AN INTERVIEW WITH BÖRJE LANGEFORS
From SARA to TAIS

Janis Bubenko and Ingemar Dahlstrand

This interview with professor emeritus Börje Langefors (*BL*) was carried out by his two former co-workers Ingemar Dahlstrand[1] (*ID*) and Janis Bubenko[2] (*JB*).

JB: Here we are, the three of us: Börje Langefors, Ingemar Dahlstrand and me, Janis Bubenko, and we are going to talk about Börje's historical times and memories. Let us start out with the question: How did you actually get into computing?

BL: I was working at the NAF[3] industries where my boss and I developed a machine for dynamic balancing of cardan-shafts. We integrated an analog device into the machine, which gave the necessary correction indications.

JB: When was that?

BL: That was in 1944, because that cardan-shaft was going into the Volvo PV 444 car. After that, I was transferred to NAF-Linköping. In Linköping, I became acquainted with Torkel Rand, who recruited me for the SAAB aircraft company (in 1949). There I was to work with analog devices for stress calculations for wings. Rand had done one-dimensional analyses, which worked reasonably well for straight wings at right angles to the plane's body. However, when we got into arrow wings and delta wings, we had to analyze in three dimensions, and that was

[1] Formerly manager of the Lund University computing centre. Developed Sweden's first Algol compiler in 1961.

[2] Professor em. at the Department of Computer and Systems Science at the Royal Institute of Technology (KTH) and Stockholm University.

[3] NAF – Nordiska Armaturfabrikerna (Nordic Armature Factories)

difficult with analog technique. I knew then about the writings of Gabriel Kron, e.g. his Potential Analysis, and had corresponded with him; also, he had published analog networks simulating framed structures. To these I could add elements corresponding to the wing's shell structure. After that, I wanted to leave analogue devices and switch to digital computation. But this called for enormous capacity, it was on a much larger scale than we had imagined.

JB: Did you know about computers then?

BL: I had visited the national computer centre MNA[4] to see if they could help, I think that was when their relay calculator BARK[5] was just ready. I was then planning a study visit to the U.S.A. to Northrop whose Maddida computer I had read about. I asked MNA's director Conny Palm (well known for statistical work on relays) whether there might be a computer suitable for SAAB. Palm said that would not be necessary, because when their electronic computer BESK[6] was ready (it started to work in December 1953) it would handle all of Sweden's computing needs in one third of a shift. How did he know that? We have investigated the need for computing, he said. That can't have been much of an investigation, I said, you have not asked SAAB, I would have known. In 1954, I made that study trip. I found out that many instrument makers built small computers with magnetic tape, and of course I knew about Univac, but I also learned that IBM had built a computer similar to BESK, but with tapes. IBM did not believe in a market for such a computer, but had contracted to build seven of them for the defense industry, as a sort of patriotic gesture.

JB: Was that before the IBM 700 series?

BL: Yes, but perhaps the 700 series developed from it. They called it the Defense Calculator. I wanted to have a look at it, but our Air Force attaché in Washington, Stig Wennerström (later to become famous when caught as a Soviet spy) said that it was impossible. Nevertheless, he did arrange a visit to Douglas Aircraft, Santa Monica. When I thanked him, he said, "Oh you're *welcome*". There, a person received me who had worked with the same problems as me; and *he* got me into the fighter plane factory. However, I concluded that the Defense Calculator could not be exported due to military secrecy, and if it could, it would have been far too expensive. Nevertheless, Univac had working equipment with tapes. The systems of the other, smaller manufacturers did not work.

JB: Would that have been the Univac-I at the Bureau of Census?

BL: Yes, it was. I reported to the SAAB management that the best thing for us to do was to build a BESK copy, but we had to have tapes. I had expected they

[4] MNA (Matematikmaskinnämndens Arbetsgrupp) built the computers Bark and BESK and ran BESK on a service bureau basis for more than 10 years.

[5] BARK – Binär Automatisk Reläkalkylator, in operation about 1950 to 1955.

[6] BESK – Binär Elektronisk SekvensKalylator.

would summon me to top management for questioning, but instead I got a free hand to go ahead with the project. Later, computer historian de Geer[7] has claimed that I had a hard time convincing top management about the project, but I do not recall that. However, I did know the task was hard.

JB: What was the problem about the tapes?

BL: There was too much noise, and many bit errors. The tapes had a check bit, but one-bit errors stopped the tape and two-bit errors were not even detected. I thought about this and found that if every character was written twice, we could correct one-bit errors automatically and detect two-bit errors. Double-writing might sound as exaggerated security, but when we gathered flight data it did not matter much whether we discarded wrong data or had a self-correcting code.

I sent two men, one of them was Kurt Widin, to spend a year learning all they could about tapes, and then develop tapes with self-correcting code for our BESK copy, SARA[8]. Widin found a solution in a paper by Hamming, which saved one bit compared to my idea. I gave them the OK to go on with that. We used 9-channel tapes because that was what we could buy in the market.

JB: This must have been about 1955 or 1956.

BL: Yes, Widin probably started work in 1954. Later he went to work for Björn Lind, a remarkable man who had been the chief engineer for the SARA project. They started a control equipment company in Mjölby, financed by multi-millionaire Axel Wenner-Gren.

When the electronics department at SAAB started building D21 computers for sale, they also needed tapes, but they wanted to be clever and do it alone. However, it did not work. After two years, SAAB had to buy back Widin. It is curious how things happen sometimes: Widin had shown his competence and I recommended him, but the D21 group had to try doing it themselves anyway.

SAAB's director of economy had said that "*tapes*" was something Langefors could never make. It amused me, partly because he realized that it was in fact difficult, and partly because I understood who had told him.

ID: I remember that director of finance very well. You, Börje, had asked me to analyze whether SARA, then under construction, could be used for SAAB's administrative data processing. I concluded that SARA was too slow with the primitive sorting methods I knew; that was before quick-sort was generally known. The finance director used this as an argument to drop the SARA option, and then they went ahead and bought a *slower* IBM computer; they wanted IBM at any cost.

JB: When did SARA start working, with tapes and all?

[7] Hans de Geer in "På väg till datasamhället", KTH & FA-rådet, 1992.

[8] SARA – SAAB's RäkneAutomat (SAAB's computing machine)

BL: In late 1957, I think. When BESK started in 1953/54, SAAB alone quickly filled one shift.

ID: Yes, when I started running BESK programs for SAAB, in the summer of 1955, I could never get computer time before 10 p.m.

BL: More about those tapes: After we had developed our system on a Potter tape drive, it wore out and we went on with Ampex drives. When Ampex heard about us running three shifts without errors on their drives, they sent a whole delegation to look at it.

ID: In 1956, Stemme[9] and Karlqvist[10] and their group moved from MNA to Facit[11]. It was part of their deal that they would be allowed to keep helping SAAB with building SARA as they had done at MNA. Did that work? Were there problems?

BL: None that I remember. In fact, I tried on three occasions to convince the managements of Facit and SAAB to form a common computer company. Later, when SAAB offered the big Taxes & Census system to the government, we did work together on that.

ID: I remember, and actually still have minutes from 1961–62, when you and I discussed common software as part of a larger cooperation effort that failed because the technical people could not agree. Later, we had a very tangible cooperation when Datasaab[12] stationed Gunnar Ehrling and Göran Engström in Gothenburg to adapt the Facit Algol compiler for the D21. I remember the first time Ehrling appeared; the rain was pouring but he walked calmly over the courtyard in his indoors clothes. Engström lived in Gothenburg for a while but Ehrling was probably only visiting.

BL: He was a very unusual man. I remember we had to remind him now and then to draw his salary.

ID: When did you complete the specification of Algol-Genius? As I remember, Genius was implemented in parallel with D21 Algol.

BL: That should have been roughly when the Taxes & Census deal started in 1960–61.

ID: The European Computer Manufacturers Association (ECMA) had a committee named TC2 that was to develop an "amalgam of Algol and Cobol". It split in three at its first meeting in 1962 and after that, I worked in TC5 Algol. I

[9] Erik Stemme, professor em. at Chalmers Technical University (CTH), chief engineer for the building of BESK.

[10] Olle Karlqvist, deceased. Systems manager on MNA and Facit.

[11] Facit Electronics, a daughter company of office equipment manufacturer Facit Åtvidaberg, specialized in computers. Produced some ten BESK copies and later special defense computers.

[12] Datasaab was SAAB's daughter company for computing equipment. It produced the D21-D22-D23 series, some 30 in all, and later specialized in office computers.

wonder why I did not later contact TC2 and present to them Algol-Genius, which was exactly such an "amalgam". Perhaps I did not realize how good it was until I had the opportunity to try it on our D21 in Gothenburg in 1965. Nothing came out of the TC2, but we were evidently not alone in thinking of Algol as a possible language for administrative data processing.

JB: The Taxes & Census deal – What did your cooperation with Facit aim to accomplish?

BL: Perhaps only that Facit should help us with the systems work. However, the deal as such is remarkable and worth telling about. Datasaab almost missed the first deadline to announce its interest! One accountant, Lundin, phoned me on a Wednesday and asked: Is not SAAB going to make an offer? The deadline is on Friday? I had heard nothing but I wrote two letters on my own: one from SAAB and one from SSI, the Swedish Society for Information Processing. Those letters were not offers but rather proposals to have one computer in each administrative region rather than a huge central computer. The SSI letter I could sign myself, being its chair; the other one was signed by SAAB's CEO, Tryggve Holm.

ID: Was that actually the government's initial idea, one computer for all of Sweden?

BL: Yes indeed, and I tried among other things to point out the industrial policy aspect, that small computers could be produced in our country. The SSI letter could be seen as a contribution to the general debate of one large computer versus several small. This was in the early sixties, before I moved to Stockholm.

JB: What was IBM's original proposal?

BL: I think they offered an IBM 707 with IBM 1401 computers in the regions, but those were just to be peripherals. The IBM 1401 was ruled out as insufficient by Datasaab's simulation program, which was run for the 1401 too, at the purchase committee's request.

ID: But that was not the proposal they made later?

BL: No, in 1964, the IBM/360 series was launched and that changed everything. However, the D21 again proved superior, and that was partly due to Algol; thanks to Algol we could use quick-sort! At that time, we heard from a prospective customer of ours that one of the arguments used against the D21 was that it had too large a memory!

JB: *Who* could have said such a thing?

BL: Yes, who indeed? After that, we were careful to explain the advantages of a large memory. The Datasaab proposal was to have D21s in most of the regions.

At that time, I heard that our PR people were to work overtime through Christmas and were grumbling about it, for they had heard that top management themselves did not believe we had a chance. I told them it was 50-50, and in fact,

Datasaab got 50% of the deal; we got the small regions and in the end, we got 100%. MNA early pointed out that the D21 had the larger capacity, but the government's computer selection committee said it was not needed. When the capacity demands were investigated again—that was probably after I moved to Stockholm—they found that D21 should be used throughout, and then fewer computers were needed.

ID: So the D21 computers were first installed in the smaller regions, the committee did not believe the evaluations?

BL: That's right. This is an internationally unique case in that two systems are compared directly in full-scale operation, and that one proves so superior to the other. This should have been brought to the attention of all much more vigorously; it was poor marketing that it was not done. Better marketing is part of the answer to how Sweden might have developed a computer industry. SAAB was notoriously weak at marketing.

ID: Do you recall the final banquet of HiNC-1 in Trondheim last summer? The former director of Norsk Data made a speech claiming that the Scandinavian computer industry never had a chance in view of the massive resources the U.S. poured into computing. However, our problem was not computer techniques; we were usually well advanced there. We lost out on organization and marketing.

JB: Could you explain that 100% again? Did Datasaab get and keep the whole deal, or was that changed again so that IBM got some of the regions?

BL: No, we got the whole deal, but not all the regions got their own computer. The D21 was so powerful that some of the smaller regions could share one between them.

ID: Were you, Börje, the driving force behind the D21 project?

BL: Oh no, not at all. I was called to a talk with our CEO Tryggve Holm, who said the board of directors was skeptical to starting a computer company along with Facit. They had still given Holm a free hand to go on, but only if I and my nearest superior, Hans Löfqvist, made a convincing case for it. However, I would not do that; there were so many economic and company strategic factors I did not know. I knew too little about economics and marketing and I told Holm so. I repeated it at a second talk we had, and we decided to do nothing. Nevertheless, I told Holm—one could be quite frank with Holm, and he appreciated it though his courtiers paled—I said we have to watch the electronics people, lest they go and sell something. "Well, we ought to be able to cope with *that*", Holm thought.

ID: By the way, have you seen that article in Dædalus[13] about the development and plans of Facit Electronics? When the technician left MNA for Facit in 1956, the idea was to build a new and better computer immediately, but they got so many

[13] Dædalus is the annual of the Technical Museum. The article is in the issue for 2003.

inquiries they started to build and sell BESK copies instead. When that market ended abruptly in 1960, it was too late to start a new computer project and catch up; they had split their resources. In the autumn of 1959 when I was newly employed at Facit, we had five offers out and everyone was optimistic, and then all five were rejected and the mood went from top to bottom with a bang.

JB: Who were the competitors?

ID: Mostly IBM.

BL: Regarding cooperation with Facit-Datasaab: I made a first try on Edy Velander's[14] initiative. I met the Facit CEO Carl-Bertil Nyströmer and Stemme and a few others sitting on one side of a large table and myself alone on the other side. I tried to explain to them that Facit did not know about large systems, but I could not make them budge. When I rose to go, they all remained seated; nobody walked me to the door. That was before Facit's move to Solna, I made another try there.

JB: Who was the driving force behind the D21 development, since it was not you?

BL: It was Gunnar Lindström; he was a professor of electrical measurement techniques and came to us from being CEO of Sweden's Atomic Energy Agency. He became engaged in the matter and did sell a computer just two months after my talks with Holm. It had two memories with word length 17 and 20 bits, respectively. I said: "You can't sell that computer; nobody can program it". My office was allowed to make an alternative proposal, my coworkers Magnus Tideman, Sven Yngvell and Bengt Asker took part in those discussions. The electronics people had planned a BESK copy, but not with the D2[15] circuits, they were too expensive. I found that a 20-bit computer with built-in double arithmetic processor would be more efficient than a 40-bit computer. Later we found that 24 bits would be optimal, one reason being that a word could store three 8-bit characters. That proposal became the D21.

ID: At that time, Control Data had 48-bit computers, a word length that seemed sufficient for all reasonable computations.

JB: Changing the subject again, in the early sixties you had started writing the papers that were later to form the TAIS[16] book. How did you get into systems theory?

BL: When we got the order from the insurance company Allmänna Brand, we had some young people working with their system; I followed that work closely. Later when we gave courses at the Rimforsa Homestead I started to think about the problems of administrative data processing. Might matrix techniques and other concepts from stress analysis be useful here?

[14] Edy Velander was then chair of IVA, the Academy of Engineering.
[15] D2 was a special-purpose computer for control of SAAB's fighter planes.
[16] TAIS - Theoretical Analysis of Information Systems

JB: So at that time, you already gave courses in systems development. What did such courses contain?

BL: They contained much of what was to become the first TAIS book in 1964, and then of course, we taught them our software and ordinary project management techniques.

JB: In due time, you were asked to head a research group. Where did that offer come from?

BL: It came from Martin Ferm, Director General of Sweden's defense research agency FOA. I said yes. I was interested, but I did not want a large department, just four to six people. At the first Nordic Symposium on Computers, NordSAM 1959, I had raised this matter on behalf of SSI, as its chair. I urged the establishment of a research council for information processing (IP) and stated that IP was a much larger matter than atomic energy. Many people were against this, but Ferm later invited me to his office. He said he agreed with me and asked if I would be interested in starting IP research at the FOA. "Yes, I would be" was my response, but I wanted to stay in Linköping. However, Ferm wanted to visit us often. I suggested he could not visit us every day and when he wanted to do so, he could still go to Linköping. About that time, interest emerged in Lund at the Department of Business Administration; they wanted courses in IP for administrative use. They asked me to go there and lecture every other week. There, I went on developing optimization and goal theory, among other things.

JB: So the people in Lund were active even before you went to Stockholm in 1965. I was engaged there myself but not until 1967 or so.

BL: In Lund, Kihlstedt and Rehnman were the driving forces. Well, in the end, I had to move to Stockholm, but I went on the condition that I would be stationed at the university, at the Department of Mathematical Statistics, as it turned out.

JB: So your research group was formed in 1965. Who became part of the group and why those particular persons?

BL: At the time when Ferm summoned me, I came somehow to meet Kjell Samuelsson[17] and Björn Tell[18]. My particular interest then was computer-aided problem solving, and we tried to find an interesting name for this activity, like "information research" or "informatology", later to be abbreviated "infology" as proposed by Bo Sundgren[19]. Therefore, the first meeting that started the forming of our group was with those two persons, as far as I remember.

JB: There were others in the group, e.g. Nils Lindecrantz and Lars-Erik Thorelli[20].

[17] Later to be professor of Informatics and Systems Science at Stockholm University
[18] Chief librarian at KTH
[19] Later to be adjoint professor at Stockholm Business School
[20] Professor em. of Computer Engineering at KTH

BL: Yes, and somehow Germund Dahlquist[21] was involved too. Maybe he was in the formative meeting. I think Dahlquist proposed Thorelli. How about Lindecrantz?

ID: He worked with us in SAAB-Linköping and then followed Bengt Kredell to ASEA[22], and must have joined your group from there. He died early, did he not?

BL: Yes, it was in the seventies. And you, Janis, do you recall how you entered the group?

JB: I first saw and heard you already in the late fifties at Chalmers, where I worked for Asplund[23]. That was where you were appointed docent in recognition of your computations for airplane wings.

BL: Moreover, I worked with your father[24] on a D21 project. However, I do not think you and I met at that time.

JB: No, it was later, in Linköping when I tried to sell you a Univac computer, probably an 1107. I worked at Univac then as systems and programming manager. So, I had to go to Linköping to tell you what a fine computer the Univac was. In the spring of 1965, I heard about the forming of your research group. I simply called you and asked if I could work for you. You said yes. Your research group started work at Hagagatan. Then the group moved to the clock tower of KTH[25], did it not?

BL: Yes, it was in preparation for applying for the professor's chair. They established the chair position in 1965, but they appointed me in 1967. However, we had started lecturing before that. I remember that you and I were supposed to lecture to the students from the Mining school of KTH. We had expected a crowd, but only a few turned up. They took notes, which they then distributed to the others.

JB: Yes, there we learned how lecturing at KTH is organized! As for the university, we started giving courses already in the spring of 1966. There we enrolled many interested students.

ID: Were you all employed full time?

BL: Yes we were, on FOA grants.

JB: How did they organize our subject area when we moved to KTH? Did we belonged to two different faculties: technical and social science?

[21] Professor em. of Numerical Analysis at KTH

[22] ASEA – Allmänna Svenska Elektriska Aktiebolaget, a Swedish company later merged with Brown Boweri, forming ABB.

[23] Sven Olof Asplund, deceased. Professor em. of Structural Mechanics at CTH.

[24] Janis Bubenko Sr, deceased. Professor em. in Electrical Power Systems at KTH.

[25] KTH – Kungl Tekniska Högskolan (the Royal Institute of Technology).

BL: Yes indeed. The Ministry of Education had formed a committee for this. Carl-Eric Fröberg[26] and Kurt Kihlstedt were pushing this matter.

JB: How did it feel being in a technical environment with Germund Dahlquist one flight of stairs up? Did we have good relations with the numerical analysis group then?

BL: Yes, but the pure mathematicians were a problem because they wanted us to be part of their department. I was definitely against that. They clearly stated that administrative data processing was our field. One condition for success was that an economist should be able to study our subject without learning additional mathematics. We were placed under severe pressure. At Hagagatan we sat in the Department of Mathematical Statistics where Ulf Grenander was professor. Grenander cooperated with Zachrisson[27]. When the proposal came up to move us to the Department of Mathematics, Zachrisson was involved and voted for it. Dahlquist, on the contrary, abstained and preferred us to be a separate department.

JB: Getting incorporated into mathematics would have been a problem for numerical analysis, too. They did not belong to mathematics then.

ID: This surprises me in a sort of opposite manner. Dijkstra wrote somewhere that mathematicians and computer scientists do not talk with each other. If they do, they do not discuss their work. However, these KTH mathematicians actually wanted you to do that!

BL: I imagine their interest was based on a hope of spreading interest in mathematics in this way. They seem to have realized that computing would keep growing. But I remember one stay in Lund when we were going to Copenhagen in 1956. There we were trying to make DASK and SARA compatible down to the bit level, also we had a debate on index registers in which you (Ingemar) took part. Magnus Tideman and I stopped over in Lund and talked to a couple of mathematicians. I argued that there would be much in computer science to interest mathematicians. Programming has its roots in logic, which ought to be interesting from a mathematical point of view. However, I got no response at all. As this was not important to me, I let the matter drop.

ID: Today, with functional programming developing, mathematicians would really be in their right element and get a lot out of some cooperation. Moreover, we have something else in common: both mathematics and IP are the "charwomen" of other disciplines.

JB: Around this time, your great work TAIS came into being. It built on several years of work and was first printed in 1966 (by Studentlitteratur, Lund). That book became a sort of bible for our subject. Many things in it still hold. Looking back at TAIS, is there anything you remember with special interest?

[26] Professor em. of Numerical Analysis at Lund University.
[27] Lars-Erik Zachrisson, professor em. of Control Theory at KTH.

BL: Oh yes. One of them is what I wrote about executive optimization. One could have developed that further. In addition, what I wrote about processes. I have recently been in contact with a systems analyst at the Taxation Authority. He is interested in what is written about processes. The concepts of process grouping and file consolidation are surely relevant in what is today called "process engineering". In essence, this technique developed in TAIS is not limited to data processing. Another thought I developed in TAIS is that if companies have similar activities, then their basic administrative routines ought to be similar, too. If we cannot easily apply standard software, it is because they have not started by defining their routines at the elementary file level. They always discuss in terms of consolidated files and grouped processes.

JB: In other words, if they had described their routines exactly at the lowest level, one could more easily have found similarities in different enterprises and been able to apply more standard programs.

BL: The reason I talked with the taxation fellow is that they are interested in object orientation. I could show them that much in TAIS gives the basis for what we now call object orientation.

JB: In those days, we made matrix based system descriptions and applied formal methods. Thy do not do that very much now. How do they get the systems to work properly nowadays?

BL: That is a good question, I have been wondering too.

JB: Another interesting passage in TAIS was the "underestimation theorem" – if you do not understand a system, you tend to underestimate its complexity. This fits nicely with your opening speech, where you talk about the difficulty of "learning to multiply (estimates) by two".

BL: There is another thing I still find interesting with TAIS—to develop a formal theory even though I do not handle mathematical objects. I discussed this with a mathematician in Lund who found it interesting, and therefore I went on working with it. I tried to build a formal structure with hypotheses and theorems. This was useful if you wanted to theorize about systems work. I also saw it as a way of organizing your own thoughts, so you could scrutinize them critically. Oh yes, however, there were people who were critical to my way of describing the theory, among them a Russian visiting mathematician at Numerical Analysis Department. Nevertheless, my personal opinion is that this kind of theory formulation must be very interesting and challenging from a mathematical point of view too.

ID: The Russians, being good mathematicians, ought to be interested in TAIS.

BL: Yes, they usually were, I noticed. TAIS was translated, by the way, not into Russian but into the Slovak language.

JB: Have you followed the way the subject originally called "information processing - particularly administrative data processing methods" has developed and spread in Sweden? At most academy sites nowadays, they call it "informatics". This has been confused with what Kjell Samuelsson meant by that word. Some departments call it "computer and systems science" and some "information systems". What do you think is a proper name for the subject?

BL: Kjell Samuelsson persuaded me to let him call his part of the subject "informatics". However, I pointed out to him that they were already calling the subject as a whole "informatique" in French, and thus it was awkward to use the name for a part of the subject. In 1965, I chaired the program committee for IFIP Congress in New York. There I proposed to divide the conference program into five parts, one of them being "Information systems" which could include "Business data processing". This proposal I presented at the opening of the congress. Consequently, the whole world, except for Sweden, now calls "Business data processing" by the name "information systems".

JB: Actually, one department in Sweden does call the subject "information systems", and that is at the university college of Skövde. However, how did that parallel subject "information processing - particularly computer science" ("datalogi" in Swedish) start? Do you recall whether that was in the group of Germund Dahlquist?

BL: I think it is right to say that. We started to discuss the separation of numerical analysis and programming into two subjects. We could have a subject focused on programming that was not tied to numerical analysis too much. I do not quite recall how the word "datalogi" came up.

ID: The Danes launched the word "datamatik" at this time.

BL: Yes, that might have been it. When we discussed the word "informatologi" we naturally also considered "datalogi". I think actually Peter Naur in Copenhagen launched both words: "datamatik" and "datalogi".

JB: At about the time that the "datalogi" subject was formed, our department moved from KTH to the university—to the F house in Frescati. Could you tell us some memories of that process?

BL: What I particularly remember is that we then had an HP (Hewlett Packard) computer, which had the advantage that students could use it online from eight terminals. According to Statskontoret[28] online operation would be too expensive on a big computer and it would be many years before this service could be generally available. My former boss Lars Brising, at that time manager of the government's

[28] Statskontoret is the Government's agency for administrative development. It was thus charged with computer purchases and upgrades for all civil government agencies. Statskontoret played a vital role in starting the university computing centers, but its preference for computer families like the IBM/360 series brought it into several conflicts with the university people.

Development Agency, helped me finance the lease of an HP computer and we had HP install it at our place. Statskontoret did not like that, in fact they were vigorously against it. At one time I was summoned to the financial director of KTH, who passed on to me a statement from a university public relations officer that if the computer remained after a certain date, say July 1, that would be a breach of law. I asked him what would happen to me then? The computer stayed, but there was a lot of trouble about it. I think you, Ingemar, must have been involved, since you were in the committee for managers of government computing centres. The committee claimed that such a small computer could not handle eight terminals.

ID: I sat on the board of university computing centres. There were also people from Statskontoret and user representatives on that board. We probably had the matter submitted to us and made a statement.

BL: Anyway, when we were moving to Frescati, we were bringing our eight terminals with us. Then the Numerical Analysis Department said they needed another eight. All of a sudden, they accepted that the HP should handle 16 terminals, and so it did, which I found quite amusing.

JB: That made it one of the first "time-sharing" computers.

BL: Yes, and I remember too that after a week or ten days, fantastic things happened to the students sitting there online. For instance, they had made an interpreter of Cobol programs, written in Basic. I wrote a whole report on what had happened during this brief period.

JB: Yes, interactive programming meant an enormous productivity gain, compared to batch processing, when you had to submit a card deck over the computing centre's counter two or three times a day, at least.

BL: Yes, I know you, Janis, and Tomas Ohlin[29] were very engaged in this matter. Luckily, there was a sensible politician, Hans Löwbeer, who was Chancellor of the Universities at the time. He arranged for the National Computer Fund to buy the HP computer.

ID: Statskontoret opposed anything that did not fit with their ideas. They were against setting up a terminal at the university college in Växjö connected to our computer in Lund, if we had to finance it by a grant for computer time. However, Växjö had checked with the university chancellor, so Statskontoret was steamrollered in this case. Later, we in Lund decided to try reduced night rates for the computer, which was also against Statskontoret's rules. Fröberg promised me that if I went to jail for this, he would bring me sandwiches. We knew then that Statskontoret could be confronted on vital matters. It was Bubenko-Ohlin in

[29] Formerly, professor at the Department of Economic Information Systems, Linköping University.

Stockholm and Fröberg-Ekman in Lund who had taught Statskontoret there was a limit to what they could do[30].

JB: How did you find the physical move to Frescati and the University of Stockholm?

BL: When we got there, we became part of the Social Sciences faculty, where Boalt was the dean. He welcomed me to the faculty and supported our entry in all manners. Among other things, he invited me to lecture at the seminars of the sociologists. Moreover, my lecture made one of students in the audience rewrite his thesis, Boalt told me. I do not recall what I lectured on, but it might have been something from the other book I wrote at that time, "Systems for enterprise management".[31] There I treated matters that might interest sociologists too. Nevertheless, when I told Boalt it would be interesting to see sociologists take part in developing the topic of administrative data processing, Boalt objected. Sociologists could not take sides for the employers against their personnel! I thought if a company could be improved by using computers, that would surely be good for the personnel too.

ID: A researcher like Kristen Nygaard[32] worked at supporting trade union work with computers. There is nothing to say that computers will benefit employers only.

BL: I had an interesting experience in Lund, before 1965, I think. There I had three very obviously left-leaning students. They were very interested in workers' matters, so I suggested they should write their joint bachelor's thesis on how to use IP to support workers' interests and what information might be interesting and useful for employees. However, this seemingly did not interest them enough, for nothing came of it. One of them was German, a very brilliant guy who had been thrown out of Frankfurt on account of a student rebellion. He walked me to the Stockholm train once, and I remember him saying it was so interesting that TAIS reminded him of Mao's Little Red Book. That might be good example of the infological equation.

JB: Speaking of that, Ingemar has gone back and read your opening speech "Reflections on the Past" with great interest. Would you, Ingemar, like to wind up this interview with a few questions?

ID: I have two, really. The one is your saying "The infological equation refutes positivistic ambitions". Could you elaborate on this? What do you mean by positivism, for instance?

BL: There was a lot of discussion and criticism against positivism in our department, e.g. from Kristo Ivanov[33]. Positivism in this sense means to claim that

[30] Here *ID* refers to the conflicts about Statskontoret's handling of the procurement of large computers for research and education in Stockholm and Lund, respectively.

[31] "System för företagsstyrning", Studentlitteratur, Lund, 1968

[32] Kristen Nygaard developed the SIMULA language together with Ole-Johan Dahl, both deceased in 2003.

one can define exact atoms of knowledge that correspond exactly to reality. What I want to prove with the equation is that that can't be so. With every token a person uses, his pre-knowledge comes in and influences the result. A word has a different meaning depending on the context in which we use it and the recipient's pre-knowledge and frames of reference.

ID: Okay. Now I understand you better. I have long embraced the opinion that words mean different things depending on the way you use them. However, I count myself as a positivist anyway, in the sense that I think one should be capable of proving or refuting a theory. Otherwise, it is not science but metaphysics. The infological equation should not upset that kind of positivism.

BL: I am not quite sure you are right. What I mean is that I am not sure I could not have objections to that. However, maybe we should not go deeper into that now.

ID: No, let us not. That answers my first question. The second one is this. You write here at the end that maybe you should have been clearer, more explicit in your writings, but it would have taken more of your time and that of the readers. Then you say, "It may have exceeded the "t" of the infological equation". However, I do not think of "t" as a sort of limit, but rather as an independent variable. Do you mean to say it would have "exceeded a reasonable "t" of the infological equation"?

BL: Yes, I am thinking of the time "t" that I expect my reader to have available. That *is* an interesting factor, especially when one considers how explicit one should be. The writer also cannot spend unlimited time on the matter. One must expect the reader to have an "allotted time", to cite an interesting book I recently found in the library.

ID: Okay. I understand that too. I must say I appreciated that poem by Garcia Lorca in your speech. It kept popping up in my head for days.

BL: It could be interesting to confront it with the Wittgenstein quote "*Everything that can be put in words can be put clearly*". At the HiNC conference, Sandewall[34] extended my quote with the lines "*on that of which we cannot speak clearly, we must be silent*". He then asked me if that changed my assertion that the infological equation refutes Wittgenstein. However, I do not see why it should.

ID: Isn't it the other way round? Sometimes we have to keep talking even though we are unclear. I do enjoy a piece of the humanities for a change in our very technical environment. Garcia Lorca is a writer known fairly little by us in the North. Do you know Spanish well?

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[33] Professor em. in Informatics, Umeå University.

[34] Erik Sandewall, professor in Datalogy, Linköping University.

BL: I have read Spanish literature for many years, not just for the sake of learning the language, but also for entering and understanding the cultural environment there.

ID: In terms of the infological equation, you create a larger common "S" (pre-knowledge) with the Spanish person you talk with.

JB: Börje, we thank you for joining us in this very inspiring and informative discussion.