BIRTH OF COMPUTER SCIENCE EDUCATION AND RESEARCH IN FINLAND

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Abstract: Several Finnish universities established chairs in computer science/information processing in 1965–68. Rather than reflecting natural evolution within universities, external needs motivated this. The first professors came from computing practice but had also academic ambitions. This paper is a recollection on how the new discipline developed in an atmosphere of conflicting goals

Key words: Academic education, information processing, Finland

1. INTRODUCTION

As in many other countries, the first computer was built also in Finland at a university.[1] During this project (1955–60), the leading position in computing expertise and education had shifted from universities to companies that imported computers. This was mainly due to the meager resources available to universities in post-war Finland. As a result, computer science did not evolve naturally within universities, as happened in many other countries. This led to a situation where the new discipline came to them from outside of the scientific community.

In 1960, Finnish Cable Works (FCW) started a Computing and Electronics Division (one of the roots of today's Nokia), which competed

[1] ESKO, a pre-von Neumann computer, was built at Helsinki University of Technology in a project of the Mathematical Machines Committee. When completed, it was moved to the newly established computing center of the University of Helsinki, where it served as their first computer.

with IBM in computer sales and computing center services. A key person in this initiative was Olli Lehto, professor of mathematics at the University of Helsinki, whose person also strongly influenced the working atmosphere in the newly established group. Several of the key employees had fresh Master of Science degrees and had ambitions for doctoral studies. Although competition with IBM turned out to be difficult, the goal of being number one in computing expertise made the environment to what was sometimes referred to as "Salmisaari[2] University". Ambitions in understanding the new field both theoretically and in practice bore fruit for the society, when serious computing education began. Several members of the FCW group then moved to universities and became professors of computer science and related disciplines.

We can argue, whether "computer science" is a correct term to use here. A more literal translation of the Finnish name "tietojenkäsittelyoppi" would be "discipline of information processing". The word "science" was intentionally not yet used in this context, to avoid pretending that the scientific basis of the emerging discipline were well understood, and to allow inclusion of topics that a strictly scientific attitude might exclude. We use the abbreviation IP of this discipline in what follows.

We should mention that there was also a notable exception from the above pattern of introducing IP to Finnish universities. In Turku, the University of Turku (UTu) and the Åbo Akademi University (Swedish university in Turku) had in 1960 established a joint computing center, which was the first academic computing center in Finland, and which received a first-generation Wegematic 1000 computer as a donation from Sweden. Instead of introducing IP as an academic discipline at an early stage, UTu followed a more conventional line of progress. Olavi Hellman introduced a strong computing component in the applied mathematics curriculum in mid-1960s and Arto Salomaa's work on automata and formal languages soon developed the mathematics department into a well-known center of theoretical computer science.

Another interesting path was taken in computer engineering research at Helsinki University of Technology, where they designed and built an architecturally innovative computer (REFLAC) in mid-1960s. The idea was Teuvo Kohonen's, and this research project gave him a concrete basis from which he started to develop his theory of associative memories and neural nets towards the end of the decade.

So far, documentation on the early development of computing in Finland is available mainly in Finnish. The most complete reference is a compendium edited by Martti Tienari and mentioned in the end of this paper. Much of the material in this paper appeared also there in Finnish, and

[2] The offices and the computing center were located in Salmisaari, Helsinki.

one can find there references to original sources. Because of my personal perspective, the reader should not take this as a balanced and total picture of the origins of IP education and research in Finland.

2. SOME MORE BACKGROUND

As we already mentioned, only meager resources were available to academic institutions in post-war Finland. In spite of this, applied mathematicians were eager to promote computer use, and courses in programming and numerical computing were included in several engineering and applied mathematics curricula in early 1960s. Some vague ideas arose then also about the need for more serious IP education. Inspired by the ideas with which I had come in contact in my work at FCW, I wrote in 1962 about academic IP education:[3] "Soon it will not be sufficient for universities to give courses in computer appreciation and programming techniques only. The field itself is a rich area of research and closely connected to topical research in other fields. Therefore it is soon time for universities to start research and special education in it."

At that time, we had both state and private universities, but also the latter depended mostly on state money. University budgets required approval by the ministries of education and finance, and each contained a relatively stable list of unfilled wishes, from which only the topmost could be satisfied each year. As a result, it was not in the interest of existing departments to propose new ones, which would have reduced their own chances to get anything.

The need for well-educated computing professionals grew, however, rapidly in practice. One of the institutes in which this was strongly experienced was the State Computing Center (SCC). Its director, Otto Karttunen, had also much power in the ministry of finance and his support was influential in establishing the first chairs in IP. Knowing that it would obtain such a chair, if a university proposed it, certainly helped in getting a proposal on a university's priority list.

Through the 1960s and 1970s, the position of SCC was also such that no state office could acquire computing equipment without their permission, which gave Mr. Karttunen the nickname "Data Czar". This rule applied also to private universities, including the use of their own funds on computing. Since SCC offered computing services that competed with other plans to satisfy computing needs, the situation was bound to lead to difficulties in getting suitable computers to universities.

[3] Free translation from Arkhimedes, a journal of Finnish mathematicians and physicists.

As for the structure of degree curricula in universities, they divided studies in each discipline into three stages for which they used traditional Latin names.[4] Students could pass the first stage, *approbatur*, in one year. The second stage, *cum laude (approbatur),* required one to two additional years, and the highest level, *laudatur,* one could achieve (in practice) after a total of four to five years.[5] An MSc degree in mathematics and natural sciences, for instance, required the *laudatur* level and the MSc thesis in the major discipline, and *cum laude* and *approbatur* levels in two minor disciplines, respectively. The choice of minors was relatively free.

3. A SURPRISE MOVE

Tampere was (and still is) a progressive industrial city, but its wish to have university-level education in technology and/or business studies had not been fulfilled. However, the School of Social Sciences – a private university-level institution – had moved there from Helsinki in 1960. In the new environment, and with active support from the city, it soon started to develop towards a full-fledged university. As a surprise to the major universities, IP was first started there as an independent academic discipline in 1965.

By then this school had faculties only in social sciences and humanities, under the charismatic leadership of a visionary rector, Paavo Koli. Close contacts began with FCW in using their computing services and expertise in statistical methods. In fact, Dr. Seppo Mustonen[6] from FCW then worked there as an acting professor, and the development of computing in the school was included in his responsibilities.

In February 1965, Koli presented a plan to establish a new faculty of economics and administration, in which Mustonen's proposal for a chair in IP was included. As a motivation for this chair, the estimate was given that Finland would need some 200 academically educated IP professionals (system analysts and programmers) within the next five years. The mundane needs in the practice of computing were not, however, what Koli mainly had in mind. When the new faculty started in fall 1965, he expressed his visions in public, speaking forcefully about the society's need for well-educated analysts and decision makers with profound knowledge of quantitative and computational methods. In today's perspective, this seems like an early vision of educating leaders for the information society.

[4] In engineering studies, the system was different, and will not be discussed here.

[5] In the absence of strict timetables, studies often lasted much longer; some universities exercised an upper limit of ten years.

[6] Now professor emeritus of statistics, University of Helsinki.

How could Koli force his ideas through, when money for universities was so scarce? The school was small, and he was a charismatic leader who could persuade his colleagues to support his visionary ideas. Secondly, as a wartime hero he used a tactic of surprise, which was not far from blackmailing for state money. Having established permanent chairs with temporary funding, he threatened the ministries with bankruptcy of the school, unless they granted the required money. Of course, this tactic could not work long, and he had to abandon it when the school received permission to have a name change to the University of Tampere (Uta) in 1966. Therefore, they never fully implemented the ideas of Mustonen and Koli, but this sequence of events is the way IP began as an academic discipline in Finland.

4. STARTING IP IN TAMPERE

When the above plans were prepared in Tampere, I was a fresh PhD on leave of absence from FCW, spending a year as visiting scientist at Carnegie Institute of Technology, now called Carnegie-Mellon University (CMU). My first contact with computers had been with DASK at Regnecentralen in Copenhagen, where FCW sent me in 1960. My advisor there had been Dr. Peter Naur[7], from whom I had also received a fresh copy of the Algol 60 report. After overcoming initial difficulties in reading it, it had inspired me to doctoral work on formal languages and syntax analysis of programming languages.

When asked to come to Tampere to start IP education as an acting professor, I did not feel competent for the challenge, of course. The first computer science departments had emerged only quite recently – even CMU was then just starting one – and no generally accepted recommendations or textbooks were available. On the other hand, I was afraid that another choice might lead the new discipline in Finland into a direction that would be divergent from what I had learned during that year from Alan J. Perlis, Allen Newell, Donald Knuth, and others. To ease my responsibility, I first accepted only half of the position, and continued part-time at FCW. For the other half, we hired Miikka Jahnukainen, who had experience in teaching IP system analysis and who had been involved in the design of a prototype curriculum for such education.

At that time, a severe split existed in computing practice according to two main application areas. In *business data processing,* the focus was in system analysis and design, whereas the emphasis of *scientific computing* was on

[7] Now professor emeritus of computer science, University of Copenhagen.

numerical analysis and "scientific" programming languages. My experience at FCW had convinced me that an application-oriented approach would not be appropriate for IP education, even though this was what people in practice seemed to be expecting. Instead, I wanted to emphasize application-independent topics like data structures and associated algorithms, and expressing complex IP processes in algorithmic languages. Additionally, to satisfy the urgent needs in business data processing, we complemented this computer science oriented core with courses that prepared students for the system analysis practices of the time. This resulted in a clear division of labor between Jahnukainen and me.

The new discipline gathered immediately a large number of students. Although many seemed to come to our courses just for curiosity, my first courses had still 150 students by Christmas time, and some 100 of them passed the *approbatur* level within the first two years. In our innocent enthusiasm, we extended IP into a full-scale discipline as soon as it was possible. We even started *laudatur* courses in 1967 with the aid of only two more vacancies, an associate professor, and a lecturer.

In addition to an introductory course, the *approbatur* level required two one-semester courses that reflected the dual character of the curriculum. The *cum laude* level initially contained four required courses. They included "Programming II" (data structures and algorithms), "Introduction to systems thinking" (introduction to a theory of systems, formal models of systems, models and design of IP systems), "Programming III" (a mixture of principles of programming languages and operating systems), and "Boolean algebra" (theory and applications of Boolean algebra, normal forms and simplification of logical functions, logical structure of a simplified computer). In addition, two elective courses were required, for which we tried to offer different kinds of alternatives.

The initial requirements for *laudatur* contained a "maturity examination" for which no course was given and which therefore turned out to be a higher obstacle than intended. In it, we expected students to demonstrate ability to apply the ideas that they already learned and to show general familiarity of such programming languages that we did not teach them. The only required *laudatur* course was "Programming IV", which emphasized the importance of different language paradigms. In winter 1967–68, Simula, Comit (predecessor of Snobol), and Lisp were used in this course, although only pen and paper were available for exercises. In addition, three elective *laudatur* courses were required; the selection included an advanced course in system analysis and design, and a course in theory of computing.

As for initial experiences, the "programming" and "system analysis" courses remained more separated than I had been hoping. Only few students appreciated both, and many of those who preferred system analysis had severe difficulties in data structures and algorithms. One reason probably

was in lack of motivation, since at that time, such knowledge was not much appreciated or used in the practice of business data processing. After all, they still considered programming in these circles as a lower-level technical activity. With a heavy heart, I eventually agreed that "system analysts" could pass the *cum laude* level also without such knowledge. In each case, in the 1970s this development led Pertti Järvinen, Jahnukainen's follower as associate professor, to start a specialization of IP in the Scandinavian spirit of "systemeering".

5. SPREADING OF IP TO OTHER UNIVERSITIES

The increasing need of IP professionals soon made also other universities prepare plans for IP education. Without further surprise moves, the universities of Helsinki (UH) and Jyväskylä (UJ) established IP chairs in 1967, and Helsinki University of Technology (HUT) and the University of Oulu (UO) followed a year after.

The first professor at UH was Martti Tienari, who also came from FCW. His PhD was in pure mathematics, and at FCW, his responsibilities included scientific computing. Before starting at UH, he spent the winter 1966–67 at the Computer Science Department of Stanford University, where the main emphasis was on numerical analysis at that time. HUT's first professor, Hans Andersin, had been involved already in the ESKO project, and had gained broad experience of industrial and business computing at IBM and SCC.

As "remote" universities, UO and UJ had more temporary arrangements with acting professors, until Pentti Kerola and Eero Peltola, respectively, stabilized their situations. Kerola's background was in IBM and industry, and before UO, he worked as an associate professor at HUT. Peltola had started with Wegematic and FCW had hired him. He had also worked for many years in the IP department of UH.

Although they could have used the curriculum at UTa as a point of reference and there was frequent contact between all IP professors, each university introduced some of its own flavor in its IP education. Between UTa and UH especially, there was much affinity; the major difference was that the latter also had numerical computing in its curriculum. Once stabilized, IP at UO differed mostly from the other universities. There Kerola started to develop his "systemeering" approach in a form where computer science topics had less emphasis. We could see similar trends at UJ, where they did not group IP among natural sciences and mathematics, but among social sciences and economics.

All first-generation IP professors came from IP practice, not from established academic departments, and they felt strongly the responsibility to educate people for practical needs. This, together with continued contact with practice, obviously affected the development of curricula. They constantly sought compromises with representatives of practice, so that students would get both a theoretical basis of IP – which the people in practice did not yet possess and often did not appreciate – and obtain sufficient knowledge of the tools and practices of the time. Of course, the balance between the two was (and still is) an endless topic for debate. What they appreciated most in practice was the knowledge of using IBM S/360 Assembler and OS/360 operating system.

The situation is also reflected in Karttunen's memoirs, written in 1985, where he expresses disappointment with "theoretical comparison of programming languages and theory of system analysis" that was taught in universities, and tells how students with *cum laude* or *laudatur* levels in IP often refused to be hired for the trivial work offered at SCC.

6. COMPUTERS IN IP EDUCATION

In early 1960s, there were small computers like Elliott 803 and IBM 1620 in universities, and computing services by IBM, FCW and SCC were used in addition. (At UTa, they started IP education using FCW services in Helsinki, since a computer of their own arrived only during the spring term 1966.) For IP education, it was, of course, intolerable that they would use a single small computer – with only paper tape and/or punched card input – for all computing needs in a university. Therefore, plans to obtain facilities that are more convenient were an immediate initiation by the new IP professors.

There were several problems in this. First, computers were expensive. Secondly, IP had yet to receive recognition as a discipline that needed computers as laboratory equipment; universities acquired computers primarily for other purposes. Thirdly, as already mentioned, they also needed approval by SCC, which offered competing services in university cities. Of SCC attitudes, it is revealing to read from Karttunen's memoirs that he considered computers to be only "toys" and "status symbols" for universities. Thanks to its special legal position, UH succeeded, however, relatively soon in getting a solution that served them well for a long time (Burroughs B 6500/8500).

At UTa, a more modest proposal for a modern time-sharing computer (PDP-10, predecessor of DEC 20) appeared in 1968. In a carefully formulated statement, SCC suggested to investigate cooperation with them

instead, in order to find a more economical solution that would satisfy the local needs of SCC, UTa, and the newly started Tampere University of Technology (TUT). Such an investigation showed, however, that the needs of the three parties – business computing services, IP education and research, and scientific computing – were so much incompatible that a single IBM S/360 system to meet them would cost more than three computers that are more specialized. The final word of SCC was, however, that, since their IBM S360/30 still had unused capacity in Tampere, also IP education at UTa should be satisfied with using it.

In December 1969, this deadlock was resolved by the decision of SITRA[8] to buy a centralized Univac 1108 to satisfy the computing needs of Finnish universities and research institutes. According to the plan, Tampere would get a single card reader/line printer terminal for UTa and TUT. Since it was clear that we could not expect anything else for years, they negotiated this terminal as exchangeable into a general-purpose time-sharing computer (Honeywell H1640), which they extended at UTa to give remote batch services on Univac concurrently with local time-sharing. This solution turned out to serve well for several years.

Struggling for suitable computers was not, however, over. In 1975, a centralized computer acquisition process was started for several universities. Although DEC System 20 was unanimously preferred, universities outside Helsinki were in the end forced to accept Univac computers, which were not good for time-sharing – not to speak of use as laboratory equipment for experimental system software. They have never disclosed the details of why it was so important for high-level political forces to manipulate the process to this end.

UTa was especially frustrated of this overruling of university expertise, and of not getting a computer that would suit the line of development chosen for its IP education and research. This led to a colorful chapter in the history of computing in Finnish universities, a long arbitration court process (the "great computer war") in which the main question was, whether Univac satisfied the promises made of its time-sharing use. This "war", which ended in 1980, perhaps sped up the process in which state control on university computers was gradually relaxed.

7. BEGINNINGS OF IP RESEARCH

When the first generation of IP professors entered universities, their research merits were relatively weak and often not central to IP. In most

[8] A fund established to celebrate the 50 years of Finland's independence in 1967.

cases, they started as acting professors, trying to achieve qualification by individual research in their own computing-related fields. The large numbers of students and a pressure to develop textbooks and other teaching material left, however, only little time for this.

As already mentioned, a notable exception to this pattern was UTu, in which a strong research group in theoretical computer science arose quite early. Within IP departments – and more so in IP practice – this research was considered as pure mathematics rather than IP. Contacts between IP and Kohonen's research at HUT were also minimal at that time.

The first to succeed in starting a solid research group in IP was Tienari at UH. The first area that he chose for himself and his students was the theory of rounding errors in numerical algorithms. With the decreasing international emphasis on numerical analysis, he moved, however, in the 1970s to compiler techniques and associated theoretical research – the most classical area of computer science – in which his group soon became internationally known.

At HUT, Andersin started a group that worked on graphical computing. The engineering goals of this group resulted in topical expertise in this area, and in a spin-off company, which was successful for a number of years.

At UTa, my idea of IP research was that it should arise from practical motivation and should aid in the design and construction of complex systems. Since compilers and operating systems were prime examples of such systems, I wanted to connect the research with practical work on them. The Honeywell 1640 system mentioned above offered the first real opportunity for such work. When industrial development of computers started in Finland in late 1960s (Strömberg 1000, soon followed by Nokia's Mikko series, and then by Nokia MPS 10 in the 1980s), more opportunities arose. This also led to starting of a software house (Oy Softplan Ab), through which IP at UTa – and later at TUT – had close connections to industry. For universities one of the benefits of this was cooperation in the development of software engineering education.

Another important component of Finnish IP research that they started in the 1970s was the "systemeering" or information systems research. Pentti Kerola at UO and Pertti Järvinen at UTa were then its main proponents.

8. CONCLUDING REMARKS

As described, they introduced IP in Finland as an independent academic discipline at an early stage. In an atmosphere of conflicting goals, they sought compromises between computer science, which was getting its shape internationally at the time, and the practical needs of the society. Although

IP practice was not completely satisfied with us, we developed a solid basis in the 1960s and 1970s for today's capabilities to build the information society, and for the wide discipline of IP, ranging from theoretical computer science and algorithmics to software engineering and information systems research. Close contacts between IP education and industry also date from these early years.

REFERENCE

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