Managers, Breakthrough and Control

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In centuries past there were long, static Innercitadel of Control punctuated by violent revolutions or invasions of Breakthrough. With quickening technology, Breakthrough is ever more frequent, and life on one level ever shorter. The pace of change is quickening, and there is properly much uneasiness about man's ability to keep up with the pace. We will examine the Great Issues posed by the endless stair steps of Breakthrough and Control. Where do they lead? What is the effect on the people involved? What are the deeper meanings for the manager? Some of these Great Issues will bear an obvious, direct relation to this month's bread and butter. Others will seem remote and philosophical.

Introduction

The stakes wagered on ability to Breakthrough are unprecedented. National security, domination of the earth, evenal security, domination of the earth, even human survival are among the stakes.

Nor are the big stakes stakes limited to Breakthrough. We might well conclude that humanity is just in the beginning stages of Control as a massive human effort. The human race has increasingly put itself at the mercy the good behavior of products, processes, structures, political organizations, all designed, built, and maintained under human direction. Increasingly, we live behind an extensive system of protective dikes in the form of Controls on these man-made devices. Now and then we rediscover the importance of control of thesj dikes:

A greedy financier outwits various auditors and makes off with huge sums of other people's money.

A battery of tests fails to detect a monstrous defect in a drug. Thousands of infants are doomed to lead crippqed lives.

A mad political organization gains command of an industrialized nation. Contumded of civilization collapse before the barbarian, and millions of lives are lost.

These gigantic shapes moving around in the background may not attract the attention of a manager wrestling with this year's problem. But the same yeast which is making these shapes move has brought the manager's problem. And the implications for the manager are the same for humanity:

The pace of change is quickening. The penalties for failure are rising, as to both failure to Breakthrough and failure to Control. In consequence: The energy which is devoted to Breakthrough and Control mut rise in greater proprtion than the energy required for operation.

To direct this energy requires greater sophistication in the use of Breakthrough and Control.

We see numerous evidences of the growth of these consequences. Expenditures for renearch and development are record proportions of the budget. Machinery, in both the office and factory, is changing remarkably--for some, their brains are costing more than their bodies. The organization charts exhibit new department names which include the word research, planning, contirol.

Control and Freedom

No seminar on Control is complete until someone has raised the question:

Aren't controls an infringement on the freedom of the individual?

Control, staying on course, certainly requires that we restrain and govern men. So control does limit freedom unless the individual has consented to it, freely. This exercise of free consent, being itself an act of freedom, converts the restraint into a self -imposed restraint. So we must look at "consent".

The revolutionists of Western society established the principle that government be the consent of the governed.

This principle is no longer limited to political; control; it has been extended to industrial as well. Where, then,do we find in industry a basis for consent of the governed?

First, let us reject the notion that men do not want to be governed. Freedom is simply opposed to

tyranny; freedom is in the middle of a spectrum, with tyranny at one end and anarchy at the other.

In broad terms, know very well the bases on which men consent to be governed. The consent has been based on a reward, or a cause, or a leader. Men have died in battle, for example, as mercenaries, as patriots, or as hero worshippers.

In industrial histoy the consent was at the outset based on a money reward. The employment bargain was struck, and the em-ployee consented.

In those days power system was was stronlgly allied against the industrdal employee. employee. The goverment, which was not based on the consent of the governed, was in league with the owners.

Quite aside from this, the economic power of owner was simply immense. In those days,the incomes of many people were belw subsintence level. Holding this very job was often literally a matter of life and death.

So the owner was able to secure compliance wdthaut getting much involved in discussions about freedom and dignity of the individual. The available evidence suggests that the owners did not concern themselves too much with developing other bases for industrial government--loyalty to a cause and devotion to a leader. Presumably there was no need for it.

Meanwhile, history has marched on, and some big changes have taken place.

The political revolutions made governments more responsive of the views of the citizenry and thereby, of employees.

The neglected opportunities for securing consent of the governed (via a cause or a leader) were seized on others--the intellectual, the union organizer, the poritician.

The balance of power, previously tilted toward the employer, was turned through the force of collective agreements. These agreements were backed up by the force of governments, now alien, if not hostile, to the employer.

The standard of living rose to a degree such that most employees were well above the subsistence level. For thene employees, holding this very job was no longer a matter of life or death.

This same rise in the standard of living solved the problme of stark survival, and removed it from the agenda. In consequence survival and removed it from the agenda. In consequence, the unsolved problems all moved up a notch. These unsolved problems include the need for belonging, for status, for "self-fulfillment" (These problems ars not solved merely by money; they require that the employee become a team meber, have a team cause to support, have the opportunity to respond to leadership.).

Finally, the growth of industry, in size and complexity, has increased the requirement for team action. Increasingly, we must rediscover what is the effect on the common good before we decide what individuals should be doing.

(This may seem to be a long sojourn into history. However, much has happened, and these happenings have greatly influenced the freedom and consent problem. The answers to our question:"Aren't controls an infringement on the freedom of the individual?" have varied with the decade in which men live in The Human Side of Enterprise, The Management Review, November, 1957. The answers for the 1960s must be based on current conditions, not on ancient conditions, or on wishful conditions.)

Evidently, we must separate "freedom" into some components.

The biggest single on industrial freedom is the act of becoming employed. The consent for this is still based on contract.

Once employment is under, the timeless needs of human beings work their way to the surface, look for leaderrhip, and begin to press. The manager cannot ignore these needs--they just press on until he is forced to confront them .

Theory X and theory Y. An important fork in the road is the manager's premise on human motivation. He may subscribe to either of two theories to explain the outward evidences of employees' indifference to work:

(X) Human beings are inherently lazy, so the manager's job is to fight this deplorable human nature through skillful use of the carrot and the stick.

(Y) Human beings are inherently willing to work, but industry gives them unchallenging, meangless task. So the manager's job is to redesign work in a way which harneses these unused capacities of people.

Under both theories the manager sets up standards and measures of performance. Under theory X, review of results emphasizes: informational control systems; formal reports; extensive use of staff personnel; rigid reward and penalty schemes. Under theory Y, review of results emphasizes: self-control; personal supervision; informal repotes, informality generally.

Companies live and presumably flourish under each of these theories. No one can say which is "better" without becoming enmeshed in endless argument. But in terms of "freedom," the contrasts are clear. Clompanies operating under theory X are definitely autocratic in nature. Goals, plans , controls are imposed from the top. The extent of restraints produces a reaction not only from the rank and fire; the reaction comes from middle management as well. The reasoning which causes top managent to adopt theory X causes restraints to be applied throughout.

An example of case for theory Y is seen in "bottom-up" management as described by the American Brake Shoe Company. The concept is stated by some of the key phrases: teaching rather than telling; freedom to fail; decentralized initative.

It is easy to become emotional when human freedom seems to be the issue. Some of advocates of industrial democracy have indeed become emotional about it. It is also easy to lose sight of the objective during the argument. The objective is to carry out the mission of the enterprise--to provide goods and services at costs and prices which will yield enough. surplus to take care of all claimants. The choice of theory X or Y should be on the grounds of which will help us best carry out tce mission of the enterprise.

Let us now return to the "cause" and the "leader" as bases for consent to restraints. These bases are interrelated; the company's operations are a team effort, and a team requires both a cause and a leader.

The teamwork argument is so compelling that one woders why we have not made better use of it. The team member is there in a dual role:

his role as an individval. Here he was duties and rdghts arising from (a) the employment contrac, (b) his membership in the human race, (c) his status as a citizen.

His role as team member of the car pool, the Union, the lathe shop, the softball team, the executive dining table. Here he has duties and rights arising from having accepted membership on the team.

The dual role is the crux of it. It is in his role as an individual that he has the protection of the "consent of the governed" When he assumes a team-mate role he consents to restraints on his role as individual to avoid damaging the team,on which he also plays a role. The restraint is part of the price of admission to the team.

Such is the way it should work out, and sometimes does. Where it isn't working out, we should look for one of several usual villains:

(a) The individualst who cries "freedom" but doesn't want to give up his team role. He wants to belong, but is too individualintic to pay the price. In athletics, he should be playing games which are man-to-man contests. In industry he should be on jobs of low restraint content (researcher, professional specia-list). If he is an extreme individualist, he is out of place in a company. He should be a proprietor, professional man, cab driver, proferrnr, etc.

(b) The special pleader who agrees that controls are fine for the assembly line, the clerical force, the warehouse, i.e., the other fellow. But managing, selling, research, i.e., his job,is different. Take researcher's line of argument--"how can yon control creativity?" He is right in asking, but the quesion is not really in poiot. Research can fall because it is channeled into directions that lead to no market; because it duplicates what other petple are doing because is no provision for taking projects from rescarch to production; because it is costing more than it will yield even if successful; because the creative activity is not backed up adequately by the non-creative services of the laboratory; because morale among the researchers is so low that strife and frustration are draining off the creative energies. The real purpose of controls should be the liberation of the creative energies, and the chan-neling of these energies into fruitful pursuits.

(c) The manager who points to accomplishments of individuals as evidence of the futility of team operation. "It looks like it's been designed by a committee. " His conclusions may be in line been designed by a committee." His conclusions may be in line with his experience. Is his company, the climate for team activity may still be so adverse that team roles are so much added baggage. He is correct as to his company, but he is mistaken when he generalizes his experience to cover industry as a whole.

(d) The manager who cries "loyalty" and "good of the company," but who, because of autocratic beliefs, benies to individuals any role as a team member. This manager becomes terribly frustrated, as do the men around him. He is in a deep self-contradiction. He doesn't have a team; he only a collection of individuals.They feel they have only one role--that of individuals.The do not respond to the "common good"because they have not been made feel a part of it. Their advice is not sought. Their ideas are not considered. In numerous other ways, they are individuals carrying out orders; they have no other role.

Finally, we return to the question asked in all those seminars: "Aren't controls an infringement on the freedom of the individual?"

Indeed they are, the individual starts it by bartering quite a chunk of his freedom for a job. He barters another chunk to belong to team.

If the manager responds by living up to his end of the bargain, there are no hard feelings--everyone has gained. If the manager fails, the loss of freedom becomes conspicuous, and the trouble begins.

Organizing

The Great Issues in organizing include the following: control over widely divergent activities
one-man responsibility for both Breakthrough and Control,

control in small company vs. large span of control.

Widely divergent activities. Putting Tiffany and Woolworth under one roof would be asping for trouble. Here we have a drastic difference in merchandise, sources of supply, quality stand-ards, packaging, pricing, complaint policy, credit policy. We also have a drastic difference in clientele, as to incomd class, buying habits, demands for service. Trying to meet these diver-buying habits, demands for service. Trying to meet these diver-sities with one store location, one decor one sfles force, one public image, etc., would nonsense, which would be obvious

to all.

Yet we have many such situations going on in industry, now. They are nonsense, but they continue on and on because the nonsense has not been dramatized and made obvious to people who can do something about it.

Using one pricing formula to misfit a wide variety of services can often be remedied by more precise cost accounting.

> A company mass-producing standard motore loses its shirt on small nrders for special motors. Reason: the same elaborate plans and procedures which are justfied for mass production are being applied to the small specialty orders.

In such cases (which are lesion) the heart of the problem is that we are asking the same person to think. Tiffony in the morning and Woolworth in the afternoon : to think Quick Service Lunch today, and Leisurely Continental Repast tomorrow; to think interchangeable mass production now, and handcrafted masterpieces next week.

We cannot, throubh cost accounting alone, solve the problem of split personalities. We may need to go deeper and split the operations, or the business itself. Tiffany and Woolworth must be housed separately, in different locations, with different decor, employing different sales forces, exuding diffent public images. As yet we cannot give a formula for how far to go when we have only different quality standards, or service standards,or design standards. But there are numerous situations in which we should go beyond just cost accounting.

Here, to solve the problems of Contrl, we must reorbanize the business!

One-man responsibilty for both Breakthrough and Control. Is it a basic contradition to make the same man responsible both for preventing change and for creating change? If it is wrong to put Tiffany and Woolworth under one, man isn't it just as wrong to put Breakthrough and Control under man?

The contradiction is not really as basic as it sounds. There is actually a common purponse--the health of the company. Control is necessary for the short-range health; Breakthrough for the long range. But the processes for achiving Breakthrough and Control are certaily widely different as we have seen.

Our present concept of responsibility males one chief executive responsible for the health of the conpany, whether short-range or long-range. So long as we retain this concept, there is no escape, at the top of the company, from one-man responsibility for both Breakthrough and Control. Below the top, we have flexibility in dividing up the responsibilies.

Our Great Issue here is whether we should move in the direction of:

(a) Perfecting our means for organizing wnrk so we do not put the same man in the position of dual responsibility for such diverse processes as Breakthrough and Control,or

(b) Conducting our superisory and executive development in ways which enable us to widen the assignment of such dual responsibility.

The division-of-work argument is based on the reality that many men who now have the dual responsibilites do not in fact carry them out. They do what is urgent, or what they like best, etc. "Hence" the solution is to "organize around" these men, i.e., organize in a way which neutalizes the weaknesses of the men.

The develop-the-man argument is that the tempo of change is upon us, and will not leave us. Hence our managers must learn to make use of change as well as to defend against it.

It is infnrmative here to look back at an earlier problem in massive change.

> The question came to a head: "Are personnel relations to be a line or a staff responsibility?" The decision adopted was "It's a line responsibility." But to make the decision effective required an immense amount of supervisory training.

We should open up our super-visory and executive development programs to admit added training for dealing with both Breakthrough and Control. Whether such training would "tfke" broadly is not fully clear. But there are precedents which suggest that it is feasible, i.e., the Work Simplification training programs.

Such an approach through executive development would not preclude refining the organizational approaches. Experience shows that as men are given responsibility, they look for ways of improving the organization form to carry out that responsibility.

Span of control

How may subordinates can a boss supervise effectively? This intensely practical question has long puzzled managers and has intrigued scholars.

Graicunas, a French management consultant, turned a new fascinating light on this topic. Instead of just counting the number of subordinates supervised by a boss, Graicunas counted the number of relationships.

For example, the boss has one subordinate. This gives the boss one direct relationship to supervise.

When there are two subordinates, the number of relationships does not merely double. The boss not only supervisen A and B separately. Sometimes he supervises AB together. So there are three direct relationships,the boss to A, and to B, and to AB.

For three subordinates, the direct relationships rise to seven; i.e., A, B, C, AB, BC, AC, ABC.

As the number of subordinates rises (by simple

arithmetic) the number of relationships climbs geometrically, as in Table 1.

TABLE 1. SPAN OF CONTROL.

Number of subordinates	Number of direct relationships
1	1
2	3
3	7
4	15
5	31
6	63
7	127
8	255
9	511
10	1,023
11	2,047
12	4,095

(This leaves out of account even gerater numbers of cross relationships, but we have enough to work on.)

Graicunas,the author of this ingenious approach, made no extravagant claims for its usefulness. But (as somoeties happens)some of his followers have exhibited undue enthusiasm. This over-enthusiasm has, in turn, brought equally vigorous to the effect that the problem of number of subordinates is one for solution through experience and judgment, and that it is ivory-tower theory to believe that mathematics can have any role in the solution.

This tempest in a teapot has brewed up periodically, the participants seemingly oblivious to the fact that people are supervised not merely through personal supervision; people are supervised mainly through impersonal supervision. Most of the 8—hour day of a man of industry is directed by the informal rules of past practice and precedent, and by the more formal rules of written routine, method, specification, manual, code, etc. Personal supervision is in the minority, and is used mainly in "new,different, exceptional" sitions. This fact has defeated those who would convert Graicunas's brilliant contribution into a math-ematical device for blindly solving organizational problems. Too little is known as yet about the quantitative ratio of personal vs. impersonal supervision.

Concept of a Control Function

We have seen that Contol takes at all levels of the Control pyramid. Most of it is at the scene of action, involves no separate information loop, and hence not become enmeshed in the farflung information network. However, what is left, which is still a lot of activity, does resemble an interwoven network. The character, size, and importance of this network have given rise to suggestions that Control is a "function" like Personne!, Research, or other major staff activity. You can guess the rest. advocates advance logical reasons for "tying this function together;" for giving one department the responsibility over the information network; for giving the function an appropriate place in the sun. The opponents advance logical reasons for not doing all this, and accue the advocates of empire building.

The sensible middle ground, as always, is found by dividing the subject into, pies and deciding piece. There is a need for coordination of the information system. But there are a dozen ways of meeting this need without giving one department command over all inaformation activities. Such noncommand coordination permits the best of both worlds--the function is recognized and coordinated, while operations remain decentralized and responsive to local needs.

A remaining unifcation problem comes up in top executive reporting. If we are to have a single repockage (or chartroom) who will preside over the package?

To date, this is still a contest in the ring. The Accountant once had a momnopoly on the package, since its contents were purely finfncial. But the contents have grown to a point that the nonfinancial tail is wagging the financial dog. Some Contrnllers have risen to the occasion, and have equipped themselves to handle the entire package. And there are still other attempts at solution.

The executive report package, while requiring a man in charge- is still no basis for overexteng the concept of a Control function. A fow companies have, on the grounds of a need for a single package the reins of entire information system to one man. It has usually been disastrous.

For the foreseeable future, coordination, not command, is the way of dealing with the Control.

The Role of Top Management

The chief executivy certainly needs a clear awareness of the motal nature of products, processes, and procedures, as well as some concept of their time and life cycle. He probably needs some claification of thinking about "improvement" so that Break-through improvemont is clearly distinguished from operational improvement.

As we have seen, "improvement" comes from a number of sources:

1. Eliminating causes of variance from standard. This causes performance to rise from substandard to standard. This activity is handled mainly by unaided operating management.

2. Increase in effectiveness through greater

diligence, making better use of existing facilities, know-how, etc. For example: selective increase of prices; change of vendor for better price; landing a few new accounts. These activities likewise are handled by the unaided operating management.

3. Establishment of a higher leve of effectiveness by Break-through of existing levels. Here operating management normally requires staff assistance.

The patterns of activities behind these results differ in important respects. These differences are so great that it is confusing to apply the single generic word "improvment" to describe them all. In fact, some of the existent terminology makes the distinctions as between 2 and 3. The former is commonly designated as an operating efficency improvement. The latter,less sommonly is designated a method improvement.

These distinctions are not just of academic interest to the linguint; they decide whether managers undestand each other on some matters of importance.

However a look at the details behind these summaries discloses that the improvements are all in the nature of operating improwements in the absence of Breakthrough. Nothing new is taking place. The company is standing still, despite what the figures say.

It is essential for companies to grasp these distinctions, and to coin the necessary words or phrases to enable the managers to communicate effectively. Here are some nominations:

Form of improvement	Propsed terminology
Elimnation of causes of adverse variance from standard	Ironing out variances
Greater effectiveness in the absence of Breakthrough	Operating improvement
Greatcer effectiveness as a result of Breakthrough	Breakthrough improve-ment

Next as to active particpation. The chief executive does need to become personally involved in urging major births--new markets, products acquisitions. He should also become personally involved in seeing to it that is doomed does not linger on.

There are men who, having gained the presidency, continue to devote themselves to their former tasks and interests.

The chief executive should be familiar with, and acquire skill in use of the levers of his office--setting the important goals, organizing to meet them, seeing that they are met.

We pass by a few matters which need attention but depend largely on the specrfic situation--centralization or decentralization; direct or informational control; much or little staff. Whether the chief executive personally gets much involved in these things also "depends."

But now we come to a fundamental, subsurface question which lurks behind quite a few exposed questions:

Shall we manage the business on the basis of theory X or theory Y?

The chief executive should personally get involved in this question. Whether we operate on theory X or theory Y affects:

whether we must use imposed plans and standards, or whether we can use a participative approach,

whether men feel they have only a personal sole to play, or both a personal role and a team role,

whether loyalties are mainly to local groups or mainly to company performance,

whether controls must be highly formalized, or can be highly informal.

Anything which affects such a formidable array of topics is itself a formidable topic. Moreover, the decision of whether to go down the road of theory X or theory necessarily a high-level decision. A middle manger who decided to take the other rould become too con-spicuous to be tolerated.

We happens to believe that theory X is unsound. So do rome other practitioners. But there are many practitioners, very likely the majority, who follow theory X. So does not press the point. What he does advocate is that:

the question of theory X vs. theory Y is vital,

so vital a question requires the direct participation of the chief executive,

the question should be faced as a major topic on the agenda, not just as incidental to some current question.

Finally, the chief ecutive should see that there is a periodic check on the control machinery itself. The financial audit is the old, obvious example of this. But with controls having spread over a wide variety of functions, the concept of audit must be expanded correspondingly.

Cross Fertilization

During diagnosis for Breakthrough the managers learn much about the operation which they never koew before. This new knowledge is then used, not only to aid is Breakthrough; the knowledge is later put to use in various steps of the Control cycle.

The converne is also true. Investgaion of causes of substandard performance can turn up information which becoms the basis for Breakthrough.

Frederick W. Taylor conducted many studies to standardize metal-cutting tools and processes. The heat-treating of tool steel was one aspect of this. As was widespread practice in those days, such detail was left to the smiths to handle, based on their experience.

Taylor's studies showed that there was great variation in the cutting capability of tool steel, even as to tools made from the same bar of steel. In collecting information to establish

standards for heat-treating temperature, he tried a temperature the smiths had previously avoided. Result--a doubling of the efficiency of tool steel, and a patent for the Taylor-White process of treating tool steel.

Taylor's accidental discovery came while he doing some studying on purpose. The frequency of similar accidents by other investigators is so high that the word "accident" begins to lose its meaning.

When one has gone through a series of such discoveries he is no longer surprised at the fact of discovery even though he could not, at the outset, predict just what form the disovery would take.

The End Points for Breakthrough and Control Do Breakthrough and Control ever end?

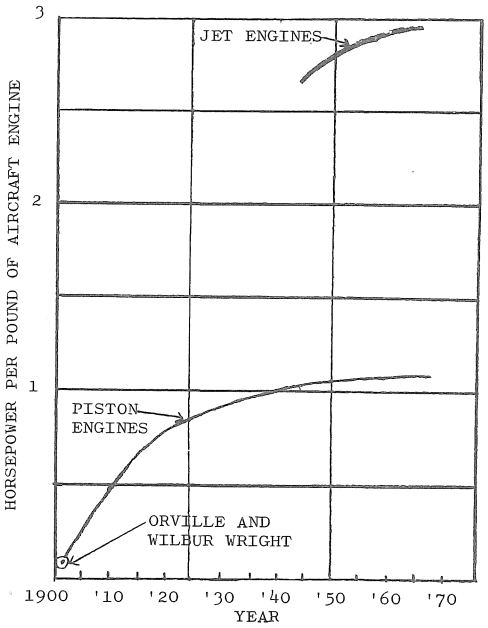

Fig. 1 Economics of Breakthrough.

There is no limit to Breakthrough unless there is a limit to human ingenuity.

In any one case, Breakthrough may not be worth it; will not pay for itself. The return on investment is too low. Such economic decisions sometimes evoke the comment "We've gone about as far as we can go." Actually, we might well brace ourselves for a flank attack from an unexpected quarter.

The aircraft piston engine started as a cumbersome thing. A critical ratio, the horse-power generated per pound of weight, was in the range of 0.20.

Then came technological breakthroughs, and the horse-power per pound of weight was increased again and again. As first the increases were large--from 0.20 to 0.35 in one jump. Then the increases were more modest--from 0.71 to 0.76. Finally, the increases were small (and hard to come by)--for 0.97 to 0.99. It was time to say We've gone about as far as we can go." The curve had flattened out (Fig. 1).

Then came the flank attack. Out of nowhere

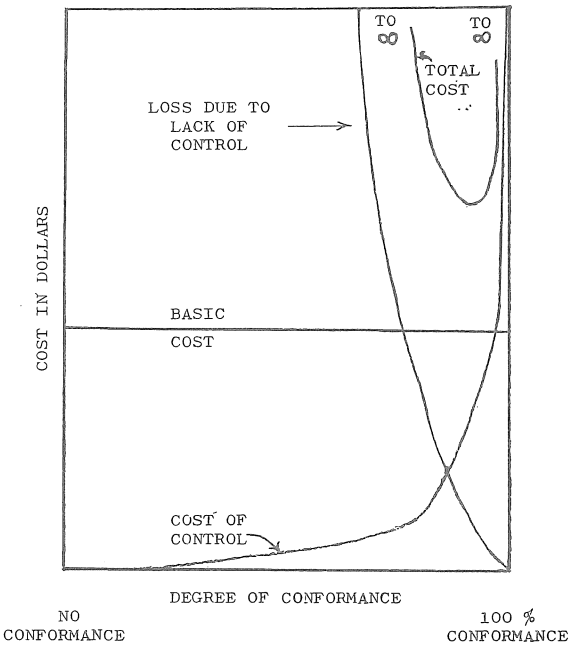

Fig. 2 Economics of control of conformance.

came the jet engine, which in one swoop raited the horsepower perpound from 1.0 to 2.7.

Is there an end to Control? In several respects, yes. We can end informational control by moving something down in the pyramid to personal control. We can end human control by automating the thing. We can end staff control by simplifying the control system and tumning it over to the ltcal opeators. We can minimize the need for control at all by desigsing more stability and reliability into our orhanizations, systems, and structures.

There is also the econmic limit--when does control pay for itself, and when do we run into perfectionism?

Control does pay for itself within most of the range of operations. Within this range the added controle cost money, but are more than paid for by reducing our losses (in bad debts,waste, poor delveries, or whatever). Beyond this range, the added controls are not paid for, and we start to lose. These losses become greater and greater as we approach perfection.

Figure 2 shows graphically the interrelation betwenn cost of control, and loss due to failure of conformance to standard, over the entire range of operations.

As we move to the right from no confor-

mance, the cost of control increases modestly, with great reductions in the losses due to failure of conformance. This continues, but at a reduced rate until we reach the optimum. This optimum goes by various names ("point of diminishing returns") which all mean the same thing--it doesn't pay to go further. If we do go further, not only are our added costs not recovered; the added costs can be astronomical. Perfection, in the theoretical sense, costs an infinite sum. The cure is weres the the disease.

There is nothing theoretical about the losses due to perfectionism. Numerous paper programs which "fall of their own weight" have been swept out of industry. (Some are not yet swept out.) The cardinal figures to look at are:

the ameunts still being lost because of failure of conformance

the amtunts being spdnt to keep the conformance at its present level

Research in Breakthrough and Control

We have learned to follow an accepted route in building a science. If we are to have a science, say of zoology, we:

1. Observe many animals in detail.
2. Classify our observations in varions plausible ways.
3. Analyze these classifications to discver possible o & er or relationships.
4. Formulate theories to explain the relationships.
5. Test the theories by further observation and experiment, which starts the cycle all over again.

By analogy, if we are to have a science management, we should:

1. Observe many management activities in detail.
2. Classify these obseryations in various logical ways.
3. Analyze these classifications to discover possible order.
4. Formulate theories to explain the relationships.
5. Test the theories by further observation and experment.

As with all theories, these can be tested and confirmed, modified or rejected, based on subsequent observations.

As it happens, we have in this case some potential help from other disciplines. Breakthrough and Control are found not only in management; they are found in engineering; in the behavioral sciences; and they are found, in great profusion, in biology. The presence of Breakthrough and Control in so many disciplines opens the way for broad interdisciplinary study. Som of this has already taken ploace, as witness the adoption of the word "cybernetics" as an interdisciplinary term in the field of Control.

Very likely we can learn the most from biology, as we discover where to look. Biology has its own dialect. It has Breakthroughs, which are called mutations—"a sudden, well-marked, transmissible variation in an organism, as distnguished from the gradual cumulative change over a long period." Biology has its controls, as, for instance, homeostasis--"the tendency of an organism to maintaintain a uniform and beneficial physiological stability within and between its parts; organic equilibrium."

We might here briely contrast the mechanisms of biological control with those of managerial control. It becomes imediately evident that they differ remarkably.

Biological control	Managerial control
Any sensor is single-purpose	Sensrs are commonly multi-purpose
Sensors never act; they only send inpulses, to one of several message centers	Sensors may either act or just transmit
Transmission lines are used exclusively either for sensory messages or for commands to effectors, never for both	Transmission lines often used to transmit either (a) sensory messages or (b) commands to effectors
Effectors are single-purpose	Effectors are multi-purpose

In making this comparinon we might well be mindful that managerial is by human design, whereas biological control is based on the Grand Design. Look at a single, geatly simplified example of the results of Grand Design:

There is something else to be gained from behavioral sciences--a scientific basis for participation, communication, incentives,and many other ingredients of human motivation. We can see this more clearly contrasting the scientific bases for engineering and management, respectively.

Engineering is (essentially) the use of the forces of nature for the benefit of man.

Management is (essentilly) the use of the forces of people for the benefit of man.

Management is (essentilly) the use of the forces of people for the benefit of man.

The forces of nature are discovered by the natural scientist--the mathematician, physicist, astronomer.

The forces of people are discovered by the behavioral scientist--the psychologist, sociologist, anthropologist.

The engineer, using knowledge discovered by the natural scientist,fashions the various tools of

engineering--thermodynamics, machine design.

The manager, using knoledge discovered by the behavioral schentist, fashions the various tools of managent--organization,motivation.

Both the engineer and the manager were in business before the shientint. As a result, much engineering and managing is done on practical, not scientific grounds. But it has been our experience that, when the scientists get around to do their discovering, some remarkable revisions in practice are in order.

It is in point here to return to the useful classification of management approaches or "schools" as made by Prof. Koontz:

management process,
empirical,
human behavior,
social system,
decition theory,
mathematical.

It is significant that many, many men now actively engaged in research in these and perhaps other directions. New tools and techniques are tumbling in profusion out of their research laboratories. A burgeoning literature has become so massive that managers are driven to the digests to keep up with it.

This movement toward research in management has some parallels to the growth of research in the physical and biological sciences. It was the Renaissane, probably the greatest Brealthrough in human history, which broke the bonds that for cesturies had enslaved men's minds. Suddenly the way was open for scientific inquiry, on an unprecedented scale. In ever-increasing numbers, swarms of investigators have deployed along the widening frontiers of science. The fruits of these researches are now so extensive that we accept as commonplace the continuing flood of discoveries. Yet each of these discoveries would have merited the term "miracle" a few centuries ago.

There is much evidence that empirical approaches to management were used in all ancient societies. In "The Prince," Machiavelli snapped some long-standing, rigid thought processes. The prior beliefs had been those of "ascribing all things to natural causes or to fortune." Circumstances, not men, had been the masters. Machiavelli's contribution was to set out priciples and methodology under which men could become the masters. The fact that his principles do not fit the twentieth century is beside the point. So is the fact that his applications were for political rather than industrial management. Machiavelli looked at management in the abstract, rather than as applied to his century or to his Florence. Like our savage in the cave, Machiavelli was trying to fing the law of 2 plus 3 equals 5, wcether we are talk-ing of rabbits, fish, children, or anything else.

The sciences do not advance on a broad front; they move more nearly in single file. Some sciences must permanently await prior discovery being made in others. Progress in physics must always lag behind mathematics, which provides the analytical tools vital to theoretical physics. In turn, chemistry lags behind physics; physiology behiind chemistry; and the behavioral scieces behind physiology. Management, which must derive its scientific base from the behavioral sciences, virtring up the rear of this long procession.

Whether at the rear or otherwise, management is in lockstep in this parade. Thereby management is inexorably being drawn into the same vortex of revolution which has already engulfed the vanguard of the awesome procession --astronomy, chemistry, and so on.

The furies of tehnological change wrought havoc among the empirical practitioners of these vanguard disciplines-- astrologers, alchemists, and so on. Presumably, a like fate awaits the empirical managers, in their turn. Yet, if science can accomplish for management what it has done in other disciplines, we might welcome the result despite the havoc. Man's mastery in the vanguard sciences has increased enormously as the result of the revolutions. We cold do with a good deal more mastery of the managerial process than we now possess.

As managers, we should like to be able to do wtth confidence many things we now do with apprehension. We wold like to be able to:

launch our Breakthroughts with confidence that the great majority will reach the goals we set.

Establish our Controls with confidence that they will tale off our backs the great bulk of our burden of fire fighting.

Design our organization of work so that the great majority of men will find, on the job itself, the challenges and satisfactions required by the human race.

Undoubtedly, our empircal ways have been moving us toward such goals, but no one is happy with the pace. Nor is the answer simply more laboratories and more investigators. The fact is that much of what the laboratories have already put out has not yet been assimilated and tried out by practicing managers. Between the two worlds of the researchers and the practicing managers there flows only a trickle of ideas and feedback. We ned quite connections.

The pattern of effort toward research in management has been changing rapidly. The

pioneering work in "Scentiaic Management" has been followed variouly, fist by practicing managers and later by the universities. In the last decade or two, much of the manpower, and perhaps most of the publications, have come from the universities. Here and there, industrial companies have gone at research in management, in an organized way buy the resulting pools of findings have not been piped managers generally. Institutions such as American Management Association and National Industrial Conference Board have increasingly been compiling and publing summaries of current industrial practice. These summaries are invaluable both to the practicing manager and to the researcher. New forms such as the American Foundation for Management Research, Inc.(founded by American Management Association), are emerging, and may become a force in establishing adequate connections between the world of research and the world of the practicing manager.

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