

DESIGNING FREEDOM

Massey Lectures, Thirteenth Series

by Stafford Beer
with sketches by the author

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THE DISREGARDED TOOLS OF MODERN MAN

II

If you were sitting under an apple tree, and suddenly an apple fell on your head, to what force would you ascribe the event? Is there an apple-throwing monkey in the tree? Certainly not: the force involved is called gravity. Because we understand this force to be quite general on the planet, we do not propose to experiment when asked what would happen if we dropped the glass of water we are holding, or what would happen to an aircraft whose engines suddenly stopped. We reckon we *know* what would happen.

And yet the concept of a force which affects everything on the planet, regardless of what that thing is, and affects it to the same extent (so that a pound of feathers behaves just like a pound of lead, for equal air resistance), is a very difficult concept indeed. How *can* there be a force which affects everything, that you cannot directly experience, that finds expression only in mathematical terms, and that (counter to all intuition) treats feathers and lead the same?

Come, come, you will say: this is to talk like an ignorant savage. Even a child can answer those questions; and besides you *can* experience the force of gravity directly, because it is this force that your body measures when it senses weight. To this I reply: do you think you would have answered thus if you had lived around the corner from Isaac Newton in the year 1687?

Our culture has had nearly 300 years to understand the problems of Newtonian physics. It has had more than half

a century to get its grip on relativity theory and the second law of thermodynamics, knowing that it is at any rate *possible* to make general statements about the physics of the universe. Not all of us, I dare say, would care to answer basic questions about these two, although one might have supposed that the culture would have imbibed them by now. The observed fact is that the culture takes a long, long time to learn. The observed fact also is that individuals are highly resistant to changing the picture of the world that their culture projects to them.

I am trying to display the problem that we face in thinking about institutions. The culture does not accept that it is possible to make general scientific statements about them. Therefore it is extremely difficult for individuals, however well intentioned, to admit that there are laws (let's call them) that govern institutional behaviour, regardless of the institution. People know that there is a science of physics; you will not be burnt at the stake for saying that the earth moves round the sun, or even be disbarred by physicists for proposing a theory in which it is mathematically convenient to display the earth as the centre of the universe after all. That is because people in general, and physicists in particular, can handle such propositions with ease. But people do *not* know that there is a science of effective organization, and you are likely to be disbarred by those who run institutions for proposing any *theory* at all. For what these people say is that their own institution is unique; and that therefore an apple-growing company bears no resemblance to a company manufacturing water glasses or to an airline flying aeroplanes.

The consequences are bizarre. Our institutions are failing because they are disobeying laws of effective organization which their administrators do not know about, to which indeed their cultural mind is closed, because they contend that there exists and can exist no science competent to discover those laws. Therefore they remain satisfied with a

bunch of organizational precepts which are equivalent to the precept in physics that base metal can be transmuted into gold by incantation—and with much the same effect. Therefore they also look at the tools which might well be used to make the institutions work properly in a completely wrong light. The main tools I have in mind are the electronic computer, telecommunications, and the techniques of cybernetics. . . .

Now, if we seriously want to think about the transmutation of elements in physics, we will recognize that we have atom-crackers, that they will be required, and that they must be mobilized. We shall not use the atom-crackers to crack walnuts, and go on with the incantations. But in running institutions we disregard our tools because we do not recognize what they really are. So we use computers to process data, as if data had a right to be processed, and as if processed data were necessarily digestible and nutritious to the institution, and carry on with the incantations like so many latter-day alchemists.

The invitation to face up to these realities is a necessary one if there is to be any real chance of perceiving the proper role of currently available tools. For it is not something scintillatingly clever that I am proposing, not a complicated new extension of mind-blowing techniques that are already beyond most people's understanding, not a "big brother" that will alienate us still further from the monstrous electronic machinery that by now seems to govern our lives.

I am proposing simply that society should use its tools to *redesign* its institutions, and to operate those institutions quite *differently*. You can imagine all the problems. But the first and gravest problem is in the mind, screwed down by all those cultural constraints. You will not need a lot of learning to understand what I am saying; what you will need is intellectual freedom. It is a free gift for all who have the courage to accept it. Remember: our culture teaches us not intellectual courage, but intellectual conformity.

Let's get down to work, and recall where we were. A social institution is not an entity, but a dynamic system. The measure we need to discuss it is the measure of variety. Variety is the number of possible states of the system, and that number grows daily, for every institution, because of an ever-increasing range of possibilities afforded by education, by technology, by communications, by prosperity, and by the way these possibilities interact to generate yet more variety. In order to regulate a system, we have to absorb its variety. If we fail in this, the system becomes unstable. Then, at the best, we cannot control it—as happened with the bobbing ball on our elaborated tennis trainer; at the worst, there is a catastrophic collapse—as happened with the wave.

So next to something new. What is it that controls variety? The answer is dead simple: variety. Variety absorbs variety, and nothing else can.

Examine first of all the truth of that statement. Consider for example all the customers who are inside a departmental store. From the store's point of view, this represents an awful lot of variety that has to be controlled. You will notice how I use the word "control". It isn't that these ladies and gentlemen have to be told what to do, and made to do it. It is that when one of them wants to buy something, the variety of the customer/store system goes up: a possible state has been made actual. The lady has chosen a pair of shoes, but she might have chosen a fruit cake. The store has to absorb this variety: there had better be someone on hand rather quickly to take the money, and wrap up the shoes. Moreover, there will also need to be someone on hand to do the same for the fruit cake.

But not for nothing is that store called departmental. There is a shoe salesman, and a cake salesman; that is what organizational structure is *for*—to carve up the total system variety into subsystems of more reasonably sized variety. The customer who is not clear what commodity, if any, will

meet her need, represents variety that cannot be trapped by this departmental arrangement; her variety will be left over, not absorbed, if the store is not careful—and we can see how this means that the situation is out of control. But if the store is careful, it will have an information bureau—which exists precisely to absorb this excess variety.

Let us return to the shoe purchaser; we observe that she is becoming angry. This is because she cannot get any attention. The shoe salesman is dealing with someone else, and four more people are waiting. The other shoe salesmen are similarly occupied. Temporarily, at any rate, the situation is out of control, because at this moment the store has miscalculated the number of shoe salesmen needed to absorb the variety generated by the customer. Well, maybe you remember the concept we need to describe this affair, and its name. The name is relaxation time. Variety is cropping up faster in this system than the system can absorb it, and this is bad from the customer's point of view. If it happens all the time, it will be bad from the store's point of view as well: the customer will desert the store, looking for somewhere with a shorter relaxation time. So the temporary instability of service in the store will become permanent, and—at that very moment—incipiently catastrophic. The trouble with our societary institutions, of course, is that the citizen has no alternative but to use them.

Only variety can absorb variety. It sounds ridiculous, but the perfect, undefeatable way to run this store is to attach a salesman to each customer on arrival. Then we could forget about those departments, where the shoe salesmen are run off their feet, while the girls in lingerie are manicuring their fingernails, and absorb the customers' variety as we go along. For, you see, not only do we need variety to absorb variety, but we need exactly *the same amount* of variety to do it. We were speaking just now of the law of gravity in physics: it is perhaps the dominant law of the physical universe.

What we have arrived at in the departmental store is the dominant law of societary systems, the Law of Requisite Variety—named Ashby's Law after its discoverer.

The example is ridiculous, because we cannot afford to supply requisite variety by this obvious expedient. We cannot give every departmental store customer a salesman, because we cannot afford it; but you may already have noticed that in very superior (and therefore very expensive) special-purpose stores, such as those selling automobiles or hand-made suits, this is exactly what happens. In fact you cannot shake the fellow off. Nor would you be able to shake off your personal policeman, if half the population were enrolled as detectives to spy on the other half. It is just because this is impracticable that we have crime. We cannot meet the demands of Ashby's Law. But we must come somewhere near it, somehow, or we are in for catastrophic collapse. How is this done?

When varieties are disbalanced, as they usually are, we structure our organizations to cope. Fundamentally there are two ways, and only two ways, of doing this. Remember: you cannot repeal the laws of nature, and Ashby's Law *will exert itself*. We met the first way in the last lecture. It is to reduce the variety generated by the system so that it matches the available supply of regulatory variety. You may recall the men we had sitting on the tall poles: this was their job. And I made a crack at the financial institutions for doing the same thing. I said they "shot the cat" that was generating variety by swinging the tennis ball. In other words, there is no way in which an insurance company can provide requisite variety for *you*—the unique human being: your variety must be attenuated, cut down so that your case fits a more general case. In theory, you can get the entirely personal quotation that corresponds to having your personal salesman or your personal policeman. Just try it (I have) and see what the insurance is going to cost. Now that is perfectly

reasonable, because the claim to be able to handle every citizen's variety is as ridiculous as I admitted my example to be.

One trouble with our institutions is that they do not admit that the only full solution would be ridiculous and that therefore it is not done. They should acknowledge, at least to themselves, that they are satisfying Ashby's Law by variety attenuation. And the reason they do not admit it is that it sounds bad in the ear of our culture. Our culture insists on the uniqueness of the individual, but our society cannot live up to that. This is no criticism, it is a scientific fact. Our culture also insists on the absolute freedom of the individual, but our society cannot live up to that either. That too is a scientific fact. Then look at the mess we get into by our pretences. Instead of understanding the situation, and using science to do the best possible job of variety attenuation under the guidance of the consumer and of the electorate, we spend vast sums of the nation's wealth—our wealth—on phoney claims. On the consumer side, we put on the advertising pressure to pretend that full account is taken of the customer's variety—which is impossible. On the electoral side, we lose the freedoms we have, when our variety is attenuated, because we are not asked how the attenuation should be done. No politician would dare to ask his electorate that question, because he is too busy standing for the inalienable rights which it is perfectly obvious we have not in any case got. Nor can we have them: let's look the facts in the face.

The second method of satisfying Ashby's Law is the one used by the departmental store. It would be madness to attenuate the customers' variety—by stocking only one kind and one size of shoe, for example, or by locking her in until she was served. The alternative is to amplify the variety of the regulatory part of the total system. You do not appoint a single salesman, but many, and you do this by departments; in each of them you try to calculate the statistical

relationship between salesmen and customers, so that the relaxation time is held steady. There are scientific ways of doing this, but they are not often used. The amplification of regulatory variety comes in where *one* salesman handles *many* customers *effectively*. In societal systems, this is the preferable way to proceed, because it helps to preserve individual freedom. We do not do it, for several reasons—but only one is real. The others are subservient to this. Think of the outstandingly spurious reason first.

This is the most obvious reason, the cost; and there are two things I want to say about that. First: the cost of a societal system is taken as its primary measure in our society, whereas the valid measure to use is variety. The cost is not what it claims to be, namely the money that must necessarily be spent to achieve certain aims. In fact, the cost is whatever is provided in the way of funds, and this total available sum operates to constrain what we shall do—within the framework we already have. If this framework is merely a joke played on us by history, so that its structure is outmoded and its relaxation time is too long, then the system will not work: period. The thing is unstable. We pour in money to head off catastrophic collapse. But that is a silly thing to do. Because the money will—naturally enough—be spent on buttressing the framework, feeding in expensive variety to stop the relaxation time growing longer still, and making the instability actually worse (think of all those poles on the tennis trainer).

Second: the constraint of cost is entirely relative to the aims of society. The aims of society are of course a set of variety attenuators. We cannot do everything we conceive as socially desirable, and our aims—our programs—cut down the proliferating variety of societal choice. In so doing, the attenuator allocates the revenue that the taxpayer will bear. Once again, our culture prefers us not to look on the matter this way round. There is a total plausible revenue: come, then, attenuate variety—choose between developing a verti-

cal take-off aircraft, fighting a small economic war with the United States for the ownership of Canadian industry, and doubling the price paid for bureaucracy by having everything done in two languages. . . .

In the deathly silence I seem to hear following *that* solecism, I also seem to hear a faint voice (it must be a madwoman) crying: "I would sooner have a twenty-four hour child care service." But that would cost money, and there is none remaining. Don't be ridiculous madam, it's my prerogative! The point is that our variety attenuators are built into the system. Freedom of choice has gone down this particular drain. So what about the antithetical variety amplifiers? If the spurious reason for not using them is cost, the real reason is that it would mean redesigning everything—so as to get rid of the built-in attenuators, and install instead the amplifiers that could really work to achieve requisite variety, viable relaxation time, and hence some sort of social stability.

I have already suggested a list of three basic tools that are available for variety amplification: the computer, teleprocessing, and the techniques of the science of effective organization, which is what I call cybernetics. Now I am saying that we don't really use them, whereas everyone can assuredly say: "Oh yes we do." The trouble is that we are using them *on the wrong side of the variety equation*. We use them without regard to the proliferation of variety within the system, thereby effectively increasing it, and not, as they should be used, to amplify regulative variety. As a result, we do not even like the wretched things.

If one of those unworkable institutions we were discussing buys a computer, what happens? It uses the thing, please note at enormous "cost", to do more elaborately exactly what was done before. And, as we know, that didn't work. One famous computer manufacturer ran an entire sales campaign for its new series of machines on the slogan that you needed simply to transfer the existing system whatever

it was, lock, stock, and barrel, to the new miracle machine.

Well, that sounded good to the financial director, who had learned the hard way that immense costs are involved (yes, those same costs again) in implementing new hardware in software terms, but had not learned that the machine to do miracles is not yet invented. The effect on the institution was inevitable: to make the existing instability more unstable. It's obvious really, once the concept of variety and the law of requisite variety are clear. The computer can generate untold variety; and all of this is pumped into a system originally designed to handle the output of a hundred quill pens. The institution's processes overflow, just as the crest of the wave overfills, and there is a catastrophic collapse. So what do we hear? On no account do we hear: "Sorry, we did not really understand the role of the computer, so we have spent a terrible lot of money to turn mere instability into catastrophe." What we hear is: "Sorry, but it's not our fault—the computer made a mistake."

Forgive my audacity, please, but I have been "in" computers right from the start. I can tell you flatly that they *do not* make mistakes. *People* make mistakes. People who program computers make mistakes; systems analysts who organize the programming make mistakes; but these men and women are professionals, and they soon clear up their mistakes. We need to look for the people hiding behind all this mess; the people who are responsible for the system itself being the way it is, the people who don't understand what the computer is really for, and the people who have turned computers into one of the biggest businesses of our age, regardless of the societary consequences. *These* are the people who make the mistakes, and they do not even know it. As to the ordinary citizen, he is in a fix—and this is why I wax so furious. It is bad enough that folk should be misled into blaming their undoubted troubles onto machines that cannot answer back while the real culprits go scot free. Where the wickedness lies—and wickedness is not too strong

a word—is that ordinary folk are led to think that the computer is an expensive and dangerous failure, a threat to their freedom and their individuality, whereas it is really their only hope.

There is no time left in this lecture to analyse the false roles of the other two variety amplifiers I mentioned—but we shall get to them later in the series. For the moment, you may find it tough enough to hear that just as the computer is used on the wrong side of the variety equation to make instability more unstable, and possibly catastrophic, so are telecommunications used to raise expectations but not to satisfy them, and so are the techniques of cybernetics used to make lousy plans more efficiently lousy.

But enough is enough. I expect that you would be more interested to hear what can be done about all this, than to hear more dreadful news. Then may I tell you that the next three lectures will consider constructive policies for handling variety. We shall start with the state itself. This is rather bold, but you will understand by now that I believe we are all captives of gigantic systems beyond our individual control, and we need to understand them. Because, as long as we have any semblance of democracy, they are not beyond our collective control. Next we shall turn to the only thing that matters: the individual. He and she—not to mention their son and their daughter—are enmeshed in all this machinery, and they have to get out. If science cannot join with politics and management to do that, I might as well be giving the Massey Lectures in that ominous year of 1984, instead of in the year of 1973. On that reckoning we have eleven years; and frankly that is about the limit. The third of these three next sessions will return to the central topic of the institution.

And so, before I come to my last point, I would ask you—if you do me the courtesy of staying with these talks—to think over a crucial question before we meet again. It is the central importance of the law of requisite variety. Please think it

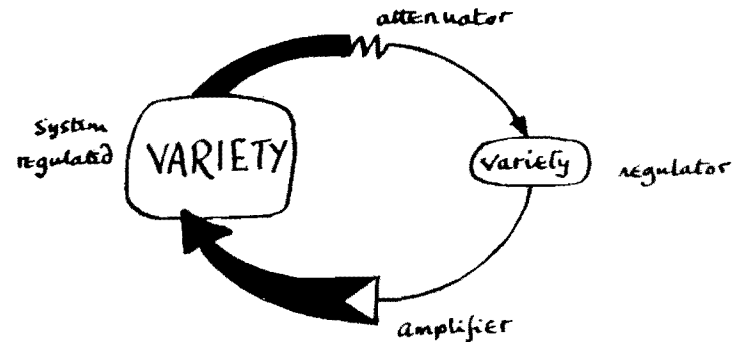
through. Think of any complex, dynamic system. How is it regulated? It will certainly be proliferating variety. Is it not true that only variety can absorb variety? How is it done? Do you not indeed find that in successful systems systemic variety is attenuated, while regulative variety is amplified? It is usually a mixture of the two. I promised you that this stuff is easy, once you break with the expositions and explanations dished out by the culture. The thinking I ask of you does not have to be done on some remote level of abstraction, or at the highest level of state affairs. Cybernetic laws are universal.

For instance, you might think over how these concepts of variety, relaxation time, stability, and potential catastrophe, work for and against you on the journey to work. You can do exactly the same exercise in the course of putting those high-variety young children to bed. Then think through how these concepts work in the big institutions of society that govern our lives. Ask yourselves how telecommunications—the telephone, television—affect those problems. Contemplate what you surely know about the role that computers play, and see if they are working on the right side of the variety equation. Finally, if it is all so easy, talk over the problem as to how we managed to get it all so wrong. Then maybe, you will see why I contend that there have to be some big changes, and that they have to come fast—before it is too late.

Then I come to the last point, which I hope will help in these deliberations. If the law of requisite variety is to be handled intelligently, and not just by leaving nature to find the variety balance (which of course can be nasty for us humans), then it follows that the regulative forces must not only dispose requisite variety—which is a number of possible states; they must also *know* the pattern by which variety in the system is deployed. On the journey to work we need to have enough options open; we also need to know the pattern of the highways—where they run, what the control points are

like, what other drivers habitually do. In the process of putting the children to bed we need several variety amplifiers at our command; but we also need to know (as we do, but let's make it explicit) the likely behaviour pattern of the children. Without these known patterns, proliferating variety looks even more threatening than it really is, which is bad enough.

What I have been calling a pattern is what a scientist calls a model. A model is not a load of mathematics, as some people think; nor is it some unrealizable ideal, as others believe. It is simply an account—expressed as you will—of the actual organization of a real system. Without a model of the system to be regulated, you cannot have a regulator. That's the point. And you can test that too.



Examination of institutional systems often reveals that the attenuators and the amplifiers have been installed in the wrong loops—on the wrong side of the equation.

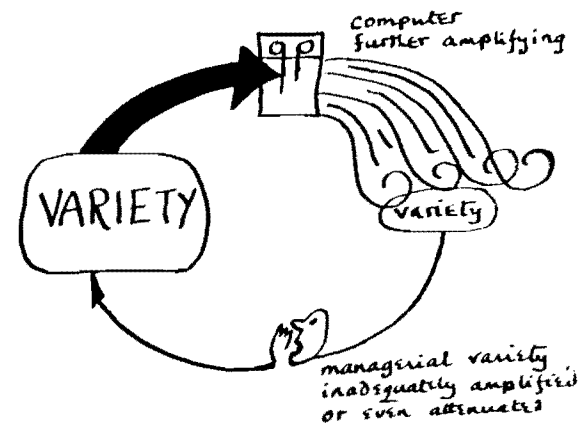
NOTES IN SUPPORT OF THE SECOND LECTURE

1687 was the year of the completion of Newton's *Philosophiæ Naturalis Principia Mathematica* containing the laws of force.

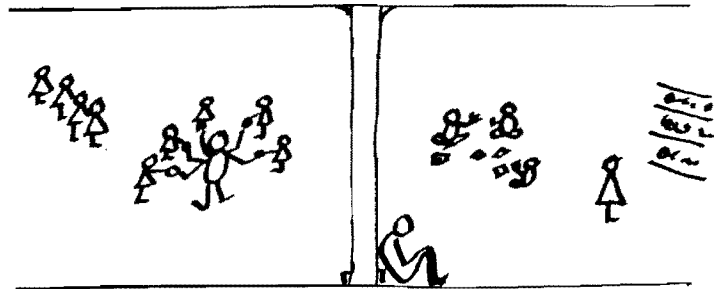
The Law of Requisite Variety (Ashby's Law)

only variety can absorb variety.

If varieties in a regulatory system are disbalanced, the system cannot attain stability. Assuming that the regulator has the smaller variety, there are only two ways of meeting the demand of Ashby's Law. One is to attenuate variety in the system, the other is to amplify variety in the regulator. These strategies can be mixed.

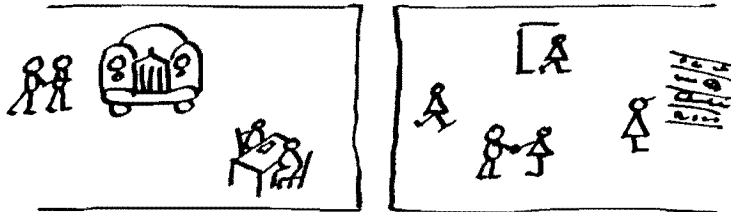


Ashby's Law Operating in a Departmental Store



Unstable: variety of store less than that of custom = inadequate service

Unstable: variety of store more than that of custom = unprofitability

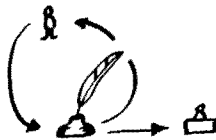


Stable: variety matched on a one-to-one basis

Stable: variety matched on a many-to-one times occupancy basis

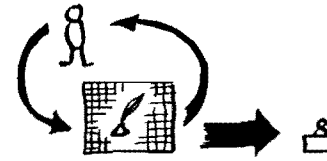
How the Abused Computer Replaced the Quill Pen

Year 1873



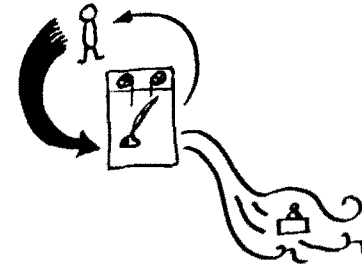
The public supplies minimal information to the institution and receives minimal information in return. The management receives minimal information too.

Year 1953



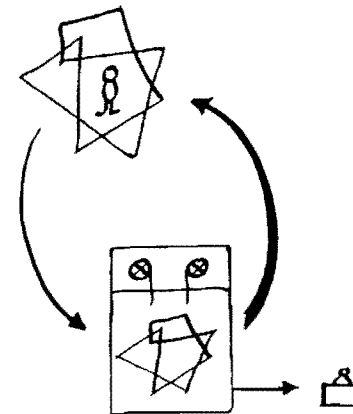
A larger public is asked for much more information, and receives much more in return. Quill pen administration continues, although the systems are mechanized. The management is threatened with an excess of information.

Year 1973



Inordinate demands for information are made on the public, which receives much less *useful* information than before. Quill pen administration continues, although the systems are computerized. The management is inundated with indigestible data.

How to Use the Computer According to Cybernetic Principles



The public is conceived as a system, a model of which is contained in the computer. The public supplies minimal information, which the computer then synthesizes in the model. This amplifies variety as required to help the public, and attenuates variety to help the manager—thereby meeting the requirement of the law of requisite variety for each of them.

There is an evident risk in installing a model of the public in the computer, since the return loop might be misused by a despotic government or an unscrupulous management. In considering this however we need to bear in mind the cybernetic fact that no regulator can actually *work* unless it contains a model of whatever is to be regulated. Much of our institutional failure is due to the inadequacy of the contained models.

It is perhaps more alarming that private concerns are able to build systems of this type, without anyone's even knowing about their existence, than that democratically elected governments should build them in open view and with legal safeguards.

The context within which most institutions operate is still the nation state, although this situation is rapidly changing. In some ways, national sovereignty is ceded to supra-national blocs; in other ways, smaller nations find their affairs profoundly constrained by the behaviour towards them of the big powers; in yet other ways, national sovereignty is just by-passed by the world-view of their own operations taken by the giant multi-national corporations.

I have no idea what can be done to bring scientific analysis to bear on the effective organization of this global mess, unless the United Nations itself determines it. But it has seemed to me for a long time that any one nation, thanks to the power of modern communications, could gather itself together and make that kind of effort on its own behalf. So I have spoken and written these many years. In particular, I have expressed the view that the whole business of government, that gargantuan institution, is a kind of machine meant to operate the country in the interests of individual freedom. But, for just the kinds of reason examined in the first two lectures, it does not work very well—so that freedom is in question to a greater or lesser extent in every country of the world. So, I declared, let us redesign this “liberty machine” to be, not an entity characterized by more or less constraint, but a dynamic viable system that has liberty as its output. The two conceptions, as you know from the first two lectures, are utterly different.

What then is the problem? There is no need to be overawed by the pomp and circumstance of the state, once we have found the scientific way in to the problems of effective organization, and understood the basic laws of variety. But is it lese-majesty to declare that the state runs on the same model as a departmental store, and has the same problems? Perhaps it would sound better to put it the other way round. Scientifically speaking, it just doesn't matter—because the pattern for handling variety, which last time I called the model, is the same. If I say that it is precise to express this point by saying that the two organizations *map onto* the same model you will have no trouble. Because fortunately the phrase “map onto” in mathematics has exactly the meaning you would expect. A map is the pattern of something, represented with much attenuation of variety, but with its significant elements preserved.

Government handles its gigantic task of variety reduction by departments, just like the store. And like the store, it needs a supply of information about the on-going state of affairs. It needs a lot *more* information than the store, true; but that is irrelevant, so long as both institutions are deploying requisite variety—and this is where the mapping holds and the model is the same. The model also tells us that the relaxation time of the system must be shorter than the average interval between shocks, otherwise instability will set in. We saw how the departmental store handles that problem, and noted that if it failed there would be a catastrophic collapse, signaled by the desertion of custom. Now if government gets into that kind of difficulty, it is more difficult to recognize. By and large, the customers will not desert. That is to say, the nation's population will not pack up and emigrate en masse. That would be a grave decision; besides, to be a little more cynical, the people may not be able to think of anywhere else to go that is any more stable than their homeland. This problem is very general, in fact it is universal, which is why it is so important.

How do we set about the diagnosis? In government, variety is handled by attenuation in four main ways. First, models are made of the country by every government department. At least, we just have to dignify the patterns that government has in its head as models, although in all honesty the mapping onto reality is not very good. For one thing, the senior departments were created long ago, and the national variety generators onto which they are supposed to map have changed their nature, their emphasis, and their rate. So new departments have to be set up to handle the excess variety, just as happened in our store example. But in governments' case the results cannot be so good. The store *does* change its departments with the change of life's emphasis, and the small excess variety is absorbed by the information counter. Government, however, does not change much; indeed it is singularly unadaptive, in my opinion because it has lost recognition of its stable state. So the excess variety for government turns out to be something really rather serious. An excellent current example is the total problem of the environment, a huge aggregation of unmapped variety. Naturally, the new department falls between the stools of all its old, component departments: it happens in every country. What we are witnessing here is the phenomenon of change that involves no actual alteration.

The second variety attenuator is the model that each department has of the component enterprises for which it is accountable. Consider the economy. Then, for example, there will have to be a model of industries, by industry, and models of those industries by product, by investment, by labour force, and so on. This is fine until we realize that these models treat the components as if they were entities, characterized by product, by investment, by labour force, and so on. But of course they are nothing of the kind. They are all, these component industries and their component firms, dynamic viable systems; and the items we were listing are continuously variable inputs and outputs. In fact, mostly

the things that interest us are best described as *outputs* of these systems, since the output determines most of the input. Investment (which sounds like an input), like raw material (which sounds like an input), is attracted into the system by the size and shape of the output. At any rate, these are concepts of system we are handling now—that much is clear; and it is also clear that it is not very clever to attenuate variety by freezing the continuous variables into arbitrary time epochs (such as periods, quarters, years, and five-year plans) when the essence of the business is the way it continuously generates its output through time. We need to observe continuous time trends, that is to say: rates of change, gradients, step functions, and so on. All that is necessary because we, as government, have to look to the *interactions* of dynamic systems. The models we have were constructed primarily to inform shareholders as to the proper custody of their money. No wonder the models don't map onto each other.

When data have been generated by these low-variety models, covering long and static time epochs, within departments which no longer quite fit reality, they are aggregated. So this is the third variety attenuator. There are two main reasons for this aggregation. In the first place, a minister for example cannot handle all the raw information being generated, even though its variety has already been twice attenuated. His brain does not have requisite variety to match the data until they *have* been aggregated. The other reason is that commercial security demands aggregation, otherwise it may be easy to spot what a competitor is up to—if he is big enough, or localized enough, to stand out in the official statistics. Even so; both these reasons for aggregation of some kind do not justify aggregation of the kind we have—the total or the average—which, as I said, kills that subtlety of information that requisite variety demands from a dynamic system. Just imagine a doctor calling on his patient in hospital to be told by the nurse: "Over the last

month his temperature has averaged 98.4 °" or: "Yesterday your thirty patients had an aggregated average temperature of 98.4 °." These statements may be true, indeed it would be most surprising if they were not; and aggregation of *some kind* is needed if the doctor is not to sit all the month staring at the thermometer. But to decide which aggregations are the ones to use is a problem in cybernetics, not economics—and still less in administration.

The fourth variety attenuator of government information is by far the most dangerous. It is the delay imposed by the methods of collection and variety attenuation. How does *delay* turn out to be an attenuator of variety? Well: the situation as it really is today includes all the information that led up to it, and the most recent part of that series of data is doubtless the most important. So delayed information chops off the latest half of the variety implicit in the situation now. That means that government does not have requisite variety. It is very proper that economic statisticians should talk, as they do, about the "timeliness" of official information. But I want to dwell as before on something a little different in concept from an entity called "the statistical tables for last June", characterized by whatever degree of out-of-dateness. I dwell on the fact that when the government acts, it is perforce reacting to a situation where the statistical delay often happens to be half a cycle in the economic rise and fall of prosperity, so that the government may find itself doing exactly the wrong thing most of the time. (I said "happens to be" but I believe that these two facts are actually linked within the system's dynamics, so that the machinery for taking decisions locks on to the wrong part of the economic cycle.)

Then these are some of the problems of the four variety attenuators. Of course, my friends in government will groan. I am not telling them anything new, and I know it. But I believe I am explaining this familiar problem in a new way, a way which enables us to do something about it. We have

fast communications: ah, but they are not mobilized. We have computers: ah, but they are busily taking over exactly the old system—and are actually taking longer than before to do the job. So look again now at the diagnosis. When the institution of government was consolidated, we had huge problems of variety attenuation which had to be solved by very crude methods. That was because all our facilities were low-variety facilities—we had no computer with remote terminals *then*. Now we do have these tools, but they are disregarded. These essentially high-variety regulators are used on the wrong side of the equation, not to cope with the truly high variety generated by the dynamic system, but to accept much attenuated variety from poor models with a time lag, and then to generate their own variety inside government. That is to say, a minister can always call for an elaborately reorganized set of data, on which complicated mathematics have been done; but it is the computer that generates the variety, and not the real world. This is quite fundamental nonsense. We are using our powerful tools to automate and to elaborate the limited processes that we managed to achieve with the unaided brain and the quill pen—processes which our new tools were invented precisely to transcend.

With this diagnosis in our minds, the prescription for action is not difficult to understand. First of all, we need better models of the components of the economy, and they must be *dynamic* models. That simply means that we need to see how the parts are inter-related on a virtually continuous basis. Then instead of the lawyers' and shareholders' balance sheet model, instead of the accountants' and managers' profit-and-loss account model, instead of the input-output matrix beloved by economists, think of a model set down in terms of dynamic variety. This will be a simple flow chart, in which variety is symbolized by the relative thickness of the lines of flow, and the relative size of the boxes that indicate processes acting on the flow. The

time lags in the system have to be shown, and this is best done by animating the flow chart so that the lines of flow move at different speeds.

All this is very easy to do inside any firm, and it is an interesting question to ask who ought to do it. Our rather technocratic culture immediately answers: a team of engineers, or accountants, or operational research men. Well, I don't believe it. That just is not necessary; and besides no one will really be interested in the model they create. The people who know what the flows are *really* like are the people who work in the middle of them: the work-people themselves. And if their interest can be captured in putting together the total model of how the firm really works, we shall have some genuine worker participation to replace a lot of talk about worker participation.

Please note the reappearance of that basic distinction between entities and dynamic processes. By what means does the firm try to give its people a sense of participation in the business? We have seen that static entity the work's committee, characterized by its standard set of debating points that arise at every meeting; we have seen that static entity the house journal; we have seen in each production department that static showcase in which the assemblies to which our products contribute pathetically gather dust. All of this has a certain unreality, because it freezes the dynamics of living and working in its tracks.

Then contemplate a company that is run from a control centre, in which the dynamic flow chart, continuously reflecting the world outside by teleprocessing data into it, constantly holds the pattern, and uses the computer constantly to monitor all that variety. We are near to this concept in running a battle, or a warship, or an electricity supply system. But for some cultural reason the whole notion is alien to running the economy. Yes: despite all this talk about the firm, I have not forgotten that we are supposed to be discussing the management of the economy.

The fact is that the total picture of industrial activity held by the government is made up of separate pieces, just like a jigsaw puzzle. The pieces are representations of economic sectors, or industries, and if these representations are not clear, the total picture when completed will be a total confusion. But there is a jigsaw within the jigsaw: the pieces of each industry are its component firms. So we must start in the right place. The picture of the firm must be sufficiently clear as to contribute to a clear picture of the industry. The picture of the industry must be sufficiently clear as to contribute to a clear picture of the industrial economy. And obviously, the question arises whether an autonomous firm will agree to collaborate in such a scheme. The reply is that government has many inducements to offer in obtaining the information it needs, and the greatest of these inducements is the fact that industry cannot expect sympathetic treatment from government policy if it will not contribute useful and timely information.

Then we can see what our potential model of the whole economy looks like. It consists of a dynamic system of simple models of dynamic systems, fitting into each other like Chinese boxes. Each box is called a level of recursion, because what we are doing is to reduplicate a cybernetic system of regulation recursively, that is over and over again, using the same components with appropriate variety adjustments. The law of requisite variety has to be satisfied at each level of recursion so that stability is induced, and off we go. Information continuously passes up and down this recursive system, appearing in its right form in the control room of the level concerned.

Now see what has happened to the problems of time lag and aggregation. Instead of accepting those problems, and misusing computers in the attempt to make adjustments for them by re-injecting variety on the wrong side of the equation, we have magically disposed of the problems altogether. I urge this precept on you: it is better to *dissolve*

problems than to solve them. If time lags are a nuisance, don't have any; use teleprocessing to eliminate the lag. If aggregation is a nuisance, do away with it: use computers to attenuate variety more cleverly.

The vision I am trying to create for you is of an economy that works like our own bodies. There are nerves extending from the governmental brain throughout the country, accepting information continuously. So this is what is called a real-time control system. Why should governments be trying to deal today with last summer's problems—which are, in any event, settled one way or another by now? Then does this then mean that government will be flooded with masses of data that it cannot handle? Certainly not. My brain and your brain at this moment are both accepting all manner of sensory input—everything in the room is registering there, and that is good, because we may need to attend to something quite suddenly. Until that need arises, however, our brains automatically inspect all this irrelevant input, and *filter out* most of it.

This is what I mean by using computers as variety handlers on the right side of the equation. They have to accept all manner of input, and attenuate its variety automatically. What they will pass on to the control room is whatever *matters*. Now we tell our brains what matters to our bodies by detecting inputs that are deviating from what would normally be expected. Everything else maps onto the understood pattern in the model. Inputs fluctuate of course, but they fluctuate within limits that can be continuously calculated by probability theory—if you have a computer. So to recognize what *matters* the computer will need to make very very complicated calculations on every item of data coming in, and assess the chances that something novel is happening. In the huge majority of cases, nothing will be happening—in which case the input item can simply be discarded. It does not need to be stored in those gigantic data banks we keep hearing about, because it has no signifi-

cance at all. We already know from our basic model what the ordinary variation is, and this input item lies within it. So what? Unless you have shares in electronic storage equipment, or are building a career as a bureaucrat, you will see no reason for keeping it. And if you are particularly interested in freedom, you will see every reason for throwing it away.

It now becomes clear why I was making those remarks earlier about cost. As soon as you think of running the economy by computer, the culture promptly feeds you an image of acres of expensive equipment. It is not required. What is required is an ordinary computer, with teleprocessing interfaces between itself and its inputs from the country and itself and the control room, plus an extraordinarily clever program. The cost is in that software, and not in acres of hardware, its maintenance and staffing. But if the regulatory model is the same at every level of recursion in the economy, because the cybernetic models map onto each other, only one set of software is required.

So now we may visualize the control room and the decision takers within it acting together in symbiotic relationships as a brain for running the economy. The nerves that feed information continuously to that brain pass into its computing lobes, where the variety filters work. The basic model appropriate to this level of recursion—which is in here running as an animated flow chart—is the focus of all discussion. It is constantly updated by the various kinds of alerting signal that the computers produce. These signals will cause the decision takers to call for more information, and they will use electronic storage to project that onto screens. Then, if they really wish to get down to serious decision taking, they will activate their dynamic systems models with their new data—and try out alternative policies by simulating them at very fast speed.

You probably know that it is possible by electronic simulation to make a ten-year-ahead projection instantaneously,

and then to change your policy and see what difference it makes. This is to take an experimental approach to policy making, doing the experiments in the laboratory of the control room. So instead of experimenting on the poor old nation, and discovering ten years later that your policy was wrong, you can test and discard a dozen wrong policies by lunchtime without hurting anyone. After lunch maybe you will find a good policy.

Now it is true that much controversy surrounds simulation techniques. But this is mainly because of the inadequacy and the belatedness of the data fed into them. What do you expect with those low-variety models, aggregations, and time lags? But by *redesigning the whole institution* (and it is the only way) all those problems are dissolved, and the data feeding the simulations will be immediate, significant, and real.

Clearly this is no more than a brief sketch of the advocated approach, which is available in full, but of course much more lengthy, detail elsewhere. The fundamental criticisms that it has evoked are four. One says that instead of this being a Liberty Machine it means the death of individual freedom. I shall talk about this later on, because it is so important, and ask you to suspend judgment until you have heard the arguments.

The second criticism is related, but is different none the less. It says that this whole approach to running a country presupposes a regime in which the state either owns industry or intervenes massively in its affairs. This is based on a misunderstanding; it confuses the machinery of government with government policy. I am not talking about that policy at all, nor taking a particular policy for granted. I am talking only about the machinery with which any modern state is equipped in the necessary task of government, and I am arguing that it ought to work. Every government regulates, every government controls—to some degree or other. In short, it governs. These arguments have been concerned

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with the "how" of governing, not with the extent of intervention.

The third criticism says: it is all too simple. Real life is much more complicated than this. The only honest reply to this is a belly laugh. What is proposed here is simple enough, I hope, to be understood—once you know some of the laws of cybernetics; and if it is not simple enough to be understood, then of what conceivable use is it? Moreover, it is a very great deal more close to real life than the system we use now, because it is dynamic instead of static, systemic instead of a collection of entities, and because it really can handle variety according to scientific principles, which the existing system cannot.

Please appreciate that once you start to use systems thinking you need fewer data than before—because the data are synthesized within the model of the system. And this relates to the previous criticism, because I by no means envisage that a private business would supply more information than it does now: probably less. Why is it that a doctor does not have to take your body to pieces, and measure everything in it, when you arrive saying: "I feel rotten"? It is because the doctor holds a good model of the human body: when he knows your temperature, pulse rate, and blood pressure, has inspected your tongue and observed the rings round your eyes, he already knows most of the usual stories. By using good recursive models of the economy we should achieve the same effect.

Ironically enough, while this third criticism says it is all too simple, the fourth criticism says it is all too complicated—you could never do it, or it would take twenty years. Maybe you have noticed that I have been describing this approach today with a force and confidence which you may have thought brash in describing a vision. Indeed, until two years ago I was much more gentle and tentative—even apologetic—in making this description. But today I am no longer guessing, because all the basic work has actually been done.

Perhaps you remember my describing how these lectures were prepared in Chile. I was not actually on holiday there, as it may have sounded, rather the reverse. Two years ago President Allende invited me to create a system of this kind for the Chilean people. Now Chile is not a rich country, and we could not afford all the apparatus we should have liked. For instance, we had to use ordinary Telex instead of teleprocessing. Even so, we made it. We had everything I have just been describing available—though not yet running the economy—in eighteen months.

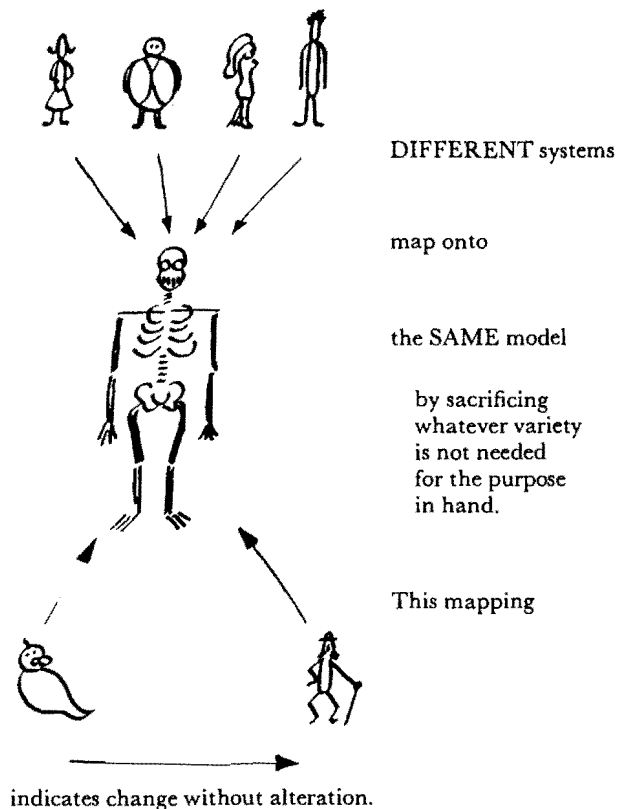
In the few months that remained to us, we were teaching the workers, for whom this offering of science to the people was created, how to use the most advanced tools yet designed for national economic management. They could sit with their ministers in the economic operations room in Santiago, watching the animated screens, and discussing the alerting signals provided daily by that clever computer program. They had buttons in the arms of their chairs, so that they could command the appearance on other screens of supporting data—to the capacity of 1,200 different colour presentations, focused through sixteen back-projectors. They could also control preliminary experiments in simulation, on a huge, animated model of the dynamic system. These people, arm in arm with *their* science, were intended to become the decision machine for the economy.

You all know what happened. On 11th September 1973, Salvador Allende died in a bloody business, of which the consequences for mankind are incalculable today. I tell you solemnly that in Chile the whole of humanity has taken a beating. Of the lessons from my own work that emerge, I mention four. Firstly, it is actually possible to redesign the institutions of government according to the principles and practice of cybernetics. These are not wild dreams. Secondly, there is a long way to go in dismantling bureaucracy, and I shall discuss the problems of effecting change later in these talks. Thirdly, the possibilities propose an

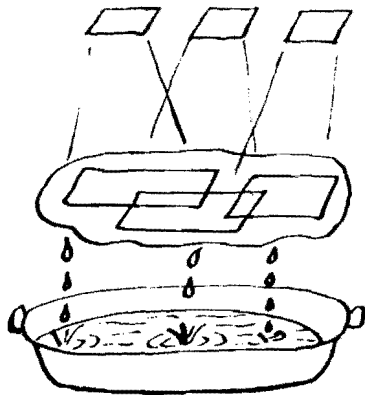
urgent task for our next meeting: to discuss the impact of such scientific advance as this on the status and freedom of the individual.

So I move to the fourth and final point for today. Individual freedom has been lost, momentarily at least, in Chile. I think I know how; but it was certainly not because the people became victims of technocracy. What is clear is that everything that I have described was accomplished (and ended) in two years, *and it was not fast enough*. When I drafted these lectures, and outlined the hypothesis you heard—that perhaps our institutions could not react fast enough to avoid catastrophic collapse—I remember thinking that I should have to defend myself against a charge of sounding a premature and too scare-mongering an alarm. Do you care to make that allegation now?

NOTES IN SUPPORT OF THE THIRD LECTURE



1. Models of Nation by Departments of Government:



departmental models

map
(rather loosely)

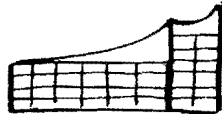
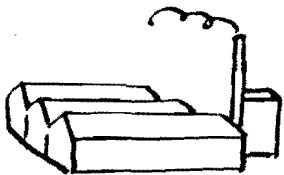
onto national variety;

excess variety generated as things change

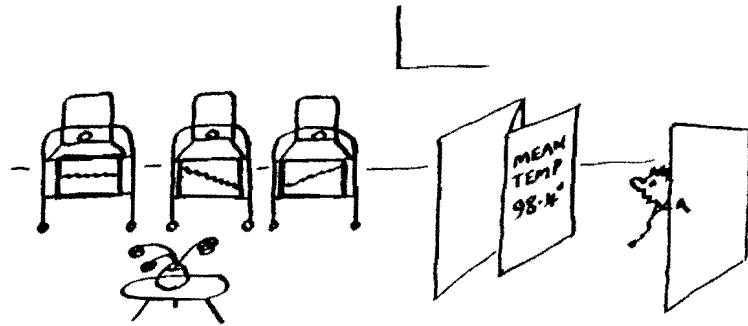
is caught by some new organization without a proper structure.

Instead, the original departmental structures should be redesigned, and made adaptive to further change.

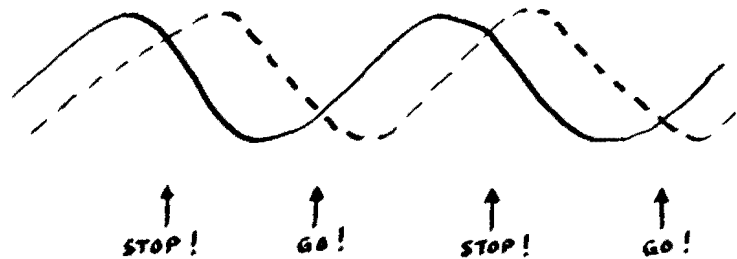
2. Models of Enterprises Within the Economy: the arbitrary choice of significant characteristics and of time epochs masks important variety.



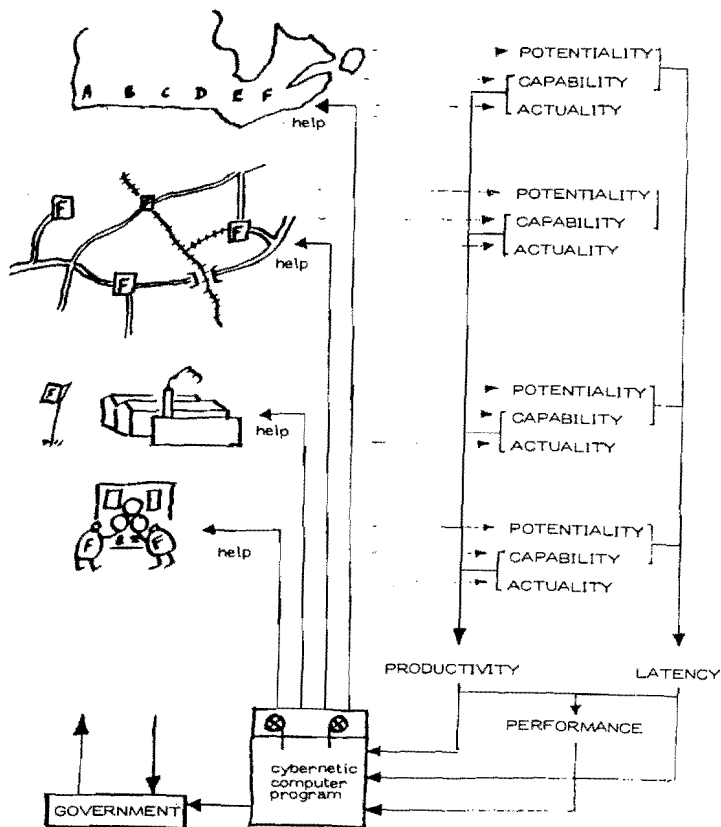
3. Aggregation of Statistical Information.



4. Time Lags in Registering Information: perception (dotted line) of the movement of economic indicators is not only "too late"—it means that at the time of taking a decision the most relevant variety generated by the already inadequate model is suppressed. We may be led to do precisely the wrong thing.



Four Levels of Recursion: One Model: One Computer Program



A full account of this approach to management cybernetics is in the author's *Brain of the Firm* (Allen Lane, The Penguin Press, 1972). An account of the Chilean application comes at the end of *Platform for Change* (John Wiley, pending publication).

SCIENCE IN THE SERVICE OF MAN

IV

The scene is a small airport at a vacation resort where a week-end conference on automation has been held for senior business-men. Everyone is going home. The man in front of me at the desk finds to his horror that the flight for which he has a ticket is already full. "I am so sorry," says the desk clerk soothingly. "We are having trouble with all the Flyaway Airline's flights—something has gone wrong with their computer." In the quiet of the little airport lounge, everyone is listening. A large man several places back in the queue leans forward and says loudly: "Excuse me, young man; I am a director of the Flyaway Airline. We do not *have* a computer."

Some people laughed, but the general atmosphere turned to acute embarrassment. I do not think that this was because the desk clerk had been caught out in his white lie. As I argued in the second lecture, the computer has come to represent a malign influence, and something of which people are frightened; therefore people are most unlikely to call on its aid, or to demand its use in the redesign of society. But the embarrassment attending this incident also suggested that the great ju-ju none the less exists, and to deny that was a somehow dangerous act. . . .

The title of this lecture is "Science in the Service of Man", and I should be terribly surprised if its announcement caused so much as a blink of scepticism. A thorough-going job has been done in putting forward the slogan that science

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or by the man who first
published. e is Humberto Maturana,
and he calls this kind of *utopoietic*—which is the pure
Greek for “making itself”. His definitive book is not yet
published.

THE FREE MAN IN A CYBERNETIC WORLD

VI

The continuous process of liberating our minds from the programs implanted in our brains is a prerequisite of personal evolution. We can embark on that process of liberation only by constantly and consciously testing the ways in which our personal variety has been and is being constrained by the very things we tend to hold most dear.

But freedom is not pure anarchy. We are not free if we are dumped in the middle of the Sahara desert, despite the absence of walls and bars on the non-existent windows. We are free when the doors of our intellectual suite of rooms are unlocked, and we walk outside to breathe some new and fresher air. But we still need maps.

The message of hope I have to deliver is that this is a possible manoeuvre, not only for individuals—many of whom listening to me now will have discovered these things for themselves, but for society itself. And here many people are not so optimistic as I find myself to be, because the task looks too great for them. As I said at the very beginning of these talks, a lot of people feel trapped.

But I would like to make sure that you hear the following words, which form a conclusion drawn from his own cybernetic analysis of the societary condition by Sir Geoffrey Vickers. He says: “The trap is a function of the nature of the trapped.” Then I should go on to say that the failed society that I have depicted to you is not a malevolent society, not a cunning trap—for I agree with Vickers that the

“trappiness” of the trap lies in our own nature. It may be nearer the mark to speak of a *Dinosaur* society.

By this epithet I mean to say that the trouble with our institutions is in their loss of the ability to respond in time, to learn in time, to adapt and to evolve. Like the dinosaurs, they cease to be viable systems. I have tried very hard to lay bare the mechanisms that appear to me to lead to this disaster, because I think they can well be understood. What we understand we can control.

“Control”: there goes that word again. I can only hope that by now you will know how I am using it. When I say that any system is “in control”, I mean that it is ultrastable: capable of adapting smoothly to unpredicted change. It has within its structure a proper deployment of requisite variety.

Just now I said: but we shall still need maps. The societal maps we need are in my view the cybernetic maps that I have tried to set forth. And so you see why I have called this series *Designing Freedom*. The contradiction built into this title is the figure of speech called oxymoron. The freedom we embrace must yet be “in control”. That means that people must endorse the regulatory model at the heart of the viable system in which they partake, at every level of recursion.

Hitherto this could be done by underwriting a constitution, or by declaring a belief in something called the democratic process. But things have changed. Constitutions, written or unwritten, turn out not to have requisite variety in a world gone crazy with its own proliferation of variety. And if the democratic process does not seize upon and use those disregarded tools of modern man, it will not itself be viable much longer.

Then all of this becomes an appeal for scientific efficiency, which belongs to the word “designing”, as providing a regulatory model to give requisite variety to human joy and fun, which belong to the word “freedom”.

The clash and conflict of these conceptions produce in all

of us, and not least me, a dissonance. The idea jars, like any oxymoron. Then let us speedily reconnoitre this trap—which is a function of the nature of the trapped.

There are two things wrong with the role of science in our society. One is its use as a tool of power, wherever that is concentrated by economic forces. The other is its elite image. None of us wishes to be manipulated by power; and if science is the tool of power, to hell with it. None of us wishes to entrust our liberty to a man in a white laboratory coat, armed with a computer and a row of ball-point pens in his pocket, if he does not share in our humanity.

The contrasting argument is just this (and I have used a lot of willpower in holding back the argument until this final lecture). Civilization is being dragged down by its own inefficiency. We cannot feed the starving; we cannot stop war; we are in a terrible muddle with education, transportation, the care of the sick and the old; institutions are failing, and often we feel unsafe in the streets of our own cities. All this is inefficient. *Then it cannot be correct to say that the only way to preserve liberty is to be so damned inefficient that freedom is not even threatened.* We have to become efficient in order to solve our problems; and we have to accept the threat to freedom that this entails—and handle it. Everything that man can do contains implicit threats. This is something written into the law of requisite variety, as far as I can see. Then we have to be knowledgeable, and we have to be untrapped.

We have to find a way by which to turn science over to the people. If we can do that, the problem of elitism disappears. For surely I do not have to convince you that the man in the white laboratory coat is human after all, and would rather use his computer to serve you than to blow the world apart? Then for God’s sake (I use the phrase with care) let us create a societal system in which this kind of service is made even possible for him, before it is too late. At the moment, the scientist himself is trapped by the way in which

society employs him. What proportion of our scientists are employed in death rather than life, in exploitation rather than liberation? I tell you: most of them. But that is not their free choice. It is an output of a dynamic system having a particular organization. Remember the waves.

And so my first conclusion to these lectures is: efficiency does not entail tyranny—if we can get the system right. To do so is a top priority, because some version of efficiency is required to save our dinosaur society.

The next point I would like to tackle also involves an oxymoron: you could call it “unpredictive prophecy”. It would not surprise me if I sounded like a prophet, or (to use a hideous neologism) a futurologist. Let me rid myself of any such pretension; because I do not believe that we can predict the future. I believe instead that we can describe the present with perspicuity, if we use the proper instruments, and that this same present constrains future variety. This is not the same thing and I will take a few minutes to explain.

If I were to offer you a cigarette, what would happen? You might take it, or decline it. You might deliver a eulogy about the excellence of tobacco; you might read me a lecture about lung cancer. If you are a director of a tobacco company, you might insist on giving me your packet. If you are the chairman of an anti-smoking lobby, you might punch me on the nose. For all I know, you might execute a war dance—and we could offer a prize for the best explanation as to why you might. The future, in short, is unpredictable, because there is too much variety in the air. It is called freedom.

On the other hand, I may have a model of you, I may have found out how you are, and have a very good idea of what you will do. This fact does not constrain your freedom; it constrains the variety of my model of how you use it. If this distinction had been understood some time back in history, there would have been less confusion in what used to be very popular discussions of free will.

Then let us extend the analysis to planning. If I set out to catch the 8.32 train tomorrow, then maybe you will find me on it. It would be absurd to say that if I were a free man I might just as well be at home in bed, or flying the Atlantic. Planning is a variety attenuator. What is planned tends to come about—but often rather shakily, so that perhaps we make a loss when the whole idea was to make a profit. If so, variety has sneaked back in again, when we thought we had rid ourselves of it. In either case, the act of planning does not rob us of free will.

Then why has planning such a bad reputation? For it has. People talk about “the planners” in a very pejorative tone of voice. The reason surely is that our plans are not adaptive, and the institutions charged with making them grind on with their implementation long after it has become obvious to everyone who will be affected that the plans are inappropriate. We are back to the unviability of the institution again. Institutions are stuck with their ponderous machinery, while the newspapers reflect the public rage. . . .

Planning should be continuous and adaptive. Societary plans should continuously abort, and be recast, before they give birth to a monster. If this is true, there is no need to base them on the predictions that no-one can correctly make in any case, but only on the analysis of an unfolding situation in which every decision constrains future variety. In that statement the unpopular notion of planning is turned on its head, and deserves to become popular again. Because it means that the future is something we use our freedom to determine, rather than something that is lurking out there, and will happen to us, unless we are mighty smart. We can make, rather than prophesy, the future.

As to variety sneaking back in again, we can keep an eye on that. Again, this is hardly forecasting. It is an analysis of current patterns of variety, so as to assess the probabilities that a system will next move to one state (indicated by a representative point) rather than another. This process has

no bearing on the problem of freedom either; it is simply quantified business acumen. Science can do something about that, through operational research. But I must add that I always laugh when I hear a businessman or a politician talk about "a calculated risk", because this invariably means that he is taking a risk that he cannot calculate.

Then let me sum up my next key points, not as predictions at all—and therefore not as doom-laden—but as analyses which indicate firstly where things are wrong and secondly how they could be put right.

Civilization operates through a set of institutions with a particular organization. This organization appears to be an anachronism. It worked well enough in a more leisurely age; but now its relaxation times no longer match the rate of perturbation. Therefore these systems are actually *designed* to have unstable outputs. There is evidence that the outputs really are unstable, a fact which tends to confirm the hypothesis; and there is no cybernetic regulation in the design to stop the instability feeding on itself to the point of catastrophe.

Then we can see what to do. We cannot grab hold of explosive variables and drag them down to earth again. If we get tough, and also expensive, and reinforce the whole machinery (which is what we tend to do) we stand to lose our freedom. Moreover, and absurdly enough, this approach simply makes the machinery heading for catastrophe more efficiently catastrophic. What we do is to redesign the system itself, so that its outputs are no longer unstable.

To do this we need much faster communications inside the machinery, and these are readily available. It means using telecommunications properly, in high-variety, real-time, broad-band circuits available to all. To be available to all, they may very well need to be free of charge—like the air and the view, on which our humanity and survival also depend. I see this large expenditure as quite proportional to the threat we have to meet, and far less absurd than equiva-

lent expenditures on which we needlessly but cheerfully embark, and which it would be embarrassing to list.

Next we need to use the computer properly inside this network; not as a device to make silly mistakes, not as a calculator to do cheap sums expensively, and not as an invigilator of the people's free expression of themselves. Those proscriptions would knock out ninety-five per cent of current applications, and free computer power so that people could engage in their personal evolution—by guiding their own learning, and editing their own input.

Very likely computer power should be free of charge as well. Let us note that it becomes increasingly expensive to monitor charges for high-variety services. Each consumer absorbs these to a different degree and in a different pattern—and it all has to be logged. If a toll-road is opened, so that the cost of building the road may be met by the toll, we shall need an organization of requisite variety to monitor the use of the road; and we may find that all of that costs more than the toll is raising. If that can happen in a relatively low-variety system, the situation is far more ridiculous in the high-variety systems that I adumbrate.

So we should beware of precedents in these matters. There is hallowed machinery built into all our institutions which knows how things are paid for from the public purse. Well, maybe all that too is out of date. If I lived in an isolated prairie community, and discovered that no-one in the capital was taking the question of my isolation seriously, so that my telecommunication circuits and computer power would have to be paid for as a function of my distance from the city, I would form a local committee and propose to charge the city dweller on his holiday for looking at our local view.

Given all this technology, we need new institutions for handling it; which brings me to summarize what I have said about freedom. So many people seem to think that to advance along these necessary paths might cost our liberty.

To this I have replied that our personal freedom is not the

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absolute we take for granted. We are profoundly constrained by the limitations of our brains and by the inexorable attenuation of our input variety. That is how we are, and we ought not to start our thinking from a worldly minded pretence. Secondly, I do not forecast or predict that such freedom as is our natural right will be imperilled: I say with passion that it is imperilled *now*, but we are too complaisant to face up to this. We live in too cosy a world. This is not the real world, uncomfortable and discomfoting, where so many people are enslaved and dying; it is a variety-attenuated model of the real world, in which these stark horrors acquire that air of unreality which our television screens know well how to bestow.

Therefore the argument is that something must be done to redesign our institutions, boldly using science in that very cause. Society, in the form of its own institutions, public and private, is making a bold use of science now—not to redesign, but to reinforce itself in what may turn out to be its most oppressive aspects.

Conspicuous consumption is an oppressive cause if it means robbing the Third World. Science is behind this, primarily because of the way telecommunications are used. Not only does television serve the cause of spurious growth; it has become little short of optical imperialism. Please contemplate those plays in which "bandits" are trying to overthrow the rightful king, only to be put down by clean-cut heroes sent in to help by the First World, from the point of view of men and women fighting dangerously for their liberation from a tyrannical dictatorship. I would like to remake one of those plays, using the same cast, from the standpoint of the so-called bandits.

Next I draw attention to computer-driven systems that compile dossiers on the individual, to rob him of his credit and his good name. That is oppression. If multi-national companies are allowed to use science on a global scale to

exploit the planet's dwindling finite resources for the benefit of the few in whom the power to do this is concentrated, then that will be oppressive. And if the might of military science is used, or even threatened to be used, against the democratic choice of any nation, then that is oppression indeed. This last example, unlike all the others, is not new; but if we are going to pour so much science into that oppressive purpose, at least let us use science in the service of freedom too.

All the oppressive uses of science that I have mentioned are in full deployment now. So science is not a neutral thing, as many scientists themselves try to believe. As for the public, I sometimes think they just hope that all this power implanted in our institutions will not hurt them, if they are quiet as mice. But the mouse trap is loaded with cheese, called growing prosperity, conspicuous consumption; and the destructive force stored in the wound-up spring is the economic power that underwrites technocracy. Then we can lose our freedom . . . *snap!*

The intuition that this could be the case is there all right. It is built into that alienation of which I have spoken. But alienation leads to impotent rage, perhaps to violence; it is an excess of human variety that is blocked off, and is explosive; alienation of itself does not lead to new constructions. Nor are we led to new constructions simply by dismantling the bureaucracies, although I have advocated this. Besides, how does one do it?

Requisite variety for running the world does not exist in any man's headful of ten thousand million badly programmed neurons. Requisite variety for running things properly exists with the people who generate the world's variety in the first place, and that means everyone. Whoever opts out of his or her regulatory role is robbing the total system of its power to be stable. Therefore it is not for me to specify the content of the total regulatory model, but only

to point to the need for it. But if this stricture applies to me, it also applies to you. The requisite variety for being messianic belongs only to the genuine Messiah.

I suggest that the first thing to note is that most of us have done what I just said we should not do: we have robbed society of regulatory variety by our passivity. The occasional democratic exercise of a vote is not a big enough variety amplifier; and besides many of the most thoughtful people I know have given up voting anyway. This is on the grounds that to choose between alternatives to which one is indifferent does not increase regulatory variety at all. Then people will need to abandon their cynicism, and become active.

Their accepted course is to get into societary institutions and to try to change them. Again, many thoughtful people have given that up—because they perceive the effort as a losing battle. And if the analysis I offered of bureaucracy is correct, they are probably right; especially if the relaxation time hypothesis is correct as well. The only conclusion that I am able to draw is that we must start again. If that is not to result in anarchy, then the institutions themselves (including of course government) must take a hand.

That would sound like the kiss of death, to any good revolutionary. But I persist in that other hypothesis: that institutions, including government, operate with good intentions, in good conscience. If you and I have understood the problems, why not they?

Then suppose that groups of people draw together to consider the problems of society, and what kind of society they want. I cannot tell you the content of their deliberations. But the regulatory model will have to do with the control of variety attenuators and the provision of variety amplifiers, at various levels of recursion; and it will have to do with the way in which science should be harnessed to these ends. I do not think that the problems of acquiring scientific tools are nearly as difficult as they sound, despite

the expense. The greater problem is the alienation from science that has already set in, and needs to be reversed. For I should be quite content if these groups of which I speak considered my views about the need for science to be quite wrong, so that they decided on a craft culture if they reckoned it would work, but only if they had free minds about it. Knowledge is a human possession, and that includes science—which is only ordered knowledge.

Science makes bold use of experiment: I mean the crucial experiment—something that may fail, and thereby falsify a theory. In attempting social advance, we work in an evolutionary fashion, testing the route with a toe all the way. Now of course I believe that this is much too slow. We do not have that much time. I advocate the bold experiment, but on condition that it is recognized to be just that. For here is a key thought: we can very well afford to pay ourselves for being wrong. To be wrong slashes variety; one thing the scientist knows full well is that, in experiments, it is just about as useful to be wrong as to be right. Both outcomes attenuate variety, until the search homes onto the answer that we seek.

So I would say that it would pay to set up experimental institutions, deliberately antithetic to the existing ones—and with their full support. The objection is immediate and clear. Just who, and just whose children, would be the guinea pigs? I tell you that the answer to this is a great many volunteers, for they could have the safeguards. They would design those, like the experiments, themselves. The reason why I feel so sure about this, is that so many people are doing it already—without any permission, without any safeguards, and also without any call on funds to which I reckon they are entitled. For this is liberation.

The rest of the design is simple. If science can do whatever can be exactly specified, and if people really do start specifying, then they will need recourse to science. It needs only a tiny team, and no bureaucracy of any kind, to make the

links. The levels of recursion must be got right. But it could easily be done. One team for every province, one in Ottawa—and that not to tell anybody anything at all, but to co-ordinate the efforts, to communicate (by videotape, of course) the results.

But I have said enough. It is not for me to project my own imaginings upon the world, although it seems legitimate to try to release untapped and perhaps frustrated variety. These things cannot be forced, but perhaps they can be freed.

Why freed, you ask? Why do they not happen of their own accord, if they are good? The answer lies, I think, in mass effect. Because to use science is expensive, the little group—however fervent—finds science difficult to command. When the movement is general, however, the cost is shared and becomes manageable. This is the reason for my little teams. And who should pay for those? Come, well-intentioned institutions, in good conscience: If one of your staff has a natural place in such a team (and his or her election by the social group would be a genuine honour), why not let go? *Second* the person: you have much to gain. And it is you, after all, you institutional man, who has tied up this person (perhaps he is yourself)—with the high salary and the fringe benefits you pay—and robbed him of mobility. Could you not make this gesture to freedom, and indeed survival?

But when I speak of mass effect, I could point to no more potent an example than that of a country, acting through its democratically elected government, that turns its whole self into an experimental society—and of course, I am citing Chile once again. In the third lecture I discussed a system designed for economic regulation; but this was an almost incidental feature of the Chilean Experiment. That began with agrarian and industrial reform, with making food and clothes available to the poor, and continued in a surge of enthusiasm for what even the main opposition party would refer to calmly as the Chilean Process. It was the middle

class who had to pay for this: they knew it, and pulled a wry face. But they were mostly well-intentioned people in good conscience, and mostly they behaved decorously. I knew many who voted for Allende. They made up jokes about the shortages and queues, and carried on.

In the two years of my own work in Chile, I witnessed several attempts to pull the government down: one very serious attempt was made in October 1972. To this, which produced high stress and great difficulties, the Chilean people responded the following March by turning out to the polls and increasing Allende's vote by an amazing seven per cent. But he was still a minority government, a fact which tied his hands; and now he looked as though he might succeed. It was time to halt the great experiment.

As I see it, the rich world would not allow a poor country to use its freedom to design its freedom. The rich world cut off vital supplies—except for the armaments that eventually reduced La Moneda to a smoking shell. The rich world cut off vital credit, so that there was no hard currency—except for the illegal flows of it that financed the contrived paralysis of the distribution system to justify the coup.

Then let us not say, as we hear said, that Allende reduced his country to chaos, and destroyed the economy. A system of world forces acting upon Chile reduced his economy to chaos, and destroyed *him*. Allende understood that his country was losing its freedom in the oppressive grip of that external system, and went and said as much to the United Nations. The free world, as it likes to call itself, heard what he said, and waited until his own prophetic words were fulfilled: "They will only drag me out of La Moneda in wooden pajamas." At that point it offered muted protests, and set about recognizing the military junta.

Thus is freedom lost; not by accident, but as the output of a system designed to curb liberty. My message is that we must redesign that system, to produce freedom as an output. If we are inefficient about that, on the grounds that scien-

tific efficiency threatens liberty, then the institutional machinery that acts in our name will fail to prevent the spread of tyranny, war, torture, and oppression. We speak of the growth of prosperity; but the growth of those four things throughout the world today is yet more real.

Let us use love and compassion. Let us use joy. Let us use knowledge. These qualities are in us, obscured though we may let them be by the lethal strategies of our dinosaur society. And let us use that acquired and ordered knowledge: science. This too is in our heritage. If it has been seized by power, then seize it back. Expect it of statesmen and politicians who represent us that they should, on our behalf; or demand a new breed of statesmen and politicians. Expect it of educators that they should change the institutions of education not to train crazy apes; or start new schools and universities instead.

Above all, let us all expect it of each other that we find ways to use the power of science in better cause. It is no more sensible to say that we cannot, because ordinary folk do not understand science, as it would be to say we cannot sail a boat, because we cannot understand the wind and the sea and the tide-race.

Men have always navigated those unfathomable waters. We can do it now.

This is the book reference you need to follow up the quotation in this lecture: Geoffrey Vickers, *Freedom in a Rocking Boat*, Allen Lane, The Penguin Press, London, 1970.

NOTES IN SUPPORT OF THE SIXTH LECTURE

Write Here: