measured or estimated in advance on a unit basis.

In preparing to build a line of railway today, the tons of rails, the number of ties on the mileage basis, the quantity of earth and rock handled on a cubic-yard basis, are easily predetermined. Predetermination was not always resorted to in the early days, and there is a story current that after the first transcontinental road was built the number of ties actually under the rails was only half the number that had been paid for. From the stories told me by eye-witnesses of and participants in the methods of counting ties delivered, I am surprised that the final result was so good. It would have been just as easy to have estimated "ties required" in advance, to have accepted no more than enough, and to have paid only for those under the track, in fact—to have counted first and paid afterwards—instead of paying first and counting afterwards. Similarly it is possible as to any operating road to estimate in advance and in detail the reasonable unit cost of each item of repair and also the reasonable number of each kind of units. The number of some units may increase, owing to unforseeable causes; but as units increase, cost per unit should go down, offsetting to some degree the accidental increase. When a careful pre-estimate is made of the reasonable cost of the great items of operative cost on a railroad it is found that they are not infrequently less than half the actual cost, and I do not know of any important railroad within the limits of the United States in which the locomotive repair cost of $0.06 per mile ought not to be ample, instead of the $0.08, $0.10, $0.12 calmly embodied in annual reports.

The cost of ties for a new railroad depends less on the number required than on the cost of each, since even the grossest waste of supply can scarcely double the quantity; but there is almost no limit to the amount which corruption and similar carelessness may pay for individual items, as was recently well illustrated in the State House furnishing scandals of Pennsylvania. So also in manufacturing operation. While the volume of business has an important bearing on cost, it is distinct from the unit cost of operation, which need not be appreciably more for a few operations than for many. It is the methods used to secure control of unit cost which are important, little known, and rarely used.

The cost of any operation consists of four items:

1.—Material used

2.—Labor service used.

3.—Equipment service used.

4.—Indirect expense, carried partly in 3 and partly as a burden on all labor service used.

Item (1) is covered by a "material" requisition.

Items 2, 3, and 4 can be combined in a single "service" requisition.

Two forms of requisition are therefore sufficient to cover every possible item of operation expenses, of cost, of accounting, and of efficiency, and, except as to form, there is no difference between a material-expense order and a service-expense order.

The best basis for a cost and efficiency system is: not to issue any material without a full requisition, not to permit any work to be done without a service order.

Stores Issued To Department______			State Use For ______		
ITEM	DESCRIPTION		ACCOUNT Entries to be	CHARGE by Storekeeper	
QUANTITY	QUALITY		COST PER $	TOTAL VALUE $	
Storekeeper please issue above material			Month	Day	Year
To ______ (Give Name. Do not make out to bearer)					190
Approved by______Foreman (Values to be filled in at storehouse)					
Issued by ______			Entries made by______		
(Name of Plant)			*The Engineering Magazine*		

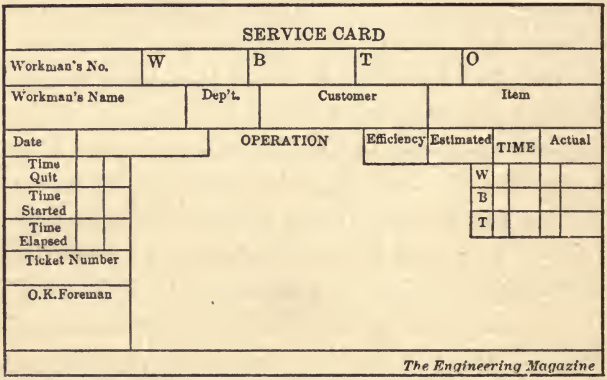
FORM 1. MATERIAL REQUISITION. THE ORIGINAL IS 5 INCHES WIDE.

Figures 1 and 2 illustrate the two forms of requisition. Nearly all operating concerns realize the importance of these fundamental records which cover both material and service, but the records are usually curiously incomplete, therefore largely without value and in consequence neglected and distrustfully used. They are supplemented by and obscured in a mass of independent and confusing records and forms, which are superfluous since all the information is more exactly contained and in more potentially available form in the original requisitions. The whole of efficient management can flow from an able superintendent making proper use of complete requisitions. The objection to full requisitions lies partly in the inherent objection of almost everybody to exactness and precision, and partly in the panicky fear of managers that their use will increase "indirect expense" for clerical help. It is, however, a fact that the same amount of tabulated complete information will cost less, if based on and built up from these requisitions, than partial and incomplete information secured along independent lines.

Industrial shops could well learn from other concerns, as banks or restaurants, which use similar requisitions effectually. A club restaurant finds it expedient to exact from each guest a minute written requisition in duplicate, signed and dated, for the meal he orders. If the requisition is paid in cash on delivery of the supplies it becomes the voucher in the cashier's hands, but if charged it is carried to the account of the individual and becomes the voucher for his bill. The duplicate goes to the kitchen and becomes the kitchen's record of portions served. A third copy should go to the commissary department, and there be analyzed and tabulated so as to know and check whether 100 pounds of purchased turkey resulted in 200 portions or in only 150. If a restaurant is able to obtain original requisitions in this manner in the rush of the noon hour, without expense, why can an industrial plant not do it also? It is obviously better for a foreman to take one minute and write on a requisition "Give to John Doe one lead pencil No. 3, and do not give him another for a month," than it is to write in 30 seconds, "Give bearer all the pencils he wants." The careless method apparently saves 30 seconds, costing $0.005 of the foreman's or the foreman's clerk's valuable time, but it results in $0.10 to $0.20 extra expense for pencils.

MATERIAL REQUISITION.

No material, whether lead pencil to clerk, or steamer-load of coal to power house, should be supplied except on requisition, and this should state the use to which the material is to be put, and specify the amount, kind, and quality. As every material issue should be standardized, the moment the standard is exceeded (as for instance lead pencils to a given clerk) reproof comes back to the foreman and to the individual before the requisition is twenty-four hours old. It is no more legitimate to overissue material, even a lead pencil, without inquiry, than it is for a bank to pay an overdraft check without proper consideration and authority. The material-requisition cards, containing, as they do, very full data, can be sorted and resorted in many ways, being used as checks on individuals or on foremen, against departments, against operations or against accounts. The use made of the requisition cards is a special department of management. The extreme of simplicity is to charge the requisitions against certain accounts, then to sort and file them away and use them only for special investigations. If for instance the question is asked why there are so many incandescent lamps purchased, it is immediately possible to collect the requisitions for all the incandescent lamps issued in each department, even to each socket, and to trace the exact point of leak or waste—due rarely to the inevitable, generally to carelessness, and sometimes to dishonesty. The extreme of completeness is to transfer by means of perforation all the requisition facts from the original material and service requisitions to a Hollerith card, to run the Hollerith sorting and tabulating machines at night, and to present a complete tabulated array of cost and efficiency facts before operations begin the following day.



FORM 2. SERVICE REQUISITION. THE ORIGINAL IS 5 INCHES WIDE.

WORK OR SERVICE-REQUISITION CARDS.

These are issued and used in the same manner as the material cards. The cards cover the whole of every worker's or gang's time in minute detail, and as to the kind and volume of work done in equivalency for the time and wages. The minutes and hours are accurately accounted for in proper sequence. All the time of every man or gang, subdivided to operations, being available, it is easy to use the records in many ways. In practice the original order card or service requisition can be made out in three or more carbon copies. The original order starts from the dispatching board, which is prepared with spaces 4 inches by 10 inches for each man, machine, or gang of men. The space is large enough to hold three cards one above the other. The uppermost space shows the job on which work at the moment is being done, the space below contains the cards of the work to be next taken up, and the last space contains the amount of work impending but not yet ready. The dispatcher, in charge of the board, who may work in conjunction with the foreman, sees to it that the first two spaces are always provided with order cards. If the two lower spaces are both bare the worker should be laid off, or if he is retained in idleness his time should be charged to a waste account.

The man who is to do the work, whether individual worker or gang foreman, obtains his authority to begin from the dispatcher, in the form of the service card which specifies the work expected. When the work is done, the service order is returned to the dispatcher, who notes on the packet the time of finishing, which coincides with the time of beginning of the next work.

An ordinary clock with a special, easily made face, permits immediate and accurate reading of hours and tenths.

The efficiency engineer or his subordinate notes on every card, preferably before it goes to the worker, the standard time for the operation, determined as accurately as current circumstances will permit, so that both the actual time and the standard time become part of the record. A guess as to standard time is a great advance over no recorded statement, but a guess is unpardonable, except for an emergency and until reliable methods are provided. Whether first record card or carbon duplicates are used, whether the original record cards are transferred to Hollerith cards, is immaterial. It is of importance that every kind of information and efficiency, as to every man and every part of his work, become avaliable, and more than this is not needed to show where leaks occur. A few uses of the cards in this regard will be enumerated.

COST ACCOUNTING.

The card contains the standard time, the cost for standard time of men, equipment, and department per hour, also the operation and the account to which the time is charged. It also contains the actual time and it is therefore in itself an efficiency record. The cost accountant can either charge up the standard cost, adding the current departmental percentage of inefficiency, or he can charge up the standard cost and the actual accidental waste. If the records given him are carbon duplicates he can file them away as vouchers.

VARIATIONS IN STANDARD SCHEDULES.

A schedule is the numbered description of an operation. If an operation is often repeated a schedule is formally and most carefully made out, but if the operation is a new one or one not likely to be repeated the same amount of care is not taken to fix the standard time, although any inaccurate estimates as to this time are easily traced to the man who made them. Every time a schedule is put in operation a carbon duplicate of the service card is filed under the head of the schedule, and a study of the repeated operations of the same schedule shows whether it averages more or less than standard time and cost, whether the different men take more or less time, whether the same man takes more or less time on different days. These variations are a mine of information for departmental improvement.

The service cards can be applied to machines, locomotives, etc., as well as to men or materials, and when filled out in the carbon-paper packet, give in multiple a complete record of the operation of the equipment, showing the machine, its number, rate, the man using it, the work done on it, and the time taken. It is possible from the records to compare the time and cost of different machines on the same work, the total time that any machine is working. The equipment specialist scans the records, and he will not be satisfied if a worker operates one machine for six hours at 100 per cent efficiency and then for four hours another machine at 100 per cent efficiency. The equipment specialist is concerned that one machine owing to idleness operates at 60 per cent and the other, for the same cause, at only 40 per cent. There are many causes for inefficiencies of this kind and many available corrections.

Chapter X

STANDARD TIMES AND BONUS

It is impossible to describe briefly all the methods to secure a reasonable standard time for a unit operation, whether of man, of machine, of gang, or as to an aggregate group of operations extending over the whole plant, as the completion of an order for fifty locomotives or the running of twenty trains a day over a road during a month. Whether the unit or the aggregate is under consideration, the methods of the analytical chemist prevail; each detail is considered separately, both as to itself and in its relation to preceding and subsequent details. Studies of this kind reveal remarkable inefficiency in usual operations. When all the conditions were made exactly right, bricks have been laid in a rough wall at the rate of twenty a minute, and $\frac{3}{4}$-inch rivets have been driven with a pneumatic gun in structural iron work also at the rate of twenty a minute. Owing to the perfect adaptation of conditions the operator found his work no more exhausting than the usual pace. This rate cannot be maintained for a long period because attending conditions cannot be kept up to the ability of the man, but a very high average rate can be maintained day in and day out and the worker thrive under it both physically and financially.

When the service card is returned and the actual time noted on it or on the carbon duplicate, it is filed against the worker and makes any other record of his going or coming unnecessary. In a working month of 250 hours the cards will show whether a worker was present all or only part of the time—thus determining the efficiency of presence or availability; the summation of the standard hours of work delivered and the actual hours taken during a pay period shows the efficiency of each man, while the record of each job shows the efficiency as to every separate job. If the worker in 250 hours delivers 250 hours of standard work his efficiency is 100 per cent; if he delivers only 200 standard hours his efficiency is 80 per cent, and if he delivers 300 standard hours his efficiency is 120 per cent. When records of this kind are maintained the efficient men appear in high relief and the inefficient appear all the worse by comparison. If the efficient men are appreciated and rewarded at their true value, if the inefficient are allowed automatically to eliminate themselves, an *esprit de corps* is developed that will make the working shop force as active and powerful an aggregation as a football or baseball team. Excellence is not gauged by any hustle and drive standards. In railroad operation the trains that pass between distant terminals in the shortest time are not those that run the fastest between local stations, but they nevertheless cost less to operate, they give less trouble to the dispatcher, they are not as destructive to motive power, equipment, and roadbed, they use less coal and water, and they earn generally per mile run the highest revenue. Similarly that shop works at highest efficiency which gives continuous employment to steady and efficient men and eliminates from its force inefficient men.

SAMPLE OF SHOP EFFICIENCY RECORD, NOVEMBER, 1907.

Name.	Sum of Standard Times.	Sum of Actual Times.	Efficiency Per Cent.	Bonus Per Cent.
J. E. H.	277	199	139.2	59.2
J. R. M.	236.4	202	117	37
F. S.	249.9	231	108.1	28.1
B. A.	247.5	247.5	100	20
C. S.	184.5	205	90	9.91
E. H.	155.6	191	81.4	4.05
C. C.	97.3	137.5	70.8	0.37
J. M.	143.	214	66.8	
J. T.	52.6	168	31.3	
G. F.	8.4	112	7.8	
10 men	1,652.2 hours	1,907 hours	86.6 per cent	

The efficiency of the whole gang is 86.6 per cent and this can be considered the efficiency of the foreman. As compared to 100 per cent, the loss to the shop is 254.8 hours, in this case at an average cost for wages and burden of $0.78 an hour, a total loss in the month of $198.74, for which the foreman can be held responsible. The elimination of the three lowest men eliminates a loss of 290 hours, amounting in value to $226.20.

If a man's wages are $0.30 per hour, if in the month he has been present 240 hours and has delivered 210 hours, his efficiency is 87.5 per cent, his wages $72.00, his bonus is 7.94 per cent, its amount $5.72. If work is defective and has to be done over, owing to fault of worker, standard time is credited but once and the efficiency of the man as well as of the foreman diminishes.

At 100 per cent efficiency 20 per cent bonus is paid, and above 100 per cent efficiency the worker is given at his standard rate *all the time he saves* in addition to 20 per cent bonus for the time he works. The bonus table is as follows:

Efficiency per cent.	Bonus per $1.00 wages.	Efficiency per cent	Bonus per $1.00 wages.	Efficiency per cent	Bonus per $1.00 wages.	Efficiency per cent.	Bonus per $1.00 wages.
67	.0001	78	.0238	88	.0832	99	.1881
68	.0004	79	.0280	89	.0911	100	.20
69	.0011	80	.0327	90	.0991	101	.21
70	.0022	81	.0378	91	.1074	102	.22
71	.0037	82	.0433	92	.1162	103	.23
72	.0055	83	.0492	93	.1256	105	.25
73	.0076	84	.0553	94	.1352	110	.30
74	.0102	85	.0617	95	.1453	120	.40
75	.0131	86	.0684	96	.1557	130	.50
76	.0164	87	.0756	97	.1662	135	.55
77	.0199	87.5	.0794	98	.1770	140	.60

As overtime is a very great evil, and as no man working overtime is capable of attaining high average efficiency, the schedule is charged with the time paid for. The worker may receive higher pay for his overtime, but he earns less premium. If he procrastinates on the work he earns still less premium, so that he is neither tempted to take overtime jobs nor to waste time on them when they come to him.

It is preferable that standard times should be made public before work is begun, that changes in standard time, whether up or down, should be made on some definitely understood and fair plan, and that the amount of reward for efficiency should also be public knowledge. There are workers so short-sighted as to think that they can prevent a determination of standard times, that they can prevent a determination of individual efficiency and prevent the reward or promotion of efficient men. If the management is fair, skilled, and wise it is not possible to make effective opposition to propositions which can be put into force just as powerfully without publicity as with it, but secrecy harms the worker more than it does the employer. In considering the gains due to efficiency, it is not sufficiently taken into account by either employer or employee that net profits are the difference between gross earnings and expenses, that gross earnings could be greatly increased by a growth of the volume of business, and that a shortening of time permits increased output without increase of expenses, therefore reduces the unit expense. If the worker earns $75.00 per month and spends $70.00 his net profits are $5.00 per month—a discouragingly small sum; but if he earns $15.00 in bonus his net profits become $20.00, an increase of 400 per cent. When unit costs (including material) are reduced to the manufacturer even as little as 10 per cent and, owing to standard time and efficiency, a 30 per cent larger output is secured, if net profits were 10 per cent, they become 24.7 per cent, an increase in net of 247 per cent.

The bringing up of an individual worker from 60 per cent to 100 per cent efficiency is to his advantage; the bringing up of a shop from 60 per cent to 100 per cent is to the advantage of its owners; but the bringing up of all shops and all operations in a country from 60 per cent to 100 per cent is to the advantage of all the people.

Constant reference has been made to the extra compensation paid to men for high efficiency. In previous ages high individual or collective efficiency in galley and other slaves was secured through threats and abuse rather than through reward. About the middle of the nineteenth century collective profit sharing was introduced, it being assumed that if the workers were more diligent, net profits would be higher, and that the workers should have a part in them. The connection between hard individual work today and a share in a hypothetical profit months hence, dependent on ten-thousand other elements than the immediate individual effort, was too slight to act as any incentive to a bright and ambitious man.

The next step, piece rates, went to the opposite extreme. The whole responsibility was placed on the individual. If he failed, even if the failure was due to conditions over which he had no control, he did not make wages; if, owing to great individual ability and ambition, he was able to make high wages, the rates were cut, thus bringing him not only down again to his old level, but, what was worse, forcing his less skilled fellow workers either below standard wages or above standard effort.

Between the extremes of vague and unrelated profit sharing and the one-sided exploitation of piece rates, many recent methods have been evolved for paying variable wages for varying efficiencies.

One method only will be described, partly because it is the latest; partly because starting with the principles of the "fair deal" and never losing sight of them, the method has been practically, not theoretically, evolved; partly because it has been tried and tested on a gigantic scale, one corporation having paid in 1908 over $600,000 in premiums under this plan; partly because this plan is of universal flexibility, applying as well to materials and methods as to labor, applying to each working individual from shop apprentice to corporation president, applying equally to a single operation, to any number of operations for any period, to any number of men on the same or on different operations.

The method has been called the "Individual Effort System," the name originally given to it when first introduced in the shops of the Santa Fé Railway; it has also been called the "Santa Fé Bonus System" because of its wide use on that road; but it has also been applied by other large corporations in many different kinds of work.

The method is evolved from the idea of buying labor or service on specification, there being a basic price with a premium for results superior to the specifications. There is the same reason for buying labor on specification as buying coal on specification.

With coal of various chemical composition all selling in the market at $4.00 a ton, a contract can specify a basic price of $4.00, no coal being acceptable of less than 9,600 B. t. u. per pound, the price, however, never being less than $0.173 per million b. t. u. Under the contract, if the coal analyzes 14,400, the seller receives $5.00 a ton instead of $4.00, and if the coal analyzes 15,552 B. t. u., he receives $5.40 per ton, or 35 per cent more than the current market price. This contract is advantageous to both seller and buyer, since coal of 15,552 B. t. u. is cheaper at $5.40 than coal of 9,600 B. t. u. at $4.00 per ton. On the other hand, to most purchasers, coal is coal, almost irrespective of quality, and the miner of superior coal cannot obtain a proportionate price for it. The extra price paid for coal, better than specification, is not a gratuity, a present, but a proper, agreed upon equivalent for superior quality, the quality to be ascertained by analyses and other tests.

In precise analogy, time and quality specifications should be predetermined for all labor and service and a wage should be specified with a standard premium for standard specifications, with equivalent gain to the seller for the extra value delivered.

Standard time determinations usually show that fully 50 per cent more work can be turned out per machine and per man if all the methods, machines, and men are toned up.

To summarize what has preceded, it is evident that one old and two modern methods will enhance efficiency.

The old method is still of most importance, namely, a capable line organization, a capable foreman in the shop. When the task begins to outgrow his ability personally to manage it in its many details, the line should be supplemented by staff assistance, and as complexity increases a theoretically sound staff organization is quite as essential as a rational line organization. To solve most of the modern labor difficulties as well as to provide suitable reward for good line administration, the method of specified service equivalent for a basic wage, with premium payments for results better than specification, has been evolved.

Assuming an attainable efficiency of 100 per cent as to all operations in a shop, good foremanship alone cannot secure this result—not because a good foreman cannot force up some single item to 100 per cent by giving it a disproportionate amount of his time and attention, but because the moment his attention is withdrawn, efficiency will fall off. Therefore if a good foreman could force a shop up to 50 per cent or 60 per cent, he would have to be supplemented by staff assistance, namely by time keepers, by records, by tool rooms, etc., if an efficiency of 80 per cent is to be regularly maintained. An even higher efficiency than 80 per cent can be attained by the combination of good foremanship and good staff, if the latter is made large and powerful, but the workers resent the combined unremitting endeavor of foreman and staff to make them deliver more work. They are like air, which when compressed heats up and resists. This resistance, this back pressure, this heat, is removed by the expedient of standard equivalent in service for wages paid, *with an increasing premium* for service above basic quality. It is inconceivable that a fruit grower should refuse to accept a higher price for his first-quality fruit than his shiftless, unskilled neighbor asks for worm-bitten nubbins; it is inconceivable that the miner of high-grade ore or coal should be content with the same price paid for low-grade ore or coal; it is inconceivable that a Paderewski should give all his concerts for the same price as is received by the itinerant street musician; and it is equally inconceivable, if the fair deal prevails, if all receive when working a reasonable basic wage, that those who possess individual skill and dexterity shall not be paid for it.

Chapter XI

WHAT THE EFFICIENCY SYSTEM MAY ACCOMPLISH

WHEN we consider the astounding efficiency of Nature's operations in minute matters—in insect and bird flight, in the stored energy of the fish, in the light of the firefly, in the warmth of the mammal, in the pervasive divisibility of a perfume, in the pumping power of the sequoia—when we consider the wasted energy of the winds and waves, the lavish waste of the radiant heat of the sun and the stars—the conviction may well be forced upon us that if we could cover the whole process and cycle we would find that these apparent wastes are regenerative and recuperative processes, and that the universe will be no nearer extinction a hundred-million years hence than it was a hundred-million years ago. Nature differs from the individual in having an unlimited and exhaustless supply of time of which it can afford to be lavishly prodigal. Because it counts not time, Nature's cycle may be wholly efficient, even as the slow oxidation of iron may evolve as much heat as the combustion of thermit; but mortals do not have unlimited time, and, in their haste, they have neglected efficiency which may perhaps still be destined to yield the basis for a higher and more universal morality than that afforded by either ancient religions or modern philosophies. Certain it is that the solution of the old problems seems easier when they are approached from this new point of view. Efficiency is not to be judged from preconceived standards of honesty, of morality, but honesty, morality, are perhaps to be reconsidered and revised by the help of the fundamentals of efficiency.

Efficiency is to be attained, not by individual striving, but solely by establishing, from all the accumulated and available wisdom of the world, staff-knowledge standards for each act—by carrying staff standards into effect through directing line organization, through rewards for individual excellence, persuading the individual to accept staff standards, to accept line direction and control, and under this double guidance to do his own uttermost best.

If we could eliminate all the wastes due to evil, all men would be good; if we could eliminate all the wastes due to ignorance, all men would have the benefit of supreme wisdom; if we could eliminate all the wastes due to laziness and misdirected efforts, all men would be reasonably and healthfully industrious. It is not impossible that through efficiency standards, with efficiency rewards and penalties, we could in the course of a few generations crowd off the sphere the inefficient and develop the efficient, thus producing a nation of men good, wise, and industrious, thus giving to God what is His, to Cæsar what is his, and to the individual what is his. The attainable standard becomes very high, the attainment itself becomes very high, and as to all activities in a nation ought to be as high as in the traveling circus, where every performer, human or animal, is a star, whether bespangled in the ring or driving tent stakes, whether hauling wagons in work clothes or in work harness. Let not the reference to the circus be considered a drop to the ridiculous, since in efficiency there is no great or small, and those who have been solving the problems of aerial flight have learned much from analyzing the flight of obnoxious gnats, of foul vultures.

Nature counts not time, but there is no eternity for the individual who, though breakfast and dinner were plentiful, is hungry again at supper time. There is not an eternity of time for the corporation which may not indefinitely default on bond interest without dissolution; but the State is perennial, and no high national efficiency can ever be attained unless the State recognizes its function in the efficiency problem and takes over perennial, secular efficiency as its share of the work. The State has not hesitated in the past, does not hesitate now, to mortgage the future for the benefit of the present, as when it piles up an enormous debt for present luxuries, forgetting that Martinique, San Francisco, Valparaiso, Messina, are suddenly overwhelmed by earthquakes and other unforeseeable catastrophies which at any moment occur and tax to the utmost the viability even of an unmortgaged community. The State has not hesitated to annihilate the present for the sake of the future, as when it drafts its citizens into army and navy and slaughters them by the hundred-thousand as in the Russo-Japanese and other wars.

It may be that even as ruthless foreign invasion and barbarous conquest were the bane of antiquity, destroying the irrigation works of Nineveh, Babylon, and India, so mortgage debts, not less ruthlessly although more slowly, may destroy modern communities and modern States. What would not have happened to England, weighted with her enormous Napoleonic debt, if the steam railroad, if the steamboat, had not been developed in the first half of the nineteenth century, if the stores of Californian and Australian gold had not, in a single decade, doubled England's trade, thus halving the relative burden of the debt?

Because the philosophy of efficiency is new, modern States have failed to recognize the chief modern justification for the existence of national government—namely, furtherance of national efficiency.

The theory of the interrelation of individual, corporate, and national duties as to efficiency is as far as possible removed from the unnatural and unworkable theories of modern socialism which work directly against efficiency, not for it, and it is equally far removed from the modern theories of State control which penalize, thwart, and interfere with efficient individuals and efficient corporations, vaguely fearing that they are a menace to the State, as if the day, the month, the year, even the century or æon, can never be a menace to eternity.

The function of the individual is not to drag down to the level of his own inefficiency the standards of the corporation, yet these are the avowed aims of modern socialism, of many modern labor unions; the function of the corporation is not to drag down to its own competitive level the standards of the State, yet great business men have no higher ideal than to apply corporate method to the State.

The function of the corporation is not to lessen and hamper, but to promote, the efficiency of the individual worker, by placing at his disposal all the resources attainable though the corporation, by directing his endeavors and by rewarding him individually, without limit, for efficiency.

The function of the State is not to substitute itself for the individual corporation on the monstrous supposition that all men are more efficient than the selected few, but to take over those secular efficiencies which are beyond the years of the corporation, even, as the corporation efficiencies are beyond the day needs of the individual. The function of the State is to act as staff guide and regulator to the activities of the corporate line, to use State powers for the reward of the efficient corporation, for the punishment of the inefficient corporation, even as the corporation uses a bonus based on efficiency to reward the efficient individual, uses penalties founded on efficiency records to eliminate the inefficient individual.

A certain marvelously wise corporation in New England laid down as its fundamental principles that it could not expect reliable and steady workers unless it guaranteed permanence of employment; that it could not expect workers above the average unless it offered them remuneration above the average; and it therefore determined its preliminary piece rates not on competitive figures, not on the extent to which it could squeeze down the worker, but on the basis of what a desirable worker ought to earn; and, finding these preliminary rates in many instances higher than those of its competitors, it reduced them, not by scaling down wage reward but by scaling up the productive capacity so that unit costs fell as effort and reward rose. Assuming that this firm, that other great and wisely directed and managed concerns, attain the highest level of corporate efficiency—what are they to do when competitors elsewhere in the United States employ women and children at starvation wages for long hours, when necessary raw materials pay a heavy import tax, when foreign markets are hampered by discriminating tariffs; what are they to do when raw materials fluctuate in a single year perhaps as much as 100 per cent in value; when interest rates fluctuate between 4 per cent and 10 per cent; when demand for the finished product flows and ebbs like the tides in the Bay of Fundy? How would the efficiency of such a corporation not be supplemented and promoted if the national, State, and municipal governments were alive to their obligations to study and standardize conditions—if the municipalities, States, and central governments stayed out of the market when individuals and corporations were bidding it up, whether for materials or labor; if they came into the market with long matured plans for unhurried improvement, to be undertaken when individuals and corporations were in a period of lull? Why should there not be a minimum wage at which employment in national works, reclamation of arid lands, harbor dredging, canals, highways, battleships and fortifications, would be always open, thus doing away forever with the disgrace of bread lines? Why should a great nation like the United States be, at any moment, scarcely three months removed from famine? Why should the national Government not establish great central reservoirs of raw materials even as it establishes water catch basins to accumulate, in periods of downpour—to supply, during periods of scarcity? Such a policy covering a dozen great staples of food, of textiles, and of mining products would finance itself and be in addition a source of revenue. Why should the Government not regulate the supply of money and rates of interest, by advancing freely and at a slowly increasing rate on finished articles of manufacture or against great constructive works of corporations, thus equalizing production?

Why should the two great locomotive-building plants of the country be forced to produce in one year, 6,000 locomotives, working overtime under uneconomical conditions, employing 50,000 men, and the next year drop to a production of 2,000, throwing 40,000 men out of work?

Why should the Government and the States and the municipalities not establish standards of hours and wages based on the capacity of able-bodied men, thus eliminating the necessity for either woman or child labor in factories?

Why should a Dingley Bill increase the tariff on stockings and socks, under the mistaken idea that the industry will be transferred to the United States—a purely protective, not revenue measure—

the actual effect of the increase being to stimulate efficiency in Saxony, to raise wages in Saxony, so that the price in the United States does not rise, the tariff becoming a revenue, not a protective, measure? As against silliness of this kind, why should the national Government not use the tariff and also its own contracts as rewards for American efficiency? Why should it not say to the United States Steel Corporation, to the Standard Oil Company, to other great corporations: "Show that you are paying standard wages per day for standard hours per day in your mines, in your transportation enterprises, in your plants; show that from mines or wells to finished product you are using the most efficient processes known; show that in all respects you are eliminating needless waste—and then the great power of the tariff shall be used, not only to protect, if protection is required, but to open to you and to extend foreign markets."

No Government can ever rival in efficiency and production a modern corporation; it is folly for it to try; but it can stimulate, promote, and reward efficient corporations even as these stimulate, promote, and reward efficient individuals.

Let us beware lest the exhaustion of our national resources, of our forests, of our free lands, of our coal and iron mines, leave us stranded, out of the running with the older nations of the world who, as Japan is already doing, accept and apply the Gospel of Efficiency.

The stimulus should come from below, assistance from above. The automatic machine should hustle the worker who tends it, the locomotive should give its driver the joy of hurtling over the track at the rate of seventy miles an hour, the Mauretania should carry in four days from shore to shore her captain and engineer and all that is entrusted to them. The mechanic, the engineer, the captain, should urge and demand from those above them best cutting tools, best grades of materials, best track, best channels and docks. Corporations should take up and develop the inventions of men like the Wright brothers, Governments should sustain and further, beyond the extent attainable under corporate power and limitations, the efficiency efforts of corporations.

We have not put our trust in Kings; let us not put it in natural resources, but grasp the truth that exhaustless wealth lies in the latent and as yet undeveloped capacities of individuals, of corporations, of States.

Instead of oppression from the top, engendering antagonisms and strife, ambitious pressure should come from the bottom, guidance and assistance from the top.

The figure of the thunderbolt striking from Jove's clenched fist is not an emblem that inspires the twentieth century. He was a malignant and vicious interferer in the affairs of mortals. Let us forget Jove and instead learn from the seed, which aided by soil and by rain, by air and by sun, developing what is in it, doing its best, grows into square miles of waving grain, or aspires upwards into a gigantic sequoia. Let each man work with the reliability of a steam valve, yet with the joy of a hunting dog and the inspiration of the artist.

And then, when we have attained to conditions such as these,

We shall work for an age at a sitting and never be tired at all!

And only the master shall praise us and only the master shall
blame;
And no one shall work for money and no one shall work for
fame,
But each for the joy of the working, and each in his separate
star,
Shall draw the thing as he sees it, for the God of Things as
They Are!

Chapter XII

THE GOSPEL OF EFFICIENCY

What I ha' seen since ocean steam began
    Leaves me no doot for the machine, but what about the
        man?
The man that counts........

THE human mind takes counsel of its fears and imagines evils that never come. True efficiency means ameliorated conditions for the worker, both individually and collectively—not only for the worker, but also for the employer—not only for the employer, but also for the corporation, and finally for the nation.

The timid and the doubters apprehend that increase in efficiency will result in decreased employment—an apprehension as old as progress, that was felt by the other members of the clan when the first aspiring ape used a stone instead of his teeth to break a nut. They feared he would eat all the nuts and that they, the slower fellows, would go hungry. This same apprehension was felt on the road to the Yukon when the pack mule with his load of 500 pounds displaced the human packer with his hundred pound load; it was felt when wagons hauling 5 tons supplanted the pack mules; and it was felt again when railroad cars, carrying 30 tons, forever displaced the wagon trains.

In case of very sudden increase in efficiency, there is often temporary dislocation of employment, as on the Yukon trail, but even there where conditions changed as rapidly in two years as they changed on the passes between Italy and the North in two thousand years, there was ample warning, and as a result of increased efficiency there has been more business, not less, more employment, not less.

Schools and colleges are not discountenanced because of the many who enter; some fall out and fail to graduate. (Those who drop out are often more successful in life than those who stay in.)

Where modern efficiency methods have been tried on a large scale the effect on employment has been carefully studied. Before efficiency was introduced, about seven per cent of the employees dropped out voluntarily each month, some because they knew they deserved better conditions, others for various reasons. It was a constant difficulty to recruit the force, to bring it up to its quota. When efficiency methods were introduced the better men were induced to stay, inferior men were not replaced, the reductions possible from increased efficiency were brought about without lay-off or discharge of any worker. This was during a period of great activity. In the following period of great depression a large plant, owing to lack of orders, closed down and all its employees were out of work. At another plant in the same city efficiency methods were introduced, as much work was made possible with 200 men as had before been done with 400 men, the managers were able to take orders at the reduced costs made possible by increased efficiency, and 200 men were given steady employment at higher average compensation. With the return of manufacturing activity this plant will double its output, double its present number of men, pay each worker more than he received before, yet lessen the cost of the product to the consumer.

Efficiency of conditions in housekeeping has greatly increased over the United States. Hot and cold water, with self-draining bowls, sinks, bath and wash tubs, steam heat, gas cooking stoves, electric lights, and elevator service have lessened work per unit of output, yet the wages of house employees have steadily risen.

The great increase in farming efficiency has multiplied many fold the demand for farm labor, not per bushel of wheat or corn, but per acre of ground. It is the greater efficiency of cotton plantations that has held and extended for us the textile markets of the world against the pauper competition of Africa, India, and South America. It is the efficiently organized fruit production of California from orchard to can that supplies Japan with American fruit products.

The increase in gold-mining operation efficiency has swelled the yearly output of gold from less than \$100,000,000 in 1883 to more than \$400,000,000 in 1908, and where one man was formerly employed in gold mining, ten now find work, a larger and larger per cent of the extracted value going to labor. As is always the case, each new ounce of money metal stimulated a hundred times as much new business.

Efficiency is not only not a menace to those who sell their time and skill, but it is the broadest and pleasantest path of escape from retrogression and disaster. The efficient man will have employment urged upon him where the inefficient begs in vain; the efficient corporation will be seeking workers when the inefficient corporation closes its doors; the efficient nation in the stress of world competition holds its own and advances, but the inefficient nation slowly but inevitably loses ground.

The timid and the sympathetic apprehend that the worker will be driven to extreme effort by the stimulus of a special reward, and when at the cost of health he has attained a high specialized efficiency, the extra reward will be taken from him, and being thrown aside a nervous and physical wreck, worn out before his time, his deluded successors for the same high output, will be paid no more than similar men earned for much less effort in the past generation.

This is a narrow view of the meaning of efficiency. It does not consist in extreme effort, but in the elimination of undesirable effort and waste of all kinds, the elimination of child and woman labor in competitive employment. Efficiency does not come to increase the nervous strain of the age, which gives railroad spine to the locomotive engineer and results in premature exhaustion of the telephone girl, but it comes to palliate that strain by standardizing both effort and reward. Efficiency does not come to perpetuate the evil of piece rates which does not distinguish between (1), wages, (2), standard times, and (3), individual efficiency, but it comes to assure standard wages to each according to age, experience, and class of work. It comes to determine, justly and without reference to wage rate, the standard time of any operation, and to guarantee to each worker, whether low or high, a special reward in proportion to individual efficiency.

There are and always will be some employers whose ideal of management is to treat unfairly those under them, but the methods of efficiency will eliminate employers of this kind, even more rapidly than they eliminate the unfit and dishonest worker. Slave labor was inefficient and it has disappeared; forced labor, *corvée*, has disappeared because it was inefficient, even from Egypt, where it flourished for 5,000 years. Child labor will be curtailed because it is inefficient.

Gorky, the Russian writer who still lives, describes labor conditions which but a few generations ago were universal all over Europe, and the desire to escape from them has peopled the United States.

> There were twenty-six of us,—twenty-six living machines shut up in a damp cellar, where from morning to evening we kneaded dough to make cakes and biscuits. The windows of our cellar opened upon a ditch yawning open before us and crammed full of bricks, green with damp: The window-frames were partly covered from the outside by an iron grating and the light of the sun could not reach us through the glass covered with flour dust. Our master called us galley slaves and gave us rotten entrails for dinner instead of butcher's meat.
>
> It was a narrow stuffy life we lived in that stone cage beneath the low heavy rafters covered with dust and cobwebs. It was a grievous evil life we lived, within those thick walls, plastered over with patches of dirt and mold. We rose at five o'clock in the morning, stupid and indifferent, and the whole day, from early morning to ten o'clock at night we sat at the table kneading the yeasty dough.

From day to day in tormenting dust, in dirt brought in by our feet from the yard, in a dark, malodorous steaming vapor, we kneaded dough and made biscuits, moistening them with our sweat, and we hated our work with bitter hatred.

There may be, in the United States, here and there, in sweat shops, in convict camps, conditions analogous; but similar industries to this, the health food companies, making soups, pickles, biscuits, breakfast foods, are running the most efficient establishments in the whole world, with welfare conditions almost unduly prominent.

If a modern efficiency engineer should go into this Russian bakery, his first effort would be directed to the reform of the proprietor, to the closing up of the cellars, to the shortening of the hours of labor to 12 to 10, to 8; to the substitution of machinery which would make the processes both easy and sanitary. Standard efficiency effort always first ameliorates the human conditions. Efficiency is unattainable from overworked, underpaid, brutalized men. Race horses are the best cared for creatures on earth, not from any humanitarian sentimentality, but because the best of treatment pays.

Efficiency means that the right thing is done in the right manner by the right men at the right place in the right time.

Whether we are animated by selfishness or by altruism, the methods, the solution and the results are the same. Ideal, highest efficiency can be attained only through a combination of infinite goodness, infinite wisdom, and infinite power.