

# Industrial Progress and Human Economics

James Hartness

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by James Hartness

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INDUSTRIAL PROGRESS AND HUMAN ECONOMICS

By James Hartness

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Address all communications relative to industries to Commissioner of Industries, Montpelier, Vermont.

This book is published by private funds

\_Fellow Citizen\_:

Vermont's natural resources have been set forth in State publications, not adequately, but nevertheless, in well prepared publications.

Supplementing such publications this book deals with our human resources, showing the way by which our greatest resource—human energy—can be most effectively employed. It uses the welfare of man as the yardstick of measure rather than treating the subjects

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under the head of natural resources.

At the present time the productive power of a day's work varies greatly throughout the country. It reaches its highest point where the most efficient implements and machines are used; where there is a high degree of special ability acquired by each executive and workman, such as has been attained in our highly specialized manufacturing industries, many of which may be found in our neighboring states. The upbuilding of such organizations is only in its infancy. There is now a natural drift away from congested cities to adjacent states where plants and homes may be spread out over larger areas.

The personal side of this to each man is the supreme need of a better understanding of human economics; that is, he must know the best way to use his own energies, and since he must work in cooperation with others he should also know what constitutes the most effective and successful organization. As a skilled worker, as a scientist in some branch of the work, as an executive in charge of some department, as a manager, investor or banker, he must keenly sense the conditions on which progress is made.

This book is written for the progressive young man as well as all those directly or indirectly interested in industrial development. It is at once a text book and a reference book, for, as a workman or executive advances he will find need of information on many of the points herein set forth.

If the book has no immediate interest to you, please pass it along to another.

Faithfully yours,

[Signature: James Hartness]

\_Governor\_.

#### FOREWORD.

The purpose of this book is to indicate the natural way to increase our industrial development. To accomplish this there is set forth an outline of an industrial policy. This policy relates to procedure and methods for starting and managing industrial plants.

It conforms to our economic conditions and offers the safest and easiest course.

While it is written to create more desirable industrial establishments within the state and to increase the vitality of the existing plants, it is distinctly a guide for the individual, for it facilitates the progress of the man as well as that of the state.

It is a practical policy that stimulates and energizes the industrial spirit and at the same time, directs our energies along the easiest road of progress in personal and state development.

It sets forth certain fundamental principles that apply broadly to all activities, but specifically to manufacturing and the means and methods that must be employed to win in the industrial conquest.

To the investor it provides the best measure by which he can estimate the economic soundness and prospects of an enterprise. It gives confidence in right projects, making money available for things that are right, and reducing the hazard of investments by eliminating the badly or indifferently managed organizations and those founded on unsound policies.

To the men in an organization it is also of great value, for by it they can estimate their own prospects for progress. They risk not only their earning power but their chances for personal development. Their chances in acquisition of high degree of ability and in advance from position to position also depends upon the policy of management and success of the enterprise. The loss of opportunity of any of these men really transcends the loss of money, for it involves the loss of personal development and all that that means.

It is obvious too that the management of each organization will be of a more successful type when the entire personnel grasps the essentials of industrial development.

When these essentials are understood and recognized as standards of measure there will be less conflict between the investors and the managers. Then it will be possible for managers and all others to use all of their energies wholly for progressive work rather than using a large part of their time and energy explaining each move to the investors.

Managers need the support and confidence of the investors. Every day requires a firm adherence to a definite policy. Nothing less than the firmest determination will hold an organization to a true course. With a division of opinion, the natural drift is away from the standards on which modern success depends. Not only is it necessary to have these principles understood by investors, but also by all whose opinions will in any way affect the spirit of the men in the organization.

The whole scheme, as it is set forth, is true to the fundamentals of human economics, for it provides ways by which the energies of mind and body are used most effectively. It brings a progressive growth and creates in each the greatest productive capacity. So that, as individuals and as a state, we will produce the greatest value for a given amount of labor.

It is the only way by which we can compete with other states and countries. It is the natural and inevitable way for Vermonters to travel.

## CONQUEST OF PEACE.

Before the war Vermont and the nation were approaching a serious economic crises. The war has accentuated the gravity of the situation, but has also demonstrated certain human characteristics that can be enlisted to correct our course. We found during the war that we were ready to take heroic action whenever an occasion demanded it--that there was a solidarity of purpose of our people. This characteristic must now be invoked. We must meet the conditions that confront us by unity of public opinion and team work.

The conditions that confront us do not involve the possibility of immediate invasion of our country by a hostile nation, but they carry a burdensome penalty if we fail to take the right action.

Happily we are not required to risk our lives or even work harder, but we must recognize the plain facts that we are not sharing in the general economic progress of our neighboring states.

In war the nation that wins the victory imposes a burden of tax on the conquered nation. In the conquest of peace the victorious nations also impose a burden on the losers. This burden is just as real as the burden imposed by war, for in both cases the losers are paying tribute to the winners. This applies to states, to communities, to families and to men. The situation calls for prompt attention and concerted action by the people of our state and country.

In the conquest of peace success comes to those people who produce the greatest value with a given expenditure of energy, or, in other words, to the people who at the end of a day's, a year's or a life's work can measure their return in the largest value. Dollars constitute our measures of value for they are our medium of exchange of our products of labor. If, to accomplish the same result, the man with inferior implements must work harder than the man with the best implements, it is very easy to see who has to pay tribute to the other in the market where values are compared and payment made for values.

Owing to the advance that has been made both in invention of implements and methods and in the organization of workers, there is now a marked difference in the value of the product of a day's work. A study of this situation shows the supreme need of action that will direct our energies as individuals and as a state in a way that will bring the largest value for a day's work.

We must choose with care our work, our equipment and our methods of combining our efforts. There must be team work within each industrial plant and each plant must be in tune with the whole competing world.

As a people we have not lagged behind, in fact we have been leaders in many important branches, but our enterprise has known no state boundaries, and many of our men and women have gone to other states. Hence, while as a people we have been leaders, as a state we have been lagging behind the more active industrial states.

Vermont is very close to the most highly developed industrial center on the face of this globe. These centers, through coordination, invention and choice of work, have been able to produce greater values per man per day. Men with the spirit of industry and a practical knowledge gained by experience in these highly developed centers go out from such centers and build up other industrial centers wherever the best opportunity appears. The nearest places to these centers are the most natural fields in which to start new organizations. But when no cooperating spirit is found near at hand, these carriers of industry go till they find better places. Many have traveled past Vermont because we were busy in other lines and our money was being sent to other states for investment. Many of our own men left the town of Windsor during the last sixty years, and from this one town there has been built a number of important industries in other states notably in Massachusetts and Connecticut.

It is not necessary to assume that the industrial spirit has spread under the guidance of man or just by chance as these men of practical knowledge and enterprise have drifted. It may be that the successful new centers were merely a few of thousands of attempts in other places. Our problem is to study the conditions

under which these industries thrive and then see how we can establish these conditions.

In this way we will be acting in harmony with the natural drift or natural law, if you prefer, and this is one of the purposes of this book.

#### VERMONT FAVORABLY LOCATED.

Our nearness to these industrial states give us an advantage over more remote states, but it is not sufficient in itself to bring our share of industrial expansion. Nevertheless it is one of the greatest advantages and constitutes one of the strong points on which we base our faith in our plan for greater industrial development.

The next element to nearness to existing plants is the spirit and understanding of the people. Vermont has the best spirit of industry but has not the fullest conception of industrial life and opportunity. It is this purpose of setting forth the principles of desirable industrial life that constitutes the next step.

When these principles are understood, we will improve the chances for the acquisition of local industries through the coming of others from nearby states or by the establishment of new plants by some of our own people who are already well qualified to carry forward such enterprise. But whether it is brought about by these or any other means, the basic principle on which successful industries are built must be known and must constitute the policy of organization and management.

The principles set forth are basic. They constitute the necessary addition of the practical knowledge of invention, management and general business knowledge gained in existing plants.

Industrial life calls for the best that is found in brain, enterprise and ability and should have every possible aid and cooperation. Furthermore it should be protected from impractical promoters, impractical managers and obstructive theorists.

It is actual work and accomplishment that counts. The workers and those who lead and cooperate with them should not have their combined efforts handicapped by those who have never done actual work or who have never been performing an essential service.

Indifference and misdirection are our greatest enemies in times of peace. These hinder our growth and if allowed to exist, will ultimately lead to our becoming a subservient people.

We are all ready to accept these facts but may differ as to the best ways to use our energies.

We are already making good progress in various branches of agriculture, granite and marble work, and in various branches of manufacturing of wood, textiles and metal, but a direct comparison with our manufacturing states shows that we do not bring into the state an adequate return for our labor.

Many of our young people migrate to more remunerative kinds of work in other states, and as already stated some of these Vermonters have led in the creation and upbuilding of great industrial establishments.

There are now many good chances to create new and energize our existing industries.

Some may ask why should we consider other industries when we can find many good opportunities in our present enterprises. The answer is that our people drift away to other states to get into these industries for there they have discovered that the best chance to produce a large value for a day's work is where best implements are used and where there is the best organization of workers.

They have found that in some respects we are lagging behind in the use of best methods and best implements.

#### OUR PROBLEM.

Without going further into the analysis of the conditions that confront us, it is obvious that an increase in the size and number of desirable industries is an object worthy of our attention and efforts.

We have clearly in mind that more money flowing into the state will improve our entire economic situation. Taxes, markets, population, schools, opportunities for Vermonters and general improvement in all values and interests.

The next thing to do is to get an industrial policy that will guide us in our course as individuals, managers, engineers, manufacturers, investors, progressive workers and as citizens. The idea must precede action and the action must precede results. The true idea will bring results of like character, hence the need of the fullest knowledge on which to form the idea.

A simple outline of a desirable industry may be drawn through the following points:

First: An ideal industry is an organization in which the energies of mind and body are most effectively employed.

Second: Since man is something more than a physical body, his work must be one in which he feels an interest and satisfaction.

Third: Since there are various kinds of implements to aid man in his work, a successful organization should use the most effective type.

Fourth: Since man is a creature of habit and functions most effectively when he has acquired skill through experience, each one in the workshop and office should be experienced in his particular branch of the work.

Fifth: Since the high skill of men is attained through repetition of operations, the management must subdivide the work into classes in which each man can become highly proficient.

Sixth: Just as there is an individual skill and ability acquired by the individual, so there must be a group skill built up. The group skill is acquired by the coordination of the energies of all the workers so that the work flows naturally and evenly from worker to worker with the minimum hindrance. This coordination takes place naturally through experience. It only needs common sense supervision and a protection of the workers from the impractical interference of faddists.

## HAVE FAITH IN VERMONT.

Travelers through the west, particularly on the coast states bring back the story of optimism that seems to be characteristic of the enterprising people who migrated west in the early days. This spirit of optimism is not found in all parts of our country, and yet it is of high value. In New England for instance, in each state there is a state pride, but perhaps not to the extent that we find in the larger cities and in the west. Here we are more interested in the success of our various branches of activities.

Vermonters have been notably free to go beyond state boundaries in the acquisition of trade or profession and in practice, but optimism, which is the parent of enterprise, has an excellent chance for existing in our state.

The early history of industrial development shows it followed along the avenues of transportation—seaports and lakeports and railways. With the railways the industries spread to other states, notably Ohio, Indiana, Illinois and Michigan. Now there is setting in a readjustment and the time is ripe for Vermonters to use some of their spirit of enterprise within the boundaries of the old state. Goods may be shipped to the best market from the top of our highest mountain at lower cost than it could be shipped from some remote competitors. There is every angle favorable except the full knowledge of the situation and the elements on which industrial success can now be achieved.

The coming and use of machinery has been a most potent force in determining the economic rating of city and state, and it is in this respect that Vermont has now its great opportunity, and it is in the field in which invention, the use of machinery, the right methods of building up an effective group of workers that there is the surest reward for the energy put forth by investors, organizers and workers.

If you have grasped these facts; continue to study the elements of the plan; fit yourself as an experienced worker or executive in some branch of the work; see that the scheme of work is one that can successfully compete with other producers; then put your whole self into the work.

If you wish to get the plan into your own consciousness and action, tell it to others.

Become a practical booster of the plan.

It fits the future.

It fits today.

Be a Booster.

It is right.

It pays.

## OUR INDUSTRIAL POLICY.

We must endeavor to establish desirable industries. The most



desirable industries are those in which there is an opportunity for development of all the workers and a chance for the greatest number to find the best opportunity to acquire special skill and special ability. In such industries there should be the open door of progress so that those who are qualified for advancement can go forward from position to position with no barrier other than their own mental or physical limitations.

Special ability, skill and team work are only acquired by long specialized practice. These qualities constitute the most valuable assets on which to create a new concern.

Very elaborate systems have been designed for controlling the flow of the work through the plant and the division of the various activities between men and departments, but the real effective coordination must grow out of the actual working conditions of the workers. This natural evolution of the group's effectiveness as a single organization is one of greatest importance. The impractical theorist coming into an old plant will start in at once to rearrange the order of things irrespective of both the group habit-action and the habit-action of each man.

Changes must be most sparingly made, with the full knowledge that anything that interferes with the habit-action of the workers is a serious hindrance. All people concerned, whether as executives in the industry, or as investors, must remember that in a growing industry, individual skill as well as group skill of the whole organization greatly improves with continued action. Under the process of continued action the average man can make a fair showing and with a reasonable degree of moral support will make good, while without it the ablest man will have a hard time and even fail if he is forced to accept changes that disturb continuity of action.

The management must conform to the best world practice in engineering, industrial life, individual welfare and economics. It must have every element of organization kept in best condition. The spirit of the group is of great importance, for the organization goes forward on the congenial nature of each man's profession or work. Each man's energies, both mental and physical, must be employed constructively with the minimum disturbance. His energies must be concentrated on his own particular work. This concentration applies to all workers and executives. This plan is based on the fact that, through continuity of attention and application to a given work, man acquires a special aptitude. It also recognizes that each man on the face of the earth, from the tramp along the railroad to the most highly developed scientist and executive, has a special knowledge and special ability that he has acquired by experience.

It is needless to say that in competition with the whole world there must be alertness every day in the guidance of details of mechanism and business, and that it is not by the gathering together of a group of men at the end of the year or even once a month or once a week that business can be effectively managed; it is a continued application to the work every day and every hour that counts.

There should be no absentee management. The men who manage must be in close touch with the work and the workers—not merely through written or oral reports, but by actual observation.

Travel, study and observation of other connections and work are necessary, but the home must be with the industrial plant and that must be the prime interest.

## LIMITATIONS OF MAN'S PROGRESS.

It is not contemplated that all men will become managers or office men. Such positions are not of a kind that is satisfactory to many of our ablest men. Some are happiest in work in which they acquire great skill. They are disturbed and made uncomfortable when required to solve mental problems. Some of the greatest achievements have been wrought by such men, who have been highly honored in the past and such men will have more recognition as time goes on, for we are coming to understand the fact that we must depend on such men for special ability in the form of skill, whether it is in the surgery, mechanics, art or any other branch or division of work or the professions. Such men are not talkers and do not force themselves into spectacular positions. To say that there is no progress for the surgeon if he cannot become manager of the hospital, nor for the skilled worker if he cannot become manager of the industrial plant, would not be in keeping with facts for we know that such men have made the greatest contribution to the world's welfare.

This plan of individual progress should not be disturbing to the worker who has come to a standstill. It is the ideal toward which we must work. It can never be wholly attained, but such a policy will make a vast difference with the prospects of all workers and in the success of industrial organizations.

## PROTECT THE INDUSTRIAL SPIRIT.

Industries and the workers should be protected from incompetent managers, investigators and impractical theorists.

Industries and the workers go forward by actual work, not on manipulation of stocks, bonds, laws and schemes to wreck or boost for temporary gain of some one interest.

In general it is safe to have faith in the honesty of the workers and those who cooperate with them--at least we can start with the assumption that honesty and square dealing are not monopolized by other professions.

If we will remember that an industry has a vitality the same as a man, that its life can be destroyed by an ignorant investigator with a probe poking into every nerve and muscle, we will make Vermont a more natural place for industrial development and progress.

The attitude of the workers and the general public should be cordial instead of antagonistic for every desirable industry is an asset of great value.

In theory and law an industry belongs to the stockholders, at least it is for the stockholders to elect the board of directors who through practical officers manage the business; but, as a matter of actual fact, to the man who has the best job in the world for himself right in that organization, the life of the organization is of greater importance than it is to any one of the stockholders. In the same sense the existence of the industry is of greater value to many others in the organization and in the community than it is to the stockholders.

Hence, anything that interferes with the success of the organization injures many people.

#### WHAT IS NOT AN INDUSTRY.

Perhaps it will be well to state first what does not constitute an industry. Power, transportation facilities, fine buildings, fine machinery and a group of skilled workmen, a complete office staff and an elaborate system of factory management do not constitute an industry. Such an aggregation might be likened to a cargo ship all ready for service excepting that it lacks a captain and navigating officer and some one to determine what kind of a cargo to take, where to go and how to get there.

The greatest value of an industrial plant that has everything but a work to do and a leader to determine its major policies, lies in the skilled workers and able executives in work and office. The buildings and machinery come next in value, but the whole thing is worthless without the idea and the vision.

#### "DEAD" ORGANIZATIONS.

In all cities we can see "dead" organizations. Many of these companies that are actually "dead" seem to have life in them because they continue to move, but in many instances the motion is only due to the momentum of a push that was given years ago.

A "dead" organization may show signs of life in its gradual growth in size, but its real character is to be seen in the extent to which it is departing from specialization or by the continued use of antiquated methods and buildings.

The departure from specialization is generally due to either lack of courage to discard obsolete designs or to an inclination to consider the business from the selling end only.

It takes courage to discard an old model and it also takes courage to refuse to build some new invention.

The indifferent management carries the old and takes on the new. This policy covering many years creates a condition that is far removed from the specialization plan.

The management that views everything from the selling side of the business is also inclined to go on indefinitely increasing the line of goods manufactured.

The drift away from specialization may not be disasters today or tomorrow, especially, if there are no competitors who are specialists, but the inevitable result will be the burial of the "dead" organization when a real competitor comes into the field.

The calamity of the existence of "dead" industrial organizations is something more than the ultimate loss to the stockholders, it is the deplorable stagnation in which the workers find themselves with their progress blocked by lifeless management.

#### SOME INDUSTRIAL HOWS, WHYS AND WHATS.

How groups of men achieve the highest results in expenditure of given energy.

What is necessary to establish such conditions.

What are the most desirable opportunities.

What are desirable industries.

Why the need of building up habit-action.

How a group of men, through team work, acquires a group habit- action by which their product greatly exceeds the product of the same number of men working without cooperation.

How the individual ability and skill, as well as the group ability and skill is only to be acquired by repetition that establishes habit-action.

Why repetition of operation is essential to acquisition of skill and special ability.

What are the boundaries that divide the Jack of all Trades, the specialist and the victim of an overdose of repetition work.

Why industrial managers should know the cardinal principles of invention, of industrial engineering, industrial management, industrial relations and the human factor in engineering and in the industries.

Why a plant may be growing in size and paying dividends and may still be dead so far as the spirit of enterprise is concerned.

Why some men try to manage industrial plants regardless of the cardinal principles of progress of workers and the state.

Why the ideal conditions for the workers and executives can only be found in an industrial establishment that can successfully compete with others.

These "whys", "whos" and "whats" are of importance to all and suggest a line of thought and interest in this industrial discussion.

## NEW INDUSTRIES.

The first men to function in the creation of new industries are those who are already well grounded by long experience in some special form of industry. The new organizations must have men well qualified to direct each of its branches.

In general it may be stated that a new organization must start with a superior article to manufacture and the elements of a superior organization. Sometimes it is possible by invention alone to win without the aid of the modern plan of specialized organization. On the other hand, the success may be attained by superior organization without a superior article to manufacture, but in general it is better to combine all of the possible beneficial factors in a new organization.

Organizers should know the market possibilities. If possible, the product should be sold directly to the user. The contact with the ultimate user is of supreme importance in the development of the

invention and the organization. In dealing through a selling agency the manufacturer is not in control of the whole business. The selling agent dictates the policy of the whole business. He dictates the policy of the manufacturing plant from the selling agent's needs and that seldom fits the manufacturing conditions. The selling department generally demands many changes in product and wide range of articles of manufacture, while the manufacturing conditions require that special skill and ability that can only be developed by continuity of action of a given kind, and this restricts the range of produce.

If the head or one of the heads of a proposed organization knows the market condition and knows what can be done in the sale of a new article, then the question of invention and manufacture can be safely left to those who have been well grounded in such principles. That leaves only the question of the financial arrangements.

The method of forming a stock company under the laws of Vermont is very simple and people are generally well disposed to invest in the stock of the new company providing the men at the head are known to be competent--the inventor as an inventor, the business man as a business man and so on all the way through. The standards of measure of each one of the men and the standards of measure of conducting the business are set forth in other chapters. At this time it is sufficient to say that getting the capital is the easiest part of the job. The real work is the preliminary work of acquiring experience and devising plans.

A plan to create a new industry does not call for disloyalty to the employer, for as a rule it is very foolish to attempt to compete with an established organization excepting on some business that gives the new organization an advantage by one or more of the following points: invention, simpler product, simpler methods, a higher degree of specialization, a more effective and direct scheme of sales or a better spirit of personnel.

One of the essential things for the business man--if the business man is not the inventor--is to grasp the fact that his success is tied up to the inventor. The inventor is needed in the development all the way through, not only in guiding the form of the manufactured article, but in a large degree by dictating the process by which the article is to be manufactured. The inventor usually needs curbing to keep him from disturbing his own market by the creation of newer forms, but these matters are treated under the chapter of invention.

The principle element to set forth now is that it is a waste of time and money for a few business men to buy a patent or an invention and then dispense with the service of the inventor. They are merely going to sea without a navigator. On the other hand it is equally true that the inventor must consider the business side of the problem and do all in his power to devise effective means to facilitate the process of manufacturing.

The point to be made here is that there is no chance to win in this game by sharp practice. It is only through work and the combined work and energy of all the men in the organization that anyone can win.

#### INVENTOR'S PROPORTION.

In the machine tool industries, one-third of the interest in the

plant is given to the inventor. This, to the average investor appears to be an unfair proportion, but it is one of those cases in which the broadest vision is necessary, and a glance at the earning power of such organizations as well as the prestige of the inventions, will bear out the wisdom of the general plan in similar industries.

The plan, however, should not be considered as something that boosts only one man or one group of men. If there is any attempt to exploit labor, the plan is wrong. The scheme must be fundamentally right so that each man coming into the workshop or the office of business finds there his best opportunity to develop and receive his best return for the use of his energies.

It is hoped that succeeding chapters will build up confidence in the scheme that will make it possible for men to see the way to progress in this line, to have faith in each other and to know that their ultimate success will come through a spirit of cooperation, concentration of attention and energies of each man to his own special work so as to attain highest ability and last but not least, the complete coordination of all in one safe, sane industrious organization.

#### MANUFACTURERS AND NEW INDUSTRIES.

One of the forces that operates against increase in the number of industrial establishments is the fact that we do not realize the need of human progress in our plants. Men should progress from job to job until they reach their best achievement. Some gain their greatest success in some manual work in which they acquire great skill and others go on to executive positions and even graduate to join other organizations or to start new industries.

We fail to see this fundamental law regarding the growth of the manufacturing organization, and seldom realize the prime necessity of the fundamental law relating to specialization. We overlook the fact that stagnation in place of progress of the men in the plant is deadly to the organization, and feel that if we get an extra-efficient man in a certain position that he must be kept there regardless of his own opportunity for advancement. We fail to realize that progress all the way through the organization, should be encouraged—that while man is distinctly a creature of habit, his mind as well as his body must be considered, and that only by changes of a progressive nature does he develop most favorably.

Too often a manufacturer is opposed to the creation of other organizations by men from his own organization, when, as a matter of fact, it would be a great deal better for his own institution if he would encourage the growth of other plants that can be created by his own men.

#### HABIT ACTION, BASIS OF SKILL AND PROFICIENCY.

We have many text books on the subject of industrial finance, of engineering, of invention, of industrial management, and all these books are written on the assumption that the human being knows his own kind. A study of our failures seems to reveal, however, that we have misunderstood the human being.

For instance, while we know that skill and experience is invaluable, we make our mistake by underrating its value, or too

often we limit its application to the hand worker. We say that skill of the pianist, the surgeon, the workman must be acquired by practice. We know that in many trades a workman must spend three, four or more years as an apprentice, and at least the same number of years is necessary of actual specialized practice in almost any department of work, but we overlook the fact that that special skill or that special ability on which modern success is based must be acquired under certain conditions.

The oriole builds a nest unlike the robin's nest. Each is qualified in its own work. We know that these birds would be sorely handicapped, and would probably be downright failures in providing nests in season for eggs, if each were required to work to plans and specifications of the other bird's nest.

Our fundamental error in understanding our own kind seems to lie in the fact that we fail to recognize that man is a creature of habit to an extent not quite equal to that of the lower animals, but nevertheless to a degree that positively stands in the way of any man who tries to create or manage an industry without giving due value to this one element.

Another way to say all this is that we must recognize experience is necessary--experience not only for the worker but for each one in the organization.

The effect of this characteristic of habit action is so profound that any disturbance in a plant due to changing the position of benches or machinery or changing the character of the work sorely interferes with man's efficiency. On account of this characteristic the degree to which man's energies are most effectively employed goes in direct proportion to the degree in which there is a minimum of changes in the character of the work. The importance of this will be realized when we consider the question of competition, for that, in the last analysis, constitutes the measure of success.

Now, if we extend the plan of acquisition of special ability to embrace men in office as well as in the workshop we have covered the whole subject and have said nothing more than that it is necessary for all men in the office as well as in the workshop to have a special ability that has been acquired by experience.

If it is as simple as this, why the need of saying it? The need is brought about by the painful fact that one of the characteristics of habit action is to continue on without change even after the mind has apparently recognized that a change should be made. Success comes not from the mere \_word\_ knowledge of these things, but through action.

## SPECIALIZATION.

Of the many elements on which industrial development depends, the question of specialization looms large.

Under the general term "specialization" we include all plans and methods of work by which the scope of activity of man is concentrated.

The highest degree of skill of artist or worker is attained by concentration of energies to a restricted range of work. It is through practice that the skill is acquired. The highest skill and highest ability is attained by the degree of interested attention

and number of repetitions of a given kind of work.

Other things being equal, the practice, combined with keenness of interest, makes the most successful man in a given profession or work.

Repetition of operation becomes an automatic (habit) action in which man accomplishes the most work for a given expenditure of energy.

These two results—proficiency and easy performance—are of greatest value, but repetition of action, like nearly all good things, is not without its drawbacks. An overdose of one kind of work with a limited range of action frequently leads to dulling the senses. This stultifying effect produces a most undesirable result. The harm begins when there is a loss of interest in the work, for it is through the interest that the progress is made. The dividing line between the good and bad results varies with different types of men.

The simplest tasks may become of intense interest to the scientist and he may achieve great success in a work that to others seems monotonous drudgery. But with all its drawbacks it still is the best way for man to work and while we must labor to eliminate the condition of drudgery, we must face the plain fact that competition between men, industries, states and nations makes it absolutely necessary to specialize.

Specialization by the men and groups of men will determine the question of superiority of advance in science, industry, commerce, general wealth and welfare, as well as military strength in the time of war.

While we have clearly before us the degrading effects of repetition of distasteful tasks; we must not ignore the other extreme.

The opposite condition is the employment of energies of mind and body in ways that cannot produce high degree of ability. With such desultory use of energies, a day's work is of relatively small value, and there is no progress.

Of the two extremes we find the most prevalent to be the scatter-brain and scatter ability type.

The industries of the higher type lead in providing the best implements and in organization of best team work by which each worker produces the greatest value for a given expenditure of energy.

The essential bearing of these facts is that the worker as well as the business man should compare his work with the work of others with whom he is in competition.

In these days of long distance transportation our competitors in the market may be a long distance away.

If it is in agriculture, the question of climate, soil and degree to which highly efficient implements can be used, are important factors.

If it is in the professions we must see how we can acquire the greatest proficiency and opportunity. This again involves the question of the extent to which we must specialize.



The measure then of success is the value of our services as compared with the services of others.

One of the important problems in industrial management is the extent to which specialization should be practiced.

On one hand we see the ill effects of a routine repetition where there has been an overdose of repetition—one that has gone beyond the beneficial point—and on the other hand, we find that the greatest achievements in the sciences and professions have been wrought by those who have concentrated in a way that has given them a higher development. Unfortunately in many of the industries, the development of machinery has gone forward with the sole end in view of dollars and cents, disregarding the effect on the worker.

This is to be found in some of the industries in which originally there was an opportunity for the worker to have a keen interest in his work. Mention is made of this situation as it comes about with certain stages of development of the manufacturing processes. It is unfortunate and something that the engineers and managers should endeavor to eliminate.

We have very few of such industries in Vermont; they can broadly be classed as undesirable industries. The fact that there are such industries should not in itself drive us from the scheme of working by which men specialize. We should, however, see to it that the degree of repetition of operation goes only to the beneficial extent. Our greatest trouble in Vermont has been the wasteful scattering of each man's energies over a variety of tasks.

Competition with the outer world makes it absolutely necessary that we use our energies in the most effective manner; that most effective manner is the one by which through repetition and experience we acquire skill and ability. The important matter to decide is the degree to which we can specialize. This degree varies with the work and the individual. To an alert and active mentality routine work becomes drudgery, while to the opposite type, mental work is annoying. In an industry, men gradually fit in with the most suitable work. Each man's job should be one that is best for him.

Nothing has been said thus far regarding the invention of new forms of articles to manufacture, or of new methods of machinery for manufacturing articles. These elements and many others are necessary in order to complete a successful plant, but the fundamentals embraced in a statement regarding the habit-action of man represented by special ability and skill acquired by experience, and the habit-action of the group acquired in the same way, constitutes a measure in determining the way at ninety per cent of the cross roads in industrial progress. Anyone undertaking the creation of a new organization or the management of a going concern must grasp these facts.

The value of experience, if acquired in an industry where such fundamental principles have been recognized, should be given the highest rating. Experience, however, in an industry where the energies of men were not most effectively employed and where there was not a recognition that the effective employment of man's energies require a general development of mind and body up to the man's capacity, cannot be counted as wholly good unless, through force of purpose, there is the strength to adopt a new path.

[Footnote]INDUSTRIAL MANAGEMENT.

[Footnote text: A revision of material originally under title of Human Factor in Works Management by James Hartness, published by McGraw-Hill Publishing Co., New York.]

The navigator in preparing for a voyage carefully examines each of his instruments. He must know the present error of his chronometer and its rate of change, and its general reliability as indicated by its past record. He must also know errors in his compasses for each point, and he should have the fullest information regarding the degree of reliability of every other means on which his success depends; and, last but not least, he must accurately determine his starting-point or point of departure.

In taking up the subject before us we will do well to follow his example.

In doing so, our task will be to examine two principal elements: one, the means on which we depend for interpreting the information that is available; and the other, the source and character of the information.

The means may be considered analogous to the navigator's instruments, and is no less a thing than the brain or mental machinery; and the information is simply the world about us as seen in the existing things, such as machinery, methods, popular notions, textbooks, etc., all of which may be classed as environments, and may be considered as analogous to the charts and other publications of our worthy example.

Like the mariner, we must determine the degree of reliability of all these sources of information and our means for interpreting observed facts.

When we have ascertained this we will know what allowance to make from the "observed" to get the actual facts. With this knowledge we will be able to accurately determine both our starting-point and best course.

The importance of considering our own minds will be seen when we realize that every new fact taken in must in a measure conform to the previous ideas. If some of these old ideas are erroneous, the mind must be more or less ready to discard them. It is very difficult to dislodge deep-seated convictions. Contradictory ideas are not assimilated. Only one of them is actually accepted. Even when to the objective reasoning they seem false, they frequently continue to control our actions.

Since we are loaded with the popular ideas which we have absorbed from our environment, it will be well for us to begin by critically examining our environment and the process by which ideas have been taken in. This may enable us to put out some of the erroneous views, and perhaps more firmly fix the true ideas; thereby preparing the mind for a more ready acceptance of what otherwise would be barred out as contradictory.

We shall not go deeply into the psychology of the subject, as it will not be necessary to go contrary to or beyond the well-known facts.

We shall not try to locate the man or refer to him as the ego or inner man. We shall simply say that we know that we can use our brains to think on any subject, and we can use our senses to

collect information regarding any chosen subject.

Our senses and mental faculties can be directed to consider one element in a business, and for the moment be unmindful of the many other elements. In other words, we can to a certain extent manage our mental processes. Just as a horse can be managed, so may we manage our brains. A driver may carefully control the expenditure of energy and the course traveled, or he may throw the reins over the dash and allow the horse to go his own gait and route. In the same way we may manage or mismanage our brains.

Good Results with Moderate Effort.

A faster pace will not be advocated, for the present gait is over strenuous. We hope, however, to point out a way by which good results may be obtained with, moderate effort.

If, in the past, the brain has been found wanting, we should not lose confidence in its reliability until we have seen how it has been managed.

Under some conditions its interpretations are absolutely correct; in fact, under all conditions that would be called fair in testing other kinds of mechanism.

Unfortunately, these conditions have not always existed. Opinions regarding important matters have been formed when accurate mentation has been impossible.

Physical Condition of Worker.

If the use of the machine induces either an adverse mental attitude or physical condition of the worker, it will sooner or later be adverse to the economic success of the machine.

We have indicated some of the problems and have suggested the well-known method of mental control for this purpose. A keen observer of men and machinery may not require as much of the so-called practical experience; another may need many years of actual work.

The practical experience in the various departments of machine construction, its sale and its use, is undoubtedly almost absolutely necessary for the average man in this work.

Its value is primarily to give an opportunity to see things in actual operation. The shop affords an opportunity to see how a machine stands up to its work, where it is weak, and a thousand and one points that can best be seen in actual operation. But there is still another phase that is comprehended more readily by the practical experience, and this applies to the various departments of business as well as to the works. It is the knowledge of the men and their mental make-up and attitude.

A keen observer soon realizes that successful life in the machinery world will not come easily to any one who lacks a good understanding of others in the field.

Capacity for New Ideas.

The assimilating capacity of the industrial world is the real gauge of the progress which should be indulged in. This capacity to take in new ideas and to work by new methods is not the same in all beings, and it is not the same in all organizations. There are ways by which it may be measurably increased. New views are more readily digestible if presented by enthusiastic advocates, as this stimulates an interest. Any attempt to forcibly inject new ideas only results in indigestion.

The assimilating capacity of an industrial organization can be greatly increased by any scheme that awakens an interest. The controlling policies should include advance in efficiency and generally in the quality of work turned out, but this advance should not involve a break in the output. It should be based on a knowledge of the whole business. In other words, it should not only pay in the long run, but if possible it should pay from the moment it goes into effect.

We have said that all changes should be of the digestible kind, and the feeding process should not be a stuffing process; that the ingestion should not exceed the digestion. We have also briefly mentioned the importance of keeping the digestion tuned up to the best speed by having the organization in a condition to most readily take in changes.

That we must make some allowance for inertia of thought and habit in all mortals goes without saying, but the exact amount to be allowed is very difficult to estimate.

Successful management depends on the degree with which a man can estimate the receptivity of other beings with whom he deals. This knowledge of receptivity should include the thought and action of men all the way from the unskilled worker to the directors, and also that of all men in other organizations in any way affected by his organization.

Just as food is more digestible if agreeable to the palate, so this receptivity or assimilating power may be increased by presenting new ideas and methods in agreeable form. A full realization of the effect of this inertia of thought and habit makes the great efficiency of specialization more comprehensible.

It is this human side that is the key, and if we do not act in full accord with it we will probably be working against a great handicap.

The inertia works two ways. It hurts a progressive man just as much to be tied to a work that requires no brainwork as it hurts a sleepy member to be disturbed by progressive talk.

Money not the Only Dividend.

The major policies of management that should be known to the inventor are those which have been adopted to make the business pay. Not necessarily to pay in dollars and cents today, but to pay in every sense, and in the long run, in dollars and in other things.

It cannot pay in dollars if the other things are missing. By other things are meant good organization built on best conditions of mind and body for each of the beings included in the organization. On such things the stability of the organization depends.

No matter how much the manager of a business may wish to run it for other things exclusively, or for dollars exclusively, he will find that one is not attained without the other. He is forced to run a business for the dollar if he wishes to make an ideal organization for each member of the human family included in it. And vice versa, he must work toward best conditions for all the workers if he wishes to protect the capital invested by making a stable and fairly long-lived organization.

This statement is inserted here to clear away doubts as to the real value or necessity of "making a business pay," and to make it clear that no thought is to be tolerated of any scheme of management adverse to the real interest of the workers.

The men selected for each of the various positions should be men who are fitted to fill these very positions. This does not mean mere physical and mental fitness; it means each position should be filled by one who wants it, one who knows he is "better off" in it than in any other place he can find. Dissatisfied men are burdens. It is better to have each position filled by a man who is barely competent to fill it than to have it filled by a man who should have a much better position.

Of course, this is the ideal, and all moves should be made in this direction whenever it is possible. As a rule, it is easier to find men on this basis than to find men who are bigger than the office. This scheme leads to more promotions in the organization and has a stimulating effect on all concerned.

#### Right Placing of Men.

The management's chief business should be to take man as he is found on earth and place each one where he will accomplish the best results for both the organization and himself.

Barring the disgruntled, the uncongenial and the habitually inattentive, almost all men may be and should be profitably employed, the prime requisite being reasonably close attention to business. The thoughts must not habitually wander away from the work.

Intrigue disappears when the management quits looking for it, and assures everybody, by the general method of conducting the business, that there will be no chance to oust this or that man. That each man will be retained in his place if he will but give reasonable application to the general interest of the organization and the particular work of his office.

The management does not "manage" if it perpetually changes its men. It should bolster up the man who lacks self-confidence; it should puncture false ambitions, and it should use men as they are found in the organization. It should not be inclined to "go back on" a man who has blundered or who has been found lacking in understanding.

It should not be over-ready to embrace a stranger just because his faults are not known.

The financial hazard of a business enterprise is greatly minimized by using men as they are found, and properly placing them at work or in offices for which they are qualified.

Unimportant Details.

We can neither regulate the complexity of our environment nor the number of problems which we must settle within a given time. But we can improve the conditions very much by avoiding overconcentration on unimportant details. The brain's best time and energy should be reserved for our own immediate problems; it should not be hampered by details of others.

The various officers of an industrial organization should know the ins and outs of the thinking machine on which they depend for guidance. With such knowledge each brain will give the greatest results, and without such knowledge the best brain may be untrustworthy.

One of the important characteristics of the mind is its tendency to lose sight of everything except the subject in mind. One danger is dodged by jumping into another which we have not seen. Both dangers were plainly in sight to any one who had not concentrated on one of them.

In the regular every-day business life, we seem to have ample time to consider each problem. But in reality our great length of time is offset by a great number of elements to consider, and a more profound effect of long continued teaching or molding of our environment.

For years engineers have concentrated energies on the steam-engine of the reciprocating type. The master-minds have made important improvements in the design, and many have given up their entire existence to the science of analyzing the effects of each variation in conditions of working the steam.

Our textbooks, our teaching, our observation all concentrated our attention on this type.

For some reason Gustav deLaval, followed by C.A. Parsons and Nikola Tesla, broke away from this spell, and we have the steam turbine engine. These individuals are endowed with master-minds, but the task of producing the turbines was probably no greater than the task of others in improving the reciprocating type.

In one case a great step has been taken. In the other, we have an example of men of undoubted ability laboring hard for entire lifetimes with relatively small gain.

This example applies to more than the inventors' world. It has many parallels in the cold business management of a manufactory and in any one of its departments. Business management requires the same kind of reasoning and getting away from the spell of environment. But this phase we shall consider later under another head.

The point to be brought out here is the effect of the spell of environment in magnifying the importance of existing views and methods, and the deceptive part this trusty brain plays in binding us to unnecessarily hard work.

Cure for Mind Wandering.

The mind should not be allowed to wander, for wander it will if it

is not rationally directed. It should be furnished with some interest, either in the form of study that is taken up out of working hours, and which can be permitted to occupy the mind while work of the habit kind is being done, or, if it is not a study, there should be some wholesome interest or pleasure.

Music to some furnishes this need. Music heard in the home or elsewhere will sometimes occupy the mind during working hours when the work is of a monotonous character. In some instances music has been provided during a certain part of the day, just for this need of workers who are employed in an occupation that in itself furnishes no mental nourishment.

But these extreme cases do not represent the vast majority. They apply only to the needs of the mind of those engaged in a work in which they can awaken no interest. Nearly all kinds of work offer a chance for the average man to get interested directly in the work itself. Such an interest soon bears fruit in the results as well as in the comfort of the worker, and it is this phase on which we must depend for making specialization comfortable and profitable to the worker. It is this phase that is wholly overlooked by those mentioned above who have seen or felt the joy of work that comes to one who rambles into a new field. We fail to see that the same kind of mental pleasure may be obtained while working along the natural and efficient lines of habit, and that in one case we have had pleasure at great expense of wasted energy, and in the other case we may have made a true progress for ourselves and others by moving along the rational way.

#### The Manager's View.

The important duty of weighing up these various views devolves on the management, and its action should be in accordance with the complete and corrected view. It must consider the subject from a top viewpoint, and must then act.

The manager keeps in mind that the machines must be built, purchased, and used by human beings, so he carefully studies their peculiarities. He knows that change of thought or habit requires time.

In looking over the history of one of the companies engaged in machine building, we find that the cost of the labor has been lowered to about one-fifth of the original. In view of this and the fact that a very slight change in model sometimes involves a temporary increase in the cost of labor three-fold or more, we see good reason for reluctance in making changes, even though we know that two or three years later the labor cost may drop as low as that previous to the change in model.

The inventor, the promoter, the salesman, and the oversanguine manager do not always foresee such things.

The manager sees the enthusiasm with which the selling organization hails the new model. He realizes that they know the faults of the previous type, and he also knows that no one knows the faults of the new, but he lets it go. Some enthusiasm must be had, even if it be dearly purchased. He knows there will be many a troublesome delay due to the newness, even if the whole scheme proves very much better than the previous type.

This manager knows that his business success rests on the facility with which the machines are satisfactorily built, the readiness of

the buyers, and, last but not least, the facility with which the product is used. The facility with which the product will be used, to his mind, is almost beyond overestimation.

#### Sub-division of Work.

The division of work into separate operations makes it possible to divide the subject into relatively small sub-problems. This division of the subject itself brings it within the capacity of the lesser brains and makes it very much easier for a brain of greater power. In other words, the subdivision of work makes places in which all mental equipments may be used.

It is of no benefit to any one to keep the problems difficult by making each man think out a process for accomplishing each one of a great variety of operations, when the work may be so divided that it is only necessary for him to think of just one little part of the whole. And we should not befog the issue by saying that this is degrading.

Some of the greatest scientists that the world has known have concentrated attention to the smallest conceivable part of this world, pieces so small that the microscope alone revealed them to the eye. There is a chance for the thinker in most any of these places that have grown out of this process of finest subdivision of work. The hardship comes only when the mind cannot get interested in the work. In many cases this is undoubtedly due to a misfit, but in most cases it seems to be due to a false notion that there is nothing there of interest.

The subdivision of work must go on. If hindered in any one plant, industry or nation more than in others, the result will be a loss to that one, and on the other hand, the one that carries it to the most efficient point will become the most powerful.

This subdivision develops greatest dexterity and skill, as well as the keenest comprehension of the ways and means of attaining a given end. And this dexterity of operation is more easily carried on than is the fumbling uncertainty of the work of the more primitive type.

#### Care in Applying New Theories.

The manual worker's energies are so absorbed in the physical tasks that he is annoyed by any suggestion to change his method. If he were given the position at a desk he would probably be interested in the progressive schemes for betterment of methods of work or management of business.

Bearing this state of affairs in mind, it behooves the progressive man to approach the problem of applying his theories in a very careful manner. He must realize that the men in various parts of the work are under stress of every day's requirements that makes it very difficult to intelligently take up any new scheme of procedure. Many an ideal doctrine is a beautiful thing in theory but of little value if its introduction requires an immense but unavailable energy to put it into practise.

He must realize that it is the doing of work that counts and that the men who are doing things must not be annoyed. All plans for betterment must conform to the assimilating power of the men and



must not cut off their food in time of change. In other words, the new plans should be so matched on to the old methods that the change to the new will not interrupt the production.

We have seen that the most efficient way to use man's energies is to allow him to follow habit lines of thought and action, and that the highest efficiency is reached when these habits are habits of concentration of attention and are restricted to the smallest variety of work.

#### Progressive Energy.

Progressive energy is so valuable that it needs no praise at this time. We have had its value stated so often that it is actually over-rated in the average mind. Not that it has been over-valued, but that the reiteration has obscured the importance of other qualities. There should be a greater appreciation of the value of energies that are wholly employed in accomplishing results by old means and methods.

Progressive energy, when it is kept within certain bounds, is a prime asset of an industrial organization. It is like a wholesome amount of labor to man; it may be drawn upon without loss, and its use actually strengthens its source. But when it is not wisely kept in control it only annoys and interferes with real progress and real accomplishment of results.

The only way to get work done is to let the worker move along habit lines. The only way to progress efficiently is to make the new ways and means lead off gradually from those in use.

The progressive man who actually directs work along such lines is the most valuable to the world. The one who ignores the "moment of inertia" is a disturber, whether he is a director or a "hewer of wood and carrier of water".

The man who is doing the real work in the world is not the so-called progressive. He is one who points out newer or better methods which may be easily established by a gradual exchange of old habits for new ones.

#### Profit by Experience.

In considering ways and means for efficient management of industrial organizations, it is not necessary to commence at the beginning of each plant. The method of dealing with the problems of existing plants is also applicable to new organizations, for a new organization is only new in a limited sense. It uses men of experience. It uses existing machines and implements. It follows existing methods of conducting business and in the general management of its affairs.

Even the so-called new method which may be the center around which the so-called new business is built contains very little that is new. The newest things in the ordinary industrial world contain many old and well-known elements. The very use of a so-called new method or machine as a center around which to build an organization is in itself so old that it is a confirmed habit with us to be lured on to investing in such things by the statement that some new process or means is to be employed.

A really new thing that calls for wholly new ways and new means for manufacture is almost inconceivable. The nearer we approach to newness in the industrial world the thinner becomes the ice on which we are moving. Therefore, let us know that when we advise following habit lines in all moves in management of an existing organization we imply that the same course should be taken in establishing a new company or organization.

In both cases we should employ existing ways and means, experienced men and well-tried implements. Both old and new should be conducted along the usual line in conformity with the state of the art, the habits of the workers, and other conditions indigenous to the locality. Any scheme of going contrary to the existing customs and usage must be entered into with full knowledge of the great need of patience, force and courage to offset the barrier of inertia.

#### Dissipation of Energies.

This tendency to dissipate energies by wandering into other fields is not confined to the worker; it is a most common tendency of business men. A manager of an industrial establishment has to continually combat his tendency to divert the energies of the organization along new lines. He knows from past experience how dearly bought is each new method that is introduced into his organization. He knows for example that it would make all of his men tardy at the plant in the morning if at the hour of arising he has issued a request for each man to dress by carefully thinking out each move. He knows that the day's work would never be well done if he asked each one to think before acting.

Even conversation comes under the law of habit. It must follow the line that has been carefully thought out.

We all know that when a man talks on subjects with which he is not familiar his words carry little weight.

The so-called spontaneous utterances that seem so full of life and are apparently the product of flashed thought are either the welling up of some subconscious ideas quickly reconstructed to fit the situation or they are a haphazard jumble either meaningless or conveying an unintended impression. They are generally in the humorous line and frequently make an impression that was not anticipated by the utterer.

The really useful talk and work is the result of wholesome habit of thought and action.

#### Tying up Capital in Stock in Process of Construction.

The amount of capital tied up in raw material supplies, stock in process and finished product should not be greater than that which is necessary to get the greatest output per dollar of investment.

In the machinery-building world there is no such thing as a steady long-lived demand for any machine. Hence the proposition to build a locomotive or printing-press by methods employed in watch or sewing-machine manufacture is entirely ill-timed at least.

For this reason the stock in process must not necessarily be considered insufficient if it appears to be on the hand-to-mouth

plan. The dividing line between excessive and insufficient stock must be drawn in each individual case.

Raw material should be purchased in reasonable quantities with due regard to the price which varies with quantities but there should always be a regard for the amount of capital used for this purpose. Any excess represents just that much extra capital unnecessarily risked in the business.

There should be a constant supply of material throughout the entire work. The stock in process should flow through the plant in a rapid but thin stream. The quantity should be no greater than absolutely necessary to insure a steady supply for all of the workers, including the assembling and selling workers.

An excessive stock of this or that piece, or of all pieces, means that much capital idle, and it also tends to slackness of management. Frequently it is the outcome of carelessness.

A slipshod management that disregards this point will use no care in purchase of material or in putting in the shop orders. All that is needed is to just hurry forward the stock that "happens" to be "out", and at the same time allow the accumulation of the unneeded stock to go on unchecked.

Immense storerooms for keeping finished stock are shown with pride, unmindful of the fact that every dollar's worth of unnecessary stock on the shelves in the stockroom, every dollar's worth of unnecessary work in the plant, represents idle money and faulty management.

If this money is to be retained in the business, the system should be changed so that the money will be put where it will bring the best return.

The excessive stock in process is sometimes an outcome of blind progressiveness—the blindness that fails to see that there is as much money tied up in stock in process and in finished product as there is in the entire machinery equipment.

An adaptable equipment facilitates keeping down the amount tied up in stock in process. The modern plant should take advantage of these modern methods and machines which tend toward profitable use of capital. Such machines are highly developed and true to the controlling ideal of adaptability and largest output per dollar of investment.

#### Cost of the Product.

The practice of disregarding the profit, when considering changes in machine equipment, is the natural outgrowth of the separation of the mechanical and the business departments.

The changes in the equipment are usually determined by the mechanical department, and this is done with particular regard for the quality of work and the cost per piece. The relation between the profit and the net labor cost is not considered.

The cost of the product of the average machinery-building plant may be divided into three nearly equal parts: the material, the labor, and the burden; or, in four equal parts, if a reasonable interest charge is made for the use of the capital invested.

The material is the iron, steel and other material that enters into the construction of the machine, and it is taken in the condition in which it usually comes to the machine shop.

The burden includes all expenses and salaries necessary for the maintenance of the business.

About one-half the amount paid for labor goes to the men who run the machine tools, and the other half is paid to workmen who do the other work, such as handwork, assembling, transporting, etc. Therefore, the cost of machining is either one-sixth or one-eighth of the total cost.

On top of the net cost of the product there should be a profit. If it is not there, the sooner something happens the better. If it is there, then it is proportioned to the volume of the output. Therefore, both the size of the output and the labor cost should be kept in mind.

The size of the profit per unit of output is not generally known to the mechanical departments. But even if it is not known, there is no reason for their being uninformed as to the importance of large output for cost of the plant.

Largest Profit Per Dollar Invested.

One of the most satisfactory policies of management is that which tends toward getting the best return or profit per dollar of investment.

We shall not refer to the quality of the product, the design, or any other elements which affect the good name and standing of the business, for it goes without saying that no business can be maintained where these are disregarded. The point to be brought out here is that, These thing being equal, the best scheme of management for profit is one that puts the capital where it will do the most good.

The above statement is one with which all will agree, but strangely enough there has been a tendency to tie up capital in ways that actually throttle the output of the entire business.

Furthermore, this is frequently done by increasing the portion of the investment that is irrevocably tied to the existing product, thus not only reducing the earning power of each dollar invested, but also increasing the hazard by tying the capital to the present product, which soon may be unsuited to the market demand.

One of the most common errors in this respect is the one that regards the reduction of the labor cost as the paramount consideration.

Reduction in labor cost has been the war-cry. The pay-roll has been talked about so much that it has seemed to become the whole thing. A man who declares that the labor cost per piece is not the most important element is at once branded as an advocate of old-fashioned methods.

It is needless to give assurance that there is no intention to disregard the labor cost. The net cost per piece is a very important element, but it should neither eclipse the question of profit per dollar invested, nor the risk of the capital tied up.

What is the gain if the means for reduction of the net labor cost reduces the profit more than the saving in labor? If doing so results in an actual loss of profit, why is it done?

We can readily see that the overhopeful managers may disregard the risk of the money invested, but we cannot see why the relative importance, or rather unimportance, of the labor cost should be so disregarded.

The machine tools in a plant usually determine its character. This character is not one that can be quickly changed, but every addition to the equipment does change it for better or worse. Usually the installation of a new machine is hailed as a progressive move, just because the new machine works better than the old, but its effect may be very bad. It may be changing the character of the plant adversely to the interests of all concerned. Therefore, the controlling spirit should see to it that each move is made on a basis that is economically sound.

It is in these changes that the scheme of management has a chance to make a great difference in the earning power of the entire business.

If too large a proportion of the total available capital is tied up in the machine equipment, the business is handicapped. There is a right amount which bears a certain relation to the total required to carry on the enterprise.

With a given amount of capital for machine equipment, the output of the plant will be seriously throttled if the net cost of labor per piece machined is allowed to become the controlling element.

#### The Workers Help Bring Success.

The inventor, the officers, and mayhap the foreman, taken all together, do not and cannot make a successful machine or business without this supplemental work or ideas that come from actual work of all workers.

This new kind of knowledge should not take away a man's courage; on the contrary, it should give him a true sense of value of existing, "going" things. With this knowledge he can confidently and earnestly push a machine that is the product of a good organization. He will know the great value of much experience and practise of each of the many men in the organization. He will neither kill the business by half-hearted indorsement, nor increase the hazard of investment by urging this or that modification. Nor will he advocate this or that machine being added to a line that is already too great.

The invention, the general organization, the proper direction of the business, are essential to success. But without that organization which is only obtained by actual, thoughtful experience of the men who do things, all the knowledge and industry of the leaders are utterly useless.

This knowledge produces a new kind of confidence that has greater faith in the existing and running things than in the claims for something that has not had the development of practice. It is the confidence that knows that the right fundamental ideas and the policy of "sticking to one thing" will accomplish the best results.

This is not a doctrine of optimism that holds there is no inferior machine. The "best" implies the existence of the inferior. In nearly all lines there are many grades from the best to the worst, but the loss of faith in the relative value of a machine is most commonly due to a lack of full knowledge of the other types, and it is this kind of loss of courage, confidence, or whatever it may be, that this chapter is intended to offset.

Have Faith in Your Products.

What has been said regarding the optimist, the pessimist, and the vacillating man, from the designing and manufacturing point of view of a machine business, applies with equal force to the business organization.

The business is pushed forward by men who have confidence in the project and in the product. If these men lose their faith in their own business, they not only lose their usefulness as pushers and managers, but they become drags on the industry, and remain so until restored to normality. The hazard of investment is greatly increased by such conditions.

Instances without number have been observed in which men who have been successful have become unsuccessful through loss of confidence due to acquiring the "dangerous half-knowledge."

The man who has acquired the dangerous half-knowledge should take a post graduate course in some institution where men are treated by all the most powerful agencies known to science. There may be no institutions of this kind in existence, but the great need will doubtless bring the establishment of many.

The men who have lost faith in their own machinery should be told that no company can survive the effects of weak-kneed advocates. Any company is better for a certain amount of aggressive competition. Any company can stand more or less opposition from its friends the enemy, but no company can continue to exist under the blighting effects of the men who have lost this confidence in them or their product.

The post graduate course for restoration of the near-wise man should include educational means of all kinds. The means should be especially adapted to the need of each student or patient.

There might be a phonograph in each room, which should work all night and all day. This machine should repeat over and over a few short sentences like the following:

"The only perfect machine is the one you do not know."

"Study the machines offered by your competitors, just to get the same degree of knowledge of the 'other' machines--not for the purpose of slandering or even mentioning--but just to restore your confidence in the relative value of your own machine."

"Don't try to get back your belief that your own machine is perfect--that has gone forever--only look at the other machines and learn that your own is the best."

This kind of confidence will not be exuberant, but it will have marked efficiency in the cold gray world in which you are to again try your strength.

Specialization.

We find that in keeping with the trend toward specialization, the machine shop is now manned and directed by specialists, whose close application to the technical science of their respective specialties has in a degree obscured other elements with which their interests should be coordinated. Among these we generally find the so-called human element. This feature of specialization, which is the natural result of concentration and undivided attention to the work in hand, has entailed a string of consequences that has lessened the spirit of fellowship and co-operation.

The workman in the old machine shop was known as a machinist, an apprentice or a helper. The machinist trade required skill at bench, vise and forge, and in the operation of the lathe and planer. It also required a general knowledge and resourcefulness which enabled the machinist to make good with the meager facilities. The large specialized shop of today was not known.

Today the machine shop is filled with a variety of machines which have grown out of the original types. Each shop's equipment is selected to serve the needs of that shop, and since each shop has a special purpose, its equipment seldom includes the full range of machine-shop machinery.

Today the work flows through the machine shop in lots of large numbers of pieces of a kind, and each machine, as well as each worker, is kept at one kind of work and usually at one simple operation.

The worker in the machine shop of today is no longer known as a machinist, because that term does not cover the present range of positions. Even the term "all-round machinist" is no longer satisfactory.

Specialization has made so many divisions in the work that it has resulted in developing men for special branches, so that today we have relatively few men who can skillfully operate for instance the engine lathe and planer. Even if there are those who ever had that ability, most of them have lost it through disuse.

The workers are now designated by many names indicating their special work.

The all-embracing term machine shop is divided into departments for drafting, designing, accounting, production, flow of work control, cost accounting and many other divisions. Each calls for executives and workers having special titles.

The subdivision of work has resulted in each executive and worker acquiring a high degree of ability and skill for work of his kind, and it keeps each one doing the highest class of work for which he is qualified so that his time is not wasted in the simpler operations which can be performed by men of lesser ability.

We can readily see the economic gain that accrues when the worker becomes more efficient; first, though the greater skill acquired as a result of fewer operations to perform, and second, through the use of the highly developed special machines, for then he is able to produce a greater value for a given expenditure of effort. We can also see the gain that results from specialization by the executives, for each one's attention is concentrated to the

management of a smaller range of work; but the average mortal has not yet reached the point of accepting the fact that to some extent there should be a division between mental and physical tasks. It is needless to say that no one in these days would suggest even a possibility of a general division of the work along the line between the abilities of the brain and hand and in these days of construction and operation of intricate mechanisms like electric and telephone instruments and machinery, aeroplane, automobiles, railroad machinery, machine shop machinery, army and navy machinery, from the smallest instrument and small arms to the big machines like the battleship. The need of the man in whom is combined the ability of brain and hand transcends any possibility of our meeting the demand. But specialization does require both kinds of division. The one that divides along the line between mental and physical tasks provides great opportunities for those men who have special ability at either the mental or physical tasks. It is undoubtedly true that the greatest achievements have been attained by those who have been unable to combine the great mental and physical ability. Such men by nature and preference are most fitted and most comfortable in the positions in which there is a greater proportion of use for either the brains or fingers.

Every student of this subject early recognizes that the man at the physical task should not be unnecessarily distracted by the vexing problems of planning and directing the work. In some way this does not seem to fit a democracy, but rather seems to lead toward autocracy. However, let us keep in mind that specialization is essential, not only at each physical task, but at the tasks at which there may be expended a combination of the mental and physical, and also at those tasks that are wholly mental, and that a division should be made to get the best results from the whole organization. While it may seem autocratic to leave to one group the determination of the methods of work, and to another the task of doing the work, the fact remains that this is an element of specialization. That which seems so objectionable to a man with an alert mind, is not so objectionable when he realizes that many men of the highest type are happiest when given a chance to work out tasks unembarrassed by problems of procedure. While this has been one of the great tragedies of industrial life, when square pegs have been put in round holes, it is one of the most important questions that an engineer has to consider.

The human view will make us all labor towards the complete elimination of degrading tasks, by changing machinery and processes so as to fit the various types of men available. Through it all, we must see to it, that our scheme of work is true to the fundamental law of specialization, and that we recognize that there must be some division between the physical and mental tasks, and that this does not necessarily lead away from democracy. In fact, we must recognize there are two extremes. At one extreme we find the ideal of a highly specialized organization in which the greatest value in quality of work and quantity of output is possible through a complete co-ordination of the work of all types of men, each at his own kind of work, in which each can excel; and the other extreme in which we find a general disorganization which returns us to the primitive condition in which man's energies were most inefficiently used. Such a state is the natural result of anarchy, and it is a state that would leave this or any other country an easy prey to a country in which specialization existed.

One means team work of great wealth-producing capacity, and the other a state in which the struggle for mere existence would be severe.

The salvation of the world will be worked out if there is at least



one well disposed nation that stands firmly for specialized industrial organizations. This will result in both industrial and military supremacy—for it is now well known that military supremacy cannot exist without the highest types of machinery building shops.

Such a nation could dominate all others and could ultimately check the disorganizing activities of the well-intentioned but shortsighted reformers.

The higher form fits our highest civilization and national security, and the other is a direct step toward chaos.

Nevertheless there is almost a stampede of sentiment against specialization and its product—the large industrial organization. This stampede has taken many of our otherwise well informed people, and now we are seeing its extreme effect in the iconoclastic fever that is raging in Russia and elsewhere.

We know that the individual, the industry or the nation that specializes will produce the greatest results with a given expenditure of energy, and we know that all this plan of specialization requires a co-ordination of the work of all.

There should be brought about through specialization the highest degree of ability on the part of the executive officers, as well as the highest skill of the workers, and each man should have the satisfaction of knowing that no one on the face of the globe can excel him at his specialty, and furthermore that his energies are expended in the best way to produce value.

Many men have already realized this ideal. Many industrial organizations have also attained it in a very high degree, and while there was a trend of some of the nations toward specialization before the war, there was developed in America a spirit of antagonism toward the large units that had grown up as a result of this specialization. Not that specialization was objectionable, but that industrial supremacy of an organization was thought to be a distinct menace.

Since it is in these specialized industries that the individual should find his best opportunity to produce the greatest wealth for a given expenditure of effort, such organizations should be maintained and all others should be gradually changed over so as to make the most economical use of the man power of the nation.

We have found by experience that industrial organizations are successful if they specialize. We have handed down to us the saying that "The Jack of all trades is master of none". Our brains accept these statements, we recognize them as facts, but owing to one of the irrational traits of the human being, it is one thing to believe and another to practice. It is one thing to superficially know that it is important for us to specialize as individuals, and it is quite another matter to bring ourselves to act in conformity with this fundamental law.

The great economic gain or advantage possessed by the Ford Company, and many of the other companies in this country, is not due to the fact that they have selected a wonderful model that is superior to others in every way, but it is based on the fact that specialization makes it possible for the various officers and workers to become the foremost men in their respective offices. Specialization of an industry becomes effective only when each man continues at a given job or work. Shifting men about the plant is harmful, excepting in so far as it may be good to promote men from

position to position to fit the development of the men and the industry. The plant can be wrecked by changing men from position to position without changing the product. It can also be, wrecked by changing the form of its product in fact any change, whether it is a change of the product or a change of the men, which interferes with the continuity of operation of a man along habit lines is an economic loss to that organization.

We have stated that each man should specialize in order to produce the greatest value for a given expenditure of energy--that specialization of the industries is necessary.

That each man has some special knowledge that fits his environment.

That the skilled worker has a special knowledge for his duties.

We have pointed out the need of a closer relationship between the specialists. That they are all interdependent and must cooperate.

In setting forth the importance of the worker we must remember the equal importance of every other member of a well-balanced industry.

Lay directors and even lay chief officers are not necessarily a menace or even burdens, if they have a fair conception of human nature and the importance of each element in an organization, and the full necessity of coordination of all.

They should know, however, that every man should be paid first in cash and second in honor, appreciation, esteem, good will inspiration, commendation for his good work and good qualities, careful consideration of his troubles and a genuine knowledge that his interests are being justly considered.

## INVENTION

The following chapter is given in its original form as a lecture to the Engineering Society of the Stevens Institute of Technology.

Its value in furnishing a side-light on the subject of habit, to which the preceding chapters have been more directly applicable, lies in its emphasis on the importance of the inventor (or designer, if you prefer) having clearly before him at all times the effect of habits of thought and action both in himself and in all others. These modes must be both conserved and combated in himself when building up favorable mental state. He must build on habit in order to have his mind continue in its application to a chosen subject, and he must combat any tendency to follow habit lines of thought that may have been established by observation of the older forms or methods. His inventions must be of a kind that will be readily made, sold, and used by men whose habits of thought and action he cannot readily change.

This should be of value not only to the designer, but also to those who direct or co-operate with him.

In designing the parts of a machine, the need of trimming here and there, of giving up this or that ideal form just to get things together, must be seen and done unflinchingly. And in the same way the whole scheme must be made to conform to the economic conditions.

If the machine under consideration is like a machine tool, and is to be offered for sale, then the manufacturing, selling, and use must be taken into account. In machine-tool design a wholly new invention is an exceedingly rare thing, and a successful new machine is still more rare.

We must remember our own tendency to follow precedent, and we must make an effort to see the problem in its natural form without being misled by the solutions evolved by others.

Be Practical.

The toughened idealist may not look or act like an idealist, but in reality his idealism is one of the practically-wise construction. He allows his memory to hold all that is helpful of the past, both of the blunders or successes.

The dreamer who has been toughened by experience is one who lets his rational brain have control. He ranks next to the stalwart knight of the eraser, because he has the courage to arrest the endless tinkering of design in order to get something done. He will not let the family freeze while he is thinking up some grand scheme of sawing and splitting wood by magic.

A most cursory glance at the machinery in use in the world will show that the work has been done by imperfect machines. A study of the design of any machine brings out the innumerable shortcomings.

If we see a machine that seems perfect, it is perfectly safe to set it down in black and white that we do not fully comprehend it. It is safe to say that the only perfect machine is the new model that is to be tried very soon.

With these facts in mind it does not require very much courage to go ahead with an imperfect design, but unfortunately these thoughts will not stay in the mind of the average designer. They are crowded out by the flood of ideas for still further betterment. That is why it is just to give high rank to the man who had courage to go ahead and build, even when he realized the faults of a design.

Perhaps one of the aids to this action is the knowledge that the apparent opportunity to improve a design may only be apparent. In reality the change is only a change, and is no betterment, a very common outcome of such ideas. The knowledge of the great array of failures of such "improvements" is wholesome and helpful to bear in mind.

The Inventor Sees Opportunities to Improve.

The inventor, from his point of view, sees the great need and opportunity to improve the design of the machine being manufactured. He sees that the big machines are nothing but enlarged editions of the early and smaller ones. He knows that with a change of size there should be a change of design. He knows that although a granite rock weighing a few tons will not be kept suspended in air by a heavy wind, a small part of the same rock will be carried away by a breeze, and may be kept suspended by a very slight current of air. He knows that the small particle of granite has a greater superficial area in proportion to its weight. He sees on every hand that a change of dimensions

frequently entails a change of design.

He also sees the opportunity to effect a great saving by building the large machine for its special service, and not on the exact lines of the smallest model. The failure of the management to adopt his plans seems nothing less than unreasonableness to the inventor, for like other mortals he is a trifle slow at grasping the fact that no two beings have exactly the same point of view or the same quality of sight.

Another inventor sees a chance to make further improvements and he is disturbed because there is a ban on changes. He feels that the mechanical success of his previous work should be a sufficient guarantee of the economic advantage of the last proposed plan.

If an attempt is made to show him that the ban on changes is absolutely necessary from an economic point of view, it is found that the reasoning does not get the same reaction in his mind as in that of the manager. To him the great advance of the new scheme fully warrants the temporary expense.

Improvements May Be Disasterous.

Improvements should be sparingly made. Any improvement that requires a change in construction or operation may be disasterous financially.

This may all seem extremely pessimistic. But it is only seemingly so. Experience shows it to be the true view.

If it is true, then the machine designer should know it. A mere knowledge of mechanism is insufficient for him. A large business experience cannot be purchased, and his success should not be contingent on the business ability of another. He should know how a machine should be designed, and should not depend too heavily on the views of the business men who have not a clear knowledge of the technical problem.

Perhaps some of you may feel that there are many other problems to be encountered before you will meet these which I have set forth. But we should remember that the mind holds some of such impressions a very long time. It holds them below the threshold of conscious thought, and under ideal working conditions it brings them above it when they are needed.

If you have caught my meaning you will not be weakened in enthusiasm for new work, but you will be protected in a measure against some of the reaction due to disappointment. There is a great field for earnest workers, and it is easy to become one by working on the lines set forth.

Natural Fitness.

One of the first questions that arises in the mind of one who intends to undertake machine design is, what constitutes natural fitness for it. There seems to be no positive basis on which to determine in advance a natural fitness for this work, but there are certain temperamental characteristics that undoubtedly have much to do with the success.

The temperament should be one favorable to continuity of thought

along a given line, as well as one that will by nature take an intense interest in the subject.

If these characteristics are missing, it may be due more to the distracting interests that in these days crowd in upon the mind, than to a lack of natural aptitude. The absorbing interest, however, is essential, and it may be developed by conforming to well-known principles of orthodox psychology. Self-torture or hard driving is not nearly as helpful as a strong inner purpose to keep the chosen subject in the real center of conscious thought.

The subject that comes to mind when there is a lull in the outside demands on the attention, or one that is insistent on taking possession of the mind, even when other matters are objectively more in evidence,—that subject is the one that holds the center of the inner attention. That is the controlling idea or purpose. Ordinarily, it is some diversion; occasionally, the haunting bugbear of some unfinished work or obligation. If the mind is dominated by such ideas or any other than the real problem in hand, the individual is seriously handicapped.

When a problem of machine design is undertaken, the mind must make it the real center of attraction. To one having an average endowment for such work, this is not a difficult task, but to get the best results it should be rightly undertaken.

#### Repeated Thinking.

A chosen subject is brought, with some lasting effect, to the center of attention by repeatedly bringing it into the mind at the moments of lull in the pressure of other affairs. The astronomers wait for the moment of best seeing, and the designer must wait for the actual psychological moment.

The best seeing condition for the astronomer is due in a small measure to his own physical condition, and in a large measure to atmospheric conditions, but the most opportune time for clear-headed vision of the designer is due mostly to his own physical and mental condition.

Probably no two men have their minds equally affected by their environment or their physical condition, but the fact that there is a most favorable time and condition for such thought and work should continually be borne in mind. Without this a man with natural endowment may try his wings at flight at an inopportune time, and if he fails he may be firmly convinced that he was never made for flying.

This undoubtedly applies equally well to other kinds of work. It may not be strictly true of a perfectly normal man (if there be such a creature), but it is truly applicable to many workers in this and similar kinds of work.

This phase is mentioned in order to make clear, not only how a designer should work, but the thought that should be kept uppermost in the mind of one who is trying to do this work.

The physical condition is more or less dependent on the mood, and to a great extent the mood is dependent on the condition of the body. The strenuous gait is seldom the best, and, of course, the extremely indifferent one is of little value. The best for the average man is one born of a quiet environment, with mind and body in a fairly restful condition, or still better, in a rested and

fresh condition.

#### Concentrating Attention.

The quiet end of the day is almost as good for clear thinking as the early morning, especially if the day has not been over strenuous and the activities have been gradually tapered off.

There are many instances that would seem to show that the strenuous gait is the best, but nearly all of these evidences are questionable. When finally simmered down, the good work done under high pressure is frequently due to latent ideas that were the product of quiet thinking. The mood and the dominant idea may be predicated as necessary.

As already stated, the habit of thought most favorable for the persistence of a single group of ideas is attained by the practice of switching the attention back to the desired subject.

This should be done at the opportune time. The subject should not be forced on a tired mind. It should not be taken in as a painful duty, but it should be made the one thing of interest. Really valuable results can only come along the line of the dominant thought. All other work lacks directness. It follows precedent to an unnecessary extent.

#### Interest Must be Awakened, Not Forced.

Another way of saying all this is that the designer must get interested in the particular problem, and he must have an interest that crowds out all other thoughts, even thoughts of similar work. It is useless, however, to say, "get interested in the work," unless we suggest a way to awaken interest. Surely, we know that interest does not come at mere bidding, and that it cannot be forced by hard work. But it can be induced by an easy process in a normal being, providing he has not already too firmly established a set of habit thoughts of another kind.

The normal being, by persistent intention, can establish the desired thought habits by returning the preferred group of ideas to mind. Interest is awakened by this comparatively easy process, and when a genuine interest exists, the actual work follows as a natural result, and it is a pleasure instead of a drudgery.

This is not intended as preaching in any sense; but only to bring to mind facts known to all, with the view of implanting these facts in the mind of the machine designer.

Some designers have done excellent work with no thought of psychological problems. But in this more strenuous age it seems best to take advantage of every aid to the desired end.

The intricacy of mechanism has reached such a state that new designers are almost overwhelmed with the mere thought of trying to comprehend the existing machines. But with the advance of the world of machinery, there has been a better comprehension of the working of the "thinking machine", and we must take advantage of this knowledge in order to win out. It is particularly needful now to study its most efficient use. We are getting to the point where mental energy saving methods should be used.

It is not necessary to go beyond the bounds of orthodox science for schemes for getting the best results from a given mind. We have known for centuries that men tend to habits of thought as well as action,—that thought habits are like ruts, and these are encountered wherever the mind travels, and these ruts bring the mind back to a certain central group or community of groups of ideas.

#### Establishing Useful Ruts.

The real secret of success is in establishing ruts of a useful kind, ruts with switches that may be operated by the mind at will, or that work automatically when the mind would otherwise wander.

Since even fleeting thoughts are germs of acts, it takes no great effort or self-torture if we will but understand the processes and smoke out the undesirable germs, and allow and encourage the growth of the preferred groups of thoughts. This may be called a lazy man's way of doing things, but it is the way to conserve the mental and physical energy, and it gets results.

In saying that the problems of the work in hand should come automatically and agreeably into the mind when there is a lull in the impressions being made by other things, it is not the intention to convey the meaning that one must have no other interests.

The mind gets its clearest view by the scheme already mentioned for creating interest, viz., by repeatedly bringing it back to the subject whenever it is found wandering.

The best view for invention is that which reveals the most natural way for accomplishing the purpose for which the machine is wanted. It should not be born of precedent. It should not follow the lines thought out by other designers.

It readily discovers the obsolete features in existing machines, features that were required in other days but have no use now. Such things remain there just because later designers have followed blindly.

All designers follow more or less. We have shown the great need of following the set habits of users, but we should make a distinct attempt to get back to nature; that is, to see just what is best for the purpose, and to get the most direct and natural means. If this is too much of a task, just hunt for the obsolete features. Above all things, we must not try to follow another's work. We too often follow unwittingly and to our misfortune even when we try to keep out of the rut.

Machine designers who have done original work will tell us that it is easier to do good work by striking out on new lines than it is to follow the work of others, or even to tinker over some of their own inventions of other years. It requires more ability to take up the work of another and change it, than to start out in some original scheme.

The machine builder knows that the success of any machine depends on the clear-sightedness of his designer and the oneness of purpose of all the heads of all the departments devoted to the construction, sale, and oversight of the running machines in the hands of the users. And last but not least, in these days of supremacy of specialization, he knows that success comes only to

the largest group of men organized for this particular kind of work.

All Men are Human Beings.

One of the first things we learn in the works or office is that all men are really human beings. The second one is that the meanest one is only so because of certain physical or mental conditions that are the direct result of natural law. Usually it is not necessary to drag in heredity, for we find ample cause in his environment, within our range of vision.

As a rule, a good understanding of men insures a wholesome regard for them, while failure to understand the other fellow (or the equivalent, the failure of the other fellow to understand us) may bring out many things that make us feel that he is not one whose feelings or interests should be considered.

To any one that has had experience in the shop and a fairly well-rounded business and financial experience in this particular field of work, the other fellow is invariably a good fellow whenever there is a chance for a fairly complete understanding.

If we can accept this statement tentatively, and follow it up by a determined purpose to actually feel it, then we have obtained something by the royal process that would have otherwise required much time and perhaps some unpleasant experiences.

This knowledge is essential to success in designing machinery. True, many have been successful with a very different attitude, but engineers of the future must see to it that as many of the phases are as favorable as can be made so.

Regarding the absorption of the knowledge of working mechanism in the works this is greatly facilitated by a wholesome relationship with other workers, and it is greatly handicapped without it. Therefore, it is one of the cardinal points for the machine designer to get thoroughly acquainted with others in the work so as to know their likes and dislikes, as well as the mechanical needs.

The favorable features in machine designs are: directness of mechanism for the purpose; its simplicity and its efficiency; its adaptability to the habit of thought and action of makers and users.

The obstacles to its success are any of the features it may have that cannot be readily comprehended by those who are to build, sell, buy, and use these devices. It is of little value for real success for a machine to be one that is readily understood by a draftsman or manager, or that it is one that may be made to perform wonders in the hands of a skilled expert.

The real economic success depends on the number of machines that will be used. The number of machines that will be used depends on the readiness with which the real workers take hold and manipulate the machine.

To get a true conception of the value of a machine, it is necessary to look at the showing of a business engaged in its manufacture. In estimating the value of a machine-building business for this purpose it is customary to speak of its "good will."



Easiest Way to Improve.

Inventions of complete novelty and of great economic value have attained success going in opposition to this principle of conformity to the habit of the world. But the easiest way is to direct improvements and inventions along lines that are the most readily assimilated by the minds of the beings to be considered, and this may be said to be one of the master-keys to economic success.

The work of building the first model of a new machine may be under the direct supervision of the inventor, and if only one machine is to be made, the inventor can follow it wherever it is used. By patience and industry he may instruct some one in the use of it, but in these days there is no chance for a great economic success in making just one machine, or in fact any machine for which there is not a large market. Hence, we will confine our attention to machines made in such large quantities that the complete supervision of manufacture, sale, and use is beyond the capacity of one person.

For all such machinery the design must more or less conform to the thought and habits of work of all concerned. Some of the most direct designs have failed to meet with success just because the inventor did things in an unusual way. The unusual way is a blind way, and is difficult to find. In some instances it amounts to no way at all, for it is never used.

If a radical change in design is to be made, the new machine should be one that will be the most readily understood. Obscure parts or unusual means should be avoided.

If moving parts must be covered, some way should be provided for convenient observation. It is the obscure departure that is the most troublesome, and it is the obvious thing that offers the least resistance to progress.

There is a chance to progress by obvious devices, and such progress is enjoyed by all, from the makers to the users. It stimulates their weak but wholesome appetite for progress.

Technical View Insufficient.

But whether the clear view of the designer is due to peculiar fitness for seeing such things, or to proper application, the fact remains that this clear view of the technical side is insufficient in itself. The man with the clear view must also realize that others do not get the same view. He must know that the mind automatically takes in things of interest to it and wards off others. Even when the individual apparently tries to comprehend something in which he has no special interest, it only results in a superficial mental impression, one that has no appreciable effect on the actions.

This failure of mankind in general to grasp the advantages of a new mechanism as it appears on paper is only a slight part of the troubles to be encountered by a progressive designer.

He has to contend with habits of thought and action of all the human beings affected by the new machine. This includes the entire

group of men in the manufacturing plant in which the machine must be made, the business organization both in this plant and the one in which it is to be used, and, after all this, the greatest obstacle of this kind is to be met in the man who uses the machine. For it is in his hands that a machine must prove its value.

When we consider the inertia of mind and body, it is truly marvelous that there has been any progress in machine design. In fact, if the machine-building trade were in retrogression, with only a few new men being taken in there would be little or no excuse for making machine tools of new design. The older workers would get along about as well without the improved machines.

This is not said in a spirit of fault finding. It is a great fact that we should grasp if we are to design machinery successfully.

It is difficult for the man of sanguine temperament to really accept this view, and it is also hard for one who is continually searching for knowledge. But it must be appreciated, and all work must conform to this principle, if it is to be pushed forward along the lines of easiest progress.

Accepting this view is no barrier to progress. It will not ultimately delay the work of a reformer if he is induced to act in accordance with this principle. It only prevents a wreck.

The knowledge of the force of habit of man should therefore be used in two ways:

First, when the designer is trying to make the most natural machine for the purpose. Then he must overcome his own tendency to follow precedent. Second, when considering the kind of a machine that can be easily made, sold, and used, he must give due consideration to the inertia of others, for their inertia he cannot hope to quickly change. Reformers in this world generally have a hard time whenever they under estimate the inertia of men's minds and bodies.

A designer of machinery, by close application to his tasks, should obtain a clearer view than it is possible for others to possess, of the way a machine should be designed, made, and used. It is not necessary to assume he has a better brain. An ordinary mind applied to a given subject sees it more clearly than an abler mind which has not considered the subject with the right interest.

**Inventions Should Not Mix With Details.**

In first working out the mechanical schemes no energy should be wasted in trying to make the sketches correct in proportion. The very functioning of the brain along the draftsman's line shifts it away from the inventive mood. The exact drawing frequently shows the necessity of change in general scheme, but that is only one of the after-steps.

The fundamental idea is the starting-point, and must be sketched out as fully as possible without losing the very frail thread of thought.

A clear view of the scheme is not to be obtained on demand. The schemer must wait in patience, as the astronomer waits for steady air, and, like the astronomer, he must have every facility in shipshape. The clear view is only clear to the watching eye.

The coast-wise skipper in making a fog-bound harbor will see a buoy through a slight shift in fog, while a landsman might look in vain.

The wanderer in the happy dreamland of mechanical scheming must not be looking for complete drawings, specifications, and working model of the invention he wishes to bring into the breathless and waiting world. He must be looking through the mist of the thickened senses as the skipper looks through the fog. The buoy and the scheme may be never so faintly shown, but yet with sufficient clearness to give a positive guide for the course.

Inventive schemes cannot be forced by strenuous effort. Such effort may result in slight refinements of a given type, but never would have invented the DeLaval or Tesla turbine.

It is not my purpose to belittle the great work that has been done in improving existing machines, for this, after all, is the real great work that must be done. It is the work to which the world owes its greatest debt for progress in material wealth. Furthermore, it is a phase that must be considered in connection with every invention before that invention can become of value to any one. But just now we must consider how the inventor must work while dreaming out the fundamental ideas of a mechanical scheme.

The clear view of a mechanical scheme is more likely to come after a good night's rest, particularly if the schemer has retired with the problem in mind. There are times when invention comes under severe stress, hard physical work, and mental anxiety, but the most usual time is after a sleep which refreshed mind and body. After this the inventor brings his scheme to the drafting board, to patent office, to factory, and to the market, and in each case he encounters barriers.

#### Designing by the Square Foot.

The ordinary work of machine design, in which well-known parts are grouped to accomplish a given end, without much thought of attaining anything approaching the best,--such designing is like painting a fence, so many square feet of paper should be covered per day. But the real higher type of work cannot be measured in this way. It requires the forethought, the close application, the keen interest, and the comfortable idea building.

Designing by the square foot is, however, a good preparation, and many a good brain has been developed by such work.

The importance of designing a machine to meet all the conditions necessary to success from a mechanical and business standpoint is fully recognized by every one. But the grouping of the ideas in the mind while working out the various phases must not be hampered by the bewildering picture of all of these problems, each demanding consideration at every move. The phase in hand must have the concentrated attention, and the best conditions for its solution.

The harmonizing is an after-process which must be worked out by a series of compromises after the various component elements have been almost independently considered.

Problems to Consider.

In taking up the problems of design of a machine, there will be found an almost endless number of elements to consider. The strictly mechanical problem of the best machine for the purpose never stands alone.

What is the measure of the best machine? How much can be spent on its design and construction? How much work is to be done? An endless variety of questions at once crowd into the mind for answer.

It is doubtful if all the elements could ever be tabulated in any form that would be a positive guide in shaping the final result, but in a general way the designer should make a fairly good guess at the kind of standard toward which he should work.

There are, doubtless, men capable of carefully weighing the almost infinite number of variants, but such men usually lack the intuitive scheme of work, on which the inventive side of a designer depends.

For the ordinary mortal the best process of working is to keep a vague picture of the whole requirement in mind while concentrating on some one phase.

When the inventive qualities are to be called into use, the economic side, the business side, the manufacturing, the selling, the personal profit in cash or glory, all these must be absolutely crowded out of the center of the mental picture. Even fleeting thoughts of other elements seem to prevent the inventive functioning of the mind.

In like manner the problems of manufacturing, selling, patents, business organization, must each be given a separate consideration. The interval between taking up the various questions should be as wide as possible. The mind seems to require a previous notice of days or weeks or more in order to take up any one of these problems, at least, with any hope of success.

The Hero of the Eraser.

The drafting board may show that no such arrangement of parts can ever be made, that the whole scheme must be altered to make it practical. A real hero is required for the work of juggling the elements of a drafting board. He must have patient endurance and sufficient strength of character to use the eraser heroically, for the eraser is mightier than the pencil in the drafting-room. There are a thousand valiant knights armed with pencils to one stalwart pusher of the eraser.

In the drafting-room the work of harmonizing must go on; compromises must be made between the ideal scheme of the dreamer and the requirements of the manufacturing and selling departments.

Next to the noble knight of the eraser comes the idealist who has been toughened by experience in the cold world.

The idealist aims to design and construct a perfect machine. He is encouraged in his work by seeing a little clearer each day, month, and year of the time spent in the right kind of application to his work. He knows that the work of last year is faulty, that this year's work seems nearly perfect, excepting for a certain slight

change that has just entered his mind. He cannot think of allowing any machine to be made without this later improvement.

He is inclined to the optimistic view, his memory works best on the good work of the past, and is extremely poor in holding afresh the view of previous mistakes.

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