CHAPTER XI

PRACTICAL APPLICATION OF THE THIRD LAW OF EFFORT (Continued)

INCENTIVE

The fourth sub-principle of the Second Law of Effort is to the effect that "effort must be remunerated". * In applying this sub-principle to each Function its aim was declared to be the isolation of specially valuable kinds of effort for the application of incentive. The Second Law of Effort does not pretend to deal with Incentive as such, but only occupies itself with finding out what types of effort are specially important in each function. It remains therefore to complete this by considering Incentive in the abstract—what it is, how it acts and what its range or scope should be. This brings us to the sixth sub-principle of the Third Law of Effort: namely, that:

* See Chapter VIII, page 196.
6. Incentive must be proportioned to effort expected

The first question we have to ask is "What is Incentive?" The answer is, in general terms, that incentive is that which moves human beings to effort. The less incentive, the less effort. The sociological law of Parsimony tells us that human beings will always seek the path of least effort to attain a given end; consequently we find that in those countries where, as in the tropics, life can be maintained by men with almost as much ease as by vegetables, absence of incentive results in absence of effort, and men vegetate in sloth without trying to rise to greater levels of culture.

Incentive may be natural or artificial. It may arise from the spur of Nature or from the needs of civilization. Hunger, cold, and wet are examples of the first. Each of them is an incentive to man to get up and do something for himself. These spurs are also felt in civilized society by the weak or unfortunate, but to the great mass of civilized men these iron hands are concealed by the velvet glove of employment. The employed man, however humble, is at least freed from the stern incentives of hunger, cold, and wet.
From this point we pass upwards. All men are not alike, either in their powers or aspirations. The strange but universal law of Average in Faculty shows that in every large unorganized group of men, the great mass will have a medium development of faculty, and above and below this mass will be smaller masses having development both above and below the average. As we neai the confines of the curve, we shall find that a relatively few individuals will have extremely low development and about the same number will have extremely high development.* This sociological law appears to hold good for whatever faculty, moral or mental, we examine great masses of men. Now the principle of Incentive rests on this—that hardly any men, except those whose development is far below the average, are free from a desire to progress a little, to enjoy more, to receive more consideration from their fellows, to do a little better on the whole than they did at the outset.

This at once brings us to an important element in Incentive. It may be either moral or material. If for the most part it is material at the present day, that is because we

* "Human Faculty," Sir Francis Galton.
have fallen into the habit just at present of valuing a man by the amount of his material possessions. Millions are more easily recognizable than worth, and not only more recognizable, but much less easily counterfeited. But even today, material incentive has not the whole field to itself. Fame, honor and public esteem have not ceased to be incentives, though they are less powerful incentives than formerly. Even in industry, which is in itself merely the development of material resources, men respond to other incentives than dollars, and this being so the matter becomes of practical importance.

Having defined Incentive as that which moves men to effort, we may next ask in what way does Incentive act? Can we overdo Incentive? If men are of various grades of capacity must the Incentive be graded in correspondence? If Incentive is of two kinds, moral and material, do these forms act in dissimilar ways? If so, is it possible to combine them to act on the individual? Can Incentive be made to assist in fostering habit and esprit de corps? All of these are very important questions, and we shall find that all of them can be answered in the affirmative.
All of these questions are in fact summed up in our sixth sub-principle that "Incentive must be proportioned to Effort expected". That we can overdo Incentive seems easily deducible from the sub-principle, and in fact it is easy to overdo it. If we offer too large a reward for a given result, one of several unexpected things may happen. First, if, as is assumed in the premises, the reward is beyond what the man would normally expect, he will quite possibly not go all the distance after it. He will be content with doing part of the work, and getting part of the reward. In some trades, particularly in England, where wages have been forced up by powerful trade unions high above the average of the class, the workers in these trades will not work a full week; they prefer to make what they consider sufficient for their wants, and idle the rest of the time. This is a clear case of over-incentive.

On the other hand, we can produce equally mischievous results on another type of man, by offering too high a reward. In his effort to attain it he will spend himself too freely, using all his reserve strength, and injuring his health. This is, in fact, one of
the main grounds on which trade unions base their objections to systems of payment by results.

It is worthy of remark that society in its gradations, its president or ruler, its legislators, judges, great preachers or ecclesiastics, leaders of science and art, captains of industry, etc., its vast mass of ordinary men, and its sub-stratum of the unfortunate and the incapable, corresponds very closely to the distribution of faculty as revealed by the law of average in Faculty above mentioned. The supply of capable men is not inexhaustible, the supply of more than usually competent men must always be small. We have heard of late a university professor lamenting the incapacity of a large fraction of students to profit by the widespread facilities for higher education that have been so liberally established and endowed in America. His opinion is that young men are being attracted out of their proper orbit, that thousands aspire to higher positions which they are naturally incompetent to attain, and they make the time-honored mistake of supposing that education will turn incapacity for leadership into capacity for it.

In the industrial field, there are also many
grades from the president at the top to the shop sweeper at the bottom of the scale. It is the just boast of our society that nothing prevents the sweeper from mounting until he fills the chair of the president. As regards the individual this is satisfactory and spectacular, but if we regard either society at large or the industrial field in particular, we shall see that cases of this kind are numerically very few, so few that the law of average is not thereby disturbed at all. We are therefore left face-to-face with the fact that both social and industrial organization is an affair of gradations, mobile as regards the individual, but permanent as regards men in the mass. Though men are actually passing all the time from one grade to another, both upward and downward, the proportion in each grade remains constant.

To confine our attention to industrial matters, we will observe how this permanent system of gradations is affected by Incentive, because it is evident that a right understanding of the matter is very important. If we suppose that any man can be spurred by incentive to attain any end, this is equivalent to saying that whole grades of men can be moved upward by the application of in-
centive. On the other hand, if we regard grades of faculty as permanent phenomena of society, then it is obvious that our task must be to adapt and proportion the incentive rather to the grade than to the individual.

In practical language this means that in fixing the incentive for any particular kind of work, we must regard the customary wages for that trade, calling, or profession. For customary wages are a natural growth or evolution and have been worked out instinctively and by the process of trial and error through generations. For certain work it has been found necessary to attract certain grades of faculty, and this can only be done by paying the customary wages* or market price of that grade of faculty. The more difficult the work, the rarer the faculty that will handle it, and consequently the higher the market price for that grade of faculty. When we speak of "Incentive being proportioned to Effort expected", therefore, we really mean that it must be proportioned to the grade of faculty concerned, and to the customary wages for that grade of fac-

* For a discussion of customary wages in the general labor problem, see Appendix I.
ulty. If we offer too little, the right grade of faculty will not respond; if we offer too much we are not only wasting money, but making individuals dissatisfied with the customary wages of their grade to no permanent purpose.

In applying Incentive, therefore, our aim must be, not to extract higher-grade activities from men than they naturally possess, but to promote the full development and use of those faculties they may be reasonably expected to possess. If this seems to neglect the interests of the meritorious individual, the answer must be that the meritorious individual is usually able to take care of himself. When a man realizes that he possesses faculties superior to those called for in his work, it is obvious that this affects the market price of his efforts, but not the market price of the work on which he is actually engaged. One of the most difficult practical problems of large undertakings arises from just this position of affairs—the grade of faculty of many men, though not of all, rises as they get older. To recognize this, and to keep such men by finding the right place for them as they develop, is no easy managerial task.
Having thus defined the aim that should be observed in creating Incentive, we may now consider the forms of Incentive—moral and material—with a view to ascertain what varieties of these can be applied in industrial practice.

Moral incentive is based on a natural human instinct, that of emulation. The desire to surpass his fellows, to shine amongst them, even to arouse envy in them, is as well marked a passion in human nature as any other. Badly directed it leads to notoriety-seeking, and even to criminality; but rightly directed it provides a good deal of the motive power of civilized society, from the days of childhood onwards. Moreover, individual progress is very often due to a kind of self-emulation,—a desire to mark one's own progress, and establish new records. Many workers engaged on monotonous tasks contrive to invest them with interest by running, as it were, races with themselves, trying out first this way and then that, and keeping count of the results of one method compared with that of another. From which, by the way, the undesirability of despotic insistence on "one best way" of doing routine work may be deduced.
The use of emulation as a form of Incentive, should, however, be made with caution. What we require in industry is not sudden, spasmodic effort, based on straining faculties, whether mental or physical, but steady day-after-day effort. It follows therefore that emulation must be made use of to foment interest rather than to force the pace. On a walking tour, a great deal of the interest arises from the sense of progress made, of ground covered, of so much done. Walking without an objective point, or walking in a country without landmarks, without milestones, so that the progress we make cannot be measured, loses half its pleasure. Yet it does not follow that the presence of milestones makes us walk faster or unduly hurry ourselves. On the contrary, our progress will be more even and sure, our pace steadier, and our condition of fitness better preserved, if we are able to mark our progress at frequent intervals, and observe what proportion the intensity of our effort bears to the attainment of our goal.

The moral varieties of Incentive therefore should be so arranged that they give rise to emulation of an invigorating and not of an exhausting nature. In the last chapter we
sketched a proposal for promoting *esprit de corps* in the power-plant staff, based on the simple idea of publicity of certain data of interest to such staff. Such a form of publicity also arouses emulation, the desire to maintain good records, not to slip back, on the contrary to make a little progress forward when opportunity offers. It is, then, a form of Incentive, and it can, moreover, be converted from a moral to a material incentive by the equally simple step of attaching some bonus, or small increase of pay, to the maintenance of satisfactory conditions and to the improvement of the record.

It must be noted that there is a great difference both in aim and result between incentive applied in this way, and the ordinary individual piece-work or bonus system. The latter has its place, of course, and is not excluded by, nor does it exclude, the former. The one is individual; the other is, in a small way, social. Both appeal to the self-interest of men, but in a wholly different way. The one appeals to self-interest alone, the other appeals to group-pride. The one has but small moral invigoration in it, the other has much. The one concentrates, the other broadens the faculties—both excellent things
in their way, but of the two the latter has probably the most lasting and satisfactory influence.

At the beginning of this chapter, two of the questions we asked were:—If incentive is of two kinds, moral and material, do these forms act in dissimilar ways? If so is it possible to combine them to act on the individual? We can now see that both the answers are in the affirmative. Moral incentive is different in its action from material incentive, for it appeals to higher instincts, and it can be combined with material incentive so that both act in the same direction.

The mistake must not be made of confusing what may be termed "collective bonus" with the form of incentive above mentioned. The essential feature in the plan proposed is not the material reward, but the moral stimulus. It is not that we reward a group of men with some few extra dollars, but that we let a group of men know when and how they have reached certain results. The few extra dollars give additional interest to the result, much as some people cannot play a game of cards without having something "on" the game. But the average man does
not play cards for what he makes out of it; he plays cards for interest and excitement, the stake being only incidental. The nearer we study the everyday actions of men and the motives that prompt them, the nearer we shall be to devising methods of industrial incentive that will give interest to life, and thereby invigorate the worker.

The aim of Incentive should be, then, both to arouse interest in a broad result, and to reward individual diligence in helping to attain that result. As has already been mentioned, this principle has been adopted by several firms in promoting efficiency among their selling staff, but very little progress has been made in applying it to the factory. It cannot be doubted, however, that it can be and should be applied to all departments of business, if only because it arouses group-consciousness and group-pride.

The practical application of incentive is obviously a matter of great variety, differing in each industry and in each plant. It is not our desire here to offer concrete suggestions or fully worked out plans, but to consider the underlying principles of concrete devices. We will therefore confine our attention to formulating in practical lan-
guage some of the conditions that should be observed in setting up forms of incentive.

First we have the natural divisions of Effort as marked out by the existence of the Organic Functions. Thus we have effort applied to the designing function, to the equipment, to the controlling, the comparison and to the operation functions. It is only in very simple businesses that we may expect to find it possible to apply any form of incentive to all these functions collectively. In most cases, separate forms of incentive, dealing with separate kinds of efficiency, must be set up for the work of each function.

Then as regards the work of any one function, the important efficiencies must be isolated (as indicated by the sub-principle of the Second Law of Effort that "Effort must be Remunerated") and thereafter analyzed and considered, as in the case of the power-plant staff already referred to, so as to disclose the data on which incentive should be based. If for example, the ratio of pounds of fuel burned to pound of steam generated is within the power of the staff to control, then this item of efficiency will be one of the bases. If the keeping up of a certain pressure at all times is similarly dependent on
the efficiency of service, this will be another base. If pressures, temperatures, vacua or voltages have to be varied from time to time according to conditions, then the closeness with which the variations are kept to the change in conditions will be another base.

Now these elements can be made the basis of individual bonus, in some cases—the stokers, for example, can be rewarded on the separate efficiency of their work—and a general efficiency factor based upon the various separate efficiencies can be made the base of a group-incentive. In the latter case the important point will be not so much the distribution of a certain amount of money as a general power-plant efficiency bonus, but rather the publication of the data on which such bonus is based in such form that all concerned can compare results from one month or period to another.

It can hardly fail to be noticed that we are here arranging incentive somewhat on the lines both of analysis and synthesis. We reward the ultimate division of unit operations, say for example, the stokers, and we also synthesize certain kinds of effort, which are closely related to each other, and arrange another kind of incentive on the result of
this synthesis. By so doing we proportion incentive not only to individual effort, but to group effort also. We comply with the principles deduced above, viz.:—we promote the use of faculties which each man can be reasonably supposed to possess, and we both arouse interest in a broad result, and reward individual diligence in attaining that result. As a by-product of this arrangement we also promote group-consciousness and therefore group-pride or esprit de corps in a way that no form of incentive a priori, lied solely to the individual can possibly do.

The subject of incentive as applied to operation, that is, to the individual operator, has been much more widely discussed than any other. The modern tendency is to base it on a careful analysis of the amount of effort required for each job, and this is studied by means of time study and motion study. It must not be forgotten, however, that time and motion study are methods of analysis of effort, and not measuring rods for wages. This has been vehemently denied, but it is obviously so. Wages depend on custom—that is, on the experience of both employer and employee over a series of years as to what is the proper price to pay for certain
grades of skill. It is true that, in some cases, time and motion study have revealed that certain work can be done by a lower grade of skill, and therefore for less wages than was thought possible. This, however, is a comparatively unusual discovery. Wages are commonly fixed by custom, and analysis simply defines how many of a certain thing can be handled efficiently in the course of a day's work. It has nothing to do with fixing the customary price to be paid for that grade of work. Much of the hostility of workmen to these useful methods of analysis is due to a misapprehension of this fact, for which it must be confessed the wild claims made by the less responsible followers of the school of "scientific management" are largely responsible. The whole subject of incentive in operation has been discussed in Appendix I under the title of "The Labor Question".

There is one form of Incentive that may possibly assume more importance in the future than it has in the past, namely, the so-called profit-sharing. But while it satisfies one of the conditions laid down here, in that it tends to interest the employees in a broad result, it appears to lack somewhat of the
other half of the same condition, namely the rewarding of *individual* diligence in helping to attain that result. In other words the defect of the plan appears to be that the reward is too remote. Nevertheless, in so far as it brings into focus the idea that all industry is in effect a partnership, it must be commended if only as an antidote to the pernicious theory of socialistic or anarchistic agitators, that labor is the source of all wealth.

In a broad and academic sense this is, of course, true. Matter being inert, it is evident that it does not build itself into forms of wealth. But neither is it built into forms of wealth by labor alone, either by manual or mental labor. Both these have to be organized and synthesized before they can effect any more efficient conversion into wealth than is found in the wigwam of the primitive savage. All the rest depends, first on a conception of an objective, and the means to realize this objective. Second, on the organization of mental and manual labor into effective functional activities to attain these ends—one of these functional activities in industry at large being the manipulation of the secreted or stored energy of the com-
munity, known as Finance. Now it is just this power of conception and this power of synthesis and organization that are somewhat rare in the world, and like all rare things, have their market price, which is high. Labor in the ordinary sense has no part in these creative activities, but is only taken into partnership at a later stage. It is, of course, "worthy of its hire" and everyone wishes that its rate of hire should be as high as reasonably possible; but it is not the only factor of wealth, nor even the most important one.

The proof of the proposition that labor is not the most important factor in creating wealth is in the lamentable fact that it is frequently a drug in the market, and cannot find any outlet for its powers. Why is this? It is that the supply of labor has for the time outrun the capacity of the organizing element to create new openings. It is a common phenomenon to find great unemployment of labor and at the same time great unemployment of capital. Yet anyone who sees a way of using either to good advantage can usually find an opportunity of doing so. If there are times when it is not done, it is because it cannot be done. The world is at
that moment awaiting some constructive concept to set things in motion. Shrewd men, searching the world for opportunity, naturally expect to be paid well for their efforts, and for their capacity, when they succeed.

While profit-sharing is a valuable idea as far as it helps labor to realize the true nature of the problems of industry, it does not seem at present to have attained a development of great promise. It is possible, however, that it contains a valuable germ, and will attain greater usefulness in the future.

TABLE XIII. APPLICATION OF THE THIRD LAW OF EFFORT

Personal Effectiveness Must Be Promoted

First sub-principle:—
   Good physical conditions and environment must be maintained.
Second sub-principle:—
   The vocation, task, or duty should be analyzed to determine the special human faculty concerned.
Third sub-principle:—
   Tests should be applied to determine in what degree candidates possess special faculty.
Fourth sub-principle:—
   Habit should be formed on standardized bases, old or new.
Fifth sub-principle:—
   *Esprit de corps* must be fostered.
Sixth sub-principle:—
   Incentive must be proportioned to effort expected.
Chapter XII

The Manager and the Instruments of Management

The whole subject of the Organic Functions of manufacturing industry and the Laws of Effort that control them has now been developed. In the present chapter it is proposed to review the matter generally, and supplement it by some observations on the relations of the manager to the science of management.

It has been shown that production is a synthesis of certain well-marked functions. Each one of these functions is essential to production in some measure, though their relative importance varies in different industries. In some the function of Design is very elementary, in others Equipment is less complex than in others. Again there are industries easily yielding to Control, and others in which a considerable proportion of the total number employed is engaged in one variety or other of the controlling function. The same applies to the function of Compari-
son. Operation alone has an equal importance in all industries, because like the fighting force of an army, it is the function to which all the other functions minister. But of course, it does not always reach the same complexity, either in variety of different kinds of skill concerned, or in the difficulty of performing the acts of operation.

No other activity of production exists outside these five Organic Functions. If any exists it is optional, such as certain kinds of welfare work, which are however really administrative acts touching, or supposed to be touching, on the promotion of personal efficiency. If they are functioned at all, they are derivatives or branches of the function of Control.

Efficiency in production is dependent, and alone dependent, on successful synthesis of functional activity. As regards each function the Laws of Effort point out what has to be done, but these laws do not apply themselves—they are applied. What then applies them, and what so consolidates the working of the Organic Functions that efficiency is realized? There is only one answer to this question, namely—the synthetic influence of a strong personality. Both the Organic
Functions and the Laws of Effort deal with relationships between living beings,—these are the only material with which the science of management has to deal. It is the association of men for various objects that alone gives rise to industry, and it is the successful synthesis of their efforts that gives rise to efficient industry.

In all history there are but few examples of armies that have done great things without two elements being present: first, great leadership; secondly, great discipline—that is, the capacity of men for following leadership. On the other hand there have been innumerable instances where a change of leaders has transformed an unsuccessful into a triumphant army, and also cases where the reverse has taken place. Above all, therefore, what is necessary to efficiency, is leadership.

Management is the science of applied human effort, just as chemistry is the science of applied chemical properties of elements and their compounds. In either case, above and outside the natural reactions which it is the rôle of the science to study, a controlling human agent is tacitly implied. If management implies a manager, chemistry implies a
chemist. Each of these men sets out to produce result by manipulating the material at his command, subject to the laws of his science, and whatever he attains he attains by skilful synthesis. But both the manager and the chemist act on and through the science, outside which they themselves stand. In either case the man brings to his aid a synthetic action which is purely individual and uses the facts and laws of science to produce a result that must first exist in his own brain.

This seems to show that the manager, the leader, must bring something into the solution of his problem beyond the science with which he works. It is not sufficient for a man to understand chemical, or military, or management science to make him a great and successful worker in these fields. There is evidently something more needed, something subtle, something which it is not possible to define with precision, but which is summed up in the very vague but well understood word "capacity". Probably one of the great components of capacity is a strong and unusual sense of proportion, a quantitative sense which tells him not only which way to go, but how far to go.
We come here to a paradox, namely that the science of management cannot produce managers. But neither can military science produce generals. In both cases study of the science can assist, can help them to systematize their work, does put them in possession of the accumulated experience of the past as regards the success or non-success of principles that have been tried out long ago; but the great leader is after all born and not made.

We come back therefore to a picture of a man of capacity using two great instruments—synthesis and analysis—to attain the ends that seem fit to him. In the foregoing chapters we have tried to depict something of the nature of the material with which he must work—the functional activity of his men; and further, certain observed influences or laws that control this activity have been discussed. These are the warp and weft of the fabric he has to create, but the fabric itself will be a result of the way in which he combines these elements. His work is to adapt these general truths to particular circumstances, just as the general of an army has to adapt the rules of military science to the changing necessities of a campaign.
In the foregoing chapters we have exhibited the skeleton and framework of the science of management in manufacturing. We have defined the scope of the five Organic Functions, and have shown the wholly dissimilar nature of their aims and objects, and the impossibility of supposing that these aims are in any way interchangeable. We cannot conceive that an act of Design can ever give rise to material product, or that an act of Operation (that is, the exercise of a machine process or trade or skill) can ever produce a new design. Similarly the mechanism and organization of Control and of Comparison have obviously such different aims that we cannot conceive an act of Control ever comparing anything, or vice-versa. Equipment also, being the function which provides physical conditions, is evidently an inert or passive function. It represents a plant in full working order, it is true, but not necessarily working. The vast reach and influence of Equipment is best realized by walking through a large plant when it is deserted by the living factors of production, and Equipment,—dead, inert Equipment, is in sole possession of the field. At such a moment one does not need to be reminded
that Equipment is indeed a thing apart, and that, by itself, it is incapable of producing product, or of exercising the functions of Control, Comparison or Design.

Across these functional activities, the synthesis of which alone makes a plant in active operation, we have seen certain Laws of Effort weaving a fabric of custom and habit. For it must be understood that these Laws of Effort,—like all other natural "laws"—are merely the recorded results of phenomena which have been so often observed to happen in the same way that we are justified to consider them indefinitely repeatable under similar circumstances. When we say that to produce fine results, "Experience must be systematically accumulated, standardized and applied", we are merely recording a particular industrial problem, in a particular way and applied to what is the universal observation of mankind. There can be no doubt about either the universality or the correctness of such a law, and what we have said about it that is in any way novel is to point out that it must be applied in manufacturing, not at large or vaguely, but in five different directions. We must accumulate, standardize and apply experience
in Design, Equipment, Control, Comparison, and Operation. This alone gives definiteness to the law.

Similarly, the second Law of Effort, that Effort must be regulated in four ways, viz.:—by Dividing, Co-ordinating, Conserving and Remunerating it, is no new discovery. Expressed in less definite and technical phraseology it has been known from the beginning. But here again we may claim to have given some definiteness to this universal law, by pointing out that each of the five functional activities concerned in production are subject to this law, and that naturally it produces different effects in each. This law, like the others, has not been invented, but observed—it has always existed.

Finally, we come to the Third Law of Effort, which speaks of the conditions necessary for the promotion of personal effectiveness in the work of production. Here again we have nothing but well-worn truths, assembled and grouped so that their application to the particular problem of manufacturing management may be studied at leisure. But this law does not apply to Functional activity as such. It deals with each individual as an individual. The first sub-
principle, indeed, is modified in application according to whom it is applied, since "good physical conditions" for one kind of work are not the same as those demanded for another. But they have no connection with the functions as such. Take for example, the question of quiet surroundings. The higher officers in each function have need of much quieter surroundings than the rank and file. The accountant has one standard of quiet, but the weighman at the cupola, even though engaged on the same functional activity, viz., record and comparison, need not be safeguarded in the same degree. The draftsman, again, must have a high degree of quiet, but the time-study man frequently carries on his operations in the shop itself with perfect comfort and success. Hence the application of even this first sub-principle cannot be regarded as divisible by functions.

The remaining sub-principles of the third Law have even less specialized application. They deal with four very important but quite abstract ideas—vocational fitness, habit, esprit de corps, and incentive. Some day, no doubt, all these matters will have been studied in so much detail that their specific
application to functions may seem feasible and necessary. But as yet this is not the case, and these matters have to be dealt with in the abstract.

On the subject of vocational fitness and the tests to be applied in order to discover it, we have thought it necessary to call attention to the warning of Professor Muensterberg with regard to the use of psychological methods of analyzing faculty. Already a good deal of quackery has developed in this direction, and methods not far removed from the old and exploded phrenological absurdity of determining character by "feeling the bumps" have been put forward for serious acceptance. The determining of vocational fitness is of course no new thing. Every employer uses it to a greater or less degree when he engages an office boy on the strength of his handwriting, his testimonials, and the personal impression he makes. The newer ideas in this direction simply seek to discover, first better and more exact grounds for determining vocational fitness of a simple order, and secondly for determining fitness of a complex order such as the work of a motorman spoken of in Chapter IX (see page 228).
The formation of correct industrial habit has been dealt with as the fourth sub-principle of the Third Law of Effort. Here again we have not dealt with a catalogue of habits desirable or undesirable in regard to Functional activities. It is the general principle that habit should be formed on standardized bases that has been laid down. It has been shown that these need not be new bases. Thus the habit of punctuality is certainly a conformity to standard, but the standard is very old. Where, however, analysis has shown old standards of performance to be faulty, then new standards when determined should be passed into habit as soon as possible. Thus if motion study applied to a particular kind of work demonstrates that the old habitual way of doing it was wrong, it is eminently desirable that the new method should be established as a tradition, that is, as a habit, as soon as possible. Every habit customary today began at some time or other, and most have been subject to modification many times in their history. But each alteration, each improvement, has resulted in new habit being formed, and though "written instructions" are sometimes a necessary stage in the pro-
cess of forming new industrial habit, they should be regarded as an unavoidable nuisance, and not carried too far, or too long. Of course, in one sense, every technical textbook is an example of written instructions, but no practical man is always running to a textbook for guidance in his daily work. He gathers from such books the practice he desires to adopt, and this practice then becomes part of his practical habit.

Considerable space has been devoted to an examination of the nth sub-principle that “esprit de corps should be fostered”, because the wide attention that has been given to analytical methods in recent years has almost submerged the synthetical demands of management. Much more attention has been given to considering the problem of production microscopically, than to considering it as a whole. Though it is true that a whole is made up of parts, as a house is of bricks, there is more in management than the fitting together of microscopic details, just as there is more in architecture than the placing one brick on another in a neat and workmanlike manner.

Among the synthetical processes that have been somewhat neglected lately, this of
esprit de corps may be noticed. True, a great deal has been heard about the desirability of a spirit of co-operation—although as we have pointed out, esprit de corps means much more than mere co-operation—but even a spirit of co-operation does not arise from a combination of mechanisms; it arises from the perception of larger issues than are contained in any mechanism. Men do not co-operate merely because it is a good thing to do in the abstract; they co-operate because co-operation comes naturally to them.

Now the real motive force is rarely or never due to the matter having been reasoned out by the individuals concerned. Men rarely or never get together and say, "let us co-operate". On the contrary, the act of co-operation is really a polarization of wills due to some outside influence, just as a host of little magnets all turn in one direction when enveloped by a magnetic field, and this outside influence is still more rarely self-interest. Where true co-operation exists it is usually unconscious, and due to the fact that a high development of esprit de corps exists. And as we have shown, esprit de corps is a complex and subtle atmosphere,
largely emanating from personality—the personality of those in control.

The last of the sub-principles of the Third Law of Effort that "incentive must be proportioned to effort expected" is also of a general and abstract character. It is an examination into the nature and elements of incentive that we have made, rather than a prescription of definite methods of setting up efficiency rewards. It was found that different and well recognized gradations of skill are present in the industrial field, and that each of these has its customary wage. The object of incentive was found to be, not an attempt to raise men of one grade to another and higher grade, for that is their personal affair, but to call out the full use of the faculties that may be reasonably expected to be possessed in any given grade. In the course of doing this, emulation may be aroused, but on condition that it is used to arouse interest in the work rather than to force the pace. There is in fact, in all questions of incentive, a group aspect as well as an individual aspect, and the best form of incentive will be that which combines both of these. Here, again, the tendency of late years has perhaps been to concentrate at-
tention on spurring the individual, to the neglect of the equally important task of fostering *esprit de corps* by arousing interest in the group.

We are now at the end of our task, which was to exhibit and delimit the five Organic Functions of manufacturing management and demonstrate how the three Laws of Effort influence their working. In a work of this kind, containing so many details, it is possible that errors have been made, and even that some small inconsistencies may be discovered. But it is believed that the broad outlines are correctly presented, and that we are here in presence of some few fundamental facts and Laws, which can be reasoned about, and practically applied. They may be considered, therefore, the commencement of a formal science of management.

In the chapters that follow, a brief glance will be given at the task of the practical organization of the five Organic Functions. Machine manufacturing has been selected as a case in point chiefly because it is more complex than most other forms of industry, and manufacturers of other classes of product
will have to ignore much that does not apply to their industry, leaving intact what does so apply. To assist the latter class of reader, however, a diagram has been prepared, showing application of the five functions to a more simple form of industry than machine manufacture.
PART II

ORGANIZING THE ORGANIC FUNCTIONS

In order to illustrate the practical organization of the Organic Functions, machine manufacture is taken as an example, because it represents what is probably the most complex kind of industry. In order to correlate the particulars thus given to other industries, all that does not apply should be omitted. Thus the function of Design in some industries is quite rudimentary, being represented by the writing of a chemical formula. Similarly in some industries the function of Control is quite a simple matter, in others it demands an elaborate organization. Generally speaking the following chapters refer to what may be considered as a maximum development in each function.
Chapter XIII

Organizing the Function of Design

The first stage in establishing a plant is to decide on the product to be manufactured. Its design for technical use should then be undertaken. The preparation of designs for use does not come within the scope of this book, which deals exclusively with production. In fact it does not follow that such design is prepared by the manufacturer at all. Not infrequently complete designs of the machine are supplied by the inventor or other person putting the product on the market. It must be assumed that whoever is responsible has applied the First Law of Effort and that he has availed himself of all the experience obtainable with regard to the technical and commercial value of his design.

We do not need to consider, therefore, the efficiency of the machine as a whole, or what may be termed its technical efficiency. This belongs to the problem of the ultimate use and value of the product, with which we, as considering the manufacturing prob-
lem purely, are not concerned. Whether the ship we are building will prove a dividend earner for her owner, whether the shoes we are manufacturing will prove acceptable to the demands of fashion, or whether the machines we are building will do what they are alleged to do, are interesting points, very important to continued commercial success, but they are not manufacturing problems.

In all such cases we must assume that the product is a well thought out product, as far as its uses go. It is only after that question has been settled that manufacture can be safely undertaken, because by manufacture we mean making in quantity. Therefore it is well to point out that Design has two sharply defined sides—design for technical excellence of use, and subsequent scrutiny and possible modification of such design with a view to manufacture.

Having decided on the product and having accepted its general design for use, the series of operations which are embraced in the term production may be said to commence. These begin with:—

1. Organization of a drafting-room force capable of undertaking design for manufacture, i.e., modifying the design of parts or components so as to bring them into a form suitable for the most economical manufacture.

2. Analysis of the machine or product into components or parts suitable for manufacture, by means of:—
3. Division of Effort. Having divided the product into units of simplest form and construction, the machine processes, skills, and trades which are the units of Operation must be mentally applied to each piece. If necessary the design of components must be varied to enable these units of operation to be applied successfully and directly. Successful design for manufacture depends on units of design corresponding exactly with units of operation.

4. Co-ordination of Effort. Having set up units of Design they must be carefully scrutinized to see that they will ultimately meet together exactly without “gap or overlap”. In mechanical work this means careful attention to “fits, limits and tolerances”. In some industries it implies correct specification of “allowances or margins”.

Want of co-ordination is a very expensive kind of inaccuracy. Having once divided effort, it becomes necessary to foresee how the separate products of such divided effort come together again, to form a whole.

In practice a “fit” may be all the way from an affair which requires the parts to be hacked, filed, anathemized and forced into place, to a simple bringing together of two components, and a slight tap with a mallet.
A great deal of money is lost by lack of clear thinking beforehand as to the co-ordination of parts, otherwise of "fits."

The nature of the fit—that is, the accuracy of dimension to be imparted to the component—is, from the point of view of efficient manufacturing, nearly as important as the shape of the part. Either unnecessary accuracy or not enough runs woefully away with profits.

It will be evident that this is a source of confusion and loss that lies with the designer to obviate, and with no one else. The use of standard tables of clearances and tolerances will materially assist; but a lively sense of the loss that will be sustained by want of precision in indicating just what is necessary, and no more, will be still more useful. This can be brought about only by bringing such losses as they occur to the culprit's attention, and so forming a good tradition in the drafting room, namely, that the question of fits is, economically speaking, one of the most important questions that the draftsman has to solve.

5. Conservation of Effort. Units of design (that is, of product) must be capable of being made by the simplest operative skill. This implies, very often, the additional design of accessories, jigs, tools, etc., so that simple skill can be applied with automatic precision. Standardization, or the principle of "fewest things", also arises from the necessity to conserve effort in regard to design. Parts, tools, and small accessories
should not be multiplied unnecessarily. Unnecessary accuracy or unnecessary finish should be eliminated by specification of the correct degree of finish to be given to the part.

Assuming that we have scrutinized our design, so that we are certain that there is no avoidable duplication of components or of elements, and that every item is in its ultimate simplest form, we wish to take means to preserve that simplicity in the future, and to prevent useless and harmful complexity creeping in, as it is sure to do unless we take energetic means to keep it out.

These means will vary in form according to the size and nature of the plant. Where the product is very simple, its components are few, and changes are made at infrequent intervals, very little more than a reasonable alertness, a good memory, and accurate observation on the part of the designer will serve to keep things from growing in complexity. But few plants are in this Arcadian condition. For the most part we shall have to rely on carefully made records, and not on anyone's memory, and these records when made will have several uses to be dealt with later.

Such records will take the form of a catalogue of components or parts of jigs and tools associated with them, and of auxiliary tools, such as drills, boring bars, taps, reamers, cutters, and so forth. A clear statement of the range and capacity of each machine should also be made.

It will be the duty of the designer to prevent accessions to this catalogue except when it is unavoidable.
It is no great task for each designer to familiarize himself with this "Book of the Plant". It should be his vade mecum and be with his thoughts at all times, both asleep and awake. If he trains himself to think in terms of it, a very large portion of the worries, complications, confusions, and errors that occur daily in every plant would be obviated.

There is a difference between rigidity of organization and definiteness of plan. This "Book of the Plant" is a case of the latter and not of the former. It prevents nothing, it insists on nothing, it stands in the way of nothing—the moment that it ceases to be up-to-date. We look on its extension with cold favor and a wary eye, but when it is necessary, it is the simplest thing in the world to do it. It is no obstructionist "system" that cannot be modified instantly necessity calls.

This is a case of applying experience to form standards. Our experience, in a new plant, begins with the determining of certain necessary elements. We record these elements as a coherent, related body of facts, once for all. As we gather more experience we add to the record. Later we may decide to eliminate part of our recorded experience from current practice, but our "Book of the Plant" always represents the conditions of the day—conditions that by this means have been kept at the zero-point of avoidable complexity.

In connection with the components of the product the question of naming or indicating them is sure to crop up. The modern tendency seems to be towards an alarming complexity of symbolization. Mixtures of letters and figures ten units long are not uncommon, and certain types of mind seem to glory in them. If it is a question of using long combinations, then there is little doubt that an
abbreviated name is better. Many persons of quite good mental equipment cannot remember figures, and consequently run great risk of setting them down incorrectly. The ordinary workman is usually less liable to err with names than with figures. As businesses of considerable complexity, with very advanced methods, have not found it desirable to replace names by symbols, it would seem that it is to be avoided wherever possible.

Symbolizing is sometimes supposed to aid in systematic arrangement of stores, but as arrangement of stores is a physical affair, it is difficult to see why it cannot be arranged by names just as easily. Of course a certain amount of symbolizing is almost obvious, such as describing the different shops by letters or numbers, machines or processes by code letters, such as P for planing, etc.; but this is a different thing from such examples as "Lq34967- XPG," which is the fashionable variety of the art. Such shorthand may be very compact, but it is dangerous, tends to tie things up in "system", and its only excuse must be a very clear advantage, which so far is not clearly proven.

Nevertheless, whatever symbols are adopted, should be made common knowledge, and incorporated in the "Book of the Plant" so that there is no ambiguity in their use.

6. Material. Design specifies the nature and sometimes the properties of material to be used. It may specify the chemical composition and certain physical properties, such as hardness, elasticity, etc. It will be observed that is quite apart from the specifications of design already mentioned, all of
which deal with changes to be wrought on the status of material by the processes of operation.

Material and the work performed on it make up the whole story of production, for it must not be overlooked that all the functions (and these latter embrace every kind of mental and manual work in the plant) exist only for the purpose of making changes in the status of material in accordance with the behests of Design. Some of these activities, as the power-plant or the cost office, contribute only indirectly to the result, but they exist only for the sake of that result.

7. Specification of Details of Operation. The above proceedings, if properly carried out, have given rise to a design of a unit of product complete in all respects as to its physical and chemical composition (if our work is so particular as to require this refinement) but in any case complete as regards the physical shape of the part itself, with all its dimensions prescribed, and sometimes with a list of particular tools and accessories which should be used in the various processes to be employed in its manufacture. We have now to complete this design by further specifications which relate not to its physical appearance but to the details of the way it should be manufactured.
It will be remembered that it was laid down as a guiding principle that the work of the designer of components should be intimately connected with an exhaustive knowledge of operation units and the way that they can be applied to perform work. Hence it follows that in a properly designed component there will be a way of making it more natural than any other, namely, that method which was present to the mind of the designer when he was working out the design. Under such circumstances, to specify the method of manufacture is as natural as to specify dimensions, or accessory tools. But as this information applies only to the one individual piece, it is evident, merely a completion of the full act of design of that piece.

8. Organization of a Production-Department force as part of the general function of Design, capable of analyzing design units into details of operation, and of making time, and if desired, motion study of such details, with a view to complete the whole chain of specifications relating to the production of each component.

As will be referred to in more detail under the heading of "organizing the function of operation," a good deal of the time study necessary (where it is necessary) on individual components in the machine industry arises from the fact, firstly, that machine tools have a very wide range of duty compared with most industrial machines, and secondly, that very little systematic experience has been accumulated about their performances. Consequently there
are few recognized standards of a general nature available. This involves separate study of operation detail for each component for which it is desired to specify time allowances accurately.

Applying the Second Law of Effort to the Operation Units on each component is the work of such a department. It first analyzes the operation into two groups, viz.,—steps necessary to prepare the material and the machine, and steps necessary to apply the machine process, trade, or skill to the work.

9. Division of Effort. Each step in preparation and in operation is considered separately, and a time study made of it.

10. Co-ordination of Effort. The various steps are scrutinized for "gap and overlap". Each step should carry the work a definite stage forward, so that the whole process is a series of independent steps in natural sequence.

11. Conservation of Effort. This involves a study of method. Alternative methods of handling work may exist; consequently when the importance of the job demands it, a further analysis is made, namely, of movements. This is commonly known as motion study.

After such an analysis has been made the shortest possible way of handling the work should be known, or, in other words, the way to do the job with the
least expenditure of effort is disclosed. When necessary this information is incorporated with the specifications of Design, and becomes part of the working instructions for production of that part or component.

12. At this point the whole production history of the component has been embodied in instructions, which may be regarded as Standards for the production of that piece. These will hold good until modified by experience in some particular. Thus, the chain of Design begins with the initial analysis of the machine or other product into components or parts. It ends when all that can be specified in advance about each component has been so specified.

It should be noted that the specifications of form, dimension and material are much more rigid than those of the detail of operation to be applied. The former must be observed exactly, since to depart from them would be to produce something else than what was intended. The latter, however, are merely indicative of what has been considered to be the best way of carrying out processes to comply with the rigid specification of form and dimension. But, if the exigencies of the shop demand, this specification of detail of operation may be departed from without endangering the production of the right kind of component. There will probably be a loss of another kind, namely, waste of effort. If the shortest and best way has been specified, then to
make the component by another way means a loss of efficiency as regards the best use of labor and machinery. But in some cases this may not matter, the loss may be counterbalanced by gain in another direction, as in "rushing" a job through, or making use of an idle machine whose use was not contemplated in the specification.

13. We have now to consider the Function of Design as a whole. We have observed each step in its work; now we have to consider it as a function—that is, as a synthesis of individuals engaged on a common effort. At the outset we saw that application of the First Law of Effort was implied in acceptance of the initial designs. Now we have to note the application of that Law to the current work of the function. We began with certain accumulated experience, which formed our standards of departure, but it is also necessary to keep these standards up to date. To do this we must continually accumulate new experience, standardize it, and apply it, as the First Law of Effort dictates.

This demands a little organization. The work of the function of Design is very various, and also very important. There are many kinds of standards involved, and each of these requires watching and when neces-
sary rectifying in accordance with experience. Without attempting to enumerate all of them, we may call attention to some of the more salient.

The object of the function being design for manufacture, it will be obvious that many problems will come up which will be more or less similar to problems already attacked and settled. Parts of similar shape, or having some similar peculiarity, when once they have been satisfactorily designed, form precedents, or as we may call them, standards, for all similar work. Therefore one of the wants of the Function will be a method of indexing and cross-indexing drawings and working instructions so that similar jobs may be quickly gathered for comparison and study.

This may sometimes give rise to a revision of the older methods of doing work. In studying over former jobs in the light of a new problem, new and better methods of doing work may be discovered. In such cases some method of noting a reference on the old specifications should be provided, so that when the work comes up for production again, the standard may be improved.

14. The same remarks apply to specification of details of operation, perhaps to an even greater extent. A good system of
classifying processes should give rise to a very complete mastery over the details of the sphere of action of every machine in the plant. In particular, preparation time should be studied in this way, so that an average of all common jobs for a given machine can be fixed. This, in its way, forms a standard preparation time for each machine, and jobs which exceed this standard average are evidently weak as regards holding fixtures or other details.

It has been pointed out elsewhere that most of the detailed study of operation necessary in machine-shop work arises from the fact that machine-tools are much more universal in their range than most others. In many industries, a machine will do only one thing and will do it in only one way. In other cases a change of work involves merely a simple alteration of the machine or the addition of some accessory, thus reducing “preparation time” to an almost or quite negligible quantity. But in machine-tool operations, the limits within which a machine acts, and the variety of work it will do, are not only large but indefinite. Hence the necessity for careful study of the individual job in all machine-tool operation.

15. Attention has already been drawn to the necessity for standardizing the product itself; that is, cataloguing the various parts which are common to different sizes, so that
unnecessary design is prevented. Similarly tools used for dimensioning, such as drills, taps, reamers, cutters, etc., should be catalogued, and a rule established that no dimension shall be specified, except under unavoidable circumstances, that requires special tools not thus registered in the "book of the plant". The same remarks apply to common small parts, such as levers, hand-wheels, nuts and bolts, and so forth. All these should be catalogued and not departed from in specification unless some imperative reason exists.

The object of this is, of course, to conserve effort. Though it may not take longer to sketch an odd size of some accessory than it would take to look up the standard size in the "Book of the Plant," it must not be forgotten that Design is the function that originates activity in the other functions. Consequently acts of design that are unnecessary lead to a whole chain of consequences that mean unnecessary effort and therefore unnecessary expense. To make a thing instead of taking it out of stock means that drawings, perhaps time studies, specifications of material, purchasing, receiving, storing and handling materials, issue of orders, job-cards and instructions, occupation of time of machines, attention of foremen, inspection, records of material, labor and expense—are all set in motion to save a few-minutes time of a draftsman. The importance of limiting the act of design to necessary things is therefore fairly obvious.
These are some of the more important directions in which the function of Design makes use of standards. In providing mechanism for making these standards available for constant reference and study we are applying practically the First Law of Effort. We are accumulating experience, using it to rectify standards, and thus applying them to our current and future work.

16. The Remuneration of Effort. It has usually been found difficult to apply the principle of special reward to the function of Design, since efficiency depends here far more on quality than on quantity. Creative work is subject to no law, and cannot be constrained or forced into grooves. In strictly routine work premiums for the avoidance of errors may be adopted. Rewards can also be offered for improvements leading to better technical efficiency of product, or to greater ease and economy in manufacture; usually however the scale of remuneration is calculated so as to take care of such events. Few examples of special reward in regard to the Function of Design are on record.

17. Application of the Third Law of Effort. As was explained in Chapter XII, the law that "personal effectiveness must be promoted" deals with individuals as such, and not with their functional activities. We
cannot therefore enter into a discussion of its application to any of the functions, since it does not apply uniformly throughout. Very considerable analysis would be necessary to show how, for example, "physical conditions and environment" should be set up. These would require not one but several standards, each relating to a small group of men. In the matter of quiet, the working out of a new design requires different conditions from the motion study of the work on that design. And so throughout.

Conclusion

We have now covered very briefly and cursorily the organization of the function of Design. Design sets in motion the most important activities of the plant. The more definitely we realize this, the greater will be our appreciation that this is the function of all others in which the exercise of forethought is desirable, so that nothing shall be done, and no activity be set in motion, that is not economically necessary. If we neglect to prescribe, with the requisite precision, such a matter as the co-ordination of parts or components—that is, of limits, fits, and toler-
ances—we leave the door open to subsequent waste of effort. And this waste is sure to occur. In like manner, unless we lay ourselves out to accumulate experience systematically, so as to form standards of practice, we shall fail to advance as much as we might; while if we do so, we shall generally be a little wiser today than we were yesterday as regards the proper method of designing our product.

**TABLE XIV. PRINCIPAL APPLICATIONS OF ANALYSIS IN REGARD TO DESIGN.**

1. Analysis of the machine or other product into unit parts or components.

2. Analysis of each part into process units corresponding with operation units (e.g., planing, drilling, etc.).

3. Analysis of each process unit into two varieties of work, namely, preparation or setting, and operation.

4. Analysis of each of these varieties into its elements, namely, the several steps necessary to do the work.

5. Time study of each of these separate steps. The aggregate of time required for all the steps of preparation becomes a standard time. Similarly with time required for all the steps of operation.
6. Motion study of preparation and operation steps may be desirable, when the frequent repetition of the same work makes it remunerative.

7. In connection with (2) above, it may be found necessary to specify the use of certain tools, jigs, etc. These may, in some cases, require designing and constructing. Then their use requires analysis and study in the same manner as components.

Note.—Analysis of the method of operating machines, apart from individual items of product, is a part of Operation, \( g \ v. \)