

The Managerial Cybernetics
of Organization

BRAIN OF THE FIRM

SECOND EDITION

Stafford Beer

Companion Volume to
THE HEART OF ENTERPRISE

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*Chile John
11. September = Putch!*

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DEDICATION

To my colleagues past and present managerial
and scientific with a motto

ABSOLUTUM
OBSOLETUM

— if it works it's out of date

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1972.

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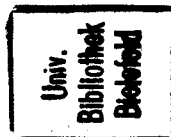
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Preface to first edition

This book is about large and complicated systems, such as animals, computers, and economics. It is in particular about the control of the enterprise, the brain of the firm. That is a difficult subject — difficult to think about or to read about, difficult to write about.

When the White Rabbit asked the King where he should begin, the King replied: 'Begin at the beginning and go on till you come to the end: then stop.' But explanation is not like that. His advice is a good example of the failure to recognize when one is up against a large, complex system. This particular system begins with two sub-systems, themselves almost unthinkably complicated, called the author and the reader. It goes on with the topic — the subject matter (also complicated) by which alone they will be connected. It then seeks to weld the three sub-systems into a meaningful whole. That is what communication is all about, and it is not easily done.

After a lot of re-arranging and re-writing, this book turns out to begin three times — which is why it comes in three parts. The first establishes some talk. The second says what I really wanted to say, using the talk. The third (hopefully) says what the reader really wanted to hear, given that he has already heard what I really wanted to say. It sounds complicated, because it is. But I hope the approach makes things easier rather than more difficult.

In communication everything depends on what you end up with, not on what was actually said or written down. Here you are supposed to end up with an insight, not with an agglomeration of facts. When everything is understood the details cease to matter very much, or can be changed, or can even be abandoned for another set. As Wittgenstein said at the end of the *Tractatus*, when you have climbed up the ladder, you can throw it away.

But the ladder must be there, and secure, and the rungs in place; the climb itself may be stiff. My only hope is that the view from the top is worthwhile. After the communication is all over, of course, we can agree to differ about all the steps on the way.

In particular, we can choose a whole new vocabulary if we like. For the moment, I have had to choose one, because I am starting this communication. Many will find it strange. But words are only names: please do not be put off by my names. Please have an agreement with me about them. I say all this because I find that cybernetics especially (these are cybernetic writings) leads people to argue with fervour about names — forgetting the ideas they name. Though all communication runs the same sort of risk.

This point is well covered by such writers as Wittgenstein. But it was brought home to me most vividly by one of my children, Matthew, when he was three years old. He had found two copper coins in a drawer. 'Daddy,' he carefully explained, 'these sixpences are half-pennies.' My sixpences may be your half-pennies, too. It does not matter as long as we both know what they will buy, because what they will buy is all they are about.

S.B.

Preface to second edition

The original edition of this book was published in 1972. Translations have appeared in Danish, French, German, Italian, and Portuguese, and preparations continue for versions in another three languages. Meanwhile, however, the original English text has been inconveniently out of print since early in 1975. The reason was that sharp changes in editorial policies and people had occurred in the original publishing house, where dozens of titles were consequently and suddenly abandoned. Publication rights in *Brain* were courteously returned to me.

By this time, however, two things had happened. A massive application of this whole approach to management cybernetics had been undertaken (1971 - 73) in Chile. The eventual overthrow of President Allende's administration was as traumatic an experience for me as for many others who, though not born Chileans, had reason to identify themselves with the nation's suffering. Years were to pass before I felt able to review all my Chilean papers, and to write a full personal account of the applications — an account which now appears in a new Part (Chapters Sixteen to Twenty) of this second edition. Secondly, if secondarily, I had been engaged in the writing of two other books: *Platform for Change*, which John Wiley published in 1975, and *The Heart of Enterprise*, which that same house issued late in 1979. The latter work, however, is the companion volume to this. Thanks to my publisher and friend James Cameron of Wiley's, *Heart* and *Brain* are now available in complementary editions that have been prepared in parallel. I hope very much that their mutual support will release synergistic energy for the readers of both.

Use of this work is certainly becoming quite widespread. It is helpful to know about applications on which I have not personally been consulted nor held a 'watching brief'. This is partly for research purposes, but also because people often write to see whether they can be put in touch with those using the approach in their own fields of management or type of organization.

The first preface, which you may just now have read, explained why the original book began three times, and therefore came in three parts (plus an Appendix). The above story is perhaps already sufficient to explain why the

book now begins four times, and comes in four parts (the original Appendix becoming Part Five). There was of course a temptation to rewrite everything, but this seemed unfair to those already familiar with the first edition. In reviewing that text, I have made additions, rather than alterations. The structure and chapter headings remain as before. The final problem about the presentation of this fresh edition concerns its title. Even in 1972, the apparent limitation of the cybernetics of the viable system to 'the firm' was too restrictive — because applications to other kinds of enterprise, and especially government, were already in train. With the inclusion of all the new material in Part Four, the title is strictly a misnomer. However, it simply does not seem either legitimate or helpful to use a new title for a book the substance of which is already established.

On the question of titles, *Brain* and *Heart* shall suffice in their references to anatomy; there is no truth in a colleague's expectation that *Big Toe* would eventually be reached. Having made this resolution, I allow myself one final reference to a bodily organ — relating as it does to the business of managerial and ministerial innovation, on which this book has much to say. The figure of Prometheus is pictured on a medal that was presented to me in Sweden in 1958, and the late Edy Verlander, who was in charge of the event, asked me what this figure portended. Of course I replied that Prometheus stood as a symbol of science, since he brought down fire from heaven. 'No, no', said Edy. 'The medal is indeed for innovators, but the point about Prometheus is that he was chained to a rock and had his liver pecked out.' I did not think at the time that he was exactly joking; but now I am sure that he was perfectly serious. The reward-and-penalty structure in management heavily disfavors innovation: it is a fact which demands fresh thinking if our institutions are to survive.

Meanwhile, I commend you to *Brain*, an organ to be treated with especial respect — even with a certain reverence, since these are the brains of a planetary future with which we deal. There is a book, written by Jocasta Innes (References D), which — to judge by the frequency with which I consult it — must be of some importance. She memorably writes:

'brains need gentle handling
or they are apt to disintegrate'.

Amen.

S.B.

Acknowledgements

To the many friends who know that I know that they helped, and equally to those who suspect that I do not know, my very warm thanks.

I salute the memory of those three grandfathers of cybernetics, Norbert Wiener, Warren McCulloch, and Ross Ashby, with much affection.

My thanks to those managers in business and industry, government and universities, and in communities too, who have allowed and even encouraged me to develop this theory of organization on their territories over thirty years.

May I also publicly thank my wife Sallie for keeping both me and the typescript going through many years of writing and through two editions — this being the only page that I typed myself.

S.B.

PART FOUR

THE COURSE OF HISTORY

*To Fernando
for our friendship*

costó pero salió

Estáfor

Summary of Part Four

Each of the summaries has incorporated the advice to re-read the earlier summaries. The last summary, which introduced Part III, ended the 'old book' by saying that Chapter 15 was 'very much a final chapter', and that it sounded 'a bit metaphysical'.

As if in answer to these two allegations came the work in Chile, which was founded — as to its cybernetics — on the original manuscript of this then-unpublished book. Hence Chapter 20, and not Chapter 15, is now 'the final' chapter. As to the 'metaphysics' ... nothing could have been founded in a more profound reality than 'the Chilean process'.

The first four of the following five chapters tell a story which is organized according to its basic chronology. A project began in Chile late in 1971, under the aegis of President Allende, and Chapter 16 accounts for its inauguration. Chapters 17 and 18 develop the story, and continue up to the extraordinary events of October 1972, which (with hindsight) appeared to mark a watershed. In Chapter 19, that story is concluded. There seems little point in offering further analysis here, in summary, of a chronicle which steadily unfolds itself in the text.

*The final chapter proffers a prospectus for the future of applications in managerial cybernetics. It does not contain any prescriptions, simply because it does not make any predictions. Instead, Chapter 20 prepares two models which — it argues — are basic to the innovative management of any such future. Firstly, it ought to be expected that the impetus to radical change derives from a critical situation. If so, it is necessary to comprehend the nature of crisis itself in the kind of society by which the last part of the twentieth century is characterized. Secondly, and because of these very societal trends, it is of the utmost importance to determine what the 'progress' to which all aspire actually means. The model put forward for this is based on the Aristotelian concept of **entelechy** rather than (for instance) per capita income or life expectancy.*

Thus the book ends with consideration for the perilous future of a planet already torn by almost unimaginable dissensions and cruelties, which are

A flying start

perhaps more a function of gross mismanagement than of brutish greed. Surely the destruction of the Chilean democracy on which this Part is based, is an example of the working out of counter-productive policies by which (maybe well intentioned) super-powers conspicuously mishandle their power — and snuff out the viable system.

The story of the use made of managerial cybernetics in Chile is a complex one. My own involvement in it was total. It seems to me that the posture of a 'neutral scientific advisor' became untenable after the experiences of World War II, and especially since the full circumstances surrounding the holocaust in Japan 1945 became known. This book has already tried to demonstrate that the role of System Four is in cybernetic principle part of the command axis; and if it is not, then in political practice nothing will happen. Thus I do not understand the outlook of the scientific overlords, in Britain for instance, who happily survive in government for a professional lifetime, while parliaments of opposite tendency come and go.

This is said for two reasons. Firstly, I think that the acceptance by both ministers and their scientists that scientific neutrality (which I take to be bogus) is possible, largely accounts for the confusion in Britain over such issues as the choice of energy sources, defence systems, transportation systems, and the like; and also it accounts for the almost total failure to make good use of science in structuring the managerial process itself. Prime Ministers of both parties, when determined to 'do something' about swelling and inefficient bureaucracy, have promptly co-opted successful businessmen on a part-time basis to this obscure end. But the objectives of private profit and the public good are completely different; businessmen do not understand the nature of a viable *system*, but only the notion of economic viability; and the problem is not a part-time affair. If only it were: surely we see in all this the abysmal failure of ministers even to perceive the magnitude of the problems they face, never mind to address them with competence.

The second reason for the opening declaration is this. I am a cybernetician and also (as C. West Churchman calls himself) a 'research philosopher'; but I am certainly not an historian. Moreover, historians appear to be no less subjective than scientists, when it comes to their dissensions. But it is better to rejoice in the human condition than to pretend to exist outside it, while yet in the corporeal substance. It follows that I can tell this story only in the first person,

and in an autobiographical vein. Indeed, people who ask about the work always ask for details as to just how such an extraordinary undertaking came about, and how it continued. This book is, however, about managerial cybernetics; therefore I have ruthlessly expunged from the story mere gossip and my own opinions, and have stuck to the facts as I knew them. But I have not dressed up those perceptions to a pretence of objective omniscience. Moreover, I consider that 'case studies' should reveal far more of the stresses under which the dramatis persona — who include the management scientists — operate than they customarily do. There was plenty of stress in Chile. Thus, to complete the opening paragraph, I declare that I could have pulled out of Chile at any time, and often considered doing so; but I did not, and therefore I hold myself accountable for the part that I played.

It began in the summer of 1971. The manuscript of the first edition of the book you have so far been reading had gone to the publishers. I had also completed most of a book called *Platform for Change*, which is an account of my efforts to project managerial cybernetics internationally during 1970, and to which part of this story eventually became a suffix. I myself was proceeding with many affairs, when a letter arrived from Chile. It is true that I had had vicarious dealings with Chile before, since my (then) consulting firm SIGMA (Science in General Management) had undertaken work for the steel industry and for the railways there in the early sixties. But although I had been concerned with that work, I had never been to Chile: teams of SIGMA people had been there for several years, but as Managing Director I did not then conceive that I had the time to go. So what now, dated 13th July 1971, was this letter from Chile?

Like most Englishmen, I was aware that Dr Salvador Allende had become president of Chile the previous autumn (1970). The fact was remarkable, because this was the first Marxist president to be democratically elected anywhere in the world, and at the time his new government was a focus of international attention. Moreover, it was a minority government, carrying 37% of the electorate; therefore it had a battle on its hands in both the congress and the senate. Nothing daunted, the president had embarked on the massive nationalization of the banks, and of the major companies working in Chile: naturally, for a Marxist, a programme of nationalization of the means of production, distribution, and exchange was fundamental to his programme. This I knew; but I did not know the means whereby this wholesale nationalization of the economy was being achieved. It was done through state agencies, and in particular through an institution called CORFO (Corporación de Fomento de la Producción).

This organization, it turned out, had been set up in the thirties as a kind of national merchant bank — to assist industry. The government was now using it as a vehicle for the nationalization programme in which it was engaged, so that many foreign firms per week (having been paid due and negotiated

compensation for the most part) and the banks (whose shares were being bought by CORFO) were arriving as entities within that corporation. Thus the role of this institution bears comparison with that of (what was later to become in Britain) the National Enterprise Board. And the letter that I received came from there, under the signature of the Technical General Manager, by name Fernando Flores. He introduced himself also as the President of INTEC (Instituto Tecnológico de Chile), which bears organizational comparison with the National Physical Laboratory in Britain — although it is of course much smaller.

This letter spoke of 'the complete reorganization of the public sector of the economy', for which it appeared its author would be primarily responsible. He had read my books, and had even worked with a SIGMA team ten years before. He went on to say that he was now 'in a position from which it is possible to implement, on a national scale — at which cybernetic thinking becomes a necessity — scientific views on management and organization'. He hoped that I would be interested. I was.

We met in London the following month. Fernando Flores filled out the details, and I became enthused with the plans that the government was making. Flores himself had been teaching cybernetics in Santiago — he was a professor of management science and a vice-rector of the university — for several years. But he had also been a founding father of the MAPU party, which — although small — was an influential member of the Unidad Popular coalition that had brought the President to power. And, of course, this is why he had been enticed from the university to his new position at CORFO. What he told me in London was that he had collected together a group of his closest friends, associates, and former students, as a government team within CORFO — and he wanted me to come over to Chile to take charge, in some as yet undefined sense, of the deliberations of this group. I was excited by this invitation, but somewhat cautious. We made a deal that I would visit Chile in November 1971, when we would all get some new perspectives on what was happening and what could possibly be done.

Thus it was that I cancelled many engagements, and spent a long time studying the Chilean problem — the history of the country, and its current political scene. The more I learned the more I came to understand what was already being called 'the Chilean process'. Eventually I arrived in Santiago on 4th November 1971, just as the first anniversary celebrations of the election of President Allende were in full swing. Fernando Flores was there to meet me, and we immediately went into session. That night, I met five more of the people who were to be so influential in the project that was soon to be devised.

It has always seemed to me that organizations, and particularly government organizations, take far too long in the bureaucratic process of merely

contemplating change. Events overtake affairs before anything significant can possibly happen. It was not so in Chile. The group of us worked to exhaustion every day for eight days. During this time, I was able to meet with various influential people in the country, including the directors of major national programmes, and the then Minister of Economics. By the 12th November, 1971, we had all agreed on a plan for the cybernetic regulation of the social economy of Chile. It seems astonishing, looking back, that so much was done in that short time; but I was prepared, my new colleagues were prepared for the approach that they knew I would in principle offer, and in that period they all read the draft manuscript of the first edition of this very book.

The primary point of which I had to convince my friends was that we should firmly take the wholly innovative step of seeking to regulate the social economy in real time. Even the most advanced countries in the world suffer from a vast lag in the receipt of economic data, and they suffer too from the bureaucratic time it takes to process these data towards any kind of conclusion. I had taken the posture that all of this, given the current state of telecommunications and the computing art, was totally unnecessary. In the world's most advanced countries, economic data arrive very late, perhaps the average delay is nine months, before the total picture is seen. This means that most economic decisions are taken out of phase with economic reality. Knowing that this is so, the advanced countries spend a great deal of money in trying to offset the errors thereby induced: they engage in econometric studies aimed at projecting data — not indeed into the future — but only into the present.

Notoriously, the answers come out wrong. Why do this? It is perfectly possible, these days, to capture data at source in real time, and to process them instantly. But we do not have the machinery for such instant data capture, nor do we have the sophisticated computer programs that would know what to do with such a plethora of information if we had it. Yet all of this is well within the compass of current technology.

The Chilean team took that point with ease. They were moreover pleased with the idea that Chile should seize a world lead in the practice of economic regulation: it was wholly consistent with their belief that Chile could show the world the 'peaceful road to Socialism' — which would necessarily involve innovations of a major kind. Even so, they were lugubrious. The country's electronic technology was antiquated: there was no foreign exchange to buy a lot of computers, teleprocessing equipment, video units, and so on, even though their scientists well knew how to use them. How could we develop a system that would be twenty years ahead of its time, using equipment that was already out of date? The answer to that was that the rich world had never understood the *managerial cybernetics* of electronic technology, and had therefore absurdly misused it. (From the time when computers were still

experimental, I had been demonstrating this fact in a constant stream of writings, which the team had mostly read.) I outlined a plan to do the job, using the equipment they already had. They took the plunge.

Thus it was that during these strenuous days, I prepared two papers, dealing with the regulation of the social economy. Before stating their contents, I recapitulate two points. Firstly, we had a shorthand. The general terminology of cybernetics was perfectly familiar to the team, and the specific terminology of this book was our *lingua franca*. There was no need for long-winded explanations. In particular, we had explored the notion of *recursions* of the viable system in lengthy discussions. Secondly, the target of real-time regulation had been conceded. There was a third point. I was being updated rapidly on the political context of these affairs, and Fernando Flores was making it very clear that he had wider plans (as his first letter had implicitly indicated) for cybernetic thinking in government than 'merely' to succeed in the present task. It was for this third reason that my first paper in Chile had a resounding title:

Cybernetic Notes on The Effective Organization of the State with Particular Reference to Industrial Control

Recursively speaking, the Chilean nation is embedded in the world of nations, and the government is embedded in the nation. This was understood; all these are supposedly viable systems.

The government should be conceived as a viable system (System Five being the President of the Republic) in which System One consists of the Headquarters of each major function — health, education, finance, industry

Picking out industry as a viable system embedded in this (System Five being the Minister of Economics), we find a set of industrial sectors constituting System One. These include such elements as food, textiles, automotive

Each sector (System Five being the Undersecretary for Economics with his appropriate committee) contains, as System One, a set of enterprises, or firms.

Embedded in the enterprise is the plant; within that the department; within that the social unit of a working group; and within that the individual worker — viable systems all.

The paper with the above heading concentrated on the organization of the enterprise, of the sectors, of industry itself, and of the state *insofar* as its relationship with the social economy was concerned.

Note: in terms of variety engineering, there seemed to be too many sectors to be contained, as constituting System One, in total industry — conceived as a viable system. It is noteworthy then, that there were soon to emerge four 'ramas' (branches), constituting heavy industry, light industry, consumer industry, and material supplies industry. This inserted an extra level of recursion. It was probably a political decision, but it was also sound cybernetics.

The paper proceeded to draw very preliminary mappings of the (generalized) enterprise, the (generalized) sector, the industrial headquarters, and the government itself, in terms of the viable system model. This was a swift attempt at a preliminary diagnosis of weakness, as spotlighted by the model.

There followed a section on planning, as a continuous and adaptive process. (The principles then briefly advocated later developed into the planning theory which may be consulted in Chapter 13 of *The Heart of Enterprise*.) This section was intended to highlight the differences between our cybernetic approach, and the approach whereby a 'national plan' based on time horizons and the usual estimating procedures, had already been created by an orthodox government agency. There were ample reasons why, contrary to expectation, the work discussed here was not related to that effort. The cybernetic reasons were paramount in my mind; but the political reasons were also clear enough.

The paper was completed with a section on information flow in this embedded set of viable systems. It pressed the uniform use of the model at all levels of recursion as constituting a powerful variety reducer. It stressed the value of indices, formulated as in Chapter 11 of this book, as homogeneous units of measurement. Thirdly, it marked the issue that by putting great effort into a highly sophisticated computer program, capable of assessing the data that we proposed to collect and process in real time, we could supply a tool to management at every level of recursion **regardless** of its managerial content — because of the uniform model and the indexical homogeneity.

The team accepted this paper almost without comment, because it was effectively a summary of our vigorous discussions on what should indeed be the general framework of the approach.

The second paper, however, left me to propose the project that would start this work moving, and gear it to achieve something in a very short space of time. It had been explained to me with vigour by the Economic Undersecretary, Oscar Garretón, just what economic pressures the government were feeling. The workers had received wage increases of forty per cent, as part of a deliberate redistribution of wealth, and peasants (who had often had no actual 'wage' at all, but only benefits in kind) were also entitled to a similar basic wage. Copper prices had dropped; and copper was almost the whole of Chile's foreign

earning capacity (at least eighty per cent). Therefore the large balance of payments deficit was becoming larger. The gross national product and industrial production were rising (probably by about seven per cent); and in the municipal elections the Government's poll had risen to fifty per cent. So far, so good; but there was an artificial euphoria in the air. Thus the lower-paid were spending, the higher-paid were not investing, and foreign credit and technical support were non-existent. This was a clear recipe for inflation, consumer shortages, and every kind of trouble. It was generally thought, internationally, that thirty-five per cent inflation had brought down the previous government of the Christian Democrats. Unidad Popular had reduced this very substantially. But within a year, in all circumstances, the foreign reserves would run out . . .

Now I had always propounded the view (see especially *Decision and Control*) that the **time-scale** of managerial problems is one of the most vital parameters involved. There is no point in telling a manager who has to give a verdict by the end of the month that a properly conducted scientific study will take a year. The management scientist has either to cut corners, or to bow out. That statement, in invoking personal responsibility, refers back to the opening paragraphs of this chapter. But it says something more — in fact, a great deal more. If the managerial time-scale is a basic parameter of the problem, then a management science that ignores the fact is not a science at all. This is clear in neurocybernetics. 'Shall I, or shall I not, run for that bus?' 'Shall I hit this man who threatens me, or run for it?' The brain that replies: 'This is all very difficult; heart and lungs must be consulted; adrenalin checks must be made; then there are statistical extrapolations . . . I'll tell you in half an hour', is *no good*.

The second paper that I wrote tried to take into account all that I had learned from Garretón, and certainly checked out with Flores. It left some of the younger scientists in the team gasping for air. The first title of the project was later superseded; it became:

Project Cybersyn

OBJECTIVE:

To install a preliminary system of information and regulation for the industrial economy

that will demonstrate the main features of cybernetic management

and begin to help in the task of actual decision-making by 1st March 1972.

It was already the middle of November 1971; but it was my judgment that we needed such a crash programme — because of the rate at which the economic situation was deteriorating.

The code-name Cybersyn is an abbreviation of 'cybernetic synergy'. The paper proposed a **plan of action** whereby, in four and a half months, the above objective would be achieved. On 1st March 1972, it declared, we should be ready to start the regulatory operation and to produce results — for a sample of enterprises in a sample of sectors.

If we were going to work in real time, we should need a communications network extending down the three thousand miles of Chile. This was nicknamed Cybernet.

Cybernet was a system whereby every single factory in the country, contained within the nationalized social economy, could be in communication with a computer. Now ideally, this computer would have been a small machine, local to the factory, and at best within it, which would process whatever information turned out to be vital for that factory's management. But such computers did not exist in Chile, nor could the country afford to buy them. Therefore it was necessary to use the computer power available in Santiago: it consisted of an IBM 360/50 machine and a Burroughs 3500 machine. There was no intention to centralize the economy, as any reader of this book will surely know; but if computer power were to be made available to the workers' committees running individual plants in the country, then it would be essential to provide the links of communication necessary to that end. Again, this presents no technical problem in an age of teleprocessing; but the fact was that Chile could not afford teleprocessing equipment either. And so we resolved the problem by the only means available, namely the telex network already instituted in the country, linked together by microwave communication that had already been established for other purposes (namely the tracking of satellites). These microwave linkages existed from Arica in the far north of Chile down to Santiago, and beyond to Puerto Montt. And there were in addition radio links that could complete the network down to the world's most southerly city, Punto Arenas. The plan for Cybernet, therefore, called for the requisitioning of telexes, and the use of the communications links to put everyone in touch with everyone else — and with the computer system in Santiago. The plan allowed just four months for this to be accomplished (and it was).

Now the intention of Cybernet was to make computer power available to the workers' committees in every factory. How could this be done? The basic idea

was that crucial indices of performance in every plant should be transmitted daily to the computers, where they would be processed and examined for any kind of important signal that they contained. If there were any sort of warning implied by these data, then an alerting signal would be sent back to the managers of the plant concerned. The next problem was: how to come by these crucial indices

Readers of this book by now understand the concept of the triple index, which measures productivity, latency, and their product — the overall measure of performance. But the problem remained: to which activities in factories ought these measures to be applied? Accordingly, under the direction of Raúl Espejo, the Senior Project Manager in Chile, and Jorge Barrientos, another senior member of the directing group, operational research teams were formed to make analyses of every sector of the social economy, down to plant level. Their primary job was to construct a **quantitative flow chart** of activities within each factory that would highlight all important activities.

For example, we certainly needed to measure the state of input stocks of raw material, and of output stocks of finished material. We needed to measure any process that might prove to be a bottleneck in the system. And there were other standard measures too: for example, it has always been my ambition to find a measure of social unease. The best approximation to such a measure that I could envisage at this time was the ratio of employees on the payroll to those present on any given day. In short, absenteeism is some kind of measure of morale, as I had learnt from work dating back into the 1950s by Professor R.W. Revans. Thus the OR teams would be charged with making models of every factory that would bring out these, and similar crucial measurement points. And they would agree with the management (in most cases by now a workers' committee) on the values to be attributed to 'capability' and 'potentiality' — as defined in this book. Then, given that these two figures, for any index, could be stored within the computer, and given, thanks to Cybernet, that a daily 'actual' figure could be transmitted, the computer would be capable of computing the triple index for every indicator for every factory. (In practice, it turned out that some ten or a dozen indices were adequate to monitor the performance of every plant; and so by then we knew the scale of the computer operation involved.) The teams were also to be instructed to make it clear that, as time went on, each participating factory would be free to add any index that it liked — without, if it wished, declaring what that index measured — and the system would monitor it for that management.

But before reaching the computer problem itself, we have to understand the human predicament of the people running these factories. For instance, some of the managers supplied by the hitherto owners were foreigners, who had engaged in very little training of their Chilean counterparts. And when the government of the Unidad Popular took over, most of the foreign managers

design the iconic system of representation which would support the indexical measures that were being elaborated, and to construct a preliminary operations room. My own task during this period, according to the plan, was to return to England. Somehow, I had to originate a computer program capable of studying tens of thousands of indices every day, and of evaluating them for the importance of any crucial information which their movements implied, so that alerting messages could be sent back to the managers in the plants. I asked for the commission to sub-contract the work required for this program, since I had done this kind of system building many times before (as my Chilean colleagues well understood), and since the computer people in Chile — brilliant though these scientists were — had many other duties to perform. Secondly, I should need to investigate prospects for a simulation system in the operations room that could accept the input of real-time data. This would be a completely novel development in operational research technique.

The PERT chart appended to the original plan is given in Figure 42, just as it was. It is clear what was meant earlier by the reference to 'cutting corners': a first action (see footnote*) commands: 'improve this PERT'. It shows the actions needed to be taken by CORFO in respect of Cybernet. It shows (although there was much more oral explanation) what Team A should be doing, first in the enterprises, and then back at base. It shows the role of ECOM, the national computing centre, where Isaquino Benadof was to become informational project manager for Cybersyn. It shows what Team B ought to do back in Britain to initiate the statistical filtration program.

Also included in the plan was a specification for an interdisciplinary team itself. It included the words: 'beware of people who have carved out a piece of the field and who want to grow flowers on it'. Of economics, that most relevant subject to this work, it said: 'no econometric models have yet proven adequate. We have to *invent* econometrics'. Having listed all the specialities required, it said:

Important Qualification for All — it limits the search — none of these professionals is to despise the professional area of any other.

The plan ended: 'I return in March'.

The presentation of this plan to the team, as mentioned earlier, was an exercise in the suspension of disbelief. Could it possibly be achieved? Perhaps it was not my *contention* that it could, but that I had said: 'I return in March', that won the day. At any rate, agreement was unanimous. Plans were made to facilitate that future, and for my return; and a communications system was determined whereby there could be constant Telex interaction between Teams A and B, in Santiago and London respectively. All that remained was for Flores to obtain permission to advance all this from the highest level.

We may well reflect, these years later, on this episode. It shows just how much proper preparation on all sides, the recognition of realities, monstrosly hard work by all concerned, and burgeoning friendship, can do. Such things have happened before; it is to be hoped that they will continue to happen — in place of the deathly prescriptions of bureaucracy.

On the evening of November 12th, Fernando Flores arranged a dinner for all concerned in a very relaxed location. Beforehand, I was to go to the Ministry of Economics. There I reviewed matters with the Undersecretary. We went together to La Moneda, the presidential palace. Obviously, Flores had prepared the whole event. Nonetheless, he did not come himself. A cynic could declare that I was left to sink or swim. In fact, I received this arrangement as one of the greatest gestures of confidence that I ever received; because it was open to me to say anything at all. I remembered it, many times, later — when in near despair.

The atmosphere, when I finally reached the rendezvous where the whole group was waiting, was understandably electric. 'The President says: Go ahead — fast.' It was an evening of great excitement and high expectations.

Dr. Allende had been forthright on this occasion, as he always remained. He particularly wished to be satisfied that the plans were decentralizing, worker-participative, and anti-bureaucratic. Since these very intentions had been fundamental to our work, there had been no difficulty at all in convincing him. It is also noteworthy that he exhibited an intellectual serenity in the process of grasping a vast new concept in a very short time that I found amazing. It was contrary to all previous (and subsequent) experience. Of course, he had been prepared; but other top men have also had their briefs. Of course, he might not *really* have understood; but a consultant learns to judge that by the questions. He did not waste a single one.

The 'real-time economy' hurdle was rather difficult. If it were at all possible, why had not the First World done it? Because they did not understand managerial cybernetics. The Third World could leapfrog over their backs — given such understanding. This argument was clearly difficult for the President to take, just as it is difficult for the Chairman of a little English company to believe that whole new vistas of managerial acumen are open to him — when ICI and Unilever, and the nationalized industries, 'have not done it'. The President said that Chile might very well do it; the idea had his blessing; but how could a small socialist state continue to exist in a capitalist milieu? The notion of cybernetic recursions was thereby invoked . . . I still cannot answer that question.

I took half an hour to rough out, on a piece of blank paper on the table between us, the model of any viable system — and its recursions. This was the

substance of the two papers that I had just written — but it included the cybernetic theory of this whole book. It is not possible to know how far he was prepared; but certainly it was known to me that the President had medical qualifications. Dr Allende had been a pathologist. Without hesitation, I embarked on an account of the viable system in neurophysiological terms. Again, his questions were probing, but he had no difficulty in accommodating to the model that is called *Brain of the Firm*. Gradually, I built up, on that piece of paper between us, Systems One, Two, Three, and Four. I explained the need for a System Five.

Much earlier in this Chapter, in relation to my first Chilean report, the remark came: 'The government should be conceived as a viable system (System Five being the President of the Republic)'. I drew the square on the piece of paper, labelled Five. He threw himself back in his chair: 'at last', he said, '*el pueblo*'.

This remark, as I have previously attested, had a profound effect on me. If the Compañero Presidente had a weakness, and which of us has not, it was a certain pride in his office. He liked to dress up, he liked to wear his sash, he liked to sit on his throne-like chair in La Moneda. But, when it came down to cybernetic science, he — System Five — was 'the people'. He was eventually to die in that exact posture.

This meeting, and that abandoned meal, being over, I returned to London on the 13th November, 1971, with all the plans in hand.

Ten days.

CHAPTER SEVENTEEN

Into its stride

During the twenty-four hour flight back from Santiago to London, I drew up a tentative flow diagram of a statistical program suite, intended to monitor thousands of indices on a daily basis

However: if it took a chapter to account for the first ten days of this activity, and the time-base of the story were now reduced to one day, this book would never be concluded. In fact, though with hindsight, the story of management cybernetics in Allende's Chile falls into four distinct epochs. The opening epoch was recounted in Chapter 16. The second epoch, which must be covered in this chapter, takes the story up to a crucial date: October 1972 and its aftermath. The treatment now will be to discuss activity by topics, rather than as a diary; so that the dates mentioned are in temporal order for each topic, but cross-referencing between them is left to the reader's integrative perception. Because the account of each topic is intended to be self-sufficient, there is a slight overlap sometimes with the introductory story of the first ten days.

From the start, as witness the quotation from the first letter from Fernando Flores, it had been the intention of his 'core' group (in which I was immediately happy to count myself) to use cybernetics as 'the science of effective organization', in all managerial affairs that could be influenced by that group and its supporting teams, on a national scale — '*at which cybernetic thinking becomes a necessity*', the first letter had said. Thus, also from the start, we were discussing wider issues than the regulation of the social economy. Flores himself moved, as was fairly predictable, into the government: first as Undersecretary of State for Economics, then as Minister of Economics, later as Minister of Finance, and finally as Secretary of the Cabinet. Meanwhile, the country was increasingly under threat, both from foreign opponents, and from internal dissensions. These included not only the left-right politics of Chile as a nation, but also internal squabbles within the Unidad Popular coalition itself. Thus, over the whole period of my two-year involvement, the exigencies of practical management changed the emphasis of what I personally was doing, and

the tasks allocated to the growing number of teams depending from the core. Surely that is a *proper* use of management science. It should not develop its own ideology; but it should attest to one. If not, what is it doing there? Popular accounts have concentrated on the technological aspect — the socio-economic regulation adumbrated in Chapter 16; but they give a lopsided view of the affair, and make it vulnerable to charges of 'technocracy' (as shall be seen later). The reality was that I have no record, nor recollection, of any core group discussion which was not focussed upon the needs of the people, or the intellectual and perceptual development of themselves and their leaders. The potency of science, and skills of technology, were to be aligned in their service.

Meanwhile, however, it is a fact that we launched the very definite plan of action at the end of the first ten days which was depicted in the last chapter. It is also a fact that this plan was accomplished by March 1972 as intended. The ostensible exception to this was the creation of the 'operations room'. What was achieved by the first plan was not the eventual result — see later — but simply a kind of informational headquarters; specifications for the room that was intended to create the 'environment for decision' of Chapter 13, and to become the prototype physical basis of Chapter 16 for a new style of management, were not even drawn up until the 'start' (as the Chapter 16 PERT chart calls it) in March 1972.

During that month, indeed, while I was in Chile, cybernetic deliberations were advanced by the core group on many fronts, and in particular the People Project (see later) was launched. But Project Cybersyn received a new boost; because, following the success of the first plan, we could now think in terms of putting together the basic tools thereby created in the cause of cybernetic synergy. Of course, they had been devised to this precise end, and all needed much development, but it was enough to gain approval for 'the start'.

The final section of the March report, which will be alluded to under each topic, was about programming. It included a personal statement: 'The month following is a bad one for me: Rome, Georgia, Washington, Philadelphia, Zurich, St. Gallen, Vienna'. Despite my sense of commitment to Chile, I was still working as a general consultant. The reaction to this was to be decisive for the next eighteen months, if not for ever in spirit; and perhaps those whom I let down at the time will at this late date accept the slight that was implied but not intended. President Allende wrote to me on 28th April, 1972, saying that he considered it 'of prime importance to count on your presence in Chile in a more permanent way and in a more executive role'. In May 1972 I was confirmed as Scientific Director of the work of which Fernando Flores was Political Director. It seems necessary to record this; for had it not been so, the momentum of the work at large could not have been sustained. There is a limit

to what anyone can do in an *advisory* capacity, unless he accepts *responsibility* too. This sentence, in my opinion, should be taken as the cynosure of System Four.

The Cyberstride Program Suite

The purpose of this suite was to monitor information flows (as depicted in Figure 27) at all levels of recursion; to provide alerting signals to Systems 3-2-1 of any *incipient* change (so that action could be taken to avert trouble *before* it occurred); and to provide the 'arousal filter' to Systems Four and Five (as depicted in Figure 32). This purpose is founded in the notion that the data informing all regulatory systems should be prospective and anticipatory, rather than retrospective and a matter of historical record.

By using only two-digit ratios as input to the suite, as specified in Chapter 11, a massive reduction in regulatory variety is attained; and it becomes worthwhile to invest heavily in a single program (this being contrary to EDP practice, in which ad hoc programs are usually written for each application).

The statistical thinking behind the approach is rooted in the quality control practices that have been commonly used on the shop-floor for thirty years. But since there has been no general movement towards their application in managerial contexts, it might seem strange to have based the regulation of an entire social economy on their use. Therefore I record references to the genesis and development of such application at the end of this section.

The program is first of all required to examine an arriving Actual figure, and to test it for acceptability as a legitimate member of its own statistical distribution. These, the so-called 'taxonomic' distributions, were the initial samples drawn according to the PERT of Figure 42, with some sixty sampled values; and there are simple statistical tests for assessing the probability of legitimate membership. Next, by looking up the appropriate values for Capability and Potentiality, in the program suite's lexicon, the three indices are created. These are statistically 'normalized' by a trigonometrical transformation, since distributions of ratios, which have a limiting value of unity, are notoriously skewed to the right. (The original intention was to transform to the inverse sine, but methods were later found to choose the appropriate transform for each time series.) Then comes the statistical filtration which detects incipient change. The techniques I had used in the past were clearly out of date, but my own PERT chart called for this program by March 1972 — and it was already late November. The scientists and programmers at ECOM (the National Computing Centre in Chile) were overloaded

Accordingly, it was decided to subcontract this work to London, if a contractor could be found to undertake such difficult research-cum-programming in so short a time. Moreover, we needed a group who also understood the operational research features of the Cybersyn project: the nature of the modelling processes and techniques of data capture that were being developed in Chile. As a Briton, I knew whom I wanted — they were a group of consultants within the London branch of the international firm of Arthur Andersen and Co. The arrangements were made, with an old friend David Kaye directing and with Alan Dunsmuir managing the job from day to day. It is relevant to record how the apparently absurd time constraint was handled. This comes from a report to Chile in January 1972 (work began on the 10th):

'The investigation established that if work on the suite began immediately, it would not be completed until the 19th June 1972. The reason for this was all too clear. A fully developed, watertight version of the suite, tested and documented for use many thousands of miles away, must be expected to take a lot of programming. Meanwhile, I was insisting that something be ready for (at the least) experimental use at the planned date — namely by 13th March . . . It seemed to me that a version of the suite should be prepared for March, and that the 'debugging' of these programs could then continue into June to produce the polished job. However the contractors convinced me that this plan would not be practicable. An experimental program (henceforth known as the 'temporary suite') could indeed be installed by March. But it would have to accept input restrictions, and corners would have to be cut in the development of the logic. Therefore it would not be possible to create the final version (henceforth called the 'permanent suite') simply by 'cleaning up' the temporary suite. The two projects were separate. However: if the two suites were developed in parallel, much would be learned by the interaction of the two programming teams, and therefore the extra money spent would not be entirely wasted.'

This is what happened; the consultants started the work in London. And almost immediately, I was confronted with an extraordinary decision.

No sooner had we reached a conclusion on the precise mathematical techniques to be used in generating the statistical filter itself, than I received a phone call late at night from Alan Dunsmuir. Had I read the *Operational Research Quarterly* for December 1971 (see Reference 1), and in particular a paper by Harrison and Stevens called 'A Bayesian Approach to Short Term Forecasting'? Hardly so, given all that was happening. I stayed up all night with this paper, and next day we determined to scrap the agreed mathematical

approach in favour of theirs. It was a bold step. This comes from the previously quoted report of January 1972:

'Briefly, the method uses Bayesian probability theory to quantify a multi-state data-generating process. The filter can automatically recognize changes in the stream of input indices, and determine whether they represent transient errors, step functions, or changes in time trend and slope. The especially attractive cybernetic feature of the system is that the filter responds to the increasing uncertainty which surrounds change by increasing its own sensitivity whenever change is signalled. Forecasts are produced in terms of a joint parameter distribution, which is more robust than a single figure forecast.

The expectation is that this 3 - 2 - 1 regulator will discard all input data that indicate performance as continuing within chance variation around the standard indexical distribution, and that it will use significant data to produce forecasts of imminent change that will be made available immediately to the managers of the economy. These people will now be in a position to forestall events — if they wish to, and if they know what action to take (see later). At any rate, there is nothing retrospective or historical about the data collection system, which is wholly oriented to prediction.

It is a primary aim to avoid creating a vast bureaucratic machine, and the true intention of the 3 - 2 - 1 regulator is simply to discard all the data once they have been wrung dry by this powerful on-line system. However, arrangements are being made for the time being, to store data so that comparisons can be made with the data generator of the Operative Plan.'

(The Operative Plan will be mentioned later under Project Checo.)

The project manager for Cyberstride in Santiago was, as previously mentioned, Isaquino Benadof at ECOM. He later took over the whole data management programme, which was originally directed by a distinguished Chilean professor — Hernán Santa Mariá. In March 1972, Alan Dunsmuir was at ECOM. The temporary suite was duly working, and therefore Project Cybersyn could proceed on course. The first printout from the permanent suite, which was brought out in its first form a little later by John Brister, is dated 11th November 1972, although it had been due by the end of August, and therefore 'belongs' to the epoch of this chapter.

Computer people will sympathize with those named in this story. The challenge was very great. Moreover, nothing was known about the performance of the Harrison-Stevens techniques in advance. It was found that

each time series had to be specifically 'tuned', and in May it was taking a week to deal with eight series — because of the shortage of available computer time. Eventually programs were written that could cope with the tuning issue. By July, the temporary suite was running without problems, and thirty indices were routinely being processed. In the meantime, the permanent suite was taking shape. The 'corner-cutting' in the temporary suite caused many problems; but as Dunsmuir had argued at the start, its direction was being shaped by experiences with the temporary suite. In particular, changes were made to deal with the need to generate algedonic signals (see Project Cybersyn). The problem of adequate computer time was solved by switching the work from the IBM 360/50 to the new Burroughs 3500, which was practically empty. By the end of this epoch, something like seventy percent of the socio-industrial economy was operating in this system, involving about four hundred enterprises, through Cybernet; and these were major components of Project Cybersyn — especially as far as Systems 3 - 2 - 1 were concerned at all levels of recursion.

Note on genesis and development (Reference 2):

The fundamental technique that lies behind Cyberstride for the control of Systems 1 - 2 - 3 was first developed in the years 1949 - 53 for the control of steelworks production. This application was prior to the availability of electronic computers, and the whole system was operated by hand using nomographs to compute standards, desk calculating machines to compute indices, and visual control charts to provide the probability filters. A paper explaining how the system worked was presented to the Royal Statistical Society in 1953, entitled 'The Productivity Index in Active Service' (published in *Applied Statistics*, Vol.IV, No.1), while an earlier paper (Vol.II, No.3) entitled 'A Technique for Standardizing Massed Batteries of Control Charts', showed how visual statistical control procedures were standardized to facilitate filtering. In subsequent years the approach was generalized, following other applications — incorporating the use of computers. It was discussed in one form as the 'Sketch for a Cybernetic Factory', Chapter XVI of *Cybernetics and Management* in 1959, and in another form Chapter 13 and 15 of *Decision and Control* in 1966. By the publication (March 1972) of the first edition of this book, the role of what became the Cyberstride Suite in a cybernetic management structure seemed evident. It is updated in terms of microcomputers in *The Heart of Enterprise*.

The Checo Programs

The basic tools for handling Systems 3-2-1 information have been discussed: Cybernet and Cyberstride. Information about the *internal* operations of any viable system will, in certain circumstances that were examined in Part III, be transmitted to Systems 3-4-5. But System Four is charged with the task of providing plans to steer the whole organization — which is not merely the sum

of Systems One in their particular environments. In the case of a national economy, the environment is firstly the whole of the nation (and not some sector of it), embedded secondly in the environment of the community of all nations.

In Chile, there was an institution known as ODEPLAN (an acronym for the National Planning Office), which in theory reported to the President through a Director holding ministerial status. It had little influence in practice. Its methodology was based on that favoured by national planners in many parts of the world, and particularly by the Eastern bloc: input-output analysis. Its work was published, and very polished within these terms. But, as one of the core group wrote: 'in point of fact it has become an institution dedicated to preparing the National Accounts and developing statistical reports'. Odeplan was not poised to create a true System Four function, any more than the National Office of Statistics and Census could have performed the System Three function that Cyberstride would fulfil. One can find comparable institutions in most countries; and it seems ironic that although they are usually *defined* — as in Chile — in terms of the Four-Three functions of a viable system, they nowhere embrace a methodology that could conceivably *discharge* those functions of a viable system. ('Nowhere' means 'nowhere as far as I know'. But I can certainly list some countries other than Chile of which the statement has at some time been true, to my personal knowledge and indeed distress: Britain, Canada, India, Italy, Denmark, and Jamaica.) In fact, the Chilean 'Operative Plan' mentioned in the last section was under the control of the Budget Office in the Ministry of Finance, which is exactly where one would expect to find the real power.

Chapter 13 indicates the route, taken via systems models and their simulation, that I had successfully argued we should take during the first meeting in Chile — witness the activity of economic modelling shown in the PERT chart of Chapter 16. Let the January 1972 report from London, which restated the case, again take over the story.

'It is certainly possible to contemplate the use of large input-output analyses as a means of balancing the Chilean economy, but there are three major problems about this approach:

- (i) matrix models are very poor in *structure*, since structure can be depicted only by listing constraints on the equations which the rows represent. This is a shortcoming even when the structure is known and accepted. But if (as I take it) an objective is actually to restructure the Chilean economy, this is a poor tool indeed.
- (ii) it is very difficult to introduce stochastic elements into input-output models — yet economic life is a stochastic process.

Brain. He managed one of the three projects just mentioned, and is in my opinion (*exponential deleted*). He holds a senior job in industry, but is thinking of switching to academic life. We also involved K.A. Gilligan, a mathematical physicist and statistician who went into OR and has been involved in real-time corporate modelling.

In this way the Checo (CHilean ECOnomy) research was born. It was under the direction in Chile of Mario Grandi. Another Chilean, Hernán Aviles, came to London for training. Obviously this was a mammoth undertaking. But the first runs of a tentative internal model were being made in June 1972 (against the target date of March), and by September there was an experimental model of the economy, at the macroeconomic level, which included sub-models of the generation of national income, inflation, and foreign exchange. The Light Industry *Rama*, and the Automotive *Industry*, had been chosen at two different microeconomic levels of recursion. Simulations were run for years ahead; they were thought provoking; but the team saw itself as 'learning the trade', and no-one was anxious to place reliance on the results. Communications with Ron Anderton, by this time at Lancaster University and having other commitments, were not easy. The development came to a virtual halt after the third epoch (next chapter); therefore it does not seem worthwhile to give elaborate details — although these are still preserved.

But while the Checo team was undertaking these experiments in the spirit of a prolegomenon to a full-bodied System Four, I had certain drives of my own to discuss with Mario Grandi, and often his team, on a short-term basis.

In the first place, study was required of the dissemination of results (when they were obtained) of any national model to the sectors, of any sectorial model to the enterprises, and so on — down to the workers' committees. The problem of recursivity in the viable system had not been solved for System Four, although it had been for System Three (see Project Cybersyn later). The Checo team set out to study these issues, and with some success: there was nothing to block their progress, and they were a well-balanced interdisciplinary team — which included a psychologist (and which other national planning group could boast such an active member?). Had the work gone on, much would have come of this initiative, as the perusal of later sections will imply.

Secondly: the real reason for lack of confidence in the results of the simulations that were coming out, was (not that the team was inexperienced, as their humility declared, but) that the data were untrustworthy. As is usual with national figures, they were out of date; and, also as usual, they were differentially lagged. Too little attention has ever been paid to these, and associated, dangers in the origins and development of *Dynamo* simulations that have achieved world-wide attention, and continue to do so. Obviously,

(iii) Chile is plunged into an epoch of rapid change, and therefore the most important feature of any System Four representation of the economy should be the adequate reflection of its *dynamics*. Input-output is deplorably static.

I therefore recommend a wholly different approach. We need a simulation model of the industrial sectors and their interaction embedded in an environment that takes account of investment capability in terms of both foreign exchange and domestic savings. The emphasis will be on structure (which can be changed — by inserting new feedback loops for example) and on the dynamic interplay of the factors modelled (which produces 'multiplier' effects of crucial importance). This model would be used to mediate between the detail of current performance (arising from the 3-2-1 monitoring system) and the current structural situation (as reflected by the Operative Plan) on the one hand, and the formulation of strategy on the other. System Four, in short, is a mediator between Systems Three and Five.

With a simulator of this kind, we can investigate the nature of the *trapped states* in which the economy is currently enmeshed, and which appear to be functions of a metasystem that extends beyond the national boundaries. For example: if foreign exchange earnings have been used to support a service sector supporting in turn the high-consumption low-saving pattern of the elite groups to whom they flow, then this would count as a trapped state. When these systems are demonstrated, the effect of single measures (land reform, copper nationalization) will (predictably) be seen as sufficient in themselves to break out of the traps. Cybernetic considerations certainly suggest that new structure, involving new information pathways and the harnessing of motivational factors, will be needed to achieve Chile's radical political goals. The simulator will be the government's experimental laboratory.

Can this be done? The first PERT chart called for a *tentative* model of this kind by the March deadline. On this time-scale, there is only one way into the problem, and that is to make use of the immediately available DYNAMO compiler that has been extensively developed over many years by J.W. Forrester of MIT. I have directed three projects in the past using this compiler, and have found it a powerful and flexible tool.

Accordingly, I sought out R.H. Anderton, a systems engineer brought up in the aerospace industry who switched to OR and the human sciences, and whose work is referred to in Chapter 13 of

marked from inside to show that mapping of the model for which any meeting had been called: elements could be named, and basic levels of performance could be indicated in terms of the three indices. Alegdonic signals were (as proposed in the Chapter 13 description) indicated with 'flashing red lights', but we dispensed with 'the ringing of bells'.

Next came two screens, one displaying alerting signals for Systems 3-4-5 for *this* enterprise, and the other alegdonic signals from contained (subsidiary) enterprises that had now reached *this* level of recursion (more on this later). These screens were designed and made in Chile *via* INTEC. The ergonomics was advanced — but they had to be worked by hand! As usual, there was no money for the proper interfaces. Had there been a teleprocessing facility, however, I should personally have opposed the use of video units in this room, and preferred to have some kind of electro-magnetic switching instead. The symbols to be manipulated were bold and clear: they had been properly designed, and all could read them. Video units would not be large enough to be seen on the wall, and each member of the meeting would find himself peering at his own shimmering box. The issue is exemplified at airports, where both systems are in use.

Similar arguments apply to the machinery installed for calling up the information that the meeting would need, having read any warning signals about incipient change. There is no need to repeat the arguments of Chapter 13 about the iconic representation of data; and it is *possible* to use iconic charts with colour TV. But the loss of clarity, and even (in my own perception, at least) serenity, induced by 'flicker' made me personally satisfied with the optical system that we used. The equipment was called Datafeed, and it was made by Electrosonic Ltd. in London. It had three information screens, that could be in use simultaneously, each being the target screen for five back projectors. Thus the iconic-picture-carrying capacity of the set was $3 \times 5 \times 80 = 1200$. These screens were surmounted by a large lexical screen, fed by a sixteenth back-projector. In order to call up a picture advertized in the lexicon, each member of the meeting — using buttons in the arm of his chair — could firstly command control of the equipment, next select one of the three screens, and thirdly select one of the iconic pictures to show on that screen. Of course, he could place three representations side by side, and make comparisons.

It is clear that it is not feasible to display 1200 titles on one screen simultaneously: a lexical list of thirty titles was the maximum that the ergonomists found effective. Hence the total lexicon was split into classes of classes. 'Here is the list of consumer industries. You want to know about textiles! Here is the list of textile companies' . . . and so on, until the detailed information available on a specific problem could be called onto a display screen. There was another ergonomic aspect to the design, with was drawn up

my own plan was not to rely on such 'national statistics' any more. I wanted to inject information *in real time* into the Checo programs *via* Cyberstride. Thus any model of the economy, whether macro or micro, would find its base, and make its basic predictions, in terms of aggregations of low-level data — as has often been done. But Checo would be updated every day by the output from Systems 1-2-3, and would promptly re-run a ten-year simulation; and this has never been done. This was one of my fundamental solutions to the creation of an effective Three-Four homestat; it remains so, but it remains a dream unfulfilled.

Thirdly, and despite the professionally admonitory warnings of the Checo team, I needed any indications that I could get in addressing the problems discussed under the later topic heading 'Externalities'. I did get such indications. Time did not permit the fructification of the plans made under this heading, but I have no reason to think — with hindsight — that the indications of the Checo simulations were misleading.

The Operations Room

In Chapter 13 a basic design was given for an operations room: we built it in Santiago, according to that specification — with the exception of the use of a hybrid computer there advocated for economic simulation. As previously explained, we used the digital program *Dynamo* to begin the Checo investigations, because it already existed and we were in a hurry; but a sub-contract was initiated in Britain (because the analogue hardware could not be found in Chile) to pursue the 'hybrid' idea. It did not come to fruition: basically the reason was that the research group were waiting for the Checo team to reach conclusions about the models they were constructing before they themselves could do very much.

The room itself took a long time to find, because no government office was big enough to hold it. The detailed design, by Gui Bonsiepe and his team at INTEC, called for a hexagonal room ten metres across-flats. There was to be no obstruction in that arena; and furthermore there had to be annular space around the room in which to house the equipment working the screens. It is ironic that we finally took over the lease of the building which had earlier housed *Readers Digest*. Roberto Cañete was in command of the Operations Room construction, and naturally also ran the communications centre of Cybernet. The layout follows.

First came the animated Figure 27, two metres high, and built by Technomation Ltd in Britain. This was in reality a cupboard, housing the spinning polaroid discs that produced the effect of movement, the screen itself being the cupboard door. Thus, the squares and circles of the model could be

in April 1972. The selection of one out of thirty is a five-bit decision: five control knobs, each either pressed or not pressed, can select between thirty-two items. In conformity with the ergonomic considerations advanced in Chapter 13 and in this chapter, I determined to use the system of five knobs — rather than any numbering system, with 'big-hand' controls — large knobs, with strong springs, that could be **thumped**. Once more: this room was a prototype room for use by workers' committees, and not a *sanctum sanctorum* for a governmental élite.

The final pair of screens were for Checo simulations. An animated chart of the economic model, using flexible lines so that the meeting could make alterations, add feedbacks, postulate new relationships, covered one wall. The flow lines on the animated *Dynamo* representation moved by the reflection of polarized light this time — an interesting and effective ergonomic innovation. Beside this screen was a primitive back-projection screen on which the results of simulation could be shown. (This would eventually have been the place for the hybrid computer, tracing out projections with a multiple pen-head on moving paper, which would then be magnified onto the screen as they were being drawn.)

Five walls were used, and the sixth was blank: we shall see why later. Everything about this room had to be specially designed, made and built. The Gui Bonsiepe team and two British subcontractors had to be kept in touch. Specifications were changed as the rest of the work progressed. And, as mentioned, no-one could for some time find a suitable physical site. No doubt the original date of 9th October fixed for completion was extremely optimistic. We were exactly three months late. The building was taken over on 1st December 1972; everything was finished and in experimental working order on 10th January 1973. Photographs of the room appear on the *inside* of the dust jacket of my book *Platform for Change*, and full details of the ergonomics involved appear in Bonsiepe's book (Reference 3).

Project Cybersyn

We saw in the last chapter how this project came to exist and what its intentions were. By now we have seen how the four main tools were created: *Cybernet*, yielding a national network of industrial communications to a centre in Santiago, through which anyone could consult anyone else, or gain access to decision-takers in other locations; *Cyberstride*, the suite of computer programs needed to provide statistical filtration for all homeostatic loops at all levels of recursion; *Checo*, the model of the Chilean economy, with simulation capacity; and the *Opsroom*, a new environment for decision, and dependent for its existence on the existence of the other three. But tools are useless in the hands of people who do not know how to use them, and a programme for the

dissemination of information had to begin as from the March 'Start'. Next, tools are useless until they are activated: how were data to be presented to the system?

All of this involved a massive and continuing exercise in (what I should call, in the original World War II sense) operational research. That is exactly what it was: *research*, by highly qualified interdisciplinary teams, into *operations*, namely production companies, with the prospect of discovering *models* and sets of *measures*.

By July 1972 there were many of these teams organized by ramas. Raúl Espejo himself was controlling the work in the Light Rama (covering the automotive industry, and manufacturing firms in rubber, plastic, electric, electronics, copper), and the light mechanical industries (refrigerators, washing machines, and so on). Jorge Barrientos was dealing with the Consumer Rama (agro-industrial, textiles, fishing, pharmaceuticals, and food). In the Construction Rama (involving forestry, with its products of wood, furniture, pulp, chemicals, chipboards; and building materials — cement, prefabricated concrete, plaster, house construction units) the work was directed by Humberto Gabella. In the Heavy Rama, we confronted a different situation. All the energy industries, iron and steel, and petrochemicals had been state owned for a long time. We were not dealing with workers' committees and *interventors*, as in the three hundred newly nationalized companies, but with established and very senior Chilean managements. What is more, there were in-house OR groups serving these managers. As to the copper industry, newly nationalized amid an international furore, new moves of whatever kind might aggravate existing difficulties. It can readily be understood that the Heavy Rama presented these innovative initiatives with a highly-charged situation, politically fraught. Thus, rather than appoint a senior Corfo man to this rama, we sought the cooperation of each management separately and, on the whole, we got it — with the OR people concerned either 'in touch with' or 'reporting to' me directly (two cases of each nuance).

The teams selected and trained for these urgent and important assignments in the three ramas were picked for their professional merit, and without regard to their political stance. Not surprisingly, a typical Chilean professional would be inclined to treat a worker with some condescension — unless he had strong political convictions towards the left. There were several incidents, and at other times attitudes were taken, where this tendency disquieted me. Especially, the teams were briefed to *explain* the quantified flowchart model in a plant, then to *enlist help* in creating it from those who worked there, and then to *obtain agreement* on the performance measures to be used. It was clear that this was not always being done in the intended spirit; and it seemed likely that this fact aided detractors who later wished to call Cybersyn 'technocratic'. It is again a reflection on the complicated nature of the Five-Four relationship

that the political director (Flores) and the scientific director (Beer) held opposing views about this matter — each taking the position that the unthoughtful might well attribute to the other. At first sight, that is to say, the politician would be expected to demand political loyalty in professional staff engaged in work of such potency, while the scientist would be concerned to see that the best staff were chosen on professional merit. What happened was the politician could not afford accusations of partiality, while the scientist looked for the hard work engendered by total commitment.

Assuming that it is clear how to set about modelling a plant as a quantified flow chart, as in Figure 43, let us turn to the problems of modelling the higher levels of recursion in which are embedded the lower, like a series of Chinese Boxes or Russian Dolls — and viable systems all. Suppose that the firm's operations are a series of plants, and that the firm is one of several operations constituting System One of a corporation. All three configurations can be mapped on to the viable system of Figure 27. Now the wavy lines connecting the operations of the *plant* have to do with whether one process feeds another, and by what ratios the outputs of these individual machines are broken down between other processes. By the same token, the flowchart for the firm specifies whether, and if so how, those wavy lines connect plants together, and by what ratios, and so on. By the time the corporation is reached there may be *no* connexions on the wavy lines between operations — beyond the effects on each other of the competition for finite capital. The point is that the *flow pattern* of all this is different for each level of recursion, although the structural model is the same. By a similar argument, the flow pattern on the horizontal homeostats linking operations with environments will be different for each level of recursion, because the environmental domains are quite different. This paragraph, then, explains that by using a universal model of viability as a sourcebook or guide to any viable system, then empirical research may be designed at each level of recursion, the result being a set of flowcharts, each unique in pattern. It follows that the quantification at each level must also be unique (because it has to apply to *this* flowchart and no other). Thus, the proposition is demonstrated:

- information must be tailor-made to suit the appropriate level of recursion.

Reductio-ad-absurdum: do not send the day's output figures for a limestone crusher in Arica to the Minister for Economics.

However, there is a difficulty about this in practice. Where can one *find the figures* for the flow-charts of the higher levels of recursion?

- there is no empirical production information about any level of recursion higher than the plant.

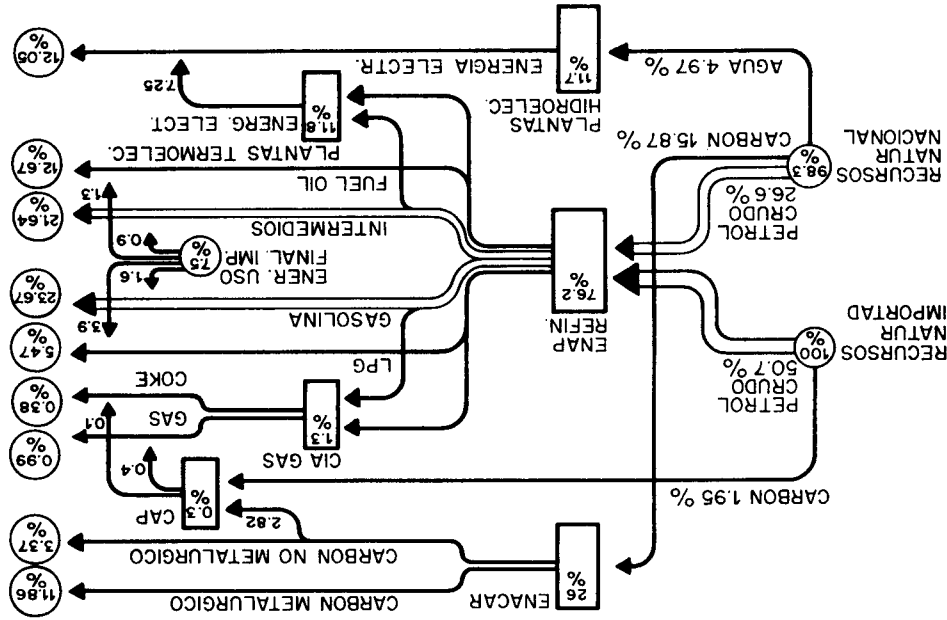


Figure 43. ENAP slide

Reductio-ad-absurdum: when you were a plant foreman, you could observe Charlie being lazy; now you are president of the corporation looking out of your skyscraper window — and you see only clouds.

There is a genuine paradox here which caused us trouble all through. To grasp its menace, it is necessary to see clearly that there is only one collection of valid data throughout the whole series of recursions — and that is at the ground level of action. As to production, there is *no* production except in plants. As to sales, there may be expensive work done at corporate level: but that is the 'ground level of action' for corporate affairs. These facts are entirely paralleled in the neurocybernetics of the viable system. We are almost wholly dependent on sensory data, even at the limits of imagination and illumination. (If there are invisible rays projected through outer space at the pineal gland, that would explain a lot; but such an input would still be a sensory datum.) And the reason for saying that we are so dependent, is that we *learn how to perceive*. (See especially Reference 4.)

In management the form of the paradox is the same. We learn how to perceive lower levels of recursion, so that the flowchart of our own level may be quantified — using the only variety reduction techniques that management accounting understands: essentially totals and averages. If the problem were simply that massive averaging may suppress whatever is really interesting, which is often the case, no matter: given Cyberstride.

This at least has the advantage over standard costing techniques that it assesses the importance of incipient change (via both the probability *and* the site on the flowchart model to which it is applied) rather than to report a (probably percentage) variance that has already occurred. But that is only part of the problem. We should be concerned that the paradox reported on may *distort* all quantified flowcharts but one's own. In Chile, we referred to shop-floor indices at the level of the enterprise as atomic, and then noted s-molecules at the sector recursion and r-molecules at the rama recursion. Problems of agglomeration were solved in a rather rough-and-ready fashion, and much more remained to be done. But the problem is surely clear: how does one quantify two different molecules made up of the same set of atoms? Juan Bulnes produced the basis of a neat theoretical solution in which the dendritic structure of the FORTRAN compiler itself was used as the mapping for the molecular structure. But our molecules may not be dendritic . . . Perhaps a topological device is missing in order to facilitate this mapping — a device analogous to the benzene ring, or the DNA double-helix.

So far we have been talking about connexions between the recursions in terms of structural modelling and the specification of measures — that are atomic, but must needs emerge as molecular too. But all this is the initial and static

framework for an interconnectivity between recursions that is most emphatically operational and dynamic. Action happens; homeostats circle; information flows. Then who gets to look in on all of this activity? The answer is Systems Five, Four, Three, Two and One of the viable system concerned, which is a firm (we may call it Beta) — first of all. Next, we recall that Beta constitutes a System One in Alpha. Then Systems Five, Four, and Three in Alpha have, as its metasytem, the authority to delimit the autonomy of any Alpha System One — which, in this example, is the whole of Beta. But it should do so according to the cybernetic rules, which we have studied, and which are intended to preserve the maximum autonomy for Alpha System One consistent with preserving the coherence of Alpha as a viable system itself (and it is certainly convenient to Beta that it should).

Suppose then, this being the scenario, that we supply Beta with the whole *Cybersyn* package: the four tools, and a computer. Beta proceeds to create the atomic indices, and to act on notices of incipient change from its computer. Its autonomy preserves it from noseyparkerdom in Alpha System Three. But Beta is an Alpha System One as well. Therefore Beta makes up, out of its total atomic data, some kinds of aggregated package to send to Alpha Three. These packages *could* be molecules (in the sense defined). But it is likely that the molecules Alpha Three needs contain packages from *all* Alpha's Betas, and not just from the one we are considering. So probably these packages, which we hope are not just lists of totals, will be some sets of indices produced as weighted mathematical functions of atomic components. At any rate, this has to be agreed; and when it is, Alpha respects the autonomy of Beta in other respects.

With its *molecular* indices, Alpha is in a position to quantify its *own* quantified flowchart, and to submit its *own* managerial indices for filtration by Cyberstride. And so on, up the scale of recursion. This arrangement resolves the paradox with which we started; since each level of management has its uniquely appropriate molecular data system, even though atomic data are the same, with which to quantify its unique flowchart. Moreover, the schema represents maximum decentralization, since any given level of recursion receives directly only its own Cyberstride reports.

'Receives directly' only its own: there are then indirect reports from lower levels of recursion in the special circumstance of algedonic signals needed to operate the Arousal Filter of Figure 32. The essence of the matter is that if an Alpha System One is in trouble, it will try to get itself out; it is after all also Beta, a viable system. If it cannot do that in a reasonable time, it recalls that it is after all an Alpha System One, and sends an algedonic signal for help.

How shall it do so? And what happens if it is too cocksure, or too lazy, or too corrupt to mention its problem in Gamma to Alpha? (Gamma is of course a

steel industry. In the top part of the chart appear the activities that mesh together to put into physical effect the modus operandi of the Opsroom. Not shown there is the integrative study that later proved necessary to provide a taxonomic system for the display and storage of data in terms of the atomic/molecular recursive logic discussed in the last few paragraphs. This piece of work emerged as a paper called *Models for Action*, and it occupied much of my time during September 1972 (when it was issued). It seems that the designer of a total system must attend to any inadequacies that appear in the underlying logic of his own vision himself — otherwise he loses control of his own understanding of the project's development. In such cases, he has to resist accusations as to a neurotic preoccupation with detail, and ensure that the structural foundations are indeed secure.

Getting such balances 'right' in terms of the exigencies of the national situation was difficult: balances between policies and details in the project work, between meticulous research and adequate explanation, between precise and approximate measurement . . . very real decisions in project direction in such dimensions as these must be taken if the time parameter of the managerial problem is to be accepted as central to that problem. A coup d'état had aborted in March, and its leaders had been captured; as the year wore on, economic pressures steadily increased; it was evident to us all that we were engaged in a race against time. Hence the title of the chart (Figure 44) as given in July: *Programme Beat-the-Clock*.

The People Project

It may be recalled from Chapter 16 that the first of the cybernetic papers written in Chile (November 1971) was called *The Effective Organization of the State*. By March 1972, Project Cybersyn (also known as Synco in Chile, because of more felicitous assonance in Spanish) was formulated as an approach to the regulation of the social economy; and we have just been reviewing its progress in the second epoch. Also in March 1972, however, we addressed the basic issue of the organization of the state that is not economic, but societal. Parallel to the paper on Cybersyn, therefore, I wrote a second about a project to examine:

'the systems dynamics
of the interaction
between government and people
in the light of newly available technology
such as TV
and discoveries in the realm
of psycho-cybernetics.'

Just as it was necessary to speak briefly about the economic situation in approaching Cybersyn, so it is necessary to speak briefly about the government-people arrangements that were at issue at that time. Strangely enough, the arrangements were basically the same, and also the criticisms of those arrangements, as are familiar enough in Britain — and many other countries with a long-established democratic tradition. There was a bi-cameral legislature; critics doubted the efficacy of the upper chamber. There was an independent judiciary; critics wondered whether its interpretation of the law was in touch with public mores, and whether its ponderous administration was not completely out-of-date. There was a very large bureaucracy for the country's size; critics thought it should be streamlined at the least, and perhaps the executive arm of government should be put on a different footing altogether.

The novelty in Chile seemed to be, not that the three arms of government exhibited these familiar features and attracted these usual criticisms, but that there was a real possibility that the government might actually do something radical about them. International commentators were fond of reporting that the president was under strong pressure from his own left wing to take drastic action. The more perceptive of them recognized the resolute constitutionalist in Allende — and therefore concluded that he was in a dilemma. My own reading does not invoke any such dilemma — because the president's personal views on all these points determined on radical change, and determined also on the use of constitutional methods to bring it about.

The situation can be summed up in reference to the so-called 'People's Assembly'. Suppose that the bi-cameral congress were replaced by such an invention, and that this change were made through a referendum held under the constitution, then there would be potent consequences for the other two arms of government as well Such matters were under debate within the parties. But what would actually constitute a 'people's assembly'; what would it do, in cybernetic terms, as a variety regulator; how could modern technology be used to enhance its value and effectiveness? The March 1972 paper, paralleling the launch of Cybersyn, was addressed to these preliminary questions: here is the gist of it (but not verbatim).

The Management of Variety in the Political Context

People generate massive variety, which has somehow to be greatly attenuated if a government is not to be overwhelmed by it.

Typical methods of variety attenuation in a democracy include:

- formation of parties, to represent large blocs of variety across the country,

- election of representatives, to represent blocs of variety by locale,
- division of time into
 - period of presidential office
 - period between elections
 which introduce artificial epochs of relative stability.

The decisions of the government have low variety compared with their needed application to the case of the individual citizen.

They have to be amplified, and in the past this has been the role of bureaucracy.

Time cycles in the past have been very extended. It takes a long time to change one's parliamentary representative; it takes a long time for the bureaucracy machine to grind out an answer.

But the system met the Law of Requisite Variety, and its homeostats (though sluggish) worked.

Inject into this situation two NEW effects:

- the explosive rate of change due to the growth of technology, the rise of political aspirations, and the outside-world condition;
- the availability of mass media of communication — especially TV.

Government now communicates directly with the undifferentiated mass of the people, as if it were speaking to the individual, and creating the illusion in the home that it is. The context of this false dialogue is that the individual is also supplied by the new media with a proliferation of information and misinformation about things — as soon as they happen.

Looking at the outside loop in the diagram at Figure 45, we see this effect as

- massive amplification of variety, insofar as single-sentence utterances may be developed into hour-long simulations of imagined consequences,
- massive change in dynamic periodicity: the government is reporting to the nation daily, instead of accounting for itself at election times.

But the return loop does not change. The variety that the people generate is attenuated as before.

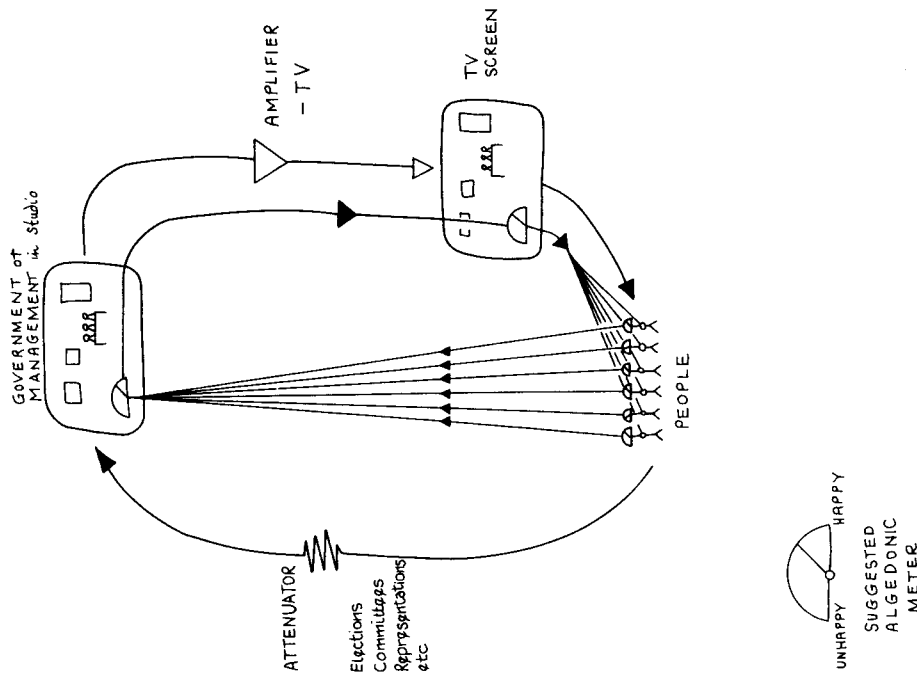


Figure 45

This situation attempts to disobey the Law of Requisite Variety, and disbalances the homeostatic equilibrium in both richness and in period.

Then it is predictable that the people, thus affected, will build up pressures in the system that can no longer be released — because the filtering capacity cannot contain the flow.

This is bound to lead to unrest: demonstrations, agitation, perhaps violence, possibly revolt.

if people have to build

It follows that the people should be provided with new means of communication with the government which

- match the amplification of government variety with less attenuation of their variety (re-establishing peaceful conditions for the operation of Ashby's Law)
- operate on the same time scale — that is immediately
- use technology to serve the people as well as the government.

The Notion of the Algedonic Loop

In the diagram the inner loop represents such a scheme. People watching TV are seen communicating directly with the government.

The main methods for doing this elsewhere have been

- plebescites
 - public opinion polls
 - the installation of a computer in the inner loop to receive public reactions on a large scale, process them, and present them publicly on the screen.
- Only the third operates in real time.

Besides, there is the same objection to each one. Each pre-emptis issues by structuring the questions. Thereby

- people find themselves answering questions they wish had not been asked (or not asked in this form) thereby appearing to support policies they do not actually approve,
- people cannot comment on issues not explicitly laid before them,
- people may not be sufficiently analytic or articulate to cope with this kind of process,
- people may not answer truthfully because they fear identification and possible victimization,
- the whole system could be used as a giant teaching machine to condition the public (some authors in the United States

actually advocate this). Advantages — such as changing eating habits to suit the food supply — could easily be outweighed by loss of freedom ...

It is a formidable list of objections.

An algedonic loop works on a non-analytic, non-articulated scale of 'pleasure and pain'. It uses the brain as its computer, structured and programmed by individuality and life experience, to produce an output indicating a degree of satisfaction that does not have to be 'rationalized'.

This is at last an attempt to provide a metric for Aristotle's eudemony, or 'state of general well being'. The algedonic meter (pictured in Figure 45) is a simple analogue device, with interleaved segments in different colours. Thus to turn the central knob changes the proportion of the 'happy/unhappy' display — and also the electrical input to the circle of which this meter is a member.

Someone holding an algedonic meter sets the display by moving the pointer anywhere on a continuous scale between total disquiet and total satisfaction. She/he does not have to explain anything — only to respond algedonically, which people may be observed to do all the time.

There could be an official locale, housing a television set and a properly constituted sample of people, having one meter between (say) three. The meters drive a simple electrical system, which sums the voltage for this locale. The rest of the proposed structure for a People's Assembly is shown in Figure 45.

Now: when a broadcast is taking place, the people's eudemony is indicated on a meter in the TV studio — which everyone (those in the studio and the public) can see. The studio meter is driven by the sum of the people's meters.

This closes the algedonic loop. It is a system that appears to respond to all the criteria previously noted. It is practicable and it is inexpensive.

It is noteworthy that this system, shorn of its technology and therefore of its formal existence, already tries to be. It is experienced as clamour of various kinds.

'It is proposed to create a new public response system, in order to provide convenient and legal outlets for pressures that are already making themselves manifest. These pressures constitute political power — in the limit they may overthrow governments.'

This statement ended the second of the papers presented in March 1972.

Handwritten notes: "Algedonic Loop" and "Aristotle's eudemony".

Algedonic Participation

There was great interest in these tentative ideas. Because they responded to a need which was real in political terms and predicted by the cybernetic analysis of variety balances, everyone from the President down took them seriously. In some advanced countries, there are plans to equip households with attachments to telephones which will enable respondents to 'vote' in response to the programme they are watching on the television set. However, the planned systems are digital rather than analogue, and their *modus operandi* is open to all the objections listed earlier. Moreover, they are conceived in the commercial context as tools of 'instant market research'; and their protagonists do not seem to have considered the inevitable political consequences of introducing such technology — for whatever purpose. Democracy suffers as the result of technical advances installed for adventitious reasons, because of the resulting variety disbalancing; yet there is a deeply reactionary response to any possible reform of the democratic process itself that calls technology in aid.

It was not so in Chile. I was enabled to form a liaison with an institute called CEREN, dedicated to social science, and to develop these concepts with two of the country's leading sociologists. A prototype system of ten algedonic meters, linked by a single wire in a loop through a large summation meter, was built in England by my son Simon Beer (an electronic engineer), and taken to Chile for experimental purposes. Because each station could make an arbitrary move at an arbitrary time, the summation meter had to be very heavily damped; otherwise, there were no technical problems.

In Figure 45, we saw the legend 'Government or Management in Studio'. Now the effective channel (Canal 13) of the public television broadcasting system in Santiago was in the hands of the political opposition, and a channel available to experiments in social democracy was (in my opinion) overdue. It should now be understood why there remained a blank wall in the Operations Room: it was intended to house an algedonic meter. The idea was that the (electrical) People's Assembly, disseminated throughout the nation, would be able to participate in arguments broadcast from the room — not by responding to questions hurled at them over the air, for this route leads to logical reductionism and to political demagoguery; but — by the continuous registration of a combined degree of satisfaction with events. It has to be noted that not only would the meter be visible to those present in the room, but also to the public whose meter it is . . .

The practical issue as to how these ideas could best be advanced led to a proposed experiment which was prepared but, alas, not finally undertaken by the time that the government fell. A brief account of it will reveal the cybernetic complexities that always arise when informational loops are closed

onto themselves, and also how variety equations come to be resolved without communication 'channels' in the ordinary sense of that word. The experiment was to be concerned with the management of a factory, in which worker participation would be continuously effective via algedonic loops.

Suppose that a small group of us forms a working team running a section in a plant. On the wall is our algedonic meter. With characteristic phlegm, we have set our meter at mid-distance between high and low eudemony. Similar meters exist in every section of the plant; there are large summation meters in the entrances to the works, and also in the boss's office. Grossly irritated by the failure of raw material supplies for our machines, we agree to change our algedonic setting to one of low eudemony. On clocking-off, we observe that the summation meter for the plant is registering high eudemony. Have we been over-hasty, then, and should we conform to the consensus? Or are our workmates blinded by managerial blandishments, and have we a duty to open their eyes and campaign for better arrangements? The meters make explicit the outcome of continuous dialogue among the workers themselves, as to their satisfaction with conditions in general, which would otherwise remain implicit in a host of small encounters never fully articulated.

More important, however, is the fact that the workers have absolute assurance that the boss knows the state of eudemony as registered by the summation meter. The boss knows that the workers know that he knows. The workers know that the boss knows that the workers know that he knows. The expectation is that requisite variety will be mediated by this algedonic closure, using no more than one loop of low-tension wire as the physical 'channel' of the system. If this point is well taken, then it is possible to project the notion into the national government scenario previously painted. Imagine a group exploring a problem in the Operations Room in the presence of television cameras; imagine the algedonic meter sinking as unpopular lines of enquiry were pursued; the viewers know that the meeting knows that they know that the meeting knows . . . One would expect positive reinforcing feedback in this kind of participation, which might well facilitate binary decisions fed by analogue inputs — which is just the way that the nervous system works.

There are manifest problems in all this, but they are not technological nor economic. Psychological research was being undertaken to establish the 'rules of the game' if genuine participation were to be effected. Sociological and demographic research was proposed to underwrite either a sampling scheme or a constituency scheme of general franchise. Political questions had to be addressed, especially that of security: but the dangers of rigged ballots and undue pressure are always with us, and a new kind of technology does not necessarily exacerbate them. At any rate, I hope that new experiments on these lines will be facilitated somewhere. A plausible experiment, for example, would be to equip a conference hall with closed algedonic loops: would the

speaker become yet more steadily boring and obscure as the summation meter steadily dropped — for all to see?

A preliminary experiment on these lines was undertaken in Chile, with a group of about fifteen people. Remember that the prototype ring had only ten metres, and note that the 'subjects' were all friends within the project. The lecturer commented on the interest and excitement engendered; but his friends rapidly learned how to rig the system. They joined in plots to 'throw' the lecturer by alternating positive and negative responses, for instance. But if coalitions are not permitted in democratic assemblies (compare the arguments about secret ballots in trade union affairs), outcomes may well be sterile. The most positive result of this limited experiment was surely the lecturer's comment, having been at pains to follow the public feedback, that the experience 'suggests that isolated speakers usually keep cool because they don't have the slightest idea as to what the reaction is'. This could well be true.

The over-riding cybernetic consideration in any large-scale application such as a People's Assembly is the problem of time lags in the public's ability to recognize the implications of given policies. And let this not be dismissed as an issue belonging to the next century, because the cybernetics of democracy are already in place — regardless of a more advanced technology, which might actually ameliorate rather than exacerbate the problem. It is hard to say whether a trigger-happy response leading to wild oscillation is better or worse than a slovenly response to events already dead. What can be judged is that it is within cybernetic competence to design feedback functions that correctly handle time lags, but that these designs would be very difficult to implement in conditions of free-range comment via the mass media — which are conditions rightly prized. There is huge scope for research in these social cybernetics; huge need as well, since the existing checks and balances (such as they are) are now in process of dislocation through a new generation of electronic intervention in societal communications. Meanwhile, reflect on the words of the late R.H.S. Crossman, who said to me just after leaving office following the defeat of his government: 'I took the blame for my predecessor's foolish decisions, and now my successor will get the credit for my wise ones'. Note not only the reasonableness of this complaint, but the ease with which opinion (just like the economic policies criticized earlier) can become locked-on to a response that is exactly out of phase.

Vox Populi...

The people have their voice. However, the channels open for its direct expression are, as we have seen, heavily attenuated; and the scheme just described was intended to restore variety and also immediacy to the people's voice. But there are other amplifiers.

First of all, the role of the artist, the poet, and the musician in the expression of every kind of popular aspiration is generally accepted as powerful in all politically self-conscious nations. In Chile, I spent every spare minute with such people — mainly out of sheer exuberance. Even so, no-one doubted (least of all they themselves) that they played a major role in the political struggle. Once again, a closed loop amplifier is detectable in cybernetic terms. A piece of art — picture or cartoon, sculpture, or wall-painting, marching-song or folk lament — focuses emotion by selecting a set of states from a plethora of variety that is in total too gigantic to be apprehended, except perhaps as a great sigh. If the selection is well-made, then individuals will identify with this artwork, reinforcing its effect by their popular acclaim. This is particularly obvious in the case of music, since all may participate in the act of its live performance.

Once more, we see huge systemic effects (in this case, the negentropy of political awareness rising rapidly) in the absence of iterative 'channels' linking the artist and the public. Even the initial 'message' may not be overly political, as it is in a protest song: simply to be evocative of fond emotions may be sufficient. But if the artist can focus the voice of the people to their satisfaction, he may also put words into the people's mouth — and always has done. In this the artist accepts, and knowingly accepts, a responsibility. But because science has indeed been largely sequestered by the rich and powerful elements of society, science becomes an integral part of the target of protest for the artist. Each makes his own *Guernica*. My own view, which I set about propagating in these circles, is that science, like art, is part of the human heritage. Hence if science has been sequestered, it must be wrenched back and used by the people whose heritage it is, not simply surrendered to oppressors who blatantly use it to fabricate tools of further oppression (whether bellicose or economic).

Secondly, the voice of the people can (by the use of elementary modern technology) be made to resound in the people's own ears. It is commonplace, all over the world, to see those who live in economically depressed areas despondent, and robbed of all will to improve their lot. They sit in doorways, telling each other that nothing can be done, and hope that one day a government programme will rescue them from their penury and despair. In Canada, however, I had had dealings with a project known as *Challenge for Change*, whereby teams of young sociologists and film makers had set out to gain the participation of the people on the Eastern seaboard of Canada in their own self-improvement programmes. This project, fathered by the Ministry of State and mothered by the National Film Board, used mobile hand-held television equipment as its primary tool. Edited video-tape of members of the dispersed community all saying 'nothing can be done, no-one is interested', when shown in the community hall to themselves, clearly demonstrated that everyone was interested, and that therefore something *could* be done . . .

Fourth Principle
 Command is neither a matter of wielding authority nor of overloading the central axis with variety-attenuating regulations: System Three delegates authority and accountability to the elemental level, and looks for synergistic advantage in taking a synoptic view of Systems One.

Fifth Principle
 Special attention is necessary to System Four: otherwise System Five identifies with System Three, and the whole cerebral metastructure collapses; instead of adaptation and self-determination, we are left with crisis management.

This was to be the cybernetic substance of 'the manual'; but now it needed translating into simple statements that could be distributed to the people through booklets, leaflets, posters, and (I hoped) songs. After many attempts at this translation, I finally produced a booklet entitled 'Five Principles for the People, towards Good Government' in early September 1972. It began with a statement which I hoped that President Allende would sign:

'The revolution of ownership is two years old.'

'IT IS TIME for the revolution of government to begin.'

This statement would be dated from the official inauguration of the Operations Room, so that the whole movement towards bureaucratic change would be totally visible and universal. The five principles were each couched in two forms: STOP the existing practice, START the new one. And each time: 'CHANGE is a state of mind that everyone shares' — a definition evolved for this purpose, but which perhaps has some general merit. There were appropriate drawings to illustrate the five themes, and the booklet is reproduced in an appendix to this section.

Having spoken of 'translation' (namely from the language of cybernetics into the English language and the cultural norms of an Englishman), it is necessary to add that a second translation would be required that I should not attempt — into Spanish, and into terms of the Chilean culture, with sectarian politics intervening. Whether this production would ever have been completed and published as a booklet cannot be judged, for other matters arose . . . In the meantime, however, I determined to tackle the question of songs. As already remarked, music was a major amplifier in the cultural system.

The central figure among the musicians with whom I mixed and became friends was the famous folklorist Angel Parra. He was at first quite amazed

These remarks oversimplify, and do not pretend to be a proper account of the Canadian work. However, the approach had something to offer Chile, as we studied the role of communications in society, and I set about recruiting a team of Canadian social scientists willing to pilot experiments. There was an enthusiastic response. But, over a period of months, I was unable to obtain appropriate equipment — little of it as was needed. We did indeed face the rigours of technological as well as economic blockade.

'The Manual'

The last of the components of the People Project that was being advanced throughout the second epoch of the work, and running *pari passu* with Project Cybersyn, was known to us as 'The Manual'. The idea emerged in debate between Fernando Flores and myself. If we thought that we were beginning to understand the cybernetics of government, and if we wanted to redesign the governmental process, then there ought to be 'a manual' in which some key principles were set down — in such a way that all could understand them.

Mulling over this requirement, I thought that seven principles, plus or minus two, would be their number — since this figure so often appears as delimiting the discriminatory ability of the human brain. To err on the safe side, perhaps something useful could be said by five principles . . . Ah: there are five subsystems in the viable system. By this route, I set out to analyse what was most important about each of the subsystems One to Five from the standpoint of the ordinary citizen: what was most notably wrong in each case, and how could it be put right. I wrote five essays to myself, and refined them; I discussed the issues with everyone I could think of, and most notably a workers' leader of no learning and profound wisdom. In the end, I had five principles, each expressed in a single cybernetic sentence, and each relating to one subsystem — although out of numerical order (the order being: 5,2,1,3,4). Here are the five cybernetic statements:

First Principle

System Five within a people's government cannot be an élite ruling class: it is somehow the embodiment of the mass of the people themselves.

Second Principle

The speed of response in an essentially lagged servomechanism is critical: note especially the anti-oscillatory Systems Two.

Third Principle

Variety engineering enables us to design homeostatic subsystems that obey the Law of Requisite Variety, and determine a recursion of metasystems: this preserves System One autonomy.

that I expected him to sing about the scientific inheritance of the people: this is hardly a familiar idiom of the folklore genre. However, he had been following our progress with great interest, and he eventually agreed. In this 'translation' of the manual, the cybernetic finesse of the five subsystems commentary was assimilated into a political appeal for reform — which somehow made all five points through the recounting of then-current events and preoccupations. And the two basic messages of the manual came through strongly in the chorus:

'Then let us STOP
 who do not want
 the people to win this fight —
 And let us HEAP
 all science together
 before we reach the end of our tether'

or, better, in the original:

'Hay que parar al que no quiera
 que el pueblo gana esta pelea
 hay que juntar toda la ciencia
 antes que acabe la paciencia'.

Angel Parra called the song: 'Letania para una computadora y para un niño que va a nacer', which in English says: 'Litany for a Computer and a Baby about to be Born'. It is a proper theme; and, as the impact of microprocessors becomes felt, it is a theme to which people's attention must be increasingly directed. Because computing in all its forms is becoming exceedingly cheap, the mass of the people can in principle be freed from drudgery; because the cybernetics of techno-social change is not understood by either the government or the people, it is likely that in fact the mass of the people will be 'freed' from gainful employment

5 PRINCIPLES

FOR THE PEOPLE

TOWARDS GOOD GOVERNMENT

" The revolution of ownership
is two years old.

" IT IS TIME
for the revolution of government
to begin. "



20th October 1972

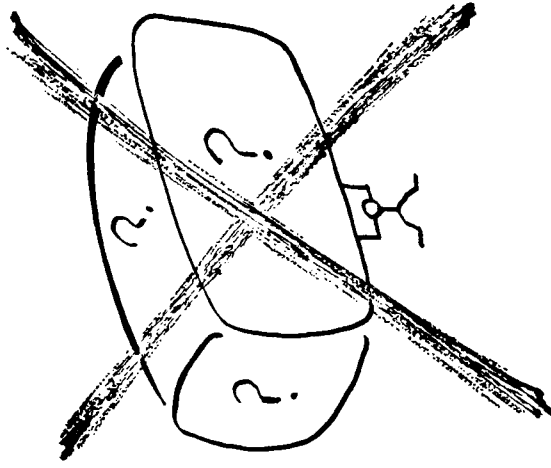
427

First Principle : GOVERNMENT IS THE
PEOPLE'S HELP

FINISHED

The view of government

- as incomprehensible
- as the people's burden



STOP THIS ↑ WHENEVER YOU CAN

Never despair

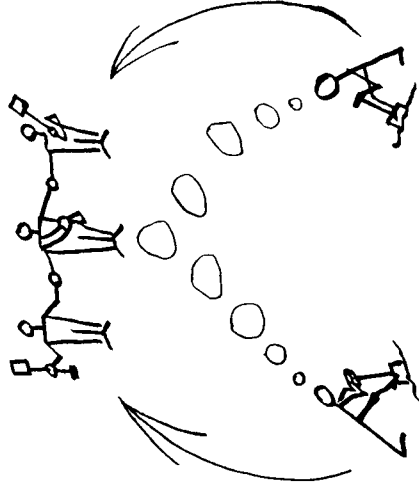
CHANGE is a state of mind
that everyone shares

428

STARTED

The view of government

- as the people thinking what to do
- as acting together to do it



The Comptroller Presidente says : "Government is the people."

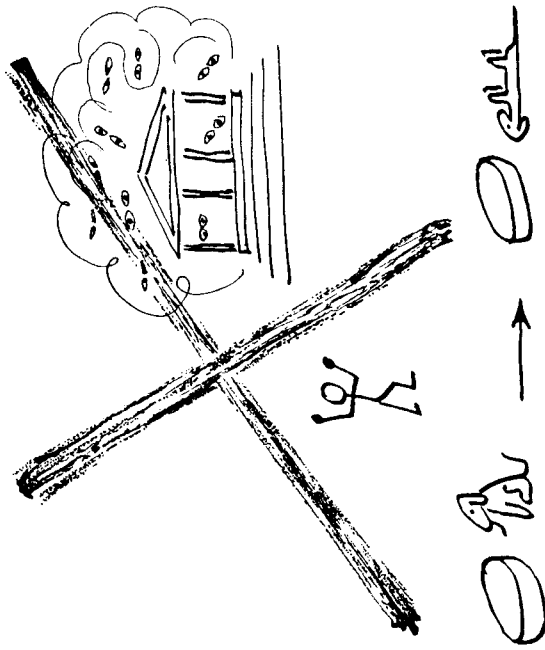
The wishes of the people will be made known to the Government at all times.

We shall use TECHNOLOGY, which belongs to the people, to do it.

Second Principle: TO HELP MEANS HELPING NOW

FINISHED

Red tape + muddle
= endless delay

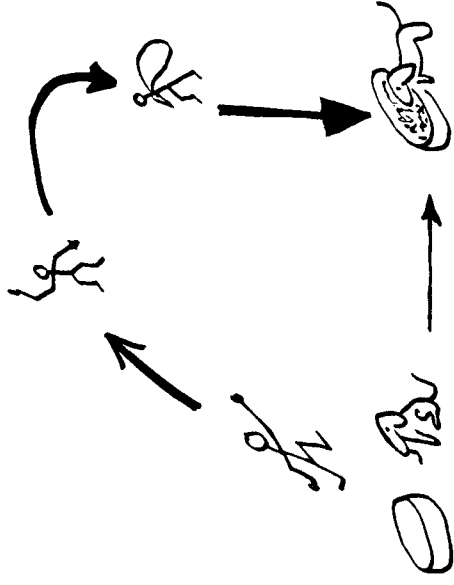


STOP THIS ↑ WHENEVER YOU CAN

Nissan Japan
CHANGE is a state of mind
that everyone shares

STARTED

Immediate contact + immediate response
= fastest possible action

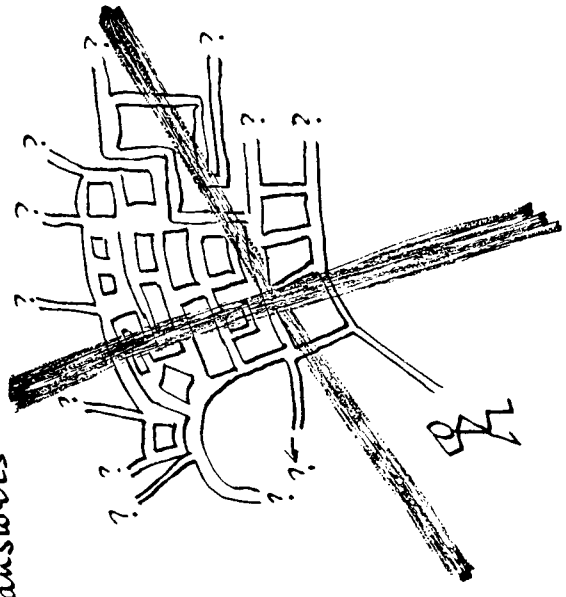


We have already used TECHNOLOGY to link 60% of the social sector directly to computers in the nation's capital, which send back immediate advice to the enterprises.
WE shall extend this kind of service to all of the people by some means.

Third Principle: THE ROAD TO HELP HAS SIGNPOSTS

FINISHED

Bureaucracy
Petty officialdom
Despair
No answers

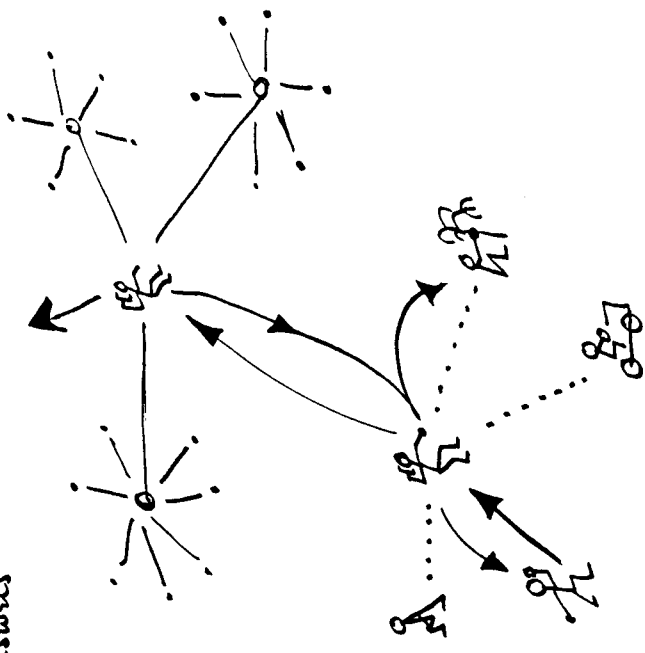


STOP THIS ↑ WHENEVER YOU CAN

Never despair
CHANGE is a state of mind
that everyone shares

STARTED

One official deals with a few problems
One straight link goes higher up
The links can reach the president himself
Answers



WE shall replace bureaucracy with a precise and clear network of officials, whose only job is to help - to give answers.

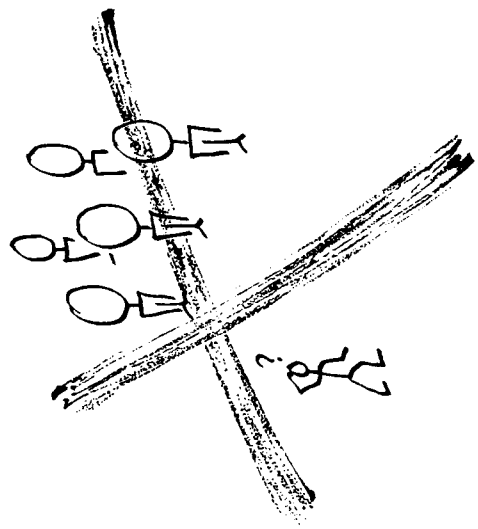
WE shall keep paperwork to a minimum - essential records. The people cannot eat paper.

Fourth principle: HELP IS A NAME

vs FACE

FINISHED

Blaming faceless people
"It cannot be done"
(and bad luck)



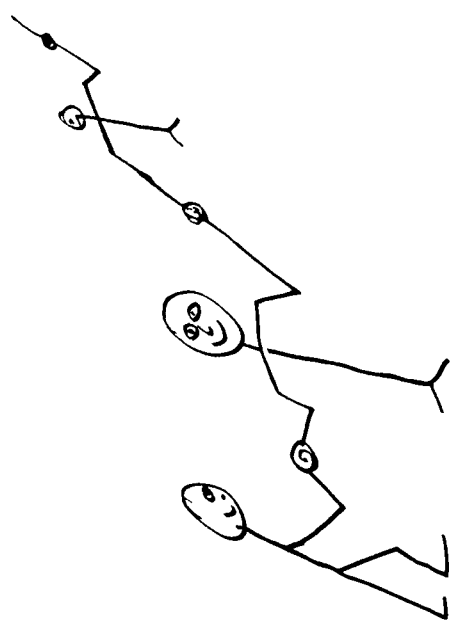
STOP THIS ↑ WHENEVER YOU CAN

Nicola Despain
CHANGE is a state of mind
that everyone shares

STARTED

Direct personal responsibility

"I will do it
..... or I know **WHO** can"

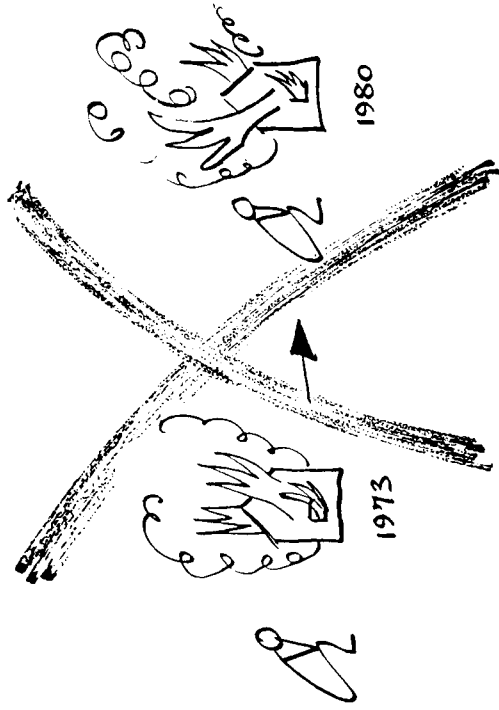


Of course officials really want to help.
After the Third Principle is obeyed, they
will have the opportunity and the time
to know the people they are proud to
help.

Fifth principle: THE FUTURE STARTS TODAY

FINISHED

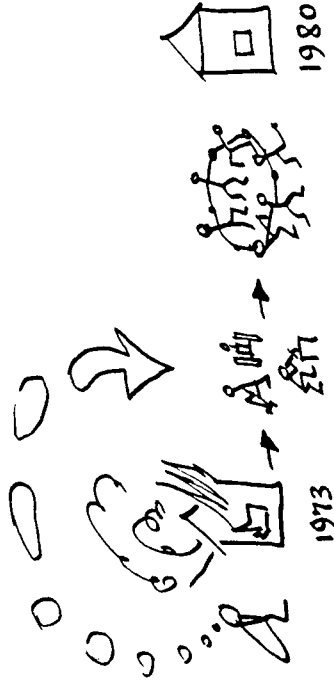
Managing a perpetual crisis
 Everyone busy grabbing what they can
 → THE SAME OLD PROBLEMS LASSER ON.



STOP THIS ↑ WHENEVER YOU CAN
 NEVER DESPAIR
 CHANGE IS AN ATTITUDE OF MIND
 THAT EVERYONE SHARES

STARTED

Thinking for THE future, which is just beginning
 Planning for our children's children
 → a BETTER society



The future is not a blank, nor is it inescapably
 worsening. For the first time in history, MAN
 knows enough to provide the kind of society that
 HE WANTS.
 We shall help the people to understand the options.
 Then the people must decide.

IF THE GOVERNMENT **IS** THE PEOPLE
THE REVOLUTION OF GOVERNMENT
STARTS WITH **YOU** .

Externalities

As time wore on throughout 1972, Chile developed into a siege economy. How ironic it was that so many eyes were focused with goodwill on the Chilean experiment in all parts of the world, while governments and other agencies, supposedly representing those liberal-minded observers, resisted its maturation with implacable hostility. The nation's life support system was in a stranglehold, from financial credit to vital supplies; its metabolism was frustrated, from the withholding of spare parts to software and expertise; literally and metaphorically, the well-to-do were eating rather than investing their seed-corn — with encouragement from outside. Even more ironic, looking back, is the fact that every advance Allende made, every success in the eyes of the mass of the people (which brought with it more electoral support), made it less likely that the Chilean experiment would be allowed to continue — because it became more threatening to Western ideology.

Central to this economic plight, which (see Chapter 16) had been forecast, was the question of foreign exchange. As mentioned, foreign earnings hinged on copper exports, and we were to see the spectacle of the 'phantom ship' full of copper that traipsed around European ports looking for permission to unload. (It was said that the Chilean government had refused compensation in taking over the copper industry; in reality, it had tabled the totals of foreign capital invested together with the revenues taken out of the country, and had raised the question as to who should be compensating whom.) Whatever the rights and wrongs of this copper problem, however, the intention formed by the 'national plan' to invest most available foreign income in the copper industry appeared absurd. Not only was such a strategy politically vulnerable — as we already knew; it made no economic sense either. This was where the Checo simulations, however 'unreliable', had their impact. What they certainly did convey was the rate at which an economy under such pressure was likely to change, compared with the rate at which investment in the copper industry could conceivably pay off.

Here was a dilemma indeed. From the point of view of responsible Chileans, it would have been outrageous not to invest the maximum of foreign exchange in copper; was not the failure of US ownership cited in exactly these terms? Nationalization had been a recognition, not only of the economic exploitation of the outstanding national resource, but of a decade of neglect in investment that would have a catastrophic effect in the longer term. Selective mining, inadequate maintenance, the failure to reshape the development of the resource, had led to disastrous outcomes already: these were the specifics of the indictment of the foreign ownership. Looking back, a member of the core group immediately reeled off different, explicit examples from five different copper sites — adding the cybernetic point that investment in copper, since it produced the maximum *surplus* in foreign exchange, provided positive

Amelia

feedback (and not simply exchange) to the Chilean economy. Even so, what was said in the last paragraph had its own validity at the time. The story reflects a perfectly general political double-bind. Of what avail is long-term planning, conducted in absolute dispassion and disinterest for the sake of a future generation, if survival in the short-term is thereby surrendered, and that future is consequently barren? Alternatively, of what avail to the future generation is an inheritance of the denial of its interests in favour of the earlier survival that made its very existence possible? Somehow the whole dilemma was summed up in the fact that when Angel Parra wrote a haunting song called *El Barque Fantasma* about the ghost ship carrying copper which no-one would unload, and when Allende approved it to the extent that he wished to take disc pressings as gifts to the members of the United Nations he was shortly to address, the President was thwarted. The record-pressing company was on strike.

The Checo team had built a preliminary model of inflation, as mentioned; and we wanted to understand, through this, the nature and the risk of hyperinflation. It was argued in text books (remember that the date was 1972) that monetarist policies could hold such a situation. Therefore I made a systems-theoretic model of monetarist economic regulation, checked it through with a leading British economist prominent in support of this approach, and tried to use it in the context of the Checo work. The cybernetics of monetarism seemed totally inimical to the cybernetics of a free society as the Chilean experiment had defined it (or as I would define it anywhere else today), because the regulatory tool embodies a model of what must be regulated that denies variety proliferation in pursuit of adaptation and evolution to any changing economy. Remembering the cybernetic theorem that declares a regulator to be effective only insofar as its model of what is regulated is adequate, we see in monetarism a diminution in variety of the real economic world entailed by a regulatory model that cannot encompass more. *Only variety can absorb variety*: Ashby's Law can be met **either** by expanding regulatory variety to absorb evolutionary variety, or by curbing evolutionary learning until variety in the economy matches the regulatory variety disposed by the only regulator — the money supply — that the ideology of the status quo is prepared to acknowledge.

Having come to this conclusion, I intensified the search for novel and evolutionary activity whereby the Chilean economy might *very rapidly* enhance its foreign earnings. Of course, this meant looking for national assets, other than copper; of course, moreover, diversification had been a major concern in Chile for many years. Even so, I identified three possibilities in which there seemed reason to hope. The first was skilled artisan labour. There seemed likely to be an expanding market in the First World, aching under the dull uniformity and plastic gimcrackery of its domestic architecture and design, for handcrafted products — especially those that draw on so rich a heritage of

vs. monetarism

symbolism, texture and colour. The second was wine. Chile produces vast amounts of wine, and drinks most of the best of it — exporting only the cheapest in relatively small quantities. In fact, the best Chilean wine is excellent; there is an advanced oenological institute, and a general belief that Chilean vines (originally from France) were the only vines in the world to escape altogether the phylloxera epidemic of the late nineteenth century. The third natural asset was three thousand miles of coast line, and the fish in those seas — notably anchovies.

With the help of others in the core group, appropriate contacts were made with government people in all three areas. It was difficult to quantify the possibilities for mobilizing artisans; but there were soon hard facts and practical possibilities with which to clothe the other two skeletal ideas. Moreover, it emerged that there was a sizeable mountain of pig iron available for immediate export. I returned to Europe armed with these dossiers, and with the promise that two authorized negotiators for the Minister could be called into the situation at any time.

It so happened that during this period I was a partner, one of five, in a consortium (now disbanded) which had the aim of facilitating major international enterprise. The other four partners listed an international jurist, a physicist and ex-diplomat, a foreign banker, and a well-known professor of economics. All the partners had strong connexions world-wide in their own fields, and the plan (which proved to be very far ahead of its time) was to seek synergistic developments in large-scale projects of all the expert inputs that would be required. It seemed that the fisheries project offered an ideal prospect for the intervention of this partnership. Thus, while I was hawking pig-iron (and discovering that the steel industry cartel across Europe was yet more powerful than when I had left the industry twelve years earlier), and also trying to establish that a wine market existed in Britain for a medium-priced product (there is a sizeable gap in quality and price between Chateau Plonk and the Appellation Controlée, for which a Chilean wine could have been tailored), my partners were considering fish.

The Japanese were already fishing these waters from very powerful vessels, to the chagrin of the Chilean fishermen — who accused the Japanese of poaching inside territorial limits. Our idea was to hire large factory ships, which would produce fish-meal continuously at sea. No delays here: such ships seemed to be available, at a price, and no shore stations would be required. The product would probably be sold to the Chinese Republic. There would be legal and political problems back in Chile, but the two negotiators were confident of handling those.

None of these plans was to mature; and it is impossible to prove exactly what went wrong, because at all times the negotiating space was thick with unreal

demands and feeble excuses. My own considered judgement, with hindsight, is that the deployment of a large piece of capitalistic economic machinery in support of an avowedly neo-socialist cause is basically untenable as a proposition to both sides — even though each can provide a rationale for reaching agreement. (Note the expression *neo-socialist*: this analysis would not apply to East-West trade agreements which are basically capitalistic in each direction.) I have already reported President Allende's words to me: 'how can a small socialist state continue to exist in a capitalist milieu?' Of course it cannot — without very powerful support, as Cuba had, and Chile had not. By the end of this epoch, another *coup d'état* was attempted: the President later called it the 'September plot'. There was much unease; There was a sense that irresistible forces from outside the country would use whatever sympathetic internal interests they could find to bring the government down. Even so, the coup was overcome, and the Commander-in-Chief again pledged the loyalty of the armed forces.

The October watershed

This personal story of my involvement in Chile, which began at the end of 1971 and came to an abrupt halt at the end of 1973, had its major turning point just half-way through — at the end of 1972. October of that year saw the beginning of the third epoch, as perceived from my own standpoint. Some of the matters discussed in the last chapter have already overshoot that date; but that was simply because it was convenient to trace through continuations of actions taken during the second epoch. This being so, however, it is as well to recapitulate the situation as it was at the start of the new epoch.

As far as Project Cybersyn was concerned, the physical facts were consonant with the development programme, given that the operations room would be late. Cybernet, the telecommunications network linking the socio-industrial economy of Chile, had been working since March and was gradually being improved. It was controlled from the communications centre that was to serve the operations room, and the rubrics of its behaviour were by now well established. Chilean-built equipment for the room was nearing completion, 300 kilometres south of Santiago; two of the British-built consignments had arrived (and the last came a few days later). All suites of computer programs were working as expected. Roughly 60% of all enterprises constituting the socio-industrial economy were by now included in the Cybersyn system, although many of the indexical time series had not yet been properly calibrated on Cyberstride.

The managerial facts surrounding all this were, however, a different matter. The political situation had begun to deteriorate seriously in September. Fernando Flores was due to leave Corfo, and to become Undersecretary of Economics: he had to bring Cybersyn, at least, into the (political) open. Accordingly, a day-long meeting had been held on September 2nd for a large number of people who were inside the project, or connected to it through the ramos, or who were politically involved. This meeting, held at Los Andes, had instituted a destabilizing change in the control of the project. Both he and I had spoken at length about the political intentions behind the cybernetic

science. These were of course the managerial purposes of the work from the beginning; but many of those working on the details saw themselves as politically neutral professionals, and some of these were distressed to be told that all future disclosures about the work must explicitly recognize the political intent. A few days later, I handed over the booklet *Five Principles*, with which Flores was delighted; and it became obvious that there would have to be major changes in the management team that was actually implementing the results of the cybernetics on which we had embarked a year before. We travelled to Europe together, although on separate missions, and discussed these issues all the way.

Thus it was that, back in Chile early in October, with the sense of unease within the project grown to alarming proportions, a new management team was appointed by the new Undersecretary. Raúl Espejo was confirmed as head of the scientific project Cybersyn. Enrique Farné, whom I did not know (but soon would, very well) was to be responsible for all cybernetic implementations; Hermann Schwember was to be responsible for the wider implications, including these of international import. This was a man whom I knew very well indeed: he had always been in the core group, and had remained in close touch throughout. This was, however, the first time that he had been given specific duties within the work. My own role was unchanged; but the managerial team was now a 'troika'. Each of the three horses was very powerful: but would they all pull in the same direction? Before we could find out, the worst crisis of the government to date broke upon the country.

The Gremio Strike

The *gremios* were usually depicted by the English-speaking media as 'trade unions'; but they were nothing of the kind (and the Spanish word for trade union is *sindicato*). Perhaps the term 'craft guild', used in the medieval sense, captures much of the sense of *gremio*. In more modern language, no doubt Engels would have called these people petty-bourgeois. They were, for example, the owners of small fleets of lorries, by which the country's transportation system largely operated. They were also retailers, owners of local shops and small distribution centres for daily requisites. The *gremios* were insistent on the protectionist line; they saw themselves as threatened by the potential nationalization of transportation and distribution under the government of Popular Unity. Indeed, they had the power to paralyse both these systems on a nationwide scale; and they had made half-hearted efforts to do so before. Their problem was that they could not sustain their 'strike' action for long — because they ran out of money.

By the 12th October 1972 a very strong action by the *gremios* was in full swing. It seemed ridiculous, because (surely?) it could not be sustained; my log of that day records this view:

'The small entrepreneurs are merely antagonizing the people they are starving of food, cigarettes, petrol Therefore the government can safely act, and have readily moved in the military. The people approve; the army prefers the image of saviour to that of stickman. But of course it means that instability grows.'

Instability continued to grow; the President declared a State of Emergency, and appointed a military governor in Santiago. From the rate at which the crisis escalated, it was evident that this was a serious attempt to pull the government down. Far from being a 'ridiculous' gesture, it was a massive assault, and it was soon obvious that external resources were being made available in its support. Fernando Flores was appointed as Coordinator of Interior Government.

As the begetter of our work, Flores had a mastery of the cybernetics of the problem that faced him. However, he was conscious that the operations room was not ready; the disseminated network for governmental regulation prematurely announced in the Third of the *Five Principles* did not yet exist. On the other hand, the communications centre was in smooth running order — ready to serve an opsroom; moreover Cybernet existed nationwide — although it had not been designed for controlling distribution. He moved fast. An emergency operations centre was set up next to the communications centre, and divided into eight functional commands (transportation, food, and so on). One of our own people was put in charge of each. Similar centres were set up regionally, on the disseminated net model, using Cybernet. Within twenty-four hours messages were flowing, non-stop round the clock, at the rate of two thousand telexes a day. This instantly posed an enormous problem in providing the requisite variety to handle such an inundation. Two of the senior cyberneticians organized a filtration system: some signals were algedonic, requiring instant decisions, while others could be attenuated into elements of the pattern that established the factual situation *in real time*. There are major lessons to be learned from this experience, the first group as illustrating the cybernetic principles of the national system, and the second as teaching much about innovatory praxis.

The first cybernetic point is that the huge surge of information into the regulatory system operated as a negentropy pump: instant communication loops sprang into being, and instant decisions were available. This contrasted with the turgid operation of the bureaucratic system, the entropy of which was close to unity — as is so common. Secondly, the inefficiency of the existing distribution system had led to high physical redundancy — again, as is normal in unplanned economies (think of idle motor transport pools, railway marshalling yards, demurrage); the ability of the cybernetic regulator to survive the hostile action, derived from the effective use of the few physical facilities remaining under the government's control. Thirdly, such a network as this exhibits that very *redundancy of potential command* described in

Fukushima 2

Hardwicke

Chapter 15. This not only helps to absorb proliferating variety: it is decentralizing, and it is robust. Finally, it had at last been made dramatically clear that properly organized information deployed in real time is a major national resource.

As to innovative praxis, the lessons learned were very clear indeed. Let us first of all note that the cybernetic projects on which we were engaged had the full knowledge and support of the relevant ministers and managers from the President down. We had intellectual assent to the proposition that information constitutes regulation, and we had political commitment to the reorganization that would embody this principle. There were no complaints on either side. But it was not until the top officials and the socially responsible ministers were plunged into the traumatic experience of the *gremio* battle, lived with the problems non-stop, used the tools provided however makeshift, and mastered the revolt, that they fully and deeply understood. We really had been talking about a managerial revolution, and not about the introduction of some rather slick administrative tricks.

It seems little short of a tragedy that this kind of experience cannot be had vicariously, although it can be 'pointed at'. For those involved, perceptions of the management process radically changed. The crisis had come on the night of October 17th, and had been survived. One senior minister said flatly that the government would have collapsed that night if it had not had the cybernetic tools. Meanwhile, the President had preserved his usual posture of calm reassurance. He was reported in a headline in *El Mercurio* thus, *Allende: 'Chile no Está al Borde de Guerra Civil'*. *The Times* in London under the dateline of Santiago, October 18th, translated this: 'Dr Allende said yesterday that the country was near civil war'. Not only was it impossible to translate profound experience; the media reporting in Britain and North America systematically misunderstood the most elementary facts, and the most elementary Spanish.

The Problem of Cybernetic Training in Industry

During the first half of October, while the *gremio* battle raged, I was preparing plans for 'The Extension of Cybernetic Management Systems to the Enterprises', as the paper issued on 14th was called. We had been engaged in training from the beginning (see the first PERT chart); but the subtitle of this paper was: 'A Reconsideration in the political context'. It was explicitly a response to the experience at Los Andes, and proposed a new approach.

As has been explained, the project's OR teams had been charged with the need to explain, to gain help, and to seek approval at all levels of recursion — *in order to create the basic system*. This was accomplished. The training problem

now under discussion concerned the replication of the total system within each autonomous unit, for all recursions. To this end, all managers and workers' committees required a complete understanding of the theories advanced in this book, so that they could recreate their own managerial systems. Much effort had already gone into this; but after Los Andes it seemed that the two methods we were using might not be appropriate to the openly radical stand it was intended to take. The variety amplifiers that had been developed were based on respectable practice in industrial training for circumstances in which there is plenty of time, and in which the major concern is to upgrade performance in an evolutionary fashion. Chile had very little time, as current events in that October were all too clearly demonstrating; and it had revolutionary intentions about the whole regulatory system. Many 'advanced' countries have less time than they now think to accomplish revolutionary practices in relation to everything from energy policy to arms control, from national 'growth' to individual liberty; and they have not realized that the regulatory system needs changing at all. Thus it is worth recording the options for training as they appeared in the forced climate of the Chilean experience. The paper mentioned identified the two methods already in use in roughly the following terms:

The Method of Prudence:

Choose an enterprise; move in a team of people, with the management's agreement, to set up an internal regulatory system; use this as a 'demonstration model' to convey confidence; use it as a training ground for teams-under-instruction from other enterprises; 'grow' the work to a national scale.

This approach was used in two major companies, with the primary purpose of discovering how to undertake the exercise, how to meet the aspirations of the workers, and how to help them to perform a more useful synergistic role while at the same time preserving autonomy for their own company. A series of intense workshops was held under the direction of Schwember. The workers quickly grasped the problems of production and organization, and linked them both to practical decisions and the political environment. They visited the Operations Room, which they found exciting — if somewhat overwhelming. It was impressive to see Dr Allende move his formal location as president of the republic to an out-of-town factory floor in order to participate. He showed his faith in winning the forthcoming election (as he subsequently did), and also his ability to discuss questions of supplies, foreign exchange, and organization on the shop floor.

These experiences were very positive, and pointed the way towards the genuine partnership between government and industry that has notoriously eluded us in Britain. But as to using the method as a training device, as a variety explosive that would 'seed' the whole social economy, the idea was hardly realistic. It would surely take ten years, even on the basis of exponential

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expansion (the epidemiological model in which everyone catches new methods like the measles); and that was not on our time scale.

The Method of Selling:

Disseminate information, instruction and enthusiasm outwards from an epicentre of Good News; make convincing presentations to sector committees, then — with their blessing — to the enterprises; 'promote' the product; provide visiting 'circuses'.

Essentially, this was the strategy in use. It was based on an excellent appreciation of the scope and scale of the problem, on a detailed plan of campaign, and a well orchestrated set of approaches to management groups at each level of recursion. How often have all innovating professionals been told: 'you will have to sell the idea'. But was this really the whole of the story for us? We were trying to transmit desperately needed tools and scarce computer power to workers' committees who were expecting help. Although there should be no coercion, although factory groups should be left with a genuine choice about their own internal organization (as distinct from their participation in the national Cybersyn as providers of minimal data), we had a duty to offer something positive. What need of cajolery? We could be more forthright. Perhaps, then, when the current programme of presentations was concluded, all of that could be treated as a 'general briefing' phase, in favour of a different and novel approach — based, not on standard practice, but on strong leadership. Hence

The Method of Decision:

Declare a campaign of national action to improve the quality of management, to advance simultaneously across the whole front (therefore not 'prudential'), as a matter of government policy (therefore not 'selling'); take advantage of the Cybersyn management systems **package, flexible, recursive**, in the context of current economic pressures.

Everyone knew that industrial management had been left in a very weak state by departing owners, and the government could be criticized for not giving a strong lead. The idea was to set up a Training Centre in one of the hotels owned by Corfo, and to mount intensive short courses of such panache and effectiveness that there would soon be a clamorous waiting list of management/worker teams asking to come. The objective would be to effect a quantum leap in the managerial prowess of Chile within a year.

To achieve this, the training programme, lasting ten days, would be largely automated. That is, a set of films would be made, to be watched by sixty people at a time, and there would be carefully prepared supportive literature.

Each course was to comprise twelve teams of five people, with four fully qualified tutors — one to three teams. Having understood the basic cybernetics and the tools made available, each team would work out for itself how it intended to proceed when it returned home. If it wished to run its own in-house programme (say, especially, that a sector committee might decide to run local courses for its component enterprises, thus becoming an amplifier), then the films and other course material would be made available to it. Here was the powerful reason for automating the basic teaching: so that in the amplification of variety, information would not be degraded by inadequate transduction.

This was the thinking behind the detailed plan, in which the course was timetabled and the coverage of ten films was elaborated. They would teach the cybernetic language and principles of this book (but not the neurophysiology), and the written material would provide Chilean examples. The completed plan claimed 'to capture the sense that we are engaged in an economic war. Current approaches look too leisurely, and make too many concessions to 'the way things are done'. If the workers can appropriate ownership, then science must be seen to come to their immediate assistance. If industry is in deep trouble, then the government must be seen to take dramatic action'.

As earlier remarked, these concrete plans resulted from 'reconsideration' following Los Andes. I had already explored the various media for training in Britain and North America, and one British specialist in particular was anxious to make a deal — in return for facilities to make a documentary film about the Chilean process itself. But now the film question arose in a much more potent context than before. It was no longer a matter of having some films available to support the selling method of training: the new plan construed film as the primary transducer of a political as well as a scientific intent. Luciano Rodrigo was the head of Chilean Films, and he entered into the work with enthusiasm, extending the concept of course training by film to the more general context. Especially, he suggested, there should be a preliminary, pre-course film showing enterprises the purpose of the training proposed; there should be a condensed film for refresher courses in-house; and there should be a version of the story that would interest and inform the general public. The only technical problems in sight for Rodrigo were the shortage of 16mm film, and the absence of opportunity to process film quickly: the absurd kinds of constraint with which we were all too familiar. He was silent on the political problems that I knew that he would also face.

I have gone into these plans in some detail here for a special reason. Training (as distinct from education) is conceived as a method of transferring established knowledge. For instance, there is a way of understanding how an internal combustion engine works, and a way of teaching people how to maintain that engine in good order. Training is based on the very solid experience of the trainer, whose credibility as an expert is never in doubt —

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also, I gave the first draft of the diagram at Figure 46 to the Undersecretary. It attempted to give perspective to all that we were doing, and to mark the October turning point in our preoccupations. The picture presented by the diagram does not need a commentary, but it should not be passed over too lightly: it took us a long time to discuss all its implications. Although Project Cybersyn was to continue as planned until the government's overthrow, it was hardly surprising that, from this time, I should devote only a fraction of my time to it. The same was true for other core group members, to the mystified chagrin of many scientists working on Cybersyn, who could not appreciate why we were infrequently seen.

'October' was nearly over. A very long and crucial meeting between Flores, Espejo, Schwember, Farné and myself reviewed the whole experience. We should proceed with all our plans; but they were now secondary to national survival. The training programme should be furthered with all speed, but facilities and funding for the films would be most difficult to arrange — wherever they were made. This problem passed back to me. The new network that had given embodiment to the Third of the *Five Principles* during the crisis must be maintained, built upon, and turned into a permanent feature in support of the new cooperative structures that were rapidly emerging in the countryside. There was much more . . .

As the political dust settled, the cabinet resigned en bloc, as was inevitable, so that the President could make fresh dispositions. On 2nd November the new cabinet was formed, and Fernando Flores was now Minister of Economics. The problem area of his direct responsibility had enlarged again. Moreover, the attempts in the reshuffle to accommodate the aspirations of all members of the coalition were to lead to such a degree of sectarian rivalry within the cabinet and the top echelons of administrative power that the viability of the government itself became a more urgent question than the viability of the economy. (The role of the military was an ever-present and shifting complication.)

Back in England during November, I was pursuing many plans already mooted in these chapters, and trying to guide progress with the operations room in Santiago by conversational Telex from London. There were meetings with film makers and financiers about the proposed films, the basic postulate being that ten training films could be made in support of this very book, and sold internationally to management schools at a modest profit, so that Chile would get the set free. Obviously, however, they would need to be more general in their relevance than we should wish in the the context of Cybersyn. Once again, it was frustrating to have important developments at the national level held up by such small considerations. While all these efforts continued in London, quieter moments were devoted to the realities of life eight thousand miles away. They were filled with concern about instability — of the country, of the government, and of the economy at large. Systemic instability is a

cybernetic concept, and it has cybernetic solutions; but these have to be formulated within the bounds of political practicability . . . The sectarian struggle was destabilizing in itself, while the activities of foreign agencies reflected (as has since been officially documented) deliberate strategy of destabilization. Although it was still possible to discuss these large issues with the minister qua cabinet member, it seemed clear that any action proposal would have to be pitched within the context of his own ministry. Here, his promotion meant that we were addressing a new level of recursion, in which the projects so far being developed were attributable as Systems One.

Messages arrived from Chile that confirmed this orientation. There were large questions surrounding the public stance that a relatively unknown minister should adopt: in short, here was a System Five function to fulfil that belonged to a recursion midway between that of the organization for regulating the social economy as a viable system, and that of the collegiate cabinet organization for preserving the state as a viable system. Secondly, and very naturally following the October experience, the organization of the supply of essential goods for the population needed special attention. The population itself, alert to its vulnerability in this respect, was rapidly engaging in measures to confirm and improve the techniques of distribution that had sprung into being during the stoppage. Autonomous, self-organizing units were developing to cover neighbourhoods, then villages, and even working-places, whereby the producer (the worker himself) could be connected to the consumer himself directly. Such development threatened to eliminate 'commerce' as such — and with it, of course, the *gremios*. These developments deserved encouragement; and it seemed that the only administrative intervention that would be needed would be to provide some version of a System Two capable of regulating metabolism in the total system. There would, however, remain policy determinants on the central axis: acute shortages of basic foods must invoke mandatory rationing in some form, and the government still had its social policy for fairer shares than those traditionally awarded according to the extreme socio-economic stratification of the populace.

The architectonics of the new recursion were formulating in my mind, but I wanted to discuss the issues in depth before attempting a written statement. By the end of November I was back in Santiago, arriving just before the President left for Cuba on route to the United Nations. There he was to make a famous address about the Chilean plight under the monstrous burdens of economic blockade and covert political intervention. This provoked world-wide sympathy, and no helpful action whatsoever. But, while I was yet in England, my compatriot and friend Ross Ashby, discoverer of the Law of Requisite Variety, who had retired to his home in the West Country a few years earlier, died at the age of 69. Cybernetics thereby lost the further teachings of a great man, whose genius is still far from being properly recognized. The event left me personally depleted.

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It is easily stated, and perhaps readily understood from this vantage point, that we were now dealing with a new level of recursion — if only because the sponsor of the cybernetic approach had emerged as Minister. It was not obvious at the time, although it was clear that something was different. Some perhaps saw this simply as a gain in prestige and authority for the work; because the man was the same man, and his contribution to the inner councils of the president had always been effective whatever his official job. Again, the ostensible cybernetic effort was perceived as being concentrated at Corfo, where Project Cybersyn had been started and where it was still housed. Its growing professional staff was increasingly remote from the centre of cybernetic activity — the core group, which was in turn expanding. This itself had no institutional focus, and was thereby rendered invisible — even perhaps to its own members, who were wholly preoccupied in urgent political tasks and economic assignments such as directing industrial sectors.

Although Cybersyn itself had still to be scientifically directed, there was much else for me to do, and I did not even meet most of the latterly recruited staff. It was December 1972: after October, the priorities were changed — as I have already said. None knew this better than the Minister himself; and his response was to draw sharply back from Cybersyn — to the consternation of many, the gratification of a few, and the obfuscation of the recursion issue. The consternation was felt by those who regarded Cybersyn as a political instrument, and who thought they saw political support incipiently withheld. The gratification was experienced by the technocratically minded, who wanted effective management regardless of the political framework. The emergence of a new recursion was obscured because all the circumstances recounted in these two paragraphs seemed adequate to explain why 'things were different', and they did not point to any structural problem in the recursive mapping of the economy.

There was one, however. If we think back to the original modelling of November 1971, we find the economy defined in terms of its assets — the land, minerals, industry — and the ownership of those assets, which in turn defined the public and the private sectors. All the emphasis was on the shift from private to public ownership, which was creating what was called 'the Social economy'; it was therefore natural to everyone to structure their approach to organization in terms of the assets owned. The land had its own agricultural ministry. Ownership of that land had been a major political issue for many years, and important changes had already been introduced before this government arrived, although they had been much accelerated. As far as the Ministry of Economics was concerned, ownership related to industry, and economic regulation related in the first place to the effective management of the assets that constituted that industry. Thus it was political reality which

originated the hierarchy of enterprises, sectors, ramas, and the administrative apparatus to go with it; and it was cybernetic necessity which mapped that reality onto a recursive nest. So far, so good; but the preoccupation with ownership makes sense only insofar as it betokens ruling power. Increasingly we find that other factors supervene. Hence privately owned industry in the West complains that the trade unions exercise too much power, and dissident minorities in all advanced societies are often accused of holding the majority to ransom. In all contemporary societies where such movement is not forcibly repressed, there seems to be a resurgence in the self-organizing capability of communities to promote themselves as viable systems — independently of, or even set against, a moribund authority that derives from archaic and legalistic courts of appeal. Thus it was in Chile, by the end of 1972; the model we were using until then could not adequately represent changes that had come about during Allende's term, and which had crystallized around the events of October, because these were changes in economic management that had nothing to do with ownership in the legal sense.

To be precise, the 'ownership' model nominated only owned assets (whether public or private) as viable systems, which between them constituted and exhausted System One. The community (considered only in its economic role, of course) was part of the environment with respect to System One, and was connected to System One operations by a homeostatic loop labelled 'demand' in the one direction and 'supply' in the other. The distribution function was depicted as metabolizing that homeostat. Certainly, and continuing the use of the ownership filter on our spectacles, the distribution function was largely owned by the *gremios*, and therefore this homeostat was vulnerable to disruption; but this fact does not necessarily turn commerce into a System One. All subsystems of the viable system, as elucidated by the model, are regarded as essential components of viability in any case — so survival depends on them all. Then so long as the management of assets determined the composition of System One, this mapping of the model obeyed all the cybernetic conventions as well as reflecting political reality, and I still consider it to have been adequate to the task originally imposed upon it. What was happening, however, as described at the end of the last section, powerfully suggested that two levels of recursion were mixed together in that preliminary model. It took a great deal of analysis to understand why this was, how it happened — and therefore what could be done about it. In the end, I think that most of the difficulty experienced at this point was due to an ideological hyperbole. What we had modelled was the public sector of industry in *n* recursions, and it had the label 'the social economy'. The social economy however, turned out to be more than this; and in order to model the ministerial totality we needed an extra level of recursion.

The evidence that this was so presented itself uniquely in my experience, and this made it difficult to recognize and later to explain. The economic

community (something different from the demographic community) was itself a viable system, because it had grown a management that was quite independent of the whole business of ownership. The distributive function (something different from transportation) was also a viable system, because it too had grown a management that was quite independent of *gremio* ownership. These two managements were the Systems Five-Four-Three of two viable systems that were part of the social economy, but *not* part of the set of industrial recursions. Then the social economy and public industry were not after all co-extensive: *the latter was a System One of the former*. This conclusion identified the missing recursion. It needed to offer an at least tripartite account of the internal economy, in which owned industry was only a component System One — along with various others. The distribution function, or 'commerce' (in quotation marks because it is conceived as independent of ownership), and 'community' (in quotation marks because it is conceived as an economic instrument), had identified themselves, because of their emerging managements — which were, it needs repeating, independent of the norms of the industrial model. Then of course there could be others, as yet not identified

For the purposes of explaining the new recursion, at any rate, and out of all the activity going on in the countryside, the emergent non-ownership managements to which I drew attention were the neighbourhood councils known as JAPs (Junta de Aprovechamiento Popular) and the Comandos de Abastecimiento, who were local volunteer bodies supervising provisioning. Both forms of organization had been fundamentally self-generating, but each had an accepted status within administrative policy by this time. Indeed, the development of the Comandos in particular had been considerably influenced by the conceptual use of this viable system model: those closely involved had for example explained how they had rapidly understood the requirement for System Two activity within this initially makeshift distribution system. Then the cybernetic argument for the fresh architectonic took shape. The new recursion should be recognized, with (initially) three Systems One. First would come the nest of industrial recursions with its regulatory procedures embodied in Project Cybersyn, and presided over by the workers' committees at each recursive level. Next would come the nest of economic communities, in which all those regulatory activities already summed under the heading of the People Project would find their embodiment, presided over by the JAPs. These would be linked by the third viable system, replacing existing commerce with the new 'commerce', over which the comandos already presided. The regulatory procedures needed here could be very rapidly provided, because they already existed in the standard tool-kit of operational research; thus an 'Allocation Project' became a possibility, which would seek to satisfy demand in an effective fashion using mathematics as well as organizational techniques.

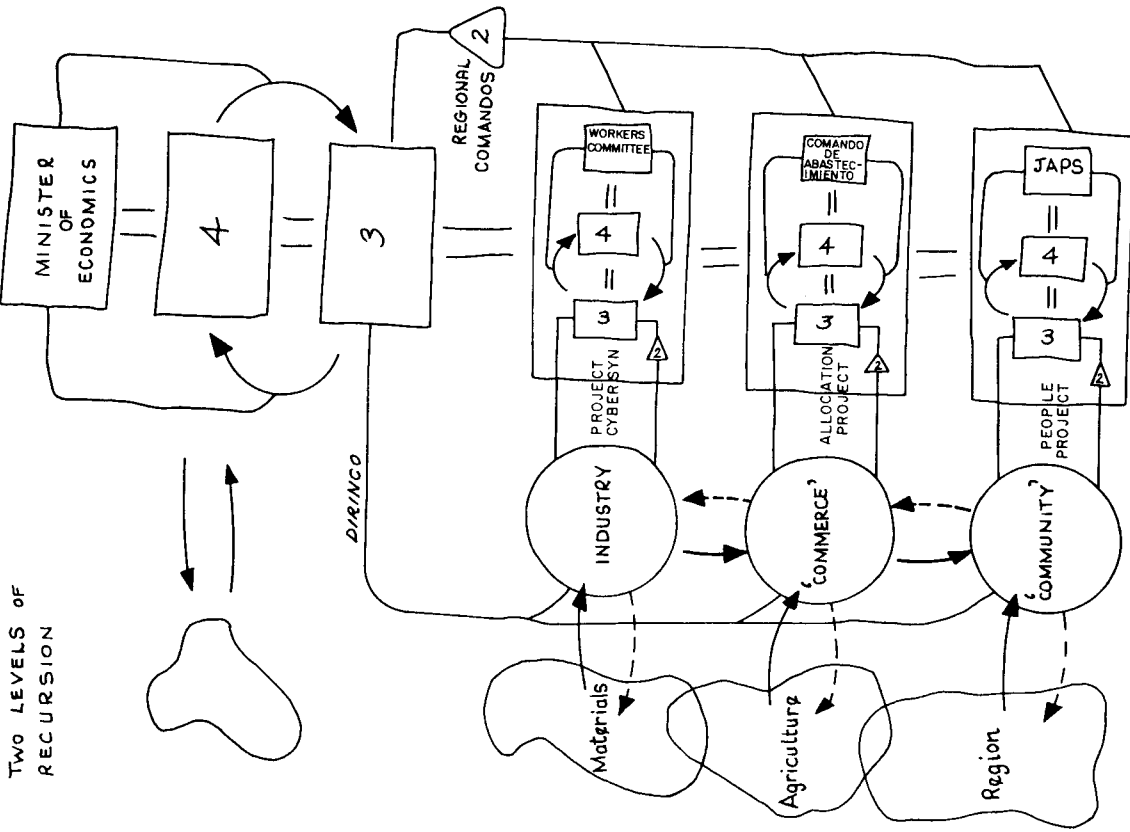


Figure 47. The proposed new level of recursion in the Ministry of Economics, which collects into System One existing projects that may be inspected on a ninety-degree rotation.

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The layout of the new level of recursion is shown in Figure 47, with its three Systems One. By turning the page through ninety degrees, the second level of recursion may be inspected. Details of the model for industry would be unchanged from those given in the last chapter. The models for community and commerce would seek to map the nests of recursions already organizing themselves on the ground. For instance, the so called 'industrial belts' were now emerging. These were self-organizing entities (in the cybernetic sense), that arose in response to the bureaucracy of the Sector Committees of CORFO itself. Again, cybernetic workshops were held, and proved to be positive experiences for all concerned. DIRINCO is shown as operating on the parasymphathetic loop: this was a government agency concerned with fair trading and price control. It had all the marks of this high-variety regulator, as had been explicitly recognized a year earlier. If we had not been active in its regard, it was because we had compressed two levels of recursion into one. By the same token, we ought to have been able to have predicted the System Two comandos, had the two levels of recursion within the model of the Ministry been teased apart in advance. Now, however, everything was falling into place.

The whole system as depicted in Figure 47 looked robust, but it really needed a new set of communications to vitalize the major loops at the ministerial level of recursion. It was now obvious that the original Cybernet, belonging to the second level of recursion (industry) for which it had been designed, was not adequate at the higher ministerial level of recursion — although it had been successfully dragged into that role during the October emergency. Again intuitions were sparkling ahead of the formal analysis. For the core group had already generated the thought that a new version of the Post Office could provide the network of algedonodes that the Ministry needed for internal regulation at the metasystemic level. Certainly that idea fitted perfectly with this architectonic, and with my own belief that although Cybernet could not properly handle the topographical requirements of the ministerial recursion, *Cyberstride* could indeed handle its filtration needs. For I could think of no regulatory indicator appropriate to the two new components of System One at the higher level of recursion that could not readily be expressed as a triple index.

To take an example, and it is no more than that: a community comando knows how much meat it has *got* (Actual) and how much it would *like* (Potential), while a rationing rubric applied to regionally available supplies could quickly compute how much meat it *can* have (Capability). Then a triple-index could be monitored to alert the 'commerce' system to impending shortage at each next-lower echelon, through a supply (equals productivity) quotient; and the appropriate System Four could be alerted to shifts in the investment (or in this case probably import) level required to match not merely need, but desire, through a demand (equals latency) quotient. And so on, throughout the model.

In the outcome, it was Cybernet rather than Cyberstride that was expanded beyond industrial boundaries. It seems that the power of instant communication provides huge advances in regulatory finesse that can quickly be assimilated, and that the filtration system can be relatively crude. Ministries, the Central Bank, and many government agencies were incorporated into Cybernet at this point. The lesson has not yet been understood by other countries.

At that moment (the end of November, 1972, and a year into the work) then, it seemed possible that by understanding the formal cybernetics of the radically changed situation we might start to resolve what I certainly regarded as an alarming degree of political confusion. There was disagreement within the core group on almost every topic. Sets of economic advisors were coming and going, and contradicting each other from within different sections of the ministry. The Minister's priorities, the division of his attention between his ministry and the collegiate responsibility of the cabinet, and his own public posture, were all matters of advice that divided his personal advisors. Probably none of this is very unusual when a government is under intense pressure. But the intellectual hubbub it creates does deafen one to conclusions that might otherwise be heard perfectly clearly. To reach the structural conclusion recorded in Figure 47, to think through the variety engineering implicit in that model (which was eventually to lead to certain theoretical cybernetic advances), and to elaborate the necessary supportive detail as to praxis, was completely exhausting. Therefore it would certainly tax my colleagues, who were already very tired and busy in their own right. These are the realities of the implementation of management science when the situation is very stressful. It is important that the degree of stress be understood: events are moving so quickly in such circumstances that it is almost impossible not to make a mistake. I go into some detail here, because my records of the two relevant weeks are sufficiently thorough as to explain what I think was eventually a mistake.

On 30th November 1972 I took Enrique Farné into my confidence as to these proposed new plans. As head of the nationalized automobile agency for the whole country, he was probably under more pressure than any other colleague, but he was the one best placed to collaborate in the implementation of any such ideas. We discussed them for eight hours, and agreed to meet Fernando Flores together as soon as we could. The meeting of the three of us took place next day, Friday at 10.45 in the evening. I left the Flores house at 3.00 a.m. The Minister's departing words are quoted in the log: 'The arguments are so cogent that I have no alternative'. During the next twelve days, I wrote the plan down, in a document entitled: *One Year of (Relative) Solitude*. This title will convey a special meaning to readers of the writer Gabriel García Márquez; but the sub-title was straightforwardly, *The Second Level of Recursion*. These twelve days were exceptionally busy: maybe their influence significantly

changed the emphasis of the recommendations as originally advanced. At any rate, this was the gist of the written statement.

Firstly, I was fairly confident about progress with Project Cybersyn considered as a piece of management development. All the project managers were enthusiastic about progress; results were emanating from Checo; the Cyberstride PERT was on course, and meetings with those running inputs from the big nationalized industries were satisfactory; the operations room was under construction, and I was visiting it once or twice every day — often with impatient would-be users. Workers' representatives were becoming very interested, and were full of suggestions. Given the evolution of Figure 47, the advocacy was to stand yet further back from the *management* of its Systems One — which, after all, ought to be autonomous. For instance, there should be a Director of Total Industry as Chairman of System Five in Recursion Two (Industry), who would be a worker, and the tools already developed would be formally handed over. Evaluating the consequences, there ought to ensue a collapse of bureaucracy, a restructuring of the sector committees (if not their total abolition), and a replacement of technocratically oriented OR groups by workers' groups. Then this would change the problem of training as so far conceived. One could look forward to the day when, instead of being enticed into attending government courses, industrial workers' committees would be demanding service on the parasymphathetic loop Indeed this was to happen, when the dockers required to know why they were not yet involved (which was because transportation as a whole remained such a politically intractable question). And yet there was something manifestly starry-eyed about this set of 'expectations', and a sense of political realism had to insert those quotation marks. More fundamental cybernetic analysis was continuing in an attempt to identify the deeper system whereby such changes are universally resisted, and the topic will reappear in Chapter 19.

Secondly, I could see no problems in developing the two new nests of the new recursion, which would clear the path correctly to design the new metasystem for the ministry. In particular, the advocacy was to found the public posture of the new Minister on the people's use of 'the people's science'. Angel Parra, whom I met twice during those twelve days, and other artists were by now ready to join in such a campaign. (Indeed, Parra sang the 'Litany' in public twice during that period.) Separate meetings with all the members of the core group, and several more with the Minister, led me to hope that all these plans were feasible. Pressing a little too hard, perhaps, the advocacy proposed a series of ministerial broadcasts on television, and the public inauguration of the operations room by the President. Such moves were plausible, and had been discussed before. If they now came over with a touch of overstatement, the error can perhaps be traced to another incident that occurred during the twelve days, when time was at such a high premium. At their own request, I saw a most distinguished pair of British television producers, who had come to

make a documentary film about Chile and its 'experiment'. They already knew (after one day) what this documentary should say, and the travesty was eventually broadcast exactly as planned. Presumably my role was intended to be to endorse the product. The impotent rage to which this interview reduced me was surely connected with the advocacy to use the medium properly, and soon.

These days of talks may have changed the emphasis in the written report, as distinguished from the *oral* report. Certainly there was no shift in the perception of social objectives, nor in the managerial cybernetics implicit in the organizational design. What was shifting, even from one day to the next, was the emphasis of sectarian politics. Fernando Flores had emerged from the events of October with an enhanced reputation and a cabinet post; by December he was under constant and vitriolic attack in the press. Thus the question as to what public actions were feasible for him was over-riding. As far as I was concerned, I took little notice of the fact that various people were loudly suggesting that I had completed my contract — a circumstance that I should have taken more seriously.

The report was not finished until breakfast-time on the day of departure, and my close colleagues did not like it. I thought that perhaps there had not been time to take the ideas beyond the 'evangelical' phase and into 'solid theology', and that the meaning of the report would sink in during my brief absence over Christmas. Perhaps it did, insofar as the dual recursion idea was effectively assimilated, and the conceptual model offered (Figure 47) was adopted as a mode of thinking and talking. But there was no outcome in terms of organizational change or ministerial stance, as I had advocated.

Almost any explanation of this could be defended. The probability is that the freedom to manoeuvre in so powerfully constrained a situation is itself curtailed — almost to zero. It is also likely that evangelism does not have requisite variety to complete any theological job. During my first late night walk in Santiago in the fateful year of 1973, which was to see the fall of the government and the death of many friends, I was dispirited. The city was peaceful enough; quiet even. But for the first time in the whole enterprise I felt made alien. The words of Nietzsche were in my head: 'Our steps ring too lonely through their streets'.

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January is high summer in Santiago: the one month when people who can afford it decamp to the coast or to the mountains to leave a capital that is like an English summer for the rest of the year. And people say: 'Don't worry, it is too hot for revolutions'.

On the 10th January 1973 I spent all day sweltering in the Operations Room, supervising changes to the Checo screen apparatus — which was not animating properly. Nonetheless, there it all was: the room *existed*. Of course it was not 'running the Chilean economy'. But it was the last of the four Cybersyn tools to be ready. It was a viable transducer. Only the linkages remained to be made. In the next few days, I prepared an inaugural speech for the President; and also a very long explanation of the arrangement of the room and its purposes, which was intended to be recorded for all the visitors that were waiting to come — from every level of recursion. It was this fact that gave rise to considerable disagreement between several of us about the Spanish language version. Were we really talking to ministers, parliamentarians, senior officials, bureaucrats, workers' committees, or the people themselves — and if to them all, as was strictly intended, in what order?

Meanwhile, and simultaneously, there was yet another major change of emphasis on the political front. For complex constitutional reasons, the Ministers of Economics and Finance had changed places. Cybersyn especially was clearly related to Corfo, a branch of Economics; we had already said that 'its tools were ready to be handed over', and all the personnel 'belonged' to Corfo as paymaster. But Fernando Flores was now Minister of Finance; and he continued to be the political director of all our cybernetics. So far as I knew, I was still the scientific director. Thus there began a new series of demands on the core group which had almost no relevance to the prior history. The strain was telling on everyone: two key people were confined to bed for the whole of January and most of February too. The President, as I spoke to him once (though unofficially) in January, seemed more relaxed than anyone, despite the imminence of the March elections.

The point about these was crucial. If the vote for Allende fell from 36% to less than a third, he would be constitutionally compelled to resign — and certainly he would have acquiesced in that. Given all the difficulties since October, such a result seemed a plausible outcome. But Mario Grandi made a detailed political analysis which suggested that the Unidad Popular vote would actually increase to at least 40%. In the event, it was 43%, and it is surely a terrifying conjecture for democracy that an increase of 7% in popular support might sign the death warrant of any administration

The Cybernetics of Public Accountability

It is against this background that we come to consider the whole question of announcements, of which the inauguration of the operations room was intended to be the first. It is first of all necessary to distinguish between the various publics to which such schemes as these are accountable.

The foremost of these is the public who will be actively involved in the scheme. As explained in earlier chapters, we had aimed for participative management of both Project Cybersyn (via workers' committees and individual advisors) and the People Project (via the political parties and the arts connexions). Be it noted, however, that the customarily fine balance between the leadership of a participating group and the dragooning of consenting assistants, which causes difficulty in every 'presidential office' type of organization, is further sharpened by the use of innovative technology. Because the would-be participants do not know what the opportunities are until these novelties have been explained; and it is difficult, if only because of enthusiasm and the need to overcome psychological and intellectual inertia, not to exert pressure in the process.

Even so, the members of the whole participative group involved in setting objectives and taking decisions have direct access to each other. Cybernetically: the network connecting them is anastomotic and not hierarchic: it is in principle capable of generating requisite variety; and it should exhibit the redundancy of potential command (see Chapter 15). It is easy, from within such a network, to perceive when these multinodal characteristics are being lost: the symptom is for the network to tend to centralize, so that actions increasingly become referred to one dominant person, and secondly for one person (not necessarily the same person, but one responding directly to him) to act as gatekeeper between the group and the outside world. Not at all surprisingly, these tendencies ebb and flow in strong correlation with the degree of stress. In normal managerial circumstances, some one person is known to be ultimately accountable for the group's activity; but in placid conditions he is 'the boss' (and the quotations marks are audible in spoken parlance), while as matters become stressful he becomes The

Boss (and the capital letters are audible too). The cybernetics of the multinode show this to be perfectly acceptable, insofar as the greater the stress, the more likely it is that the boss rather than anyone else has the information needed to relieve it, because he has the better contacts among his own organizational peers — so the potential command is momentarily realized in him. The caveat is of course that when placid conditions return, The Boss must again become 'the boss', which is something he may forget to do — having got into the bossy habit. Other members of the group then have certain duties to the boss and to the group which are difficult to discharge: I have experienced the difficulty in both the roles concerned more than once.

The last paragraph, as its final sentence is intended to show, is a generalization based on fitting experience into the cybernetic framework of a viable System Five. It was well borne out in the Chilean work, but it was handled successfully by the group. A test for this success can be proposed. Consider the mismatch existing at any given time between the bossiness of the boss in a participative group, and the degree of external stress that generates the bossiness through the realization of potential command. If the mismatch grows over a period, the danger signals in the network's homeostats will be steadily amplified by positive feedback, until (maybe) homeostatis breaks down. It sounds something like this: 'Look what he's done', 'Now look what he's done', 'I could see this coming all the time', 'he's mad I tell you', 'I resign/you are fired' as the case may be. Whole management groups have been seen to explode into fragments by this process, which obviously ought to be constrained. Because of the stress, such a process often started in the Chilean cybernetic network. But in two years, the names of only three actual casualties occur to me: one who resigned, one who was fired, and one who was as-it-were extruded by mutual consent. The test is more qualitative than quantitative: the group did not explode; its attrition was natural.

Next we come to consider the public that is not directly affected (those who are represented therefore by participation) but who are affected indirectly, and in this case the entire Chilean nation — insofar as these plans intended to change managerial modes of government. Again, then, in this case, there is no method whereby requisite variety can be obtained, except through external amplifiers that are outside the control of the sponsors of the work. This comment refers outstandingly to the political opposition. Remembering that Unidad Popular was a minority government, and remembering the case already submitted in these chapters that the cybernetic group was working as a management service to that government, it would make no sense whatever to invite *participation* from the political opposition. As already remarked, there were political opponents working inside the projects, as a matter of professional freedom; but they were not there to *represent* their parties' causes. Had they been no consensus would ever have been reached about anything. (I refer again to the opening arguments of Chapter 16, but do not repeat them here.) It follows that

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regulate the amplification process that was not under control in Chile: the hope was that by enlarging the Chilean public to the world-government public, a more objective media-treatment on an international scale would insist that the Chilean media held substantially to the truth.

The machinery was this. I had been asked to deliver the Richard Goodman Memorial Lecture for 1973 at the Brighton Polytechnic in England. Goodman had been a brilliant cybernetician, and a dear friend; but I had felt preoccupied by the Chilean work, and originally contemplated making excuses — at least for that year. Suddenly, the invitation became exactly the right medium through which to make the Cybersyn announcement in England. It was the occasion *par excellence*. Richard Goodman had been dedicated to the under-privileged; he had fought in the Spanish Civil War; thereafter he had devoted his work to ordinary teaching in a college well-known for its Third World student intake, spurning high academic honours. Had he still lived, he would surely have taken sabbatical leave to join me in Chile. Everything fitted together: what a celebration! It was still January 10th. The Richard Goodman Memorial Lecture had by now been fixed for February 14th.

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On Sunday, January 7th, the science correspondent of the British Observer newspaper, Nigel Hawkes, published an article entitled 'Chile run by computer'. The article gave its own source: 'the underground science newsletter Eddies, published in London'. The Observer article correctly reported me as 'somewhat taken aback at the disclosure', and said that I should be giving more details in Brighton mid-February. Meanwhile, however, it is noteworthy that the Observer pre-empted the whole story, without a detailed interview (I was taken aback only by telephone). This is called a scoop. It thereby set the whole tone of subsequent reportage, not so much by the article itself, as by its title (woe to sub-editors). By Monday 15th, less than a month before the Brighton assignment, the Observer article had been widely noticed and a cabinet meeting in Santiago considered the original leak, plus its Latin American copies and speculative elaborations in Colombia, Argentina, and Chile itself (in Valparaiso!). The story had been printed in Eddies in the first place, as a result of what I had told a political group in London in the attempt to gain help for the activities earlier called Externalities. There had been a 'misunderstanding' about confidentiality, on one man's part.

Nothing, not even the most expensive public relations programme, can generate the requisite variety needed to regulate the media worldwide. All such attempts have fortunately always failed, and will continue to do so as long as free speech is anywhere allowed. Our plans had gone wrong. I gave very strong advice that the government should immediately make a full-scale and high-level press presentation of Cybersyn, with a televised tour of the Operations Room, in order to amplify the government side of the variety equation to the full. The counter-argument was that the place would then need twenty armed

the Law of Requisite Variety can be met only through amplifiers capable of reaching the whole nation, and not only the minority of the nation as represented in participative project management. Such amplifiers are usually referred to as the mass media; and in Chile these were dominated, heavily dominated, by outspoken opposition interests.

This analysis pinpoints a dilemma. It would have been cybernetically wrong (even if it had not been unethical) to try to keep the work a secret, because of the counterproductive consequences of attempting to thwart Ashby's Law. The Law always reasserts itself — and if the mode of amplification (in this case from 40 to 100 per cent, equals times two-and-a-half) were not properly designed, then the government initiatives were likely to be overwhelmed. A two-and-a half-times discrepancy in variety matching hardly lies within experimental error. But the amplifiers could not be designed, since they were under the opposition's control. This being so, we had neither sought secrecy for the work, nor attempted to advertize it, and this was surely the best policy. Up to this point, early in 1973, we went about our business — just circumspcctly. Even to do this presented problems. Large numbers of people were involved in our activities, including political opponents (although not in the core group, as I called it before). My own presence in a government office quickly drew attention, and therefore I left it: for the whole of 1972 I worked out of the biggest hotel in Santiago, unnoticed among the celebrities, Chilean and foreign, who were continuously in occupation. But the work was based in Corfo, which was entirely appropriate so long as Flores was in Economics; and we were dealing directly with the industrial economy, rather than with agencies spotlighted as planning or policy-making — which moreover, were regarded as the sectarian 'property' of individual parties within Popular Unity. In this way the force of the Ashbean dilemma was deflected for more than a year. But it is always dangerous to tamper with natural laws, and we were alert to the need to take the initiative in redressing the variety balance at the propitious time. We defined this as the official launching of Cybersyn via the inauguration of the Operations Room. Alternatively, we knew that we needed to act quickly if these matters came to public attention. Meanwhile, silence rather than secrecy was enough — because the media were very slow indeed to catch on to the importance of the work. But as it turned out, they were inconveniently too fast by just one month — as shall be seen.

Returning once again to January 10th and the Operations Room, it was clear that the 'propitious time' for announcements to the larger public was drawing nigh. These announcements stood to be radically perverted by the opposition-dominated media. The Flores solution to this had for a long time been that I should make an announcement about Cybersyn in England at the same time as the Chilean government spoke in Santiago. The idea could be viewed, in public relations terms, as an attempted escalation in credibility — London supporting Santiago, and vice versa. Cybernetically, it was of course an attempt to

guards to resist sabotage by the opposition, not to mention the vulnerability of the hundreds of input stations spread over three thousand miles of country. Various decisions were reached, and then rescinded, at least once a day through the week. Many other things were happening, notably a copper strike. At any rate, the initiative in the battle of Ashby's Law for Project Cybersyn was lost that week. The story had already been filed, as far as the British media were concerned. There was no support nor extra information coming out of Santiago, as had been planned. I left for Europe after an extremely friendly and particularly useful meeting with the Minister, during which this issue was virtually disregarded. Nothing was going to be done about it, obviously; and there was so much else to be done about the other limbs of our work, especially in the circumstances that realists now knew for certain that the administration would not be allowed to run its full term. He gave me a new brief in this regard.

But one thing relevant to Cybersyn still had to happen — namely the delivery of the Goodman Memorial Lecture itself on 14th February 1973. That did happen. The address itself, called 'Fanfare for Effective Freedom', is printed *in extenso* in *Platform for Change* (John Wiley, 1975). Present on this occasion was the Chilean Ambassador to London; absent on this occasion was any one of the twenty scooped journalists invited by the Goodman Trustees. The questions afterwards were mostly elementary, save for those of one well-informed academic, who wanted full details of the relationship of Project Cybersyn to all the planning agencies in Santiago. Naturally (the reasons have already been given in these chapters), I could not go beyond saying that the work came under the aegis of Corfo.

During March I was engaged in *Externality* matters around Europe, and was not in Chile again until April. By this time, Cybersyn had been praised to the skies and damned to hell by a variety of critics. The details are of no concern to the cybernetics of public accountability, consisting as they do of the usual mixture of carefully considered reviews and *ad hominem* assaults (the latter coming exclusively from two British journals which take a special pride in scientific and social responsibility, but which — perhaps for that very reason — reduced themselves on this occasion to hysteria). This section is concerned only to point out how the attempt to regulate (not the media, but) the design of the government's own amplification system failed; and especially how — once such a transducer has become denatured — then, as with a neuron that cannot respond during its refractory period, nothing happens at all. For this was the cybernetic truth: the battle of Ashby's Law for the reputation of Project Cybersyn had (as was said earlier) been lost *in advance*. The algedonic signal constituted by the immediate effects of the first major leak (January 7th) had been ignored. That was the cardinal error. What happened in April in Santiago was not an error, it was the natural reaction of a denatured transducer. Not

only was there all the published evidence to consider; not only was there a question of the efficacy of the project to consider; not only was so much else happening at the same time ... the academic member of the Richard Goodman audience whom I had perforce turned aside, chose this moment to make a vitriolic personal denunciation — through a private channel open to her which led straight to the cabinet. This attack nearly finished me in Chile. That it did not was due to the support of the man who had fetched me to Chile in the first place — aided, I suppose, by the general knowledge at cabinet level that at least some of the accusations that had been made in *odium academica* were manifestly false.

All of this argues that public accountability can be discharged *locally*, because the local system can be designed to exercise requisite variety. This means that the negentropy pump called information can successfully offset the entropic drift towards disorganization by invoking the basic cybernetic principles of the multinode, as already discussed. Secondly it argues that on some larger scale the capacity to deploy requisite variety is lost; because control of the design of the amplifiers of regulatory variety is lost; in the Chilean case this happened, for political reasons, at the national level. Thirdly it argues that by engaging in a yet higher level of recursion (and in this case the international level of governmental systems), negentropy can in principal be pumped back into the intermediate (i.e. national) level of recursion, but that this is a very difficult manoeuvre to handle. In principle, one does not have requisite variety to handle it, and the only recourse is to be exceptionally alert to algedonic warnings of disaster. These, to conclude, were missed in the presentation of the Chilean cybernetics applications ... possibly because my colleagues thought, if so erroneously, that the danger signals were hurt pride in masquerade; much more plausibly because there were too many other things to do; and certainly because there was no *organizational* apparatus for handling algedonic signals outside those built into the social economy regulation itself. We had not got that far.

Healthy and Pathological Autopoiesis

At the end of Chapter 18 the concern was expressed that there had been no organizational consequence of proposals which had allegedly been assimilated into the corporate mind of the group. In the preceding section of this chapter is recounted the failure of an algedonic signal, which again implicated incapacity in organizational adaptation. The paper issued in April was an attempt to penetrate the basic problem to which these outcomes pointed. It is reviewed here in detail, because it is inevitable that a major confrontation would have occurred between the established bureaucracy (including the party Establishment of the political left itself) and the cybernetic innovators concerning that problem, had the government survived into 1974.

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Autopoiesis

Elsewhere in this book, the concept of homeostasis has been invoked *passim*. It was defined as 'the capability of a system to hold its critical variables within physiological limits in the face of unexpected disturbance or perturbation'. Now we may define autopoiesis as characterizing a special kind of homeostat: one in which the critical variable held steady is *the system's own organization*. This is a very powerful concept indeed, as it needs to be — since autopoiesis was first advanced by Humberto Maturana and his associates as the basic characteristic of a living organism. Hitherto people had placed emphasis on the ability of living things to reproduce themselves. The new approach emphasized that living things produce themselves: 'to make oneself' is the exact meaning of the Greek term used (see Reference 5).

Maturana, distinguished biologist and cybernetician, was the first Chilean whom I had ever met — many years before this current story. I had not met his major collaborator Francisco Varela before. It was a delight to be with either or both of them occasionally during these days, and especially to debate the cybernetics of autopoiesis. For these two were not agreed about the societal implications of their theory; and my own view differed from each of theirs. This must be on record, both in deference to them, and also to free them from any 'guilt by association' with my views.

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Naturally I had very closely compared the conditions for life as expounded by the theory of autopoiesis, with the conditions for a viable system as expounded in this very book. To me, they were complementary and mutually enriching. To me, both applied to societal systems. Such a system is (in my view, by applying the discoverers' own thesis) necessarily autopoietic. In order to survive as a viable system, it must produce itself. Then let us proceed to examine the possible autopoiesis of the five sub-systems of the viable system. Evidently, System One must be autopoietic, because of the recursion theorem which declares its components to be themselves viable systems. Evidently, Systems Two, Three, Four and Five are not individually autopoietic, because they have no status in their own right. They are subservient systems of the total viable system. (So, too, is System One subservient — but it uniquely has the capacity to survive independently.) Then we may argue:

- (i) a viable system is autopoietic;
- (ii) the autopoietic faculty for this viable system is embodied in the totality and in its Systems One, and nowhere else;
- (iii) therefore any viable system developing autopoiesis in any of its Systems Two, Three, Four, or Five is *pathologically autopoietic*; and that entails a threat to its viability.

By these definitions and by this argument, all the governments that I have studied have been pathologically autopoietic in all four subsystems that are not themselves supposed to be viable systems. There is, moreover, good reason for

the general recognition of a network within this quadripartite pathology that is known as the Establishment. This could well be defined as the pathologically autopoietic principle which pervades them. Then the point behind the analysis of the April 1973 paper (called 'On Decybernation') was the recognition that, although we had already effected major change of a sort, we were not impinging on the Establishment's own organization — which therefore retained the ability to nullify our efforts. It was in fact beginning to do so, by the well-worn expedient of lauding and gladly incorporating some individual components of the total cybernetic plan (such as Cyberstride and the Operations Room) within the existing managerial paradigm, rejecting other components (such as Checo) as too exaggerated to belong to that paradigm, and ignoring the whole class of components (such as algedonic metering) as irrelevant which were not even stateable in paradigmatic language. This expedient obviously discards much important work; but the real issue is that it denatures the viability of the plan that was cybernetically designed as a totality. It is to take the cybernetics out of the cybernetic plan; it is to take any actual change out of the set of proposed alterations. In fact, it dismantles the invention altogether.

In arguing this case, the paper made strong use of four statements made by Maturana. They draw a distinction which is so valuable that they are repeated here in his own words:

'The term *structure* emphasizes the relations between the parts as well as the identity of the parts which constitute a whole.'

'The word *organization* emphasizes the relations which define a system as a unity (and thus determine its properties) with no reference to the nature of the components which can be as long as they satisfy these relations.'

'If the organization of a system changes the identity of the system changes, and it becomes a new one, a different unity with different properties.'

Conversely, if the organization of a system stays invariant while its structure changes, the system remains the same and its identity stays unchanged.'

'Although we make these connotational distinctions in the use of the terms structure and organization, we are usually unaware of them, and thus do not realize that the organization of a system is by necessity an invariant. We talk about change of organization without realizing that such a change implies a change of system.'

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Maturana

So: the argument was that the Chilean governmental Establishment was accepting, and would continue to accept *structural* change — but not *organizational* change (and in this they were and are not alone). However, this was the explanation advanced for the two examples of failure that the paper set out to examine. It went on to discuss the extent to which we could regard the whole work as successful — a matter which has since been debated in the forum of management science internationally, mostly from a solid plinth of ignorance as to what actually happened. The following was the view of current success taken by my paper; it is still April 1973.

'If what we wanted to do was to *meet the objectives listed* for Cyberstride and Project Cybersyn, then we have succeeded. Those were **technical** objectives, and meeting them may count as success to some people.

If what we wanted to do was to *display that technical achievement* in management action, then we may yet succeed. This is the **technocratic** objective, and meeting it may count as success to some people.

If we wanted to '*help the people*', this was a **social** objective, and the outcome is ambiguous. For if the invention is dismantled, and the tools used are not the tools we made, they could become instruments of oppression. This would count as failure.

If we wanted a *new system of government*, certainly a **political** objective, then it seems that we are not going to get it. This too must count as failure.

Any one person who has worked on this team may have a complex motivation, in which the above technical, technocratic, social and political objectives are mixed in unique proportions to constitute his own 'objective functional'.

This would explain some current confusion, and the disagreement about success.'

It still does, I think. We had made huge strides in developing non-bureaucratic management by simply ignoring the established bureaucracy — by setting up a separate framework. Please note that this is the ultimate form of *organizational* change, because the *structural* entity is altogether replaced (Maturana's terminology). Then innovations cannot be merely structurally assimilated: they redefine the system.

Having remarked that my own recent proposals for effecting change on this scale had indeed been 'assimilated' rather than 'implemented', the paper

complained that other members of the core group were not making any proposals at all to this end. It called for them; and it offered certain criteria that any such proposals ought to satisfy. These are repeated here, not because they have generality (for they do not) but because they do illustrate how a topic sounding as vague and remote as 'the cybernetics of change' can be sharpened to precise ends in an actual situation.

Criteria for Proposals for Organizational Change in Chile (dated 27th April 1973)

1. A proposal must aim to change the organization of the established order, and not be a proposal for simply implementing a system of management.
2. A proposal must involve activity by the workers. The system was designed for them, and they are the variety amplifiers. (I think that going rather than teaching is the key to this required proposal. That is why I am now so hesitant about making films.)
3. A proposal must identify structural change, which is easily accomplished, in non-bureaucratic terms — these we already know, because of Cybersyn.
4. A proposal must envisage our invention as an instrument of revolution. I mean that 'The Way of Production' is still a necessary feature of the Chilean revolution, but that 'The Way of Regulation' is an extra requirement of a complex world not experienced by Marx or Lenin.
5. A proposal must treat our invention at the right level of recursion.

The invention needs to be seen in perspective. Some of us see nothing but the invention, and stand to be abandoned by those who see the political setting in which the invention is embedded. Some see nothing but the immediate political crisis (and who shall blame them?) and therefore have forgotten the purposes of the original inventing.

All our endeavours could fall between these two stools.

Obviously this list is based upon the political philosophy of the national management at that time, as these chapters have consistently argued that it should be. It is not the intention of this book to discuss politics *per se*. The list does demonstrate how cybernetic generalizations may be 'sharpened to precise ends in an actual situation'. It was followed by a long commentary on the political implications of any putative proposal. Then it returned to the managerial cybernetics which are our current concern. It claimed that we, the agents of change, were missing our opportunities, because the facts of the situation could not be understood without reference to some model of that

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situation which enshrined political beliefs raised upon ideological foundations. The argument was that we were ignoring — therefore 'eliminating' — those facts that did not map onto this model. How common, indeed, this is: it is endemic to the human condition. Such models are paradigms; if there is to be a mapping of the facts onto a paradigmatic model, it will be homomorphic — many-one. The variety reduction involved fails to transmit the information that 'the facts' supposedly constitute.

Three examples of this phenomenon were discussed in the April paper. First was the issue of organizational change, and second our treatment of bureaucracy. The third talked about corruption, which is a problem in so many countries, and is always difficult even to discuss because no paradigmatic model of good government can possibly include corruption as a variable. It can include illegal acts, because these are straightforwardly negations of the law, and their perpetrators are liable to punishment. Corrupt acts are, however, in some sense accepted in a society where they are the norm. These considerations led the April paper to define corrupt acts as 'those acts which explain away actions that are contrary to law'. In discussion of the paper, Maturana proposed this alternative: 'corruption: all those acts which do not validate the system we want to validate'. In any case, it seems clear that the evident epistemological problems faced in trying to deal with such issues are founded in logical mappings that do not exhibit requisite variety. Then this is one of the mechanisms whereby viable systems may be more readily become pathologically autopoietic: a System Two, for example, that is intent on its own survival rather than its dedicated anti-oscillatory function, can actually fund this false activity from corrupt acts. Those who concern themselves about this particular System Two, then, are likely to address themselves to the disgrace of the evident corruption, and to fail to understand the pathological autopoiesis; this in turn will make them less capable of rooting out the corruption

Discussing these matters once in India, a cabinet minister was astonished that anyone should challenge his conviction that the Indian character is distinctively flawed. Of course it is not. If we ask the cybernetic question: 'For which autopoietic system is this flow of corrupt money the salary?' we shall be led straight to the pathological structure that requires diagnosis and treatment.

The End of 'The Peaceful Road'

The situation was still deteriorating. As the months went on, the mounting pressures were tangible in the atmosphere of the Santiago streets. The core group was also completely alert to the foreign activity that meant that the government could not survive for much longer, and certainly not into 1974. Let it be clear that this was understood by all of us, as I am sure that it was by Allende himself. But it was April, still; and the paper I had just written would provoke a response. The immediate facts of the cybernetic activity were these.

The 'troika' that is to say the threesome team, was already inoperative as such. Raúl Espejo was running Project Cybersyn, which was still precisely on course. Enrique Farné was much preoccupied with his automotive sector. Hermann Schwember had moved from Copper to be general secretary of the Agro-industrial sector. Fernando Flores himself was preparing for a crucial meeting of the Latin-American Finance Ministers in Jamaica. I was spending a lot of time, but separately, with each of them. There was really nothing that I could do personally to further the cause of either Project Cybersyn or of the People Project. Cybersyn had by now a professional and politically uncommitted staff of some seventy people; and it was very much part of the changed Corfo that Flores had completely left behind. Twice, the official there who was playing a central role in further planning avoided meeting me. Also, by now, the People Project had entirely embraced and was totally absorbed by political realities of such potency that it was no longer even decorous to speak of cybernetic formalism in its regard (even in my solitude). But *Externalities* certainly remained. And in May I returned to Europe in pursuit of those economic potentialities in which I still believed. *Might* there yet be sufficient time? Many issues were ostensibly poised for action over there

They awaited the delivery of letters of authorization from the various government agencies concerned with minerals, with wine, and with fish. It was on the eve of my flight that I discovered that I should have to go without the letters; also I discovered the ironic cybernetic reason for that.

Mention was made in the last section of the role of corruption in these Chilean (and internationally comparable) circumstances. The *variety* of corruption had proliferated in many agencies. Obviously the variety of corrupt acts is far greater than the *variety* of *incorrupt* acts, since corruption recognizes no boundary. Then suppose that you are an incorruptible president, facing such a variety proliferation of corruption. You do not have Requisite Variety to hold that situation, and you must therefore attenuate it. Allende's solution had been to declare that general abuses had amounted to a public scandal, and that in future all international trading decisions were to be in the hands of one man. This man's reputation was inviolate. He was the head of the International Trading Office. He was upright; he was scrupulous; and he was known to be so by all.

Then that is fine, so far as it goes. But if everything has to pass through a one-man filter, we may be short of time. Secondly, and naturally enough, most of what time there had been was absorbed, because 'the filter' was undertaking a his own negotiations abroad. Thirdly, those negotiations had created a protocol, which was highly desirable; but it was a protocol that left its negotiator disinclined to countenance international agreements that were not passed through the international Establishment. My propositions were not of this kind. The Minister of Finance could intervene in that situation, and he did. But still the letters of authorization did not arrive in time; and it is easy to

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understand why they did not. Corrupt variety proliferation had been designedly attenuated to near-zero via an incorrupt low-variety filter. Then high-variety incorrupt amplifiers were needed after that phase, to restore requisite variety. The people who were needed were there, and I was dealing with them. They had the will and the imagination to act; they did not yet have the constitutional means. And this was probably because they did not have the sectarian 'clout' — even with ministerial support.

The requisite variety equation was never to balance, and the European trip in May 1973 was inevitably a failure in its absence — although I tried. Should I have gone in May, and should I have returned in June? Opponents of Unidad Popular, and even technocrats within our own part of the governmental machine, wanted me to go, and *not* to return: I was a real nuisance, and they made this evident. Because they made this evident, and because of mounting public attention, there were also personal friends who wanted me to go, and not to return — because they thought that I had run into too much personal danger. The core group around the Minister, whom I knew also to be personal friends, resolved the problem by suggesting that I both go and return — but return surreptitiously, to a cottage on the Pacific coast, away from Santiago. This idea I immediately accepted. The arrangements went ahead. Fernando Flores himself found the idea tiresome. Because of a number of international developments, he strongly urged me to stay close to him in Santiago. Certainly there would be no desertion; but it was necessary to interpret what 'close' ought to mean. It was important not to embarrass him in the public eye. In the event, I was anonymously in a cottage by the shore at Las Cruces during (what was to prove) the final visit to Chile, during June and July 1973. It was a good solution. Few people realised that I was in the country at all. But all necessary meetings were held; the movements took place between several cities, whether by me or by others, by night.

On the way to Chile for this last assignment, I was in transit on the last airliner to land at Buenos Aires before the airport was closed to await the ultimate return of President Juan Perón to Argentina. There were two million people around the airport. Because of serious threats, his plane was diverted to a military base: even so, a gun battle broke out. The southern tip of Latin America was clearly in a tempestuous condition. And yet none of our scenarios for Chile, all of which foresaw the end of the government, most of which foresaw the loss of political freedom which a period of military rule entailed, and most of which were extremely accurate in evaluating the intentions and involvement of the United States (as Congress subsequently established these in public hearings), none of them foresaw the massive bloodshed and absolute oppression that was to come. The Chilean military gave the appearance of upholding the constitution against all comers, of whatever political complexion. Since, in addition, the Commander-in-Chief, General Prats, was a staunch ally and personal friend of Allende, it was all too easy to be misled.

But he himself faced the gravest difficulties. On 28th June his car was cornered in the public street. No armed attack was made; but the circumstances seemed to have been arranged to mimic the assassination of his predecessor, General Schneider. Perhaps the incident was meant to intimidate him prior to the mutiny of a tank regiment which began the next day, and appeared to herald civil war. Santiago was cleared, and my log says 'went into use as a firing range'. Sixteen offices in the presidential palace were shot up, and holes were blown in the Ministry of Defence building. But no-one else joined the mutiny, and the tank commander concerned was personally disarmed by General Prats. This produced euphoria among government supporters. But it was the beginning of the end: Prats shortly resigned; after the coup, he went into exile in Argentina, where he was later murdered.

Throughout these months, the cybernetic core group were trying to assimilate and to understand the events through which we were living, and to incorporate the lessons in an adaptation of the political theory that had inspired the Chilean experiment which Allende had led. What else could we have done with the insights and tools of cybernetics than what we had done, and what plans could be made, while there was yet the time to plan, for the range of possible futures? It seemed to me that much that was internally amiss could be accounted for in terms of the pathological autopoiesis of the viable system, and could therefore be put right by proper diagnosis and prescription; therefore I began the construction of a whole new theory of social cybernetics based on this proposition (it is still under development). As far as attack from outside is concerned, however, there is no way in which poor countries can protect themselves against rich ones if the latter have a mind to suppress them: this has always been the case, and will remain so unless the problem can be tackled successfully at the next level of recursion. It would mean the cybernetic design of a so-called United Nations that is already so far gone in pathological autopoieses that such a proposal cannot even be mooted.

At the end of July, there were strong political currents felt around Corfo and Project Cybersyn. Several strange messages reached me at the coast; they were coming from the political opposition. It seemed that this was the best project undertaken under Allende's aegis, and that his (self-assumed) successor would continue it in his own way. This way would not, of course, involve any 'nonsense' about worker participation . . . I found these overtures obnoxious; but our strategies were well prepared. However, these stirrings came to the ears of the President. He sent a car to the coast to fetch me to Santiago.

While waiting in his outer office, I discussed the military situation at length with the ADC on duty, Arturo Araya, a Captain in the Chilean Navy. He was assassinated that very night: loyalty to the constitution was becoming less possibly daily for even the best of servicemen. The Campafero Presidente was tired and harassed. He interrogated me closely about the new currents surrounding Cybersyn, and I told him all that I could. Certainly there were

many people involved who did not subscribe to industrial democracy as we had planned it. He asked me whether I had anything to ask of him. I said yes; in view of the confusion being generated around the project, would he tell me quite directly the extent to which he expected worker control of the social economy. He replied: 'El maximo'.

During August, a second attempt to bring down the government by *gremio* action was made. Having successfully endured the experience of October 1972, my associates knew what they must do. Two special purpose operations rooms were constructed, and connected to the network of communications through the country which Cybernet embodied. Filtration systems were set up for the spate of messages, and Cabinet Ministers and senior industrial managers dealt with them in *real time*. Raúl Espejo has recorded that during this period between 10 and 30 per cent of the normal lorry fleet was in operation. But thanks to the 24-hour-a-day management of distribution, the levels of fuel and essential food that were normal in the country before the strike were maintained. State enterprises playing a strategic role in the economy received their normal supplies of raw materials. If all this sounds an impossibility, it must be recalled that transportation systems are highly redundant: think of parked lorries, of railway wagons in sidings and under demurrage, and of the notorious delays that happen at docks. This redundancy was mobilized into instantly responsive action in Chile, taking up much of the slack in a system that is normally (and in any free country) allocated to both preparedness to compete and also pure inefficiency. Moreover, the levels of supply to which folk had become accustomed were already depressed by earlier disruption that could now be corrected. Even so, the achievement was still dramatic; and there is little doubt that, as in the previous October, this stoppage would have been successfully handled, despite the influx of foreign money to support it, had events run their course.

The potency of cybernetic thinking was again being vindicated within the country of Chile; but how could this small, poor country withstand the pressures from outside? I have often been asked why we were not able to stipulate a behaviour which would accommodate that threat. It is like complaining that a man, who is supposed to be an adaptive biological system, cannot adapt to a bullet through the heart.

On 8th September, the President sent an order to the Cybersyn project team: it was ~~the last that they were to receive~~. The operations room built on the Avenida Santa María was to be moved to the inside of the Palace, La Moneda. He well understood that none of the existing rooms was large enough to accommodate this apparatus, and allocated one of the most traditional and important rooms to be transformed for the purpose. During the next three days, the drawings were completed.

NO ?

On 11th September 1973, I was fulfilling a last engagement in England prior to returning to Chile. It was in the City of London, and I was expounding these matters, and especially the *Exterralities*, to an inner group of the Liberal Party, as represented in 'the City'. The Party Leader sat in the front row. Following the official proceedings, there was considerable informal talk, and the gathering broke up slowly.

Eventually, I left the building alone. It was to confront a newspaper placard in the street outside: ALLENDE ASSASSINATED.