

The Falcondale Collection

Stafford Beer

Initiates an Audience into the World of
Systems and Managerial Cybernetics

Session 1

The History & Nature of Cybernetics:
Part 1

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This transcript relates to a set of nine video tapes where Stafford Beer introduces an audience to the world of managerial cybernetics.

The event took place over five days in July 1994 at the Falcondale Hotel near Lampeter in mid-Wales. It was organised by The Liverpool Business School at John Moores University where Stafford is Honorary Professor in Organisational Transformation and a Senior Fellow.

The aim was to provide a video learning resource by recording discussions between Stafford and an audience that had little or no previous knowledge of the subject.

Over the course of the event Stafford explains the development of the subject from the initial scientific discovery of Cybernetics. Through his own development of managerial cybernetics he introduces the tools and models that he has created to offer an alternative approach to conventional management practice.

The resulting material embraces the key principles and models that have previously been introduced in his thirteen books and referred to in many of his published papers. This is the first learning resource where all these have been brought together in one integrated way.

Managerial cybernetics continues to be the only available scientific and coherent account of effective managerial practice, and Stafford provides numerous anecdotes, applications and insights from the perspective of practitioner, manager and scientist.

The set of videos which accompany this transcript are available for sale from the JMU Services Limited office at:

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For further details of costs and how to place an order, please visit the official Stafford Beer web site at

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Contents

Session		Page
1	The History & Origins of Cybernetics: Part 1	1 – 1
2	The History & Origins of Cybernetics: Part 2	2 – 1
3	Complexity & the Measure of Variety	3 – 1
4	Homeostasis & Viability	4 – 1
5	The Elemental Organisational Unit	5 – 1
6	The Horizontal & Vertical Variety Balance	6 – 1
7	The Viable System Model: ‘The Inside & Now’	7 – 1
8	The Viable System Model: ‘The Outside & Then’	8 – 1
9	Syntegration	9 – 1

Well its very nice to meet you all I hope that you're all relaxed and seem to be enjoying each other's company which is all very nice.

Now I expect you know that there is an institution which to the shame of the countries concerned is still very much in existence which is called death row.

Well, there was a prison governor who sent for three men to tell them that their time had come. He asked the first man, who was a Roman Catholic what his last request would be and he said. Well I haven't lead a very good life and I would like to see a priest. This was noted. How about you, he said to the second man. He said he was a Professor of Cybernetics and would like to give his last and definitive lecture on "What is Cybernetics?" I think that can be arranged he said. Third man, and you. I am a doctoral student of the Professor here and I would like to be executed second!

I don't know if you have ever tried to find out what Cybernetics is but you would get some very odd stories because I think you will see by the time we finish, why it is. In trying to introduce this subject to you rather than plunge you into academic definitions I would like to tell you the story of how this all began. There are some very extraordinary people involved in this and I had the very great privilege of knowing all of them, and there aren't many of us left. So I'm very happy to share this with you and I want to try and impart some of the excitement that went with the origins of this subject. Now there aren't many sciences that you can date. When did physics start? Nobody knows. Cybernetics quite specifically started in 1943. Which is more than fifty years ago you realise.

And the war was on.

The first man I want to introduce to you is Norbert Wiener, has anybody heard of him?

Well one of the things that all these characters I'm going to introduce to you have in common is they were world authorities in their own subject. Now that is a very unusual situation, and it meant that they were not defensive which means they were not having to prove anything. Where most of us, unfortunately, are always trying to prove something, because we are insecure and our society is like that. I think you might agree.

Well these guys, not so.

Now Norbert Wiener was one of, I suppose the six ranking mathematicians in the world. He was very very famous and he... this is 1943 so the war is on, he is drafted to the task of doing something about anti-aircraft fire. I don't know if you can imagine what aeronautics was like fifty years ago, you had an aeroplane there and you tried to hit it, so you say "Oh well I better aim off a bit", and that was roughly the state of the art. It must be unthinkable to you now that could ever have been the case but Wiener had the problem of how to track an aircraft which is probably dodging around and there's the whole problem of whether if you're the aircraft, do

you take defensive action or what the hell you would do.

In support of him, he has got his knowledge of mathematics. Why was he famous? He was the man who developed Fourier analysis. It's a way of looking at a time series of some function developing over time which is very very complex and involves, therefore, prediction of the next terms, and you can immediately see why this should be relevant to the task of shooting down an aeroplane.

He has a very great friend who is Arturo Rosenbleuth. A man I have never met, but I met his son who was quite old, even then, who was the Head of Neuro-Physiology in the University of Mexico in Mexico City. These two men became great friends and one of the things that became obsessive... now he is a mathematician what does he know about Neuro-Physiology and what does the Neuro-Physiologist know about mathematics? I can tell you, nothing. In both cases. They began to get very interested in the question of what the other was doing. Then they came to a very extraordinary arrangement whereby they spent six months of every year in each other's company alternately at the Massachusetts Institute of Technology where Wiener was and in Mexico City where Rosenbleuth was. Out of this began to emerge a most fruitful collaboration as you will hear.

So that is Norbert, now it's a most precipitous year, this is 1994, to be talking about Wiener because it is his centenary in November. I have been much concerned with organising a celebration of his centenary.

I have brought a photograph of this fellow. I have raided my personal album.

This is Norbert

Many, many tales are attached to this extraordinary person. Extraordinary people are very extraordinary, you can expect it. He became very famous for the story of walking across the quadrangle at Cambridge, Massachusetts and encountering a student, who said. "Excuse me Professor I wonder if I can ask you this?" "Yes my boy, yes my boy what is?".... and when he had finished he said to the student "Excuse me which way was I walking when you stopped me,"

and the student said "You were going over there sir" Wiener said "Oh good I've had lunch!"

These are the sort of stories that circulate. He lived in a rarefied atmosphere. I can't tell you how marvellous a person he was. He is often called the American Leibniz. Some of you will have heard of Leibniz I hope? The philosopher who was notorious for being a polymath. He knew everything, and people often say you can't do a Leibniz these days because there is too much to know; which I dispute.

The story about Norbert, which I am sure is not true, but I'll tell anyway because it gives the flavour of the man is that when his first family grew up he moved house away from Cambridge, Massachusetts, to a smaller house to accommodate his smaller needs. When he

left for the University his wife said "Goodbye Norbert and don't forget we are moving today". He says "Oh tush woman, I know that", but none the less he comes back to the house. The locks have been changed the curtains have been drawn. "My God we have been burgled," and he thought God, no, we have moved. It was close by, just a smaller house but where have we moved to. He stopped a little girl riding by on her cycle and said "Excuse me my dear, the Weiner's used to live here do you know where they have gone to?" and she said, "Yes daddy!"

So, that puts him on the map, and there he is in Mexico, with Rosenbleuth.

The next person I want to introduce is Warren McCulloch. Now he is very special to me because he became my mentor.

That's the very alarming looking Warren who was nothing if not dramatic.

Now, Warren McCulloch, if asked by ladies at cocktail parties what he did would say "A Blacksmith", and he was a very good blacksmith, he was also a physician and lived next door to Einstein who was one of his closest friends and they were.... they also., Please note what is emerging here. Einstein is a physicist this guy is a physician. Somehow they are recognising each other, and in that very year 1943, where I am discussing where Weiner turned up in Mexico. Warren persuaded the New York Academy of Science to hold a meeting, which he called Teleological Mechanisms. Now, what does Teleology mean?

Telos is Greek for End so it's where we are going. Now a teleological machine would be a machine with a purpose, which is an odd concept straight away. Here he is holding this meeting. In those days, - now we are going to hear more of this. In those days it was very common for leading people to get together in sponsored meetings which were sponsored by foundations or whatever. We don't seem to do that any longer, there don't seem to be the funds. A lot of the inter-disciplinary ideas, which is obviously what we are beginning to talk about here, came up because of putting really distinguished people together who would then try and discuss things. So, that was what Warren was doing.

Weiner's works have been published I think in two volumes, and there is a biography of him by Massani who was a mathematician. Warren's works have just come out in four volumes and it is just amazing to see the scope of what he covered in his life. He was the country's leading expert on nerve gases, for instance. He was all manner of things. The Chicago Literary Society invited Warren to talk to them. I guess they expected him to explain what science was all about in words of one syllable. So he didn't, he read them his poetry.

Shook them.

That little book which is called the Natural Fit.

He wrote in the front of that to me a sentence of four lines. I am desperately anxious to share

these people with you, these personalities.

Here goes the four lines which I don't think have ever been published. It's just one sentence but it is long. Are you ready? It says

“Since that loveliness, I know is you
which in quick having holds me quite content,
love could not gather what had never grown or what from my poor gardening never grew
I to the frenzied and immortal few turn hungry home.”

Enjoy that?

So that's Warren.

Warren and Norbert were friends, eventually fell out as always seems to happen, but at that time they were friends. Gradually around this nucleus various other people got sucked in and pretty well every subject you can think of was represented, with people who were authorities, therefore, not scared, therefore, willing to expose themselves to this kind of chit chat.

At this point we get the Josiah Macy Jnr. Foundation moving in an absolutely historic move to me. They sponsored a cybernetic conference, among these leading people, there were about twenty of them, every year for ten years and that is the foundation of Cybernetics. That is the foundation of Cybernetics, those conferences.

All sorts of people were sucked into that.

Now I've mentioned, Mathematics, Physiology, Medicine. Try Anthropology. Can anybody name an anthropologist?

Margaret Mead

I'm so glad someone got it.

That's Margaret.

A very redoubtable woman. I'll tell you a story about Margaret, if I may.

She told me this herself so it's bound to be true. Churchill in the war was very concerned about the behaviour of the American troops in Britain and they were running amok, or that was the popular belief, with the local girls while the local boys were in Burma and places like that. He asked Roosevelt for somebody to investigate this and Roosevelt sent Margaret Mead to Churchill and she looked into this and quite an interesting little thing. See, the belief in England, I was a young man at the time, and I was a part of this belief system, that Americans

were paid about six times as much as we were paid in the army and they could walk off, and they had collars and ties on their uniforms, where we just had these clipped up things. So we thought we hadn't got an equal chance at all. What Margaret discovered was that the American soldiers were chatting up English girls and they said to them, "Will you come to bed with me?". Now it seems that this is a complement to a woman, in those days in the American culture. It was a way of saying, I think you are lovely. English girls thought it was a proposal of marriage. Different cultural stint, you see. So they said "Oh yes", the Americans then said "These English girls are a push over" and whoosh!! This is an explosive system we are talking about here.

So that's Margaret, she got in on this group and McCulloch became the Chairman of the group, and all sorts of people tried to get in on the band wagon but McCulloch was absolutely fascist about the thing, he wouldn't let anybody in who he didn't think was right. In other words he was looking for the inter-disciplinary balance, and he managed to sustain that for all of these 10 years of meetings. What had such an impact on anybody who was studying these matters was that the conference proceedings were published, year after year after year. These little green books started to accumulate with me, I was amazed.

Now into this group had come a young Austrian scientist called Heinz von Foerster. Now I'll introduce you to him. After the Anschluss when Germany took over Austria. They hijacked all the leading scientists and the result was that Heinz von Foerster was the man who invented airborne radar for the Germans. Now, he has appeared in the USA he doesn't speak much English, at all but he's there.

These guys needed someone to take on the task of editing the conference for publication, and Warren, with a stroke of a typical stroke of genius, nominated Heinz von Foerster to do the job, on the grounds that he would then have to learn the English.

This is exactly the truth of the matter, that's what happened.

I've got Heinz here I'm sure I have.

Who is a mercurial Viennese man For years I have known him, and he would often talk about Uncle Ludvig. Uncle Ludvig became some sort of character to me who was an odd chap that was the subject of many anecdotes and it took ages before I realised that Uncle Ludvig was Wittgenstein. You've heard of him I take it?

Some of you obviously haven't but then some of you have.

Wittgenstein was a very very famous philosopher who worked with Bertrand Russell at Cambridge.

So I really despair of giving you a proper glimpse of Heinz von Foerster but I'll tell you one

little story about him.

He said to me “Stafford you are forgetting my first theorem”. I said “Oh. I'm sorry. First theorem I'm awfully sorry I don't know what it is?” “You don't know my first theorem?” he says. He then told me his first theorem. Which is “The more profound the subject that you ignore the greater your chances of fame and success” It's a very deep remark. don't you think?.

There they are, this gang, some of the people I have introduced you to. So what do they get up to.

All of them were working on war work, all of them arrived and came and went to the centre of this activity in Mexico City because it was a neutral country, you see. They had not got their spouses with them and they talked a lot at night and they began to focus on this question. “Suppose that the things that matter most to science, to philosophy, to human race are issues which fall between the stools of established subjects”, don't forget they are all experts in their own fields. They don't have to defend anything. They started to talk about what sort of things aren't really accounted for in the university. Now, university is supposed to be that it is universal, it is holistic and you couldn't find a more reductionist and non-holistic place as some of you have probably discovered and others will. I mean it is absolutely appalling. You will have two eminent professors of soil ecology, in adjacent laboratories, looking at this same sample of soil and they can't talk to one another about it because one has one slant at it and the other another. As the expert of sea-weed down the corridor well !! This is really how science has developed.

I don't know if you've thought about that but I want you to because who says God knows the difference between physics and chemistry ?

This is what we know as reductionism. Our whole intellectual apparatus is based on reductionism, which means taking things apart and reducing them and studying the bits. Of course, this trick has paid off very well hasn't it ? It's given us an atom bomb for instance. The point is that in doing that you may be losing all the results of the interaction of the parts. Say you take your radio apart, and you are knowledgeable in electronics and you say this is a capacitor and this is a resistor, this is this and that is that etc.. That accounts for the radio set, doesn't it. okay where is the Guns and Roses noise, I don't see this. You take an engine apart and you have pistons etc. what is most characteristic about this engine is its speed. No speed anywhere to be seen.

So, I'm trying to show you there are terrible traps lying in wait for us when we use this reductionist method, as powerful as it is, and I don't want to disparage it. Except we have lost the counter balancing, holistic view, which tries to put the pieces together again and which gives us the benefits of, I don't know if you know this word, synergy, which is the energy available from the syn. Putting things together.

This was all very clear, to these guys in 1943. They began to agree that this was the case and they started actively to consider what sort of topic might pervade everything and not be recognised because of this reductionism. They came up with the notion of control.

Now if you put on any hat as a scientist, an artist, a citizen, you are going to have some views on control, aren't you? Politics is all about control and what kinds of control we think are and are not acceptable.

Administration is all about control of a different sort. Is it different ?

If you were an astrophysicist and you wanted to talk about control, there is gravitation, pretty strange how all these solar systems go round their suns. That's a form of control, after all isn't it?

If you were a brain surgeon, you'd be saying the reason you've lost your feeling here is because of something here which is a control circuit.

These guys realised that all of them knew a hell of a lot about control and as soon as they started analysing it they realised that didn't know the same thing. The politician meant something different from the physicist and the physicist meant something different from the brain man and so forth.

They said what gives, perhaps control is something that we should really examine in its own right.

This is what became Cybernetics.

One of our problems here is that because we all have different views of what control is. To some people the very word is like a red rag to a bull because it suggest, you do this or else the very word has this in its connotation which isn't very useful.

So these guys started meeting on a regular basis and trying to discuss what they meant by control. All of them have attested in their various writings, that it took them about three years to know what they were all saying because they would pick on some guy one night and say just explain what control is to an astrophysicist So I mentioned gravity, then there's cosmic radiation, there are all sorts of peculiar things going on there, and then somebody else would have a go and it took them all this time to understand each other, but the more they understood, the more they perceived identity, the more they realised that there were common features to all of this.

Now that is astonishing isn't it?

Because we have been taught the difference between our subjects and our ways of looking at

the world and we don't know how to put them together. Then somebody comes along and says well there are unifying things that are working across here.

Well, now the story I want to tell you now is not as jokey as my earlier stories. I think this should give you the real flavour of this thing and what I'm going to tell you is high science and I really want you to hang onto it because it gives me a frisson every time I think about this story. If this doesn't give you a frisson then you shouldn't have come.

Its a challenge isn't it.

Now I've brought a pad with me.

What's that?

What is a frisson?

Oh I see ha ha ha. It's the feeling that comes crawling up the back of your neck that makes the hairs stand on end.

OK I'll have one of those.

Well this story concerns some of the people I have mentioned to you. McCulloch walked into the common room of this place in the evening and there was Norbert Weiner sitting there, reading and Warren said listen my colleague whose name is Walter Pitts and I have been considering the following problem and I would like to discuss it with you. Norbert says carry on. Now Warren says you've got all these blind people who can't see, I'm trying to make a machine to enable them to read with their ears. Now how would you do that?

Any ideas.

Somebody reads something out to a tape.

That was a trick.

He wants the machine to look at the print. What he is saying is this, now what we shall do is scan the print with a photo-electric cell which of course can see. The photo-electric cell is going to encounter this I when this line is broken it makes a sound and when it encounters the l this line is broken it makes a different sound. So when it hits I it will go bonk, which is a distinctive noise and then when it hit l it goes boing. Then the idea is you can distinguish the I from the l.

Then you've got an n which goes blunk eeee blunk

So one can see this is sort of possible to do. Now what is the big snag?

Now if you were asked to put money into this what would you say?

It's going to be rapid ... What's that ... It's going to be very rapid

People can read Braille so you could train your ear to hear it. You get Gestalten. You get whole words like 'the' would goand you would say that's 'the' and you would soon learn that.

'H' and 'B' are quite close.

Yes, There are ambiguities to clear up.

[AUDIENCE SPEAKS]

Nobody is really mentioning what the real problem is.

The things got to go, its the direction with which its going the printer has got to be solid I think and how do you run it

you've got to scan Like a television.

Exactly on the line.

Ah. Now we are getting to it.

Exactly on the line.

What does that mean?

Well its position onto the line. If its not exactly on the line you could pick up half the line above and half the line that's right

Precisely and the generalisation of this problem is that type is different sizes and different spacing. Now you could say well, you better reprint everything on a standard format. We've got that already, it's called Braille and we don't need this.

Warren said to Norbert. This is Warren talking to Norbert you see "If we have The solids are photo electric cells and the circles are oscillators. You set up a vibration between a photo electric cell and oscillator and then along comes your scanner like thisThese are your three lines which you are going to look at that, You are obviously going to need a battery of these things so let me put in some more. This diagram gradually grew in front of Norbert and Weiner and I'm not expecting you to bother with the technology of this but I'm hoping I can make clear to you what this schematic will look like because I want you to realise that this is

not a circuit you see. It is a schematic diagram of how you would do this.

Now then .We now have a bank of photo cells and a bank of oscillators and a scanning apparatus which is going to find out and make all these funny sounds. Now, the problem how to deal with all the various sizes of type was the thing that Warren now tells Weiner that he thinks he has solved.

What it involves is going across the thing. You have to find out where you are geometrically across these three lines which is exactly addressed to the problem you immediately saw there. So you would be doing something like that both ways and you would have something that looks roughly like that.

I don't want to waste time on this diagram that is roughly what was drawn. They discussed the problems with this and whether it would work and so on and they were mixing here the mathematics of the series produced by scanning, the electronics of how you would do it, and the pattern recognition. About recognising patterns in things which would somehow would give you the answer. Warren pours himself a large whisky if I can remember Warren. Speaking of which!! - Goes off to bed, and leaves the drawing on the table. Now in comes Gerhardt von Bonin. I haven't mentioned him yet. He is one of the leading world figures in neuro-anatomy. He picks this up and says to Norbert Weiner whose been trying to make a diagram of the fourth visual layer of the cortex.

Getting the frisson?

Yes

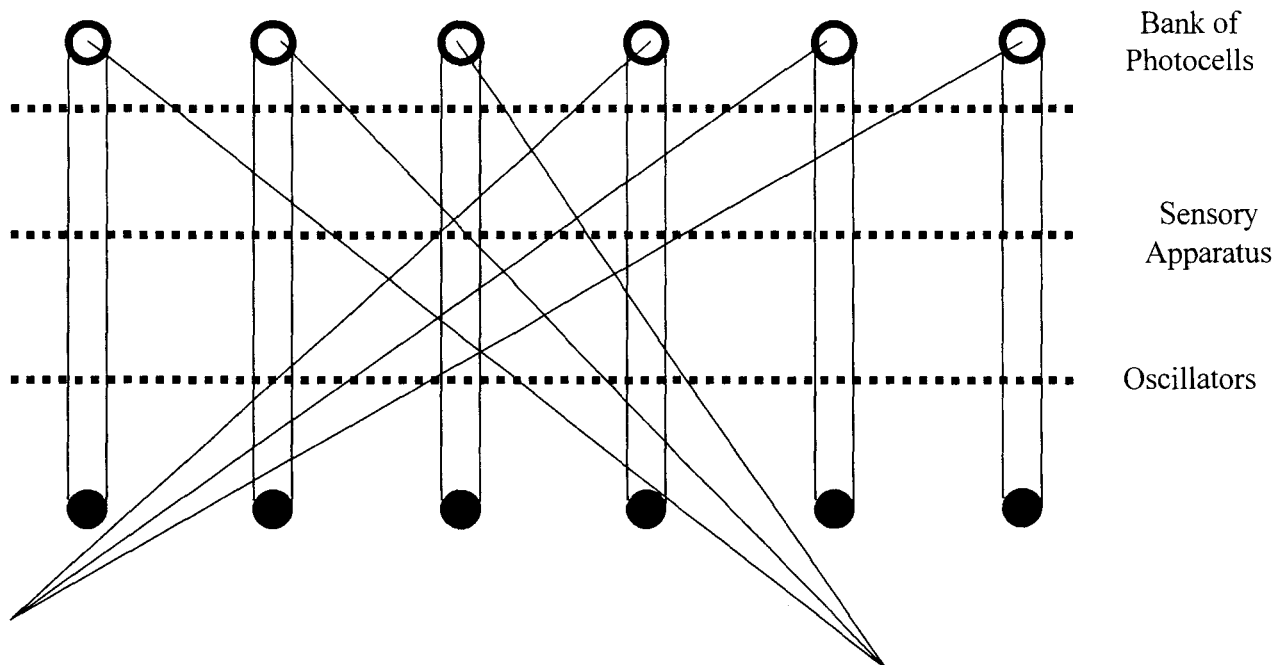
It always happens to me when ever I tell this story.. isn't it just amazing wow !!

Some people say so.... and don't get the frisson I'm glad you did.

There is a bit more coming.

Weiner was bowled over by this and so next time the group got together for one of their regular evening meetings, he told the others what had happened. He said he could make a mathematical analysis of this so called machine or this so called bit of brain if I knew the rate at which nerve impulses are coming up here if I could quantify the diagram in short. So various people say I've spent a lifetime doing that I can tell you that the impulses come in and they did quantify the diagram. Weiner did the maths and he said I can now tell you what the scanning rhythm has to be.

Diagram: Mechanism for Blind People to Read with Their Ears



Any guesses? This is cycles a second.

Any thoughts.

Same as the human eye.

That's a good answer, not right but a good answer

It's ten cycles.

What is that?.

Anybody know?.

It is the alpha state of the brain. Which is the resting rhythm of the brain. Which has solemnly scanning this stuff at ten cycles per second. That is the second frisson.

You see Cybernetics has built out of those disclosures out of those excitements. A wildly exciting subject. Now it is portrayed as artificial intelligence, boring as hell. The whole thing I'm trying to get across to you is the inter-disciplinary quality of this and what happens if you stir this pot of specialities.

They held these meetings and all sorts of things emerged I suppose the most famous of all the things that emerged was the notion of error control negative feedback. Now what this says is that if you were trying to do something you constantly measure the extent to which you are not succeeding and feed that error signal back into the input.

Pretty obvious when we say it like this but it wasn't and again the inter-disciplinary quality comes out because if you said.... Look at the terminology I'm using. Error control negative feedback is a term from servo mechanics, from engineering.

If you have a power brake and you stab at the brake you have feedback coming into the system. Now you don't normally think of that in the social context but you've got it all the same. Warren says in one of the last papers he wrote before he died, Warren McCulloch. That the whole essence of Cybernetics is the lesson of never do anything until you know the result of your last action.

Again it appears so devastatingly simple but if you look at the modern government, it makes you giggle. It makes me giggle to apply that criterion, for goodness sake.

So, all this stuff started to emerge.

Weiner bless his cotton socks had a tax problem. So Weiner wrote a book called Cybernetics. It was published in 1948. In which he announced the discovery of a new science, and it's most amusing to me that he did do it to make a little money on the side.

Now where comes this word. They had decided that they needed a term for the science of control, but watch this word again. I've tried to show you that it's a much more subtle use of the notion of control, perhaps the word regulation is better. But again that sounds like a bunch of bureaucrats you see so we are short of words here very short of useful words.

Any rate he chose the word Cybernetics.

Anybody got a clue as to the origin of that word?

Greek

Any philologists here?

The Greek is Kybernetes and it means steersman.

Now that is interesting because they had already realised that the notion of control; do this and he doeth it, or pull this lever and it goes clonk clonk clonk., was too simplistic.

The idea of the steersman is that, this word turns up in Homer. It's this guy at the back of a

long ship who is saying I want to go over to that light across the bay and he does this and he steers towards the light. If you said the problem is folks we have got a sea running here and all these currents and we've got winds, and they change and they veer about. You would never get there, would you? Nobody could solve the problem, not even today, with all the computers and mathematics and the rest of it, can you actually do that because the meteorological conditions are not well enough understood, and never will be. What you do is, look out there and steer. So it was a very good choice of word from that point of view. From another point of view it was a disaster because everyone said. What is Cybernetics - before they were shot?!!

It is a good word, now that word steersman appears in Homer, Plato uses it for regulation in societies, so it's getting a nice patina on it. It turns up in Latin. I don't know how interested you are in language, I presume some of us are. The Greek Kappa turns into a G a harder sound and out of Kybernetes you get gubernator in Latin which gets into English as governor.

What do we know about governors folks?

Control

But there are various kinds aren't there. Now take a prison governor, a prison governor has a lot of variables under his control and they are called convicts. If the prison governor goes off to have dinner with the mayor or something, and the convicts dig a hole under the fence and evaporate, too bad. The first thing the governor knows about it is, whilst having dinner with the mayor, he hears the bells going clanging, saying somebody's got out. Now that's not very clever; method of control is it? This governor hasn't got a clue.

Look at another governor.

Have you ever heard of the Watt Steam Governor? Invented by James Watt, with the kettle, how does that work?

Its has two balls it twists round that close it and goes faster.

That's exactly it.

You have a shaft which is revolving and on this is a sleeve and there are the two balls, that Lee mentioned, and another sleeve. Now as that engine goes faster and faster the centrifugal force drives the balls outward and the sleeve moves up, doesn't it? That shuts off the fuel.

Now that's damned neat! because it's what I call intrinsic regulation. The regulation is in the system. In other words, in the process of going out of control it comes back into control and you can have dinner with the mayor until it comes out of your ears and it's going to work. Look at the difference with the prison governor, you see, all our social systems fail, and I don't think anybody in this room is going to have a fight about that. They fail.

They fail because they don't have intrinsic regulation built into them. You are always trying to catch someone out.

Look at the Finance Act, every year the income tax, the manual gets fatter and fatter with amendment after amendment.

I know the lawyer who drove a coach and horses through the then Finance Act, on behalf of Englebert Humperdink and Tom Jones and there had to be a special act of parliament to plug the gap. You've got a whole profession of astute lawyers and accountants looking for loop holes then you try and plug them and then it's too late. This is no way to go about the task of regulation and a cybernaticion wouldn't dream of it. I'm sure you can see that now.

The whole point is to find the various kinds of mechanism which would be built into something so the governorship, the governance, is a word I quite like, because it doesn't sound so aggressive as control, will work. Well now, Weiner wrote his book, 1948 it was published, and he defined Cybernetics, in the front sub-title of the book, in a very interesting way, and you are now in a state of mind to understand this definition, which nobody else is! He called it the science of control and communication in the animal and machine.

Now people read that and they say what does that mean? or obvious or something. It isn't obvious at all, is it? You have to analyse it a bit.

The first clause says 'control and communication' that is a recognition that all control, regulation, let's lose the word as gently as possible, depends on the communications that effect it. If someone cuts the wire then nothing is going to happen! We have a whole mathematical theory of communication now, called information theory which explains what has to happen to make the control system work. So now we've got intrinsic control, we've got the notion of feedback and now we can see that everything is dependent on communication, which people haven't realised.

Secondly, 'in the animal and machine'. Now that is devastating, if you actually stop and think because what it is saying is that the subject of biology and the subject of physics and engineering, which we always regarded as absolutely distinct, have much in common. Regulation across the animal and the machine. My god-fathers what are we taking about. It's contrary to all the set up that we are familiar with throughout our educational system, terrifying.

Of course, a lot of people are very up-tight about it they don't like to be told there is any resemblance. They say, he thinks that I am some sort of computer. No I don't, but what I do know is that you couldn't operate your body unless some of these things were in place.

I'm going to pick this up, okay. I've just succeeded. Now, how have I done that? It's because

there are circuits in the cerebellum and as my hand goes out, and if I'm going to miss it, it pulls it back until I've got it.

You can build a machine to do that, of course you can.

They don't have to go mad and say a machine hasn't got any ethics or something.

Yes I know, but all that can be explored later, first let's see what is common.

Now, somebody who does this and there are some of the folks around. Parkinsonianism and so on this is called Attacksia. It's the result of something going wrong in the cerebellum which doesn't produce this error controlled negative feedback which is exactly the term I used at the outset.

So, I hope you're beginning to see the flavour of this thing. That's 1943, - 1948 the book came out. I think between 1946 and 1956 these conferences are going on so this is the huge excitement which has been generated within science and may I say philosophy by this group of people.

I wish to introduce also, the key Englishman in this, his name is Ross Ashby.

He is a psychiatrist, another discipline coming in here and he ran a mental hospital in Bristol for a long time and then became the Head of the Burden Neurological Institute in Bristol. Then he went to Illinois, here Heinz von Foerster was at the biological computing laboratory again trying to put the words together in Champagne-Urbana was where Heinz von Foerster operated and so I now finish with an anecdote about Ashby.

I was with Ashby in Illinois in 1960 and we had a most incredible conference there of a similar kind with a group of very high powered people.

We were in Heinz's house and a very extraordinary thing happened. Heinz was trying to persuade me to emigrate to USA and had offered me a Professorship at Illinois and I was loathed to do anything about this, I had young kids, I'm sorry, Kathy, I couldn't face the idea of "Gee Pop", and chewing gum. Too English, you see.

So I was resisting this like mad, when Heinz said to Ashby, "Ross, you said not a word, put your weight in here. Persuade Stafford" and Ross comes back with "Why should I nobody's ever offered me a Professorship!" Deathly silence.

I said, "Are you serious?" and he said, "No", Heinz said, "We thought you'd turned them down by the score". He said, "Nobody ever asked me". In this frightful hush, Heinz cleared his throat and said. "Doctor Ashby I formally offer you a Chair in this university" Ross said "Thank you, I accept". Then he said "May I telephone my wife?"

Now he went out and telephoned his wife.

Her story is that he rang her and said. "We're emigrating, sell the house."

She never forgave him for it.

He was a very strange man. They're all very strange these people, I'm the only sane one.

So the point of my story is to crisp up Ashby for you. Very meticulous man, very dapper, little neat beard, striped trousers kind of character. Well, psychiatrist, you know.

We were walking by moonlight across this huge campus in Champagne to the Faculty Club where we had adjacent rooms and I said "Ross, you really shattered everybody tonight". He said, "Why?" I said "Well, you know if I were ever to criticise you, which God forbid, I would say you're a bit over meticulous Ross". "What's that supposed to mean". I said, "Well I would have thought you would have said, *give me three months and I'll list all the pros and cons and then make a balanced judgement*".

Ashby actually stopped dead in the middle of this quadrangle and he said "What, have you taken leave of your senses. I with three months, I couldn't do it in three years it's impossible. It's an impossible assignment, and you ought to have the sense to see that". "It's difficult, I know, I've been trying to do that myself after all. Why did you just say yes?"

"There are only two things to do in that circumstance, if you don't have enough information", Cybernetics etc. He said "you obey hunch, now, the brain is a complicated piece of machinery and might produce the right answer. I can't account for it. My brain said do it, so I did." So we resumed walking, and I began grappling with this. Then I stopped and said "okay say you don't have a hunch, what is the second most obvious thing to do."

He looked at me most pityingly and said "you toss a coin". It is the only rational thing to do.

Now this is one of the world's leading authorities on the brain.

I just brought in myself because I want you to know were I was in 1943 when all this began. I was 16, the war was on and had just escaped from school which was driving me potty, because of reductionism. I was in 6th mathematics and, therefore, I couldn't study Greek which I most wanted to do. A mathematician is not supposed to study Greek.

I couldn't study French.

I got round that by going to classes to be trained as an interpreter because all the parachutists who were going to come down dressed as nuns. That was the theory!

So you know, I was struggling to do the things that interested me, and kids can't you know. I

have eight children and I am trying to help them get through this bloody awful system in which you are forced to do this, that, and the other and it's all carved up and you're told what you can and can't do. It's reductionism.

I'm sorry for everybody present, including myself.

1943 I escaped, I got into University when I was 16 and I got into University College London, and the Germans promptly dropped a land mine on this and I found myself in Aberystwyth and I'd never been in Wales and that is why I'm here now because I fell in love with Caerydigion and the Welsh language and all sorts of things.

I fell in love with quite a lot of things actually! Dear me I'm misleading myself here.

That's what I was doing.

I got plucked out and into the army and so on. I got into Operational Research at the end of the war and I found myself in 1950 I was Head of Operational Research and Production Controller at a steel works in Sheffield, when I read Weiner's book and I thought I'm a Cybernetician and I didn't know. There it all was all laid out with batches of mathematics and it was wonderful. I wrote to Weiner and the rest is history. I came to know all these people.

Warren McCulloch became my mentor as I said. He used to visit me in Sheffield, in the late 50's I was head of Management Science for the whole of United Steel and Warren was very intrigued by what I did and used to come and stay at my house, and I met Heinz von Foerster and so on.

I met Weiner in 1960 by which time I had written a book called Managerial Cybernetics. No it was called Cybernetics and Management but that was the foundation of what's become Managerial Cybernetics and I've just written my 13th book on that.

Informal After Session Discussion

Einstein's great problem, if I may say that about the great man, was precisely that he wasn't inter-disciplinary at all. It was a great problem because it lead him into all sorts of absurdities in physics because he couldn't get the illumination that he would have got from other topics some and other people have had to do that. The famous remark, God doesn't play dice.

Faced with the stochastic universe.

Einstein never came to terms with that.

You see the answer to that is you need to be a logician to answer that the answer to that is God is the dice, and there is no problem any longer. There are ways of looking at things.

Wasn't it Einstein who they say of him that although he indeed had a great mind yet could not

do basic maths and taxes. Einstein just could not cope with the addition and subtraction...

That's right but addition and subtraction are nothing to do with mathematics. That's arithmetic.

Quite a gang to have known, you know

They sound like a great load of strange people ... like funny ... individuals.

They certainly were.

Are they still alive ?

Heinz is. The rest are dead. Ashby's dead. They all die at about 70, for some reason.

The picture of Warren McCulloch makes him quite a stern.....

Yes he could look stern butbut he was quite a funster.

Warren told the story of himself, several times, in print, and I've heard him tell it in person.

He went to a Quaker college on the East coast and his Professor was an eminent Quaker philosopher because he read philosophy originally and the Professor said to the young Warren. What do you want to do with your life. Warren said "What is a man that he may know a number, and what is a number that he may be known by man." The Professor looked and him and said, "Thee will be busy all thy life".

I've just published my 1960 diary. It's the only time I've ever kept a diary in my life. It was my first trip to the States. It's 100 pages long and it's in the new book that has just come out. I'd forgotten. It was found in my papers. It's absolutely fascinating, all my first week meetings with Weiner and I gave 17 lectures and I whizzed round and round the States. There is an account of everything I was doing. Things like " I spent this morning on the worlds largest computer. It has 287,000 valves. "

Here we are only 30 years later and you could fit it all into a fountain pen.

I don't know if the story about the diary would amuse you.

It tells the story about Ashby, the one under the moon, because that is where it happened.

I hope that this type of introduction is pleasing to you guys, because I want you to try and grasp the excitement of it and these extraordinary people we are dealing with.

I knew that if I made a whole lot of notes and so on, we'd be here all week discussing the

original cybernetics and hence the story of the execution.

I don't want to be the official historian but I do want to share my experience of these people.