The Programmer as a Young Dog[∗]

(1976)

This autobiographical sketch describes the beginning of the author's career at the Danish computer company Regnecentralen from 1963 to 1970. (The title is inspired by James Joyce's "A Portrait of the Artist as a Young Man" and Dylan Thomas's "Portrait of the Artist as a Young Dog.") After three years in Regnecentralen's compiler group, the author got the chance to design the architecture of the RC 4000 computer. In 1967, he became Head of the Software Development group that designed the RC 4000 multiprogramming system. The article was written in memory of Niels Ivar Bech, the dynamic director of Regnecentralen, who inspired a generation of young Danes to make unique contributions to computing.

I came to Regnecentralen in 1963 to work with Peter Naur and Jørn Jensen. The two of them worked so closely together that they hardly needed to say anything to solve a problem. I remember a discussion where Peter was writing something on the blackboard, when Jørn suddenly said "but Peter . . ." and immediately was interrupted with the reply "yes, of course, Jørn." I swear that nothing else was said. It made quite an impression on me, especially since I didn't even know what the discussion was about in the first place.

After a two-year apprenticeship as a systems programmer, I wanted to travel abroad and work for IBM in Winchester in Southern England. At that time Henning Isaksson was planning to build a process control computer for Haldor Topsøe, Ltd. Henning had asked Niels Ivar Bech for a systems programmer for quite some time. Since I was thinking about leaving anyhow,

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Bech felt that I might as well move to Isaksson's department in Valby. So it was not because of my vast experience that I got the opportunity to design the RC 4000 computer.

Henning was an efficient manager and very pleasant to work for. Our programming group consisted of Peter Kraft, Charles Simonyi, and me. Peter was an experienced programmer, who had learned his craft during the Gier-Algol project. Charles was a long-haired teenager, a refugee from Hungary who was fascinated by everything in the western world. Later he went to the United States and worked for Xerox in California.

It was in an old cozy villa in Valby that I defined the instruction set of the RC 4000 computer. It became a nice, uninspired copy of the IBM 360. However, one thing set the RC 4000 apart from other computers: its function was concisely defined in the programming language Algol 60 before it was built. It was no doubt the only computer in the world that made it possible for the user to predict the result, bit by bit, of dividing two non-normalized floating-point numbers!

One of Isaksson's young engineers, Allan Giese, was inspired by this to extend Algol 60 so it could also be used to describe the internal structure of the RC 4000 (the microprogram).

At the same time, Peter Kraft developed our first process control program for a chemical plant in Poland. A few years later, Peter continued this pioneering work and (together with others) produced RC 4000 software for real-time supervision of two Danish power plants, Vestkraft and Nordkraft.

Our group was also joined by a student, Leif Svalgaard, who became so absorbed in programming the RC 4000 for the Meteorological Institute in Copenhagen that he forgot to take his final exam. Leif liked to show off. Once he told us that he had a new theory of the magnetic fields of the sun and earth. That made us smile a bit. Later, I met Leif in the United States. He was then working at Stanford University and his theory was world-famous.

Early on, Henning Isaksson realized that our new computer would become the successor of the Gier, and that we had to start thinking about developing software for it. But first it had to be named. I suggested calling it the RC 4000, since "who would buy an RC 3 for a million kroner when you can buy an RC 3000 for a lot less?" So RC 4000 it was.[†]

I now returned to the Rialto Center as Head of Systems Programming. Bech's directive was rather amazing. His only request was: "I need some-

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[†]The RC 4000 was Regnecentralen's third computer architecture. The RC 3000 was a special-purpose device for data conversion.

thing new in multiprogramming!"

In my opinion Niels Ivar Bech was somewhat of a gambler and show-man. He could rarely resist the temptation to do the unexpected. I once participated in a negotiation between Bech and a customer about the sale of an RC 4000 in the middle of a noisy discotheque. Perhaps it is true that unconventional acts rarely succeed in business (we did not sell a machine that evening), but they almost always work in research.

Research is gambling at the highest level. A cautious effort only leads to uninteresting results. A research director must have a sense of which problem to attack next and the courage to give his collaborators the freedom to solve it without imposing narrow constraints. The talent for inspiring his associates to create new things of world-wide renown was one that Bech possessed in the highest degree. Once you have known a leader who has this intellectual courage, it is quite depressing to realize how extremely rare this quality is.

Niels Ivar Bech was a dreamer in the most creative sense of the word. His time scale was longer than the one I adopted as a young, impatient engineer. I found it unreasonable that he gave Regnecentralen's senior people time to write textbooks on computer science without considering how this would influence the future of the company. That was short-sighted of me. While Bech gave his younger colleagues the chance to create new things, he gave Peter Naur, Christian Gram and Henning B. Hansen the opportunity to lay the foundation of computer science education in Denmark.

It wasn't easy for me to measure up to the standard of excellence set by the Gier-Algol compiler (Edsger Dijkstra called it a masterpiece). The instant rivalry between Søren Lauesen and me did not improve matters either. Søren and I were both "promising" and ambitious, and no room was big enough for the two of us. However, we had no choice but to cooperate and try to match the achievements of the compiler group.

In such a creative environment only personal ability counted. Unfortunately, it seemed that none of us had any original ideas whatsoever about multiprogramming. Finally, I went to Bech and said: "We aren't getting anywhere. Is it all right with you if Jørn, Søren, and I stay at a country inn for a weekend?" I wanted us to discuss the software issues in depth in cozy surroundings to give ourselves one last chance. We had already agreed that we would either return with new ideas or give up and settle for copying the best ideas we could find elsewhere. Bech immediately agreed (he had done the same thing when Regnecentralen's Cobol project had come to a stand-

still). And it worked! The thought of returning to Regnecentralen without new ideas was simply unacceptable to us.

Out of that weekend came the first seminal ideas for the RC 4000 monitor (the nucleus of a multiprogramming system). Four years later, the U.S. National Academy of Engineering published a report about the need for courses on operating system design. It stated that in the whole world there were only three operating systems that were so simple and completely described that they could be used for teaching. The first one mentioned was the one that enabled the RC 4000 computer to do many things simultaneously. The accolade was a letter from Edsger Dijkstra expressing his admiration for our system.

Denmark has made four world-class contributions to data technology: Peter Naur's Algol 60 report, which Tony Hoare called a considerable improvement over its successors; the Gier-Algol compiler, which has never been surpassed; the world's fastest paper tape reader, the RC 2000 (which Bech gave a co-worker money to design at home, because his manager didn't believe in the idea); and, finally, the RC 4000 monitor, which has been imitated by other computer companies.

Each of these products combined radically new ideas, which were years ahead of their time (and therefore could not be motivated by an immediate "need"). Without Niels Ivar Bech's brilliant sense of innovation, a Danish company could probably not have attracted so many outstanding young computer scientists and be at the cutting edge of programming technology for more than a decade.

In 1970, I left Regnecentralen and moved to the United States. At that time, Niels Ivar Bech was already showing signs of illness. Since then I only saw him briefly at a conference in Yugoslavia. There was one thing I would have liked to tell him. I have lectured at most of the leading universities and research centers in the United States. But only at Carnegie-Mellon University and Xerox Research Center have I found programming groups that measured up to Regnecentralen's.

With Niels Ivar Bech's death, Denmark lost its leading role in the development of programming technology. Since then I have met some of the most creative computer scientists and outstanding leaders in the computer industry. But no other human being has had a deeper impact on my work and given it a broader perspective than Niels Ivar.

Acknowledgements

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