Kybernetik in Urbana

Ein Gespräch zwischen Paul Weston, Jan Müggenburg und James Andrew Hutchinson[1]

Paul Ernest Weston was born on February 3rd 1935 in Garland, Maine. After studying physics at *Wesleyan University* in Middletown (Connecticut), 1952 through 1956, Paul Weston came to the *University of Illinois* in summer 1956, receiving his M.S. in August 1958. The following autumn, as a graduate student of physics, he attended a seminar led by Heinz von Foerster under the promising title „Cybernetics".[2] In June 1959 Paul joins the newly founded *Biological Computer Laboratory* (BCL) as a half time research assistant employed by the Electrical Engineering Department.

Through roughly 1962, Weston's primary emphasis was upon simulation of the processes of perception, with work in neuron models and pattern recognition. Together with Murray Babcock, Weston was one of the most prominent creators of prototypes built at the BCL. Already in 1961 Weston becomes widely known as the inventor of the NumaRete, a parallel operated pattern recognition machine, which played an important role in the public perception of the BCL through out the following years.[3]

After 1964 Weston continues his research at BCL on the basis of a full position as a research assistant and starts to focus on information processing, particularly interested in problems associated with natural-language interaction with machine. As a member of the *Committee for Cognitive Studies* Weston is also increasingly interested in the potentials of how the new information technologies could shape society. In June 1970 Weston receives his PhD for developing a new and more efficient data structure called CYLINDER.[4] After the BCL was closed in 1975 Weston continued to work as a Research Associate at the *Department of Electrical Engineering* and the *Coordinated Science Laboratory* of the *University of Illinois*.

Jan Mueggenburg: Paul, you were a member of the Biological Computer-group from the very beginning in 1958 until its end. Heinz von Foerster often referred to you as one of the key characters, if you want to understand the history of the BCL. Do you remember when you first met him?

Paul Weston: Oh, of course! The time I first saw Heinz? That vision will always remain in my head! It's one of these things you have a mental picture of even several years later. It was a lecture hall in the fall of 1958 and I was attending a seminar on „Cybernetics". I was sitting in one of the back rows and he was down there talking. I simply had never seen a man who could deliver a message like that. He was completely organized, entirely engaged and of course talking about a topic that absolutely fascinated me at that time!

JM: In your text „A walk through the Forest" you mention that you were very excited about Norbert Wiener's ideas on Cybernetics at that time and that it was his book, which eventually brought you to Heinz and the BCL. If you look back, how popular was Wiener's book and the concept of „Cybernetics" among young student like you? What exactly did you find so fascinating about it?

PW: Well, I am not sure if I can express precisely why I was intrigued with that, so maybe you can explain to me why you are so intrigued with the material now? [*laughs*] I guess to you that's a very old book now, but for us of course it was fresh and new in the 50s. When I was getting out of College in the year 1956 I was becoming aware of folks like that. I can remember Grey Walter's turtles and Norbert Wiener, at the same time, had published some articles about these little machines he had built, that could find their way on their own. It's just the sort of thing that resonates with you. It simply generated genuine excitement and of course it was at the dawn of an era when things that now seem so primitive were revelations when they were done. Shannon's Information Theory for example, I had been introduced to that in my last year in college. That was a revelation, that you could schematize the thing to that degree! So these all fit together. Things that have to do with actually bringing out stuff which is associated with the human mind I think was the essence of interest, which was of course a core idea throughout BCL's existence.

JM: So I guess one could say that Cybernetics for you is where it all started, but what about the rest of the Engineering world? It seems that many people had a copy of Wiener's book at that time, but did they actually read it or was it just a book you had to have on your bookshelves?

PW: Well as you probably know our experience at BCL was a very isolated one. We were almost hermetically sealed from the rest of the Electrical Engineering World. We didn't really belong to that, although we were of course based in what was certainly the technology available or being developed in the electrical engineering of that time, the computer and things that led to the computer, the use of information theory and so on. Concerning Norbert Wiener's work, I don't think that it had simply taken over as *the* book to read or something like that. It was a very popular book for a technology book. It sold well and it was certainly known everywhere, but it was not something everybody *had* to read. I doubt that too many of my acquaintances there in the school had any interest in it…

JM: Do you remember if Norbert Wiener ever visited the BCL? Did you ever meet him?

PW: Well, Norbert Wiener was never part of the presence that I experienced. I don't recall him ever visiting our campus at a time at least when I was there. But of course Heinz knew him well through the conferences. As you probably know, Warren McCulloch got him established in the United States and got him into the Macy Conferences. He helped him get his position at the *University of Illinois*. McCulloch was always playing the role of the grand old man and the two of them together were an unstoppable combination. I can still remember that long white beard and the pontifical statements, which sure had a certain amount of truth to them. So it wasn't just all hot air. McCulloch's interest at that time was the possibility of finding out how neural networks do things that are part of the life of living creatures. And I guess it was not long after that Humberto Maturana's article came out about the frog's eye and the frog's brain. So that was where it started…

JM: To what degree did this paper written by Maturana and Jerome Lettvin, „What the frog's eye tells the frog's brain" influence you in your work at the BCL?

PW: As I say, our first year was very intensely focused on the possibility of neural networks. Murray Babcock was building his machine using the only technology we had at that time, which was barely adequate to simulate even the simple – very naïve by present standards actually – model of the neuron that we had. And, as you are undoubtedly very familiar with Heinz's output, he started publishing right away things having to do with neural networks. We had graduate students at that time who were interested in the field. I remember having long arguments with Ron Swallow who was one of those. He was totally convinced that the conditioned reflex, which of course was about all we could simulate with our idea of the neuron at the time, was the *only* building block needed to simulate higher intelligence and I said that couldn't possibly be, myself. I still hold to that opinion. But yes we had a great activity centered on that and I was also a skeptic with respect to that network business. That was, of course, the time when Frank Rosenblatt from *Cornell University*[5] came out with his Perceptron. Seymour Papert and Marvin Minsky immediately pounced on that with the usual venom and vigor that MIT men pounce on anything that they want to suppress. And they definitely showed that there were mathematical limits to what that thing could do and it was pretty much in the forefront of anybody's thinking about neural nets at the time. I of course was a skeptic anyway and it didn't bother me that the Perceptron turned out to be a failure.

JM: You've then of course built our own parallel computer, which became quite famous. A device that could count the number of objects you put on its surface!

PW: Yes, I built the NumaRete and I said to myself I am not going to make the same mistake. I am, however, going to show that you can have a machine that can reliably sense some abstract property of its environment – without being a neural net! But it had to be a repetitive network of some type, by the nature of it! I used these photocells and I guess that was my Achilles' heel. I built this thing and it worked beautifully. So we took it to a little exposition down to the state capital and passersby came and they tried to fool it, but it just couldn't be fooled! We had these little things with holes in the middle to put on the NumaRete and you could put other objects inside these holes and it still counted correctly.

JM: Heinz von Foerster later claimed that among these people who, over the years, tried to fool the NumaRete was John von Neumann, but of course that's technically impossible, since von Neumann died in 1957…

PW: That's true! I don't know what Heinz was talking about there. Right. This thing didn't appear until 1958.

James Hutchinson: The idea of taking the NumaRete to Springfield; was that connected with the funding stream for the Laboratory or the University?

PW: No, I think it was just a public kind of exhibition. I have forgotten exactly what the sponsorship was, but it was similar to our Engineering Open House here on campus. People would come and they would see what technology was doing in these days. They would play around with the NumaRete and they would ascribe to it reasonable intelligence: „My gosh, that thing could really count!" Of course it wasn't any of these things! In fact I was told one day that somebody else attributed to the NumaRete a neural network design that senses edges and counts edges. Well, that algorithm is manifestly flawed, it couldn't do correctly many of the things that the NumaRete could do without any trouble. In fact the way I built the NumaRete was rather the Rube Goldberg-scheme for doing it, but it worked perfectly. Unfortunately everything looked like a neural network structure: We had this long printed circuits boards with photocells on top and little transistors and diodes and things in the bottom, and it just looked like everything was repetitive all the way down the board and people looked at it an said it has to be a neural net – but it wasn't!

JM: Interesting! I always thought that the concept of the NumaRete was closely related to the approach of „Bionics", another term coined by Heinz von Foerster. According to him the basic idea of Bionics was to construct devices based on the model of the fundamental principles of nature, hoping to eventually come to an operational definition of these principles.

PW: Well, when you look back at history, we achieved locomotive machines, cars, railroad trains by using wheels, we didn't use legs! And we have no ornithopter, but flying machines that use these funny airscrews, which are impossible for biological mechanisms to produce. Time and again, whatever we've done that was inspired by biological mechanisms we've had to resort to other means. And so it will probably be for a long time. Perhaps with genetic engineering we could start producing biological mechanisms that have airscrews, although I doubt it. So, it just seems to be that technology being what it is and us being who we are and our abilities to manipulate the universe are focused in some directions that don't have much to do with the design principles that have been evolved through the process of evolution. So I wouldn't expect these machines to very likely to use neural networks, ever.

JM: But nevertheless Heinz von Foerster used the NumaRete, or either the concept of the NumaRete, many times to demonstrate the superiority of parallel computation, which he assumed to be the natural form of computation!

PW: Well he did, but you have implicitly made a conceptual error here, when you include under the very generic heading of parallel processing the neural network. Yes, that's a subdivision of it and yes, there is parallel processing to some degree involved here. All of the cells under a particular shadow do respond essentially instantly. And they all communicate with each other all the time in parallel. Without parallel work you couldn't do the job. But not everything that's a parallel processor has the structure of a simulated neural network. That was my only problem.

JM: Would you agree that besides being an essential part of the research done at the BCL one of the main purposes of these machines was to demonstrate them to an audience? It seems to me that they were used as visual arguments, just like Heinz von Foerster did with the NumaRete.

PW: Oh yes! As you already know, we were always building machines. We felt that it was absolutely necessary to put reality to our thinking and prove to the world that something could be done in this area. Yes absolutely! So our history in those early years was indeed entirely one of one machine after another. That was our intention! Heinz of course was steeped in physics and I was a physics student too, until I changed to Electrical Engineering. We were all of us steeped in the idea of science and had to have a practical side where we demonstrate the reality of our thinking. We wanted to show everyone that these theories are really going to work. I think that was the main idea here. We could talk and pontificate and write all kinds of beautiful journal articles, you know, ad infinitum, but to really show the world that we were talking about something, we had to have these machines! We were very interested in the possibility of having these machines and using their capabilities to forward technology and the betterment of the world, if you will.

JM: Well that train of thought of course leads to the question of possible applications for these prototypes. If we take Wiener's early work for example: He developed his first cybernetic ideas when experimenting with an Anti Aircraft system. And when Warren McCulloch and Humberto Maturana did their research on the frog's eye at the Research Laboratory of Electronics – the former Radiation Lab where most of the radar technology for WWII had come from – you could say they were dealing with a similar kind of problem…

PW: Yes, a frog catching flies! It is an anti aircraft, isn't it?

JM: Exactly! So, if you then took the next step to the NumaRete, what applications did you yourself have in mind? It seems that all these efforts were done in search for new radar technologies!

PW: In the beginning I myself was not expecting that this little toy-machine that I put together would ever be the heart of anything specific, but we did put it into a journal where it could be distributed among practicing engineers, in the case that somebody might pick up on the possibility for an industrial process. None of them, by the way, could ever understand what I thought was a simple explanation of the thing. Several engineers wrote to me, but either in the engineering community or the larger academic community interested in bionics, nobody seemed to understand the simple principle of this thing. It was too simple [*laughs*]. It was just such an unexpected way of doing a particular job, so it came to naught for that reason, I guess. But, yes, I was aware of distinct possibilities and hoping perhaps that it might become the heart of some industrial equipment.

JM: You've already mentioned the controversy between Frank Rosenblatt on the one side and Marvin Minsky and Seymour Papert on the other, which, at least temporarily, brought an end to this enthusiasm for neural networks.

PW: Yes, it would have been mid sixties when they finally drove him into the ground. Rosenblatt had a really devoted following and he was that kind of charismatic character. Of course Heinz was our charismatic person too, he had the same reputation at our department. But that was when a lot of people including most of BCL members were critical of Rosenblatt not necessarily on scientific grounds but simply because of the fact that he had made so much media hype about his thing and overblown the possible capabilities of it rather blatantly. He was considered something of a pariah in our business and it was to his efforts and obvious over-hyping that we attributed some of the loss of interest of the whole field. It's true, it was after this debate in the late sixties when support for this simply declined precipitously, right?

JM: Did Marvin Minsky ever visit the BCL?

PW: Oh yes, Minsky was a regular! We saw him several times a year easily. He was a good friend of Heinz and respected his ideas. Both Marvin Minsky and Seymour Papert, I think, had great respect for Heinz, they really did. They were also greatly respectful for Warren McCulloch, I think it was that combination again that did it.

JH: Another BCL member, James Beauchamp, told me that he had spent his sabbatical at Stanford Artificial Intelligence Laboratory in 1968 and that the people at Stanford didn't have much respect for the work done at BCL.

PW: Well, I think you're right there. We did have a little interaction with the Stanford Lab, shortly before they were coming out with their little robot, a self-analyzing robot that could work with simple geometric shapes and find his way around the room. So they were right up there and of course later on in the language area they did great things too. They were able to maintain the funding and they were able to make significant contributions for at least a decade beyond where we had fizzled out. I give them credit for that.

JM: What always strikes me is the fact that the end of the BCL around 1974 coincides with the first indications of the rise of Personal Computers. Why do you think Cybernetics in general, and the BCL in particular, didn't manage to get involved with the design of this new technology? Or, to put it more clearly, why can students nowadays study Computer Science, but not Cybernetics?

PW: Well, that's a tough one, it really is. The computer scientists were very, very interested in issues that are strictly computer science issues. At that time in the early seventies, they were very busily at work developing the theories of parallel computing, how to program these things and how to verify algorithms by some logical means and so on. All these things were abstract theoretical issues but very important and of course the results of which we very much need today. So, they did what you would expect, it's an engineering discipline and these were the key issues in advancing the technology, so they were working on those, not at all oriented toward the social implications or the use of the technology. That's why I think they never got interested in cybernetics, because there was too much to do just to advance the underlying technology and the theory of it.

JM: Regarding the later years of the BCL it seems that you on the other hand were less occupied with the construction of computers, but more concerned with the question of how society could profit from these new technologies.

PW: Well that surely was the idea that we were getting into. But of course you must realize that our hope was that we would continue to generate actual working results to show that our ideas were meaning something with obvious use. But yes that was what basically brought the Cognitive Studies Committee together as a group, and I don't think it would ever have happened by itself, without some overriding, some common idea that people were really pushing forward. We were definitely onto something that, if you looked at the extrapolations of it, definitely had the power to radically transform modern society.

JH: To what degree were you involved with the Committee for Cognitive Studies?

PW: Well, I've never been a political animal myself, but there was a real problem after Bill Everitt retired from the leadership of the engineering college. He was Heinz's mentor and protector. Everitt saw that this was good stuff Heinz was doing and was willing to go out on a limb for him. After he left, the new leadership was only interested in the teaching of engineering. They wanted to stuff our students full of math and science, wanting to get the most powerful group of graduates, who would become renowned through out the world and would invent transistors right and left. So, then they looked at us: Here's this guy writing about strange things with no immediate practical application. He's bringing in Gotthard Gunther, who never saw an electron in his life! And what's this, a logician? And then we had Ross Ashby, who was trained as a psychiatrist! He of course had made some very interesting electronic devices, so he knew a little technology, but that certainly wasn't something that he could teach…

JM: …and Noah Eshkol…

PW: Oh yes! I've forgotten about her, the dancer! And then we had Humberto Maturana, a neurophysiologist! What's he doing here? And then look at the courses they are trying to teach! So called „Heuristics-classes". What's that? That's got nothing to do with engineering! The guys just sit there, they twiddle their thumbs and they do crazy things that look like party games! To sum it up: they couldn't stand the sight of us, because in their opinion we were just simply so untechnical. During the time that we were under the supervision of Rowena Swanson of course, our great friend and protector from the *Air Force Office of Scientific Research,* things were different. During that time we were getting enough money and of course regardless of how ridiculous you look, if you got a million dollars to put into the pot, you're going to be able to demand a few perks. So we were riding high as long as we got the money, but as soon as our last proposal failed, the next day we were out. Heinz was moved into an upstairs office in Electrical Engineering. He had really no practical alternative but to retire, which he did of course. And I? Well, I have to admit that I was one of those perpetual students. I was almost grandfathered out of the whole business, but we got my dissertation done in time, because then it was a matter of do or die. So I went into Electrical Engineering and started teaching, since I at least had taken a few courses. We were just unacceptable to them and just as soon as we couldn't pay our way, immediately we were wiped off the map.

JM: You mentioned Rowena Swanson, did you ever meet her in person?

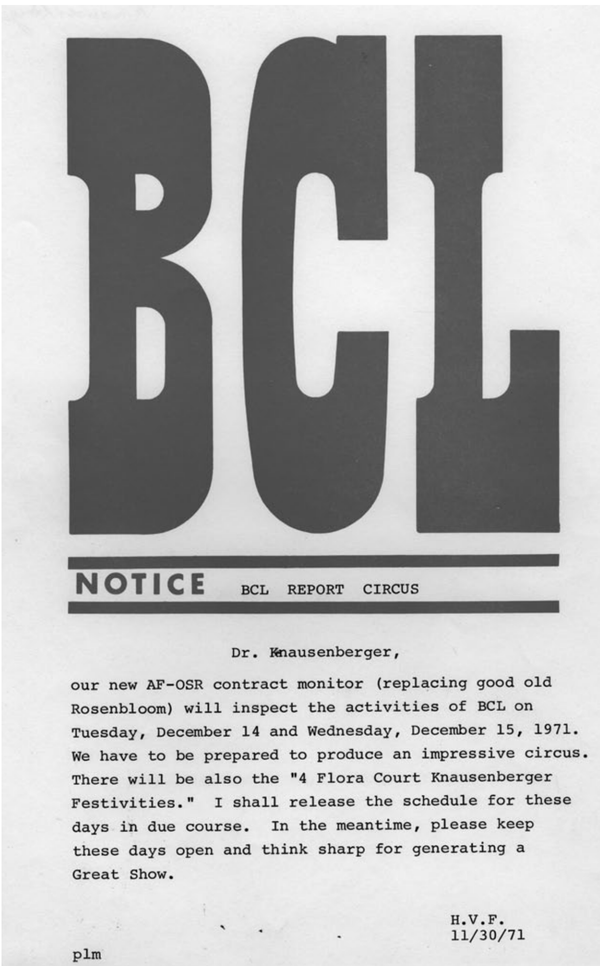
PW: Oh yes of course, I think she was the only person from Washington that I actually was personally acquainted with. I saw her mainly at conference settings, but also on occasional visits to the Lab. I know that there was a good deal of a personal friendship there with Heinz and that the two of them had to discuss possible proposals thrusts and so on. So there was good reason for her to come to campus and she did have a habit of going around to her key projects and personally visit them just to see how we were doing and what we were doing.

JH: People say that Heinz would go to great length to spiff things up for these sponsors, always put on a great show…

PW: Oh yes! Who would not do that? And what better showman to put on a show! We would bring out the vacuum cleaner when they were coming [*laughs*] Absolutely! I don't see anything underhanded about that. I know that everybody does that, who wouldn't?

JH: Back to the Committee! There was some technology behind the Committee for Cognitive Studies proposal you were heavily involved with, involving natural language and a computer interface, is that right?

PW: Yes, the natural language thing became my obsession and I explained a little of my motivation in this text *A Walk through the Forest*.[6] We had been very focused on this business of neural networks and mainly with pattern recognition, which at



BCL

NOTICE BCL REPORT CIRCUS

Dr. Knausenberger,

our new AF-OSR contract monitor (replacing good old Rosenbloom) will inspect the activities of BCL on Tuesday, December 14 and Wednesday, December 15, 1971. We have to be prepared to produce an impressive circus. There will be also the "4 Flora Court Knausenberger Festivities." I shall release the schedule for these days in due course. In the meantime, please keep these days open and think sharp for generating a Great Show.

H.V.F.
11/30/71

plm

Figure 1: Memorandum from Heinz von Foerster to members of the Biological Computer Laboratory at the University of Illinois, on paper prominently featuring the logo of the Biological Computer Laboratory, regarding the activities of Dr. George Knausenberger, the new AF-OSR contract monitor. (Image dated November 30, 1971) Found in RS: 11/6/17, Box 12, Folder, Knausenberger, George, 1971-72. Courtesy of the University of Illinois Archives.

that time was seen to be an aspect of intelligence. But I always knew, that there is much more involved as in this simple little machine that counted, even if it really convinced people that there was something smart going on. It was obvious to me that no matter how many patterns we could recognize and however accurately, that that would have nothing to do with what the human would actually do with that information. Indeed what you see, when you look at what people do when interacting with the world, you find that a given physical stimulus can result in many different perceptions, it depends on what has happened before and what may have happened long before. So I saw that ambiguity right away and was convinced that these first years' efforts are not going to lead to any ultimate solution of anything. We had to look at the bigger problem. And that's how I got embroiled in the language problem.

JM: Was that at the time when you started to work on new concepts for data structures?

PW: Yes! In dealing with the rather complex interrelated structures that you see when you look at what language must be talking about, you see that you need complicated structures. You need to represent them, you must be able to process with them and find information from them. So first, people began to solve that problem by using the serial data structures that we had – after all a computer memory is just a long one-dimensional row of pigeonholes. But each one can contain enough information to point to any of the other pigeonholes and a little more information besides. So you start linking them together using a large part of your storage capacity simply to point to other things, but at least that gives you the ability to pull a thread from one pigeonhole to one way down the line and then have a different colored thread from that one to this one and you have a data structure in your hands. These colored threads are just the ability to store a memory address inside the contents of another memory address. So we have the pointer-structure! So this first thing was basically another one-dimensional structure, but one that could be pulled out into a tree kind of thing, where you have some things linked together and then you'd have a couple of links spread out, so that you can build trees. That was about where things were at, but as I was seeing it, you need more than that. I took as an example, something to focus the thought, some interesting logical puzzles by Lewis Caroll. For example this one:

> „A train is operated by three men: Smith, Robinson and Jones. They are engineer, fireman and brakeman, but not necessarily respectively. On the train are three businessmen of the same names Mr. Smith, Mr. Robinson and Mr. Jones. Consider the following facts about all concerned:
> 1) Mr. Robinson lives in Detroit.
> 2) The brakeman lives halfway between Chicago and Detroit.

3) Mr. Jones earns exactly $ 2000 annually – this was a long time ago –
4) Smith beat the fireman at billiards.
5) The brakeman's nearest neighbor, one of the passengers, earns three times as much as the brakeman, who earns $ 1000 a year.
6) The passenger whose name is the same as the brakeman's lives in Chicago.
The question is: Who is the engineer?"

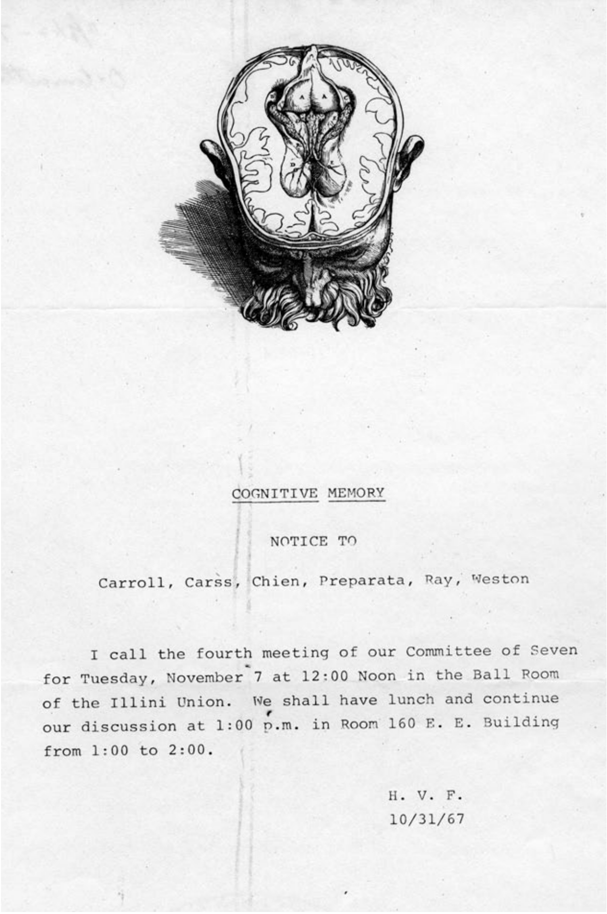
Now, you are not going to solve that one in five minutes! It's really hard, because these are all seemingly unrelated facts. So I took this puzzle and tried to produce an algorithm that could solve the problem. The first thing to look at was how to represent the relationships. Each of these statements is the basis of a relationship. And then it comes to something looking a lot like a scrambled network where there are multiple connections to elements of multiple sets and they can be arbitrary in number and they can be arbitrarily dense and interrelated. I knew that the present data structuring concepts were not going to handle this, so I set myself to develop something richer and also maximally productive in terms of using the available storage. I solved this problem with a data-structuring concept that I called Cylinders.

JM: Which was part of your doctoral thesis, right?

PW: Yes indeed! Without going too much into detail, the minimal data-storage entity in the Cylinder system can be visualized as three-dimensional in structure. Its internal linkage paths can be represented by a wireframe model of a cylinder with multiple rings connected by vertical strands, not necessarily running all the way through but in various lengths. There were little windows all through between the verticals and the horizontals, and those little windows were the representational elements of this model. The way I designed this thing it was easy to link any one to any other with no problem at all. The system offered extremely rich data structures and it turned out not to be using appreciably more storage than the more linear structures we began with. So I had that concept worked out and I put that into software and actually had a working version of it on the University's PDP-computer. I showed that you could build an algorithm using those data structures that systematically and with remarkably few steps actually was able to solve that puzzle by Lewis Caroll. Given the data structure, you could even come up with other things and ask other questions. You could actually ask the machine to explore for things that weren't obvious in the original setup. So that was why it was called: „To uncover, to deduce, to conclude". And that of course was at the level of complexity that begins to give you a handle on what you might have to deal with just in representing the structure of a simple sentence, you know, „See Spot run" or something like that. Yes, that was what put us in mind that this kind of capability was able to take the complexity of a realistic situation, and with computer means allow people to question it as they would question a person and get information in ways that have been unthinkable before. That was our hope in the cognitive studies proposal.

JH: One of the things the committee envisioned back then was to establish a citizen's problem solving computer network. Did you ever consider PLATO as a possible tool to implement this network?[7]

PW: Well I worked with PLATO on a practical basis, supplemented some course work with it and so on. I simply couldn't get around the extremely restrictive environment that you had. You had a hundred and fifty words of memory for everything and very limited program space too. I was able to put together a program that I used for teaching elementary network theory. As the teacher you could put in a simple



COGNITIVE MEMORY

NOTICE TO

Carroll, Carss, Chien, Preparata, Ray, Weston

I call the fourth meeting of our Committee of Seven for Tuesday, November 7 at 12:00 Noon in the Ball Room of the Illini Union. We shall have lunch and continue our discussion at 1:00 p.m. in Room 160 E. E. Building from 1:00 to 2:00.

H. V. F.
10/31/67

Figure 2: Memorandum from Heinz von Foerster to the Committee of Cognitive Studies, printed on paper featuring a logo of a cross section of a man's brain, regarding the calling of a meeting, (image dated October 31, 1967), found in RS: 11/6/17, Box 7, Folder Organizational Committee, 1967–67. Courtesy of the University of Illinois Archives.

string of letters that described the serial parallel network structure of a resistive network. The computer could read that and put it on the screen in terms of an actual diagram so that the students would see it. It would label each of the elements with a unique and appropriate label, so that the machine could test the student as to what's the relationship between R1 and R10, say. Maybe they are in parallel, maybe they are in series, maybe they are neither one. So this was just a little thing to help them at the conceptual level to deal with that. I was able to get this all into PLATO, but that was as far as I could go. Of course at that time PLATO was about the only thing in terms of wide spread public access networks. But that's all it had. It didn't allow the individual user to do anything significant at the scale necessary. The Personal Com-

Figure 3: A young woman uses a PLATO terminal as part of her studies, (image dated ca. 1968), found in RS: 39/2/20, Box COL 13, Folder COL 13-13 Computer Ed. Research Lab / PLATO 1952–74. Courtesy of the University of Illinois Archives.

puter and the Internet, would have been a much more interesting possibility. Today everybody has got a super computer on his desk and is used to communicating at a suitable bandwidth to anywhere in the world. When you really think about it, a lot of the things you can do with things like Google are coming remarkably close to what we had in mind.

Anmerkungen

1 The conversation took place on February 22nd 2008 / Café Kopi, Champaign/Ill.

2 „The speaker was short somewhat balding, spoke with a definite German accent, had an engaging personality, and lectured very well", Paul Weston, A Walk through the Forest, in: Albert Müller u. Karl Müller, eds., An Unfinished Revolution: Heinz von Foerster and the Biological Computer Laboratory, Vienna 2007, 89–117.

3 Paul Weston, Photocell Field counts random objects, in: Electronics 34 (46–47), 1961.

4 Paul Weston, Cylinders: A Relational Data Structure, Urbana 1970.

5 The Perceptron is a mathematical modal for an artificial neural network invented in 1957 at the Cornell Aeronautical Laboratory by Frank Rosenblatt. In the 1960s the Perceptron was heavily debated between supporters of „Connectionism" like Rosenblatt and supporters of „Artificial Intelligence". In 1969 Marvin Minsky and Seymour Papert published their book „Perceptrons", in which they proved that specific mathematical problems cannot be solved with the Perceptron. This eventually led to a stop in funding research in artificial neural networks and a concurrent boost for „Artificial Intelligence"; vgl. M. L. Minsky and S. A. Papert, Perceptrons, 2nd Edition, MIT-Press 1988.

6 Paul Weston, A Walk through the Forest, in: Albert Müller u. Karl Müller, Hg., An Unfinished Revolution? Heinz von Foerster and the Biological Computer Laboratory, Wien 2007, 89–117.

7 „PLATO was one of the first generalized computer assisted instruction systems, first widely used starting in the early 1970s. PLATO was originally built by the University of Illinois and ran for many years, both for in-university coursework as well as being remotely accessed by local schools", see: http://en.wikipedia.org/wiki/PLATO.