THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Organising Computing Work

Data Processing at the Swedish Defence Research Agency in the Mainframe Era

JULIA RAVANIS

Department of Technology Management and Economics

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2025

Organising Computing Work: Data Processing at the Swedish Defence
Research Agency in the Mainframe Era
JULIA RAVANIS
ISBN 978-91-8103-225-3

Doktorsavhandlingar vid Chalmers tekniska högskola
Ny serie nr 5683
ISSN 0346-718X

Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

Printed by Chalmers Digitaltryck
Gothenburg, Sweden 2025

Organising Computing Work

Data Processing at the Swedish Defence Research Agency in the Mainframe Era

JULIA RAVANIS

Department of Technology Management and Economics
Chalmers University of Technology

ABSTRACT

The era of mainframe computers laid the foundation for the digitalisation of Sweden. This thesis explores Swedish computing during the period 1955–1975 by analysing how computing work was conducted, organised, and conceptualised at two data processing centres, that were based on IBM mainframes and belonged to the Swedish Defence Research Agency (FOA). The formation and consolidation of scientific computing, with its strong relationship to military research, represented a process that occurred on multiple levels: from political visions of neutrality and modernity to the daily organisation of punched cards, paper result lists, and personnel. The focus on computing work enables analysing various computing tasks, ranging from scientific labour to systems programming, as well as the gendered and class-dependent hierarchies separating these different tasks and the political visions that conditioned them. I combine analyses of archival documents relating to the daily administration and overall regulations of these centres with oral history and studies of media coverage.

My analysis of overarching political goals through contingent work routines shows how the Cold War political landscape in Sweden enabled computing work practices and professions to form. I argue that the prioritisation of military research in the mainframe era resulted in complex data processing centres dominated by data flows in constant need of organisation. Computing work at FOA was organised according to principles of rationality, automation, and abstraction, which in turn shaped the rise of scientific computing in Sweden. By tracing computing work in Sweden, the thesis expands the emerging field of work-oriented computing history, which has thus far primarily focused on the US and the UK. Moving beyond histories of individual computing policies and domestic computer industries, while broadening the scope of what constitutes computing work, this thesis offers new ways of understanding Swedish computing history.

Keywords: Computing history, computing work, scientific labour, mainframe era, IBM, FOA, data processing, military research, Sweden.

Table of Contents

Acknowledgements

I have often doubted whether I would finish this thesis. While doubt often sneaks up on you when you are alone, awake in the middle of the night, or lost in a new city, getting the strength to finish a doctoral thesis often comes from other people. Without all the support from my colleagues, friends, and family, this thesis would not exist.

First of all, thank you to everyone I interviewed for this thesis: Ingemar Dahlstrand, Margareta Franzén, Torgny Hallenmark, Lena Jönsson, Björn Kleist, Eva Lindencrona Ohlin, Tomas Ohlin, Bengt Olsen, and Yngve Sundblad. Being invited to your homes or local restaurants and hearing your life stories was perhaps the most intriguing and rewarding part of my research.

Throughout my PhD studies, my supervisors Per Lundin and Gustav Holmberg have supported me. Per, my main supervisor, has generously shared his extensive knowledge not only related to mainframe computing and Cold War research, but also when it comes to learning and teaching the history of technology, as well as pursuing an academic life in general. My texts have benefitted tremendously from his sharp editing and ability to pinpoint the crucial parts of an argument. My co-supervisor Gustav has offered emotional support and been an intellectual sounding board ever since we first met in 2016, when he taught the basic course in the history of ideas that changed my path in life. I am grateful for all the discussions, conversations, and chitchats we have had, in good times as well as in bad.

When I embarked on my PhD studies, Per initiated a research forum at our division, where scholars interested in history met and discussed the historian's role and ways of doing research. These meetings offered a much-needed space for reflections on what we are doing and why. Thank you all who participated over the years, and especially thanks to: Jens Millkrantz, with whom I have shared an office and all the joys and hardships of being a PhD student in this field; Anna Åberg, who offered guidance at a crucial stage of my thesis writing; and Saara Matala, who gave me structure when I felt as if my work was slowly but irretrievably dissolving.

The division of Science, Technology and Society at Chalmers has been my academic home throughout my PhD studies. Whenever I came to the division, while living in Stockholm and mostly working remotely, I felt struck by this warm and encouraging environment. Thank you to all my STS colleagues, both for shaping my thesis into what it is now and for showing me the advantages of academia beyond research, at lunches, seminars, workshops, afterworks, and fikas. Thank you Stina Hallman for helping out with bureaucratic or practical issues, big and small. I am so glad to have been part of our doctoral student group, which rapidly became a support network and breeding ground for friendships. Thank you Stefan, Kjell, Angelica, Kai Lo, Nicholas, Alicja, Parissa, Oshin, Henrik, Mariam, Aron. Especially thanks to Malin Nordvall – the first of us to finish – who shared her home with me when I had no place to stay and gave me the courage I needed to take control of my work.

In addition to the STS division seminar, the seminar on the history of science and technology organised by Chalmers and the University of Gothenburg has been an important space for me, where I have tried out new ideas and picked up on ongoing debates in the field. Thanks to all of you who attended, presented, and helped organise these seminars. I am also grateful for all the great comments I received when presenting my work at the Stripe seminar at Tema T, Linköping University, and the history of ideas seminar at Lund University.

Crucial parts of this thesis have been written at residences where I have had the great pleasure of staying thanks to scholarships. I am grateful to Adlerbertska stiftelserna for enabling a trip to Cambridge, to Harald and Louise Ekmans stiftelse for my stay at Sigtunastiftelsens Hotell, to Jonseredsstiftelsen for the apartment at Villa Martinson, and to Nordiskt Forum för Kultur och Vetenskap for welcoming me to Drakamöllan Gårdshotell.

Many colleagues have over the years read and commented on parts of my manuscript, and I am indebted to all of you. Especially to Arne Kaijser for pointing me in the right direction at my mid-way review and for all the encouragement since then; Thomas Kaiserfeld for identifying the missing pieces at my final review; and Eric Bergelin for sharing his expert knowledge and offering me friendship and archival tips.

Tack till alla mina vänner som peppat mig och också stundtals fått mig att glömma att den här avhandlingen existerar. Utan er skulle världen vara kallare och mer ogästvänlig. Tack till mamma, pappa, Fredrik, Fanny, Martin och Mathias för att ni alltid är på min sida, oavsett hur bra jag lyckas med saker. Till Britt och Daniel för tiden vi fick tillsammans. Och till Erik, som med tålamod, kritik, inspiration, övertalning och ömhet har rott det här projektet i hamn tillsammans med mig. Jag älskar dig.

List of Translations and Abbreviations

Translations of Swedish Institutions

The Army Supply – Försvarets materielverk (FMV)
The Atomic Energy Corporation – AB Atomenergi
The Board for Technical Development – Styrelsen för teknisk utveckling (later called Vinnova)
The Board for University Data Processing Centres – Styrelsen för universitetsdatacentraler (STUD)
The Central Committee for Real Estate Data – Centralnämnden för fastighetsdata
Chalmers University of Technology – Chalmers tekniska högskola (CTH)
The Civil Defence Board –Försvarets civilförvaltning (FCF)
The Data Processing Committee – Databearbetningskommittén
The Data Processing Delegation – Databehandlingsdelegationen
The Defence Council – Krigsrådet
The Home Research Institute – Hemmens forskningsinsitut (HFI)
Karolinska University Hospital – Karolinska sjukhuset
Linköping University – Linköpings universitet (LIU)
Lund University – Lunds universitet (LU)
The Ministry of Education, Science, and Culture – Ecklesiastikdepartementet
The Ministry of Defence – Försvarsdepartementet
The National Defence Radio Establishment – Försvarets radioanstalt (FRA)
The National Museum of Science and Technology – Tekniska museet
The National Statistical Bureau – Statistiska centralbyrån (SCB)
The Nordic Symposium for the use of computers – Nordiskt symposium över användandet av matematikmaskiner (NordSAM)
The Planning Institute for Health and Social Care – Sjukvårdens och socialvårdens planerings- och rationaliseringsinstitut (SPRI)
The Research Officer – Forskningsofficeren
The Royal Swedish Academy of Science – Kungl. Vetenskapsakademien (KVA)
The Royal Swedish Academy of Engineering Sciences – Kungl. Ingenjörsvetenskapsakademien (IVA)
The Royal Swedish Air Force Board – Kungl. Flygförvaltningen (KFF)
The Royal Swedish Army Board – Kungl. Arméförvaltningen (KAF)

The Royal Swedish Navy Board – Kungl. Marinförvaltningen (KMF)
The State Computer Fund – Statens datamaskinfond
The State Council of Social Sciences – Statens råd för samhällsforskning
Sweden's Television – Sveriges television (SVT)
The Swedish Agency for Administrative Development – Statskontoret
The Swedish Board for Computing Machinery – Matematikmaskinnämnden (MMN)
The Swedish Defence Research Agency – Försvarets forskningsanstalt (FOA), (later called Försvarets forskningsinstitut, FOI)
The Swedish Defence Research Board – Försvarets forskningsnämnd
Swedish Employers' Confederation – Svenska arbetsgivarföreningen (SAF)
The Swedish Higher Education Authority – Universitetskanslerämbetet (UKÄ)
Swedish Government Official Reports – Statens offentliga utredningar (SOU)
The Swedish Institute of Military Physics – Militärfysiska institutet (MFI)
The Swedish Meteorological and Hydrological Institute – Statens meteorologiska och hydrologiska institut (SMHI)
The Swedish State Power Board – Kungliga Vattenfallsstyrelsen (later called Vattenfall)
The Swedish State Railways – Statens Järnvägar (SJ)
The Swedish Telecommunications Administration – Televerket
The Swedish Trade Union – Landsorganisationen i Sverige (LO)
The Technical Preparedness Committee – Statens uppfinnarnämnd
The University Council – Universitetsrådet
Uppsala University – Uppsala universitet (UU)

Translations of Swedish Functional Titles

Assistant – biträde
Associate professor – laborator
Calculation assistant – räknebiträde
Chief engineer – överingenjör
Chief operator – chefsoperatör
Controller – kontrollant
Director – byråchef
Director-General – generaldirektör
Head of operations – driftschef
Head of systems – systemchef
Machine operator – I/O operatör
Machine hostess – maskinvärdinna
Office guard – expeditionsvakt

Office messenger – kontorsbud
Office supervisor – expeditionsförman
Operation assistant – driftsassistent
Operation engineer – driftsingenjör
Operational systems specialist – driftssystemspecialist
Operational systems manager – driftssystemchef
Program librarian – programbibliotekarie
Puncher – stansoperatris
Receptionist – kundmottagare
Research engineer – forskningsingenjör
Research technician – forskningstekniker
Support programmer – stödprogrammerare
Supreme Commander of the Swedish Armed Forces – överbefälhavare (ÖB)
Systems programmer – systemprogrammerare
Technical manager – byråintendent
Telephone operator – telefonist

Abbreviations Used in the Thesis

Asea – Allmänna Svenska Elektriska Aktiebolaget
Besk – Binär elektronisk sekvenskalkylator
Cern – Organisation européenne pour la recherche nucléaire (European Organization for Nuclear Research)
Eniac – Electronic Numerical Integrator and Computer
FOA – Försvarets forskningsanstalt (The Swedish Defence Research Agency)
GDP – Gross Domestic Product
IBM – International Business Machines Corporation
KTH – Kungliga tekniska högskolan (The Royal Institute of Technology)
Nasa – The National Aeronautics and Space Administration
Nato – The North Atlantic Treaty Organization
Rand – The Rand Corporation
Saab – Svenska Aeroplan Aktiebolaget
Sage – Semi-Automatic Ground Environment project
STS – Science and Technology Studies
SU – Stockholms universitet (Stockholm University)
QZ – A common acronym for the Stockholm data processing centre
Univac – Universal Automatic Calculator

List of Illustrations

1 Introduction

Computing was a tedious task in the 1960s. At Sweden's most advanced data processing centre in 1963, located at the Swedish Defence Research Agency (FOA), the time from an order being made to the results of a normal computing job being delivered ranged between four and five hours.[1] The surprising thing about the FOA data processing centre is not that the turnaround times were so long – we all know that computers were slow back in the day – but that they had very little to do with computing capacity.[2] Out of the five hours it took to process an ordinary job, the actual computing task only took two minutes.[3] The remaining four hours and 58 minutes were spent on sorting, ordering, carrying, and translating data.

Receptionists registered incoming orders. Operators punched code and data into punched cards, sorted the cards and bundled them together. Machine operators carried these bundles to a peripheral machine, which translated them into magnetic tapes, the data format read and processed by the mainframe. After that, the operators reversed the translation process. Opaque magnetic tapes were sent through a machine that turned them into paper printouts to be sorted, bundled, and distributed to the customers. Papers were everywhere. The annual cost of punched cards alone at the FOA data processing centre was comparable to the salary of a full-time programmer.[4]

This thesis is about punched cards and result lists, the material data flowing through the 1960s data processing centres. But it is also about people, the diverse workforce managing the different steps of the computing process, and their visions of computing, their negotiations to get more economic resources, and the political circumstances in Cold War Sweden that conditioned these negotiations. More specifically, the thesis analyses computing work performed between 1955 and 1975 at two data processing centres: the FOA data processing centre, organised around an IBM 7090 mainframe, and the Stockholm data processing centre, or the QZ, as it was commonly known. While

---

[1] Report A 4333–428, October 1963, FOA open archive (FOA Ö), Avdelning 4 Rapportcentralen (Avd 4 RapportC), B1:19, Krigsarkivet (KrA).

[2] Prior to World War II, the word "computer" was the term used for human workers performing manual calculations. When the word started to signify a machine instead of a person, it was still used very broadly, incorporating both analogue computers and relay-based digital computers. When I use the word computer without any further specification, I use it in the modern sense of the term (i.e., an electronic digital computer).

[3] Report A 4333–428, October 1963, FOA Ö.

[4] Punched cards cost 40 000 Swedish krona each year at the data processing centre, compared to a monthly salary of around 2700 krona with 25 per cent overhead costs. See "Maskintidpriser vid FOA:s datacentral," November 1961, FOA Ö, Centralkansliet (CentralK), F7a:14, KrA.

the former belonged solely to FOA, the latter was a joint venture by FOA, Stockholm University (SU), and the Royal Institute of Technology (KTH), based on an IBM 360/75 and located at FOA. When they were established, these two were the largest and most advanced data processing centres in Sweden, representing crucial sites for the early development of a digital world.

The thesis is set in the mainframe era – a period when Sweden underwent a quite remarkable digitalisation process. The number of Swedish computers increased from two to around two hundred between 1956 and 1962, making Sweden – with a population of 7,5 million people – one of the most computerised countries in the world in the early 1960s.[5] The rapid computerisation of important societal services such as taxation and social security registration spurred debates regarding digital vulnerability and integrity, which in 1973 led to Sweden becoming the first country in the world with computer legislation.[6] Despite this, studies on Swedish digitalisation remain scattered. Some aspects, such as computer policies, have been analysed deeply, while military research computing has hardly received any attention at all.[7]

Yet, computers such as the IBM 7090 at FOA had enormous potential in terms of restructuring practices, professions, and money flows. Hence, they may serve as entry points when exploring early digitalisation. In the mainframe era, civil servants, factory workers, military researchers, and bank clerks all saw their work tasks change, as well as new projects made possible by the sharp increase in computing capacity. In the recent book *Maktens maskiner* (2024), for example, historian of technology Arne Kaijser et al. describe how the introduction of computers modernised the Swedish military, engineering industry, infrastructure, and public sector during a few crucial decades after World War II.[8]

This was an era when computing was concentrated in data processing centres, serving as physical nodes that every computer user had to pass by. The cost of computing

---

[5] Although the exact numbers differ from study to study, this approximation should be valid. Tord Jöran Hallberg claims that in 1962, the only countries with a higher number of computers in relation to the population were the US and Switzerland. Tord Jöran Hallberg, *IT-gryning: Svensk datahistoria från 1840- till 1960-talet* (Lund: Studentlitteratur, 2007), 273.

[6] Lars Ilshammar, *Offentlighetens nya rum: Teknik och politik i Sverige 1969–1999* (Örebro: PhD diss.: Örebro universitet, 2002).

[7] On computer policies, see, for example, Hans De Geer, *På väg till datasamhället: Datatekniken i politiken 1946–1963* (Stockholm: Stockholm Papers in History and Philosophy of Technology, 1992); Thomas Kaiserfeld, "Computerizing the Swedish Welfare State: The Middle Way of Technological Success and Failure," *Technology and Culture* 37, no. 2 (1996); Ilshammar, *Offentlighetens nya rum*; Johan Fredrikzon, *Kretslopp av data: Miljö, befolkning, förvaltning och den tidiga digitaliseringens kulturtekniker* (Lund: Föreningen Mediehistoriskt arkiv, 2021). The role of military research at the very beginning of Swedish computing has received some attention, but these studies focus on the time before 1955, see Jan Annerstedt et al., *Datorer och politik, Studier i en ny tekniks politiska effekter på det svenska samhället*, Zenitserien, (Lund: Bo Cavefors Bokförlag, 1970); Arne Kaijser et al., *Maktens maskiner: Hur stora datorer moderniserade folkhemmet* (Lund: Arkiv förlag, 2024).

[8] Kaijser et al., *Maktens maskiner.*

equipment was tremendously high, and the most expensive and advanced machines were usually aimed at scientific and technical computing and found in military research institutes such as FOA.[9] The buyers wanted a return on their investment in terms of efficiency, overview, enhanced production, or new solutions. To achieve such goals, they needed people to work with their computers. The far-reaching consequences of digitalisation in the mainframe era – how computers "changed the world," as computing historian Tomas Misa put it in 2007 – were achieved through the work of people.[10] Yet this work was for a long time overlooked by computing history scholars.[11]

In the field of computing history, digitalisation has been understood in several distinct ways: as a progressive development of specific hardware and software technologies, as a rapid expansion of information processing, or as a meandering turn of events dependent on institutional contexts.[12] Such histories have offered us important insights into how and why digitalisation occurred, whereas the human work required to make something digital is often missing from the picture.[13]

Important exceptions are found in studies focusing on scientific work practices and the gendering of professional identities, which have led to important breakthroughs in our understanding of digitalisation in general. As shown by historians of computing Thomas Haigh, Mark Priestley, and Crispin Rope in their innovative study of work practices at the Eniac, long-forgotten work routines may overturn persistent narratives in computing history, such as the importance of a few technological milestones in the

---

[9] The cost for an advanced computer in 1960 could be around 10 million Swedish krona, or a couple of million US dollar. Globally, military research spearheaded scientific computing, through projects such as the Semi-Automatic Ground Environment project. In Sweden, the IBM 7090 at FOA was the most expensive computer ever purchased in the country. For an overview of the distribution of early Swedish computers, see Hallberg, *IT-gryning*.

[10] Thomas Misa, "Understanding 'How Computing Has Changed the World'," *Annals of the History of Computing, IEEE* 29 (2007).

[11] Computing history is often used interchangeably with computer history. The former is not confined to the history of digital computers but it focuses on these machines. I use the term computing history as I am interested in what people did with computers rather than the machines themselves.

[12] This characterisation of computing historiography was made by Misa, "Understanding 'How Computing Has Changed the World'." Examples of the first tradition include Alice R. Burks, *Who Invented the Computer? The Legal Battle that Changed Computing History* (Amherst: Prometheus Books, 2003); Herman H. Goldstine, *The Computer from Pascal to von Neumann* (Princeton: Princeton University Press, 1972); Emerson W. Pugh, *Building IBM: Shaping an Industry and Its Technology* (Cambridge, Mass.: MIT Press, 1995). The second tradition: Jon Agar, *The Government Machine: A Revolutionary History of the Computer* (Cambridge, Mass.: MIT Press, 2003); Martin Campbell-Kelly, *From Airline Reservations to Sonic the Hedgehog: A History of the Software Industry* (Cambridge, Mass.: MIT Press, 2003); Martin Campbell-Kelly et al., *Computer: A History of the Information Machine* (New York: Taylor & Francis, 2018). The third tradition: Janet Abbate, *Inventing the Internet* (Cambridge, Mass.: MIT Press, 1999); Thomas P. Hughes, *Rescuing Prometheus: Four Monumental Projects That Changed the World* (New York: Pantheon Books, 1998); Thomas P. Hughes and Agatha C. Hughes, eds., *Systems, Experts and Computers: The Systems Approach in Management and Engineering, World War II and After* (Cambridge, Mass.: MIT Press, 2000).

[13] Work is largely missing in the historiographic tradition identified by Misa and described above. An early study of the work required to make early business computers function is, however, Thomas Haigh, "The Chromium-Plated Tabulator: Institutionalizing an Electronic Revolution, 1954–1958," *IEEE Annals of the History of Computing* 23, no. 4 (2001).

development of global computing or the distinct separation between skilled programming and unskilled computing labour.[14] From another angle, STS scholar Janet Abbate and historian of technology Mar Hicks have explored how work recruitment processes and professional identities formed in the US and the UK. Their studies reveal a new history of computing, in which gender discrimination turns out to be key for the development of national computing expertise.[15]

The above-mentioned studies all focus on the US or the UK. Computing history, in general, is dominated by case studies from these two countries, famous for having the first computers in the world.[16] Yet, Sweden is a society in which digitalisation was uniquely swift and broad, while previous research has not yet turned to computing work practices nor the formation of gendered computing professions in Sweden.[17] This thesis contributes with such a perspective.

The thesis is situated in the history of computing. To conceptualise my research object, I use philosopher Hannah Arendt's theory of work. Based on her theory, technological developments in computing can, on the one hand, be tied to its cyclical and material prerequisites and, on the other hand, its political conditions and consequences.

In *The Human Condition* (1958), Arendt defines work as a fundamental human activity aimed at creating material things to be used by humans over time.[18] A computer program is such a thing – which, in the mainframe era, was built through the work of the people at data processing centres. According to Arendt, work is linked to two other

---

[14] The Eniac was one of the first computers and was built in the US during World War II. Thomas Haigh, Mark Priestley, and Crispin Rope, *ENIAC in Action: Making and Remaking the Modern Computer* (Cambridge, Mass.: MIT Press, 2016).

[15] Janet Abbate, *Recoding Gender: Women's Changing Participation in Computing* (Cambridge, Mass.: MIT Press, 2012); Mar Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing* (Cambridge, Mass.: MIT Press, 2017). See also Nathan Ensmenger, *The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise* (Cambridge, Mass.: MIT Press, 2010).

[16] The notable studies on global digitalisation mentioned above also take place in the US or the UK. Recent exceptions from this tradition include G. Alberts and Ruth Oldenziel, *Hacking Europe: From Computer Cultures to Demoscenes* (London: Springer Verlag, 2014); Thomas S. Mullaney, *The Chinese Typewriter: A History* (Cambridge, Mass.: MIT Press, 2017); Jaroslav Švelch, *Gaming the Iron Curtain: How Teenagers and Amateurs in Communist Czechoslovakia Claimed the Medium of Computer Games* (Cambridge, Mass.: MIT Press, 2018); Hallam Stevens and Jiahui Chan, "Computing Nanyang," in *Abstractions and Embodiments: New Histories of Computing and Societies*, ed. Janet Abbate and Stephanie Dick (Baltimore: Johns Hopkins University Press, 2022); Sebastina. K. Boell and Janet M. Toland, "Histories of Computing in Oceania," *IEEE Annals of the History of Computing* 45, no. 4 (2023); Erin McElroy, *Silicon Valley Imperialism: Techno Fantasies and Frictions in Postsocialist Times* (Durham: Duke University Press, 2024).

[17] No studies on Swedish computing history have focused on work. There are, however, important studies of computer use, such as Per Lundin, *Computers in Swedish Society: Documenting Early Use and Trends* (New York: Springer, 2012); Kaijser et al., *Maktens maskiner*.

[18] *The Human Condition* was a critique of the consumption society emerging in the 1950s, and what Arendt saw as the capitalist threat to democracy. Hannah Arendt, *The Human Condition: Vita Activa*, 2 ed. (Chicago & London: University of Chicago Press, 1998 [1958]), Ch. 4. For a longer contextualisation of Arendt's theories, see Section 1.4.

human activities: labour and action. Labour is the cyclical strive for survival by consuming food and satisfying other vital needs, commonly enabled by the salary from a day-job. Action is the stories humans tell about themselves and the world, conveyed through unique speech and acts. Thus, action gives meaning to work, while labour is its inevitable companion.[19]

Computing work at a 1960s data processing centre relied on labour: the transportation and translation of material data, described at the beginning of this chapter, in order to maintain the mainframe's cyclical consumption of data.[20] The work and labour at the data centres gained a purpose through action, partly stemming from the desires and visions of the computer pioneers at FOA and partly from societal visions.

One such vision, permeating Swedish society in the early Cold War, was the image of Sweden as a neutral country in need of a strong and technologically advanced military. The foreign policy to keep Sweden out of military alliances enabled major military investments and particularly military research funding, which turned military research institutions into forerunners within advanced technological fields such as computing.[21] Military historian Wilhelm Agrell has argued that this situation spurred a militarisation of Swedish research, which increasingly became subordinated to military goals and bureaucratic planning.[22] In this thesis, I identify militarisation as a crucial part of the Swedish political action that enabled and directed computing work during the mainframe era.

The prioritisation of military research in Cold War Sweden turns FOA – the central hub for military research – into a crucial actor in a history of computing work in the mainframe era. By focusing on FOA, I challenge the history of Swedish computing that has so far been quite limited to civilian computing.[23] I also expand the broader history

---

[19] Arendt, *The Human Condition*, 7–9.

[20] Even though work and labour are often entwined in practice (people working on making tools typically buy food for their salary, which is emblematic for labour), they have distinct temporalities. Labour is cyclical, while work is forward-oriented. Data management was more cyclical than coding computer programs. Cards were punched, translated, processed, and then returned to the customers, who handed in new orders to be punched, translated, etc.

[21] This foreign policy, the neutrality paradigm, has been analysed thoroughly by historians, who have found evidence of major technical and military cooperation with the Western nations during the Cold War, despite the political rhetoric of absolute neutrality. This is discussed further in Section 1.3. In the financial year 1960/61, atomic energy and military research alone received 40 per cent of the total state research allocations in Sweden. Per Lundin and Johan Gribbe, *Att följa pengarna: En analys av forskningsfinansieringen i efterkrigstidens Sverige*, Score (Stockholm, 2023), 42.

[22] Wilhelm Agrell, *Vetenskapen i försvarets tjänst: De nya stridsmedlen, försvarsforskningen och kampen om det svenska försvarets struktur* (Lund: Lund University Press, 1989), 40. For a more detailed discussion, see Section 1.3.

[23] In Swedish computing history, the military use of computers has only been studied before 1956 and in some specific defence projects. Jan Annerstedt, *Staten och datorerna: En studie av den officiella svenska datorutvecklings- och datorforskningspolitiken* (Lund: PhD diss.: Lunds universitet, 1969); Johan Gribbe, *Stril 60: Teknik, vetenskap och svensk säkerhetspolitik under det kalla kriget* (Hedemora: Gidlunds, 2011); Kaijser et al., *Maktens maskiner*, Ch. 4.

of science and technology in Sweden, where military research has only recently started to receive scholarly attention.[24] By using Hannah Arendt's theory of work to bridge the focus on practices and gendered labour in computing history with the recent turn toward military research in Swedish history of science and technology, this thesis suggests new ways in which to historicise computing in Swedish society. Computing becomes a set of diverse work tasks, subordinated to political visions and deeply rooted in material practices, in constant need of organisation.

The deliberations on how to organise computing work and negotiate material labour and abstract knowledge have echoes into the present. The relationship between materiality, labour, and abstraction is at the heart of contemporary debates on the social and environmental costs of our digital society. In order to make sense of the past – as well as the digital present – we need to account not only for the astonishingly short computer runtime but also the extensive human work enabling it.

1.2 Research Objectives

The aim of this thesis is to explore computing work in Sweden in the mainframe era. It does so by studying the computing work carried out at the Swedish Defence Research Agency during the period 1955–1975. The overarching research question is: *How was computing work conducted, organised, and conceptualised at FOA in 1955–1975?*

Computing work refers to the different tasks performed by the employees engaged in computing at FOA.[25] These tasks include both practical computing procedures and the planning processes preceding the establishments of the two data processing centres operated by FOA in this period: the FOA data processing centre and the QZ.

Conducting work includes practices, work routines, and assignments. This part of the research question is answered by exploring how computing work was performed at the data processing centres and by whom.

---

[24] Even though Agrell analysed FOA's role with regard to Swedish research in 1989 (in Agrell, *Vetenskapen i försvarets tjänst.*), military research has been overlooked in not only overviews of Swedish research but also in more specific studies, see Thorsten Nybom, *Kunskap, politik, samhälle: Essäer om kunskapssyn, universitet och forskningspolitik 1900–2000* (Hargshamn: Arete, 1997); Ulf Sandström, *Det nya forskningslandskapet: Perspektiv på vetenskap och politik* (Stockholm: Swedish Institute for Studies in Education and Research, 2002); Ingemar Pettersson, *Handslaget: Svensk industriell forskningspolitik 1940—1980* (Stockholm: PhD diss.: Kungliga tekniska högskolan, 2012). Recent studies on military research in traditionally civilian areas include Eric Bergelin, Per Lundin, and Niklas Stenlås, eds., *Det dolda universitetet: Militär forskning i kalla krigets Sverige* (Lund: Nordic Academic Press, 2025); Eric Bergelin, *Planeringsforskningens genombrott: Försvarets forskningsanstalt och det globala kalla krigets planeringsexperter* (Uppsala: PhD diss.: Uppsala universitet, 2023); Fredrik Bertilsson and Camilla Eriksson, "Totalförsvarets livspolitik: Kunskapsförsörjningen i den svenska livsmedelsberedskapen," *Historisk tidsskrift* 144 (2024).

[25] Not all of these were necessarily employed by FOA, even though this was the case for the majority. However, they all went to the data processing centres located at FOA to work.

Organising work involves two aspects. First, it refers to the overarching organisational framework at the data centres. Ownership, finances, and political missions conditioned the work performed. This is studied by tracing the establishment of the centres, the political decisions to invest in computing equipment and the internal discussions, conflicts, requirements, and visions that informed the choices made.

The second, narrower organisational framework for the data processing centres relates to their practical design, the organisation of machines, data, and work tasks. Financial and spatial dimensions are particularly important here as both data and machines were expensive and required vast spaces during the mainframe era. Another aspect of organising work concerns the division of labour – how work was divided among employees. Such a division of labour always comes with a hierarchisation of tasks and professions, depending on skills, merits, class, and gender.[26]

Finally, the conceptualisation of computing work concerns with how the employees made sense of their work, how they understood, described, and valued different kinds of computing work. Professional hierarchies and recruitment procedures provide an insight into how specified work tasks were viewed. The metaphors used to describe computing at the data processing centres also reveal how computing work was conceptualised.

How computing work was conducted, organised, and conceptualised relates to broader aspects of early Swedish digitalisation. The processes to establish overarching organisational frameworks for the data centres provide an insight into the major political projects enabling and conditioning technological development in Sweden at this time. How work was conducted and organised in practice at the centres sheds light on gendering mechanisms, the formation of distinct workforce categories in computing, and how theoretical underpinnings and formal merits were viewed within the workforce. The conceptualisation of computing work depends on both material conditions and linguistic abstractions, thus telling us something about the historical tensions between materiality and abstractions inherent in computing.

1.3 Previous Research

This thesis is based on and contributes to two research fields: international computing history and Swedish history of science and technology. Computing work has been studied in various ways in the field of international computing history. Here, I discuss

---

[26] The racial aspect is not as relevant in a Swedish Cold War context, since the populations in cities such as Stockholm was overwhelmingly white at the time. In the 1960s computing community in Stockholm analysed here, I have seen no record of non-white people.

two perspectives on computing work: exploring the use of computers in different institutional contexts and analysing gendered computing professions and work practices. I then turn to Swedish history of science and technology, to which this thesis contributes by highlighting the military research institute FOA as a crucial actor in Swedish computing history.

These three research areas all tell deeply relevant histories of computing. However, it is at the intersection between all three of these that we find a relatively unexplored area with great potential – a cultural history of computer use and practice in Swedish military research, where programming is decentralised while gender is still a relevant analytic category. By applying Arendt's concepts of work, labour, and action to the history of Swedish computing, this thesis is able to present such a history. Before discussing Arendt's theories, the three research areas to which I contribute deserve lengthier introductions.

The Difference Between Using and Working With Tools

Although computer user studies do not explicitly address work, they often analyse work environments and work tasks in practice as computer use outside workplaces did not exist in the mainframe era. Classical studies of computer use include business historian James Cortada's three-volume analysis of US industrial computer use and computing historians William Aspray and Paul Ceruzzi's exploration of how Internet use changed US businesses.[27] In Sweden, the user perspective has received a great deal of scholarly attention, at least compared to scientific computing practices and the relationship between gender and computing.

In the early 2000s, a series of witness seminars on early computer use were held at the National Museum of Science and Technology in Stockholm.[28] Papers based on the seminars soon followed. They explored, for example, how computer art was co-produced by artists and engineers in 1970s Sweden or the surprisingly limited reach of management information systems in the 1960s.[29] In *Maktens maskiner*, written by Arne

---

[27] James W. Cortada, *The Digital Hand. Vol. 3, How Computers Changed the Work of American Public Sector Industries* (New York: Oxford University Press, 2008); James W. Cortada, *The Digital Hand. Vol. 2, How Computers Changed the Work of American Financial, Telecommunications, Media and Entertainment Industries* (New York: Oxford University Press, 2006); James W. Cortada, *The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries* (New York: Oxford University Press, 2004); William Aspray and Paul E. Ceruzzi, *The Internet and American Business* (Cambridge, Mass.: MIT Press, 2008).

[28] This project was more documentative in nature and was intended to form a basis for future use-centred historical research. See Lundin, *Computers in Swedish Society*.

[29] Anna Orrghen, "Collaborations between Engineers and Artists in the Making of Computer Art in Sweden, 1967–1986," in *History of Nordic Computing 3*, ed. John Impagliazzo, Per Lundin, and Benkt Wangler (Berlin, Heidelberg: Springer, 2011); Gustav Sjöblom, "The Totally Integrated Management Information System in 1960s

Kaijser and a number of co-authors, the user perspective reveals a history of government power and control enacted through the computerisation of the Swedish military, production industry, and public administration.[30]

This thesis contributes to this field, trying to grasp the historical changes linked to computing by analysing why various institutions introduced computers and what they used them for. One of the major benefits of the user perspective is that it directs scholarly focus towards institutions sometimes neglected by historians of science. As historian of science David Edgerton pointed out in 2012 when criticising historians of science and technology for focusing too much on academic research, scholars should "follow the money" and study the research projects that often dominate government funding: industrial and military projects.[31] Advanced research fields were often institutionalised in the fields of industry and military research at an earlier stage compared to in academia. Since this was the case with computing at FOA, I thus follow Edgerton's call in this thesis.

User-centred computing history research emerged from a broader historiographical tradition seeking to grasp how users shape and are shaped by technology.[32] One of the main criticisms of the user perspective in the history of technology is that it tends to focus on quite privileged users, those with the power to change the technology at hand.[33] At the same time, the users unable to change anything are often much more numerous. Different users are also hard to separate semantically, as the word users is associated with interchangeable people doing something specific on equal grounds.[34] Another persistent critique has been the limited temporal scope of the user perspective.

Sweden," in *History of Nordic Computing 3*, ed. John Impagliazzo, Per Lundin, and Benkt Wangler (Berlin, Heidelberg: Springer, 2011).

[30] Kaijser et al., *Maktens maskiner*.

[31] David Edgerton, "Time, Money, and History," *Isis* 103, no. 2 (2012). Edgerton implements this strategy in his study of military research in the United Kingdom: David Edgerton, *Warfare State: Britain, 1920–1970* (Cambridge: Cambridge University Press, 2006).

[32] It originates from a social constructivist perspective coined by Trevor J. Pinch and Wiebe E. Bijker, "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," *Social Studies of Science* 14, no. 3 (1984). The perspective was at an early stage a feminist critique of historians overrating the importance of male inventors. See, for example, Ruth Schwarz Cowan, "The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas Hughes, and Trevor Pinch (Cambridge, Mass.: MIT Press, 1989). In response to criticisms of the user perspective being too innovation-centred, Trevor Pinch and Nelly Oudshoorn expanded the user theory in Nelly Oudshoorn and Trevor Pinch, *How Users Matter: The Co-construction of Users and Technologies* (Cambridge, Mass.: MIT Press, 2003).

[33] See John Krige, "How Users Matter: The Co-Construction of Users and Technology," *Contemporary Sociology* 35, no. 1 (2006).

[34] Pinch and Oudshoorn discuss differences between users and distinguish between "end users", "lay end users", and "implicated actors". However, there is still a significant variety within the end user group. Oudshoorn and Pinch, *How Users Matter*, 6.

Technologies are most clearly shaped by users in the innovation process, which is why maintenance, repair, and re-use are often lacking in user studies.[35]

Maintenance, keeping technology working, is as crucial as it is neglected, both in scholarly accounts of technological systems and in the public imagination. There is an obsession with innovation stretching from historians to politicians and laypeople.[36] Almost everyone seems to agree that innovation is what drives society forward.[37] Yet, as pointed out by STS scholar Lee Vinsel and historian Andrew L. Russell, the maintenance of an overwhelming majority of technological systems has always had – and still has – a much greater impact on people's lives than the innovation of a few radically new technologies.[38]

"Ignoring maintenance and maintenance labourers is endemic in all areas of the history of business and technology", says historian of technology Jeffrey Yost in his innovative study of the IT services industry.[39] The IT services industry is by far the largest computing industry – surpassing both hardware and software – and yet it has not received a great deal of historical attention, and no one can name a famous pioneer within IT services comparable to John Machly or Grace Hopper. From another angle, sociologist Paula Bialski has recently criticised the perception of software work as a glorious and deeply creative innovation process.[40] By means of ethnographic studies of tech company employees, she shows how software development has often been a continuous trial-and-error process aimed at keeping flawed IT systems working.

An analytical focus on work instead of use, however, may include aspects of computing history that tend to slip out of a user perspective, such as the uneven distribution of power between different computer users and the need to continuously maintain computing technologies. Workers are easily divided into a power spectrum through their different salaries, merits, and titles. And everyone knows that it takes work to make something work. Maintenance is much easier to incorporate into a study of

---

[35] David Edgerton, *The Shock of the Old: Technology and Global History Since 1900* (New York: Oxford University Press, 2007), 111–20.

[36] Although innovation-centred histories have received scholarly critique, see, for example, Edgerton, *The Shock of the Old*; David Edgerton, "From Innovation to Use: Ten Eclectic Theses on the Historiography of Technology," *History and Technology* 16 (1999); Svante Lindqvist, *Changes in the Technological Landscape: Essays in the History of Science and Technology* (Sagamore Beach: Science History, 2011).

[37] In Sweden, for example, innovation is a stated political goal. See Swedish Ministry of Enterprise, *The Swedish Innovation Strategy*, Government Offices of Sweden (Stockholm, 2019). A Swedish scholarly critique of innovation is found in Lindqvist, *Changes in the Technological Landscape.*

[38] Lee Vinsel and Andrew L. Russell, *The Innovation Delusion: How Our Obsession with the New Has Disrupted the Work that Matters Most* (New York: Currency, 2020).

[39] Jeffrey R. Yost, *Making IT Work: A History of the Computer Services Industry* (Cambridge, Mass.: MIT Press, 2020), 274.

[40] Paula Bialski, *Middle Tech: Software Work and the Culture of Good Enough* (Princeton: Princeton Univeristy Press, 2024).

work than one of use. This thesis contributes to the studies of historical computer use by incorporating those aspects.

Gendered Work and Computing Practices Beyond Programming

In the history of gender and computing, differentiating between different computer workers has been a key element from the very beginning. Gender in this kind of history constitutes an analytical tool used to explain the differentiation and hierarchisation of work. Gendering work means associating professions with feminine and/or masculine traits.[41] In computing history, the very word "computer" originates from the feminised occupational group carrying out manual calculations before World War II and who was tasked with operating the new computational machines.[42] The transition from this early feminised computing work to the masculine professions of our time has recently received an increasing amount of scholarly attention.[43]

By studying salaries, job ads, metaphorical descriptions of work, formal merits required for computing jobs, and factual work tasks, Janet Abbate and Mar Hicks identify the formation of distinct professions in computing as a cause behind masculinisation.[44] Masculinisation is the process in which a phenomenon seen as essentially feminine becomes associated with masculinity, thereby often gaining in status. Computing historian Nathan Ensmenger links the masculinisation of computing to the emerging view of computing as an activity relying on theoretical knowledge rather than practical know-how.[45] The formation of computing education thus turns out to represent an important part of gender and computing history.[46]

The emerging conceptualisation of computing work as a skilled profession based on theoretical education clearly serves as an explanation of how computing work was

---

[41] A pioneering study in the history of science and technology adopting this perspective is Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore: Johns Hopkins University Press, 1982).

[42] David Alan Grier, *When Computers Were Human* (Princeton: Princeton University Press, 2005); Jennifer S. Light, "When Computers Were Women," *Technology and Culture* 40, no. 3 (1999).

[43] See Abbate, *Recoding Gender*; Ensmenger, *The Computer Boys Take Over*; Hicks, *Programmed Inequality*; Thomas Misa, *Gender Codes: Why Women are Leaving Computing* (Hoboken: Wiley, 2010).

[44] This is often referred to as a professionalisation process. For the relationship between professionalisation and masculinisation, see Cynthia Cockburn, *Machinery of Dominance: Women, Men and Technical Know-how* (London: Pluto, 1985); Ruth Oldenziel, *Making Technology Masculine: Men, Women, and Modern Machines in America, 1870–1945* (Amsterdam: Amsterdam University Press, 1999). An interesting Swedish case study of such a process is Lena Sommestad, *Från mejerska till mejerist: En studie av mejeriyrkets maskuliniseringsprocess* (Lund: Arkiv förlag, 1992).

[45] Ensmenger, *The Computer Boys Take Over*. This is often referred to as an academisation process, see Jonathan Harwood, "Understanding Academic Drift: On the Institutional Dynamics of Higher Technical and Professional Education," *Minerva* 48, no. 4 (2010).

[46] For computing education, see Atsushi Akera, *Calculating a Natural World: Scientists, Engineers, and Computers During the Rise of US Cold War Research* (Cambridge, Mass.: MIT Press, 2007); Donald A. MacKenzie, *Mechanizing Proof: Computing, Risk, and Trust* (Cambridge, Mass.: MIT Press, 2001); William Aspray and Bernard O Williams, "Arming American Scientists: NSF and the Provision of Scientific Computing Facilities for Universities, 1950–1973," *IEEE Annals of the History of Computing* 16, no. 4 (1994).

masculinised in the US and the UK during the Cold War. However, such explanations – combined with indignation regarding the visible sexism in so many computing histories – can lead to an exaggerated focus on programming at the expense of other kinds of computing work. The abstract and logical nature of early computing work performed by women is often emphasised. This, for example, was the case with one of the earliest discoveries in the history of gender and computing, when the previously neglected female operators and programmers of the Eniac were discovered by scholars.[47] These women are now famous, not only showing up in scholarly work but also in popular culture.[48] However, as pointed out by media scholar Wendy Hui Kyong Chun, they were quite extraordinary workers, being middle-class and well-educated women performing skilled work in a crucial and very early stage of the development of computing.[49]

The skilled and complex computing work carried out by later female generations continues to be studied.[50] At the same time, punched card operators and janitors – of all sexes – are often neglected in historical accounts of computing.[51] Wendy Hui Kyong Chung stresses the need to not only consider logical white-collar work in computing but also working-class occupations.[52]

In this thesis, I broaden the field of gender and computing history by studying the broader category of computing work instead of exclusively focusing on programming. Programming was just one part of computing in the mainframe era, and it was hard to distinguish from machine operation. In their groundbreaking study of Eniac – which is not only the first but probably also the most studied computer in computing history – Thomas Haigh, Mark Priestly, and Crispin Rope highlight the constant tensions between abstract and concrete dimensions of early computing practices.[53] "Programming" evolved as something both logical and hands-on technical, thus incorporating the work of mathematicians planning the numerical analysis as well as technicians physically configuring the machine to fit the analysis.[54]

---

[47] Light, "When Computers Were Women."; Grier, *When Computers Were Human*.

[48] In Sweden, journalist Katrine Marçal, for example, has written about them. Katrine Marçal, *Att uppfinna världen: Hur historiens största feltänk satte käppar i hjulet* (Stockholm: Mondial, 2020), Ch. 4.

[49] Wendy Hui Kyong Chun, *Programmed Visions: Software and Memory* (Cambridge, Mass.: MIT Press, 2011), 34.

[50] See, for example, Mar Hicks, "The Baby and the Black Box: A History of Software, Sexism, and the Sound Barrier," in *Abstractions and Embodiments: New Histories of Computing and Society*, ed. Janet Abbate and Stephanie Dick (Baltimore: Johns Hopkins University Press, 2022).

[51] A recent exception is Corinna Schlombs' study of female punched card operators in West Germany, Corinna Schlombs, "Built on the Hands of Women: Data, Automation, and Gender in West Germany's Financial Industry," *Technology and Culture* 64, no. 1 (2023).

[52] Chun, *Programmed Visions*, 34.

[53] Haigh, Priestley, and Rope, *ENIAC in Action*. Other notable studies of the Eniac include Burks, *Who Invented the Computer*; Nancy B. Stern, *From ENIAC to UNIVAC: An Appraisal of the Eckert-Mauchly Computers* (Bedford: Digital Press, 1981). The Eniac is also well-documented in historical overviews such as Campbell-Kelly et al., *Computer*.

[54] Haigh, Priestley, and Rope, *ENIAC in Action*, 279–83.

Studies of scientific work practices – a tradition in which Haigh, Priestley, and Rope's study may be placed – have a long history of highlighting technical maintenance. This tradition originates in classical studies such as sociologist Bruno Latour's laboratory ethnographies or historian of science Steven Shapin's famous call to redeem the "invisible technicians" from the dustbin of history.[55] Such studies seek to find the relationships between researchers and their colleagues, as well as their lab equipment and office routines. In computing history, key topics have included data flows and the manual work tasks linked to data handling.[56] Such work is often gendered and some occupational groups, such as punched card operators, were in the mainframe era dominated by women.[57] Data studies can also reveal continuities in terms of scientific questioning and procedures, where one would expect to find radical, computing-induced shifts.[58] My analysis of employees, data, and computing machines at FOA's data processing centres is based on this tradition as well.

Early Computing and Military Research in Sweden

This thesis contributes to this research field not only by studying computing work, but also by studying such work at the Swedish Defence Research Institute. Established in 1945, FOA was the primary institution for military research in Sweden during the Cold War. It was a rich and prosperous institution. In the financial year 1960–61, nuclear energy and military research alone received 40 per cent of the total government research allocations in Sweden, and FOA's funding doubled between 1958 and 1960.[59] Although Wilhelm Agrell in 1989 highlighted the significance of FOA with regard to Swedish

---

[55] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge, Mass.: Harvard University Press, 1987); Steven Shapin, "The Invisible Technician," *American Scientist* 77, no. 6 (1989). Since then, many efforts have been made to uncover previously neglected lab assistants and technicians. See, for example, Jeff Hughes, "William Kay, Samuel Devons and Memories of Practice in Rutherford's Manchester Laboratory," *Notes and Records of the Royal Society of London* 62, no. 1 (2008); Iwan Rhys Morus, *Frankenstein's Children: Electricity, Exhibition, and Experiment in Early-Nineteenth-Century London* (Princeton: Princeton University Press, 1998); Peter Rowlands, *Oliver Lodge and the Liverpool Physical Society* (Liverpool: Liverpool University Press, 1990); Richard Sorrenson, *Perfect Mechanics: Instrument Makers at the Royal Society of London in the Eighteenth Century* (Boston: Docent Press, 2013). For an overview of this tradition, see Iwan Rhys Morus, "Invisible Technicians, Instrument-makers and Artisans," in *A Companion to the History of Science*, ed. Bernard Lightman (Chichester: John Wiley & Sons, 2016).

[56] See, for example, Elena Aronova, "Geophysical Datascapes of the Cold War: Politics and Practices of the World Data Centers in the 1950s and 1960s," *Osiris* 32, no. 1 (2017); Schlombs, "Built on the Hands of Women."; Bruno J. Strasser and Paul N. Edwards, "Big Data Is the Answer … But What Is the Question?," *Osiris* 32, no. 1 (2017). From another angle, Johan Fredrikzon shows how material data conditioned the postwar definitions of the Swedish population, environment, and public administration, Fredrikzon, *Kretslopp av data*.

[57] Schlombs, "Built on the Hands of Women."

[58] Jon Agar, "What Difference Did Computers Make?," *Social Studies of Science* 36, no. 6 (2006).

[59] Lundin and Gribbe, *Att följa pengarna*, 42; Agrell, *Vetenskapen i försvarets tjänst*, 134.

science and technology, since then there have not been all that many studies concerning civilian research areas focusing on or acknowledging FOA's influence.[60]

In a recent anthology, historian of technology Per Lundin, historian Niklas Stenlås, and historian Eric Bergelin refer to the military research complex in Sweden as a "hidden university".[61] Scientists in a broad range of fields – including computing – started their careers at institutions such as FOA and exported knowledge, methods, and entire research fields to the academic and industrial institutions that they subsequently entered. However, these processes have to a large extent been invisible.

The Swedish military has for a long time been considered an entity separate from the rest of society. And yet, the size of the military in the postwar era was quite exceptional: Sweden had the fourth largest air force in the world in 1950 and spent about five per cent of its GDP on the military in the early stages of the Cold War.[62] A great deal of scholarly efforts have been dedicated to aircraft, intelligence services, and the inner workings of the defence industry.[63] But the intertwining of military and civilian institutions, methods, and goals that is essential for understanding research in other countries with similar defence spending, such as the US, is a perspective often lacking in the Swedish history of science and technology.[64]

Computing is an example of this. Ever since political scientist Jan Annerstedt in 1969 argued that the military need for a computer was the most important driving force for the procurement of Sweden's first computers while also criticising the continuous military influence on Swedish government-run computerisation, there has not been all that much focus on military computing.[65] When historian Hans De Geer in the 1990s wrote his comprehensive overview of the introduction of computers in Sweden, he

---

[60] Agrell analysed FOA in Agrell, *Vetenskapen i försvarets tjänst*. The history of nuclear energy research is one of the few fields in which the role of FOA has been thoroughly studied. See Wilhelm Agrell, *Svenska förintelsevapen: Utvecklingen av kemiska och nukleära stridsmedel 1928–1970* (Lund: Historiska media, 2002); Thomas Jonter, *The Key to Nuclear Restraint: The Swedish Plans to Acquire Nuclear Weapons During the Cold War* (London: Palgrave Macmillan, 2016); Stefan Lindström, *Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945–1956* (Stockholm: PhD diss.: Stockholms universitet, 1991). Other examples of studies on FOA include Bergelin, *Planeringsforskningens genombrott*; Gribbe, *Stril 60*.

[61] Bergelin, Lundin, and Stenlås, *Det dolda universitetet*.

[62] Military historian Wilhelm Agrell finds that the Swedish government spending on its military in these years was comparable to that of the United States. Agrell, *Vetenskapen i försvarets tjänst*.

[63] See, for example, Ingemar Dörfer, *System 37 Viggen* (Oslo: Universitetsforlaget, 1973); Birgit Karlsson, *Svensk försvarsindustri 1945–1992* (Stockholm: FoKK, 2015); Wilhelm Agrell, *Sprickor i järnridån: Svensk underrättelsetjänst 1944–1992* (Lund: Historiska media, 2017).

[64] The military-industrial-academic complex is an example of this, Stuart Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (New York: Columbia University Press, 1993). As Naomi Oreskes has shown, military funding can have significant impact on the direction of civilian research areas, Naomi Oreskes, *Science on a Mission: How Military Funding Shaped What We Do and Don't Know About the Ocean* (Chicago: University of Chicago Press, 2021).

[65] Annerstedt, *Staten och datorerna*; Annerstedt et al., *Datorer och politik*. An exception is Kaijser et al., *Maktens maskiner*, Ch. 4.

instead highlighted the combined scientific, industrial, and military computing needs.[66] While Annerstedt had a clear political objective with his research – to democratise computer access – De Geer adopted a more neutral stance.

From then on, Swedish computing historiography has almost exclusively focused on civilian institutions. The Swedish Board for Computing Machinery, tasked with constructing the first Swedish computers, was thoroughly studied by De Geer.[67] The electronics company Facit AB, which took over the Board's computer development in 1956, has also been studied.[68] Other domestic companies pioneering the development of computing, such as Saab, also received a lot of attention at an early stage in Swedish computing historiography, often in studies written by the practitioners themselves.[69] Studies on important breakthroughs in terms of developing computer networks followed.[70]

Welfare computerisation projects and political debates on digitalisation are also well-covered topics in Sweden.[71] Two recent studies include media historian Johan Fredrikzon's analysis of how the massive collection and cultivation of data in the public administration transformed our understanding of the national environment and population, as well as media historian Lina Rahm's exploration of the government's ambition to foster digital citizens.[72] These studies have presented a thorough understanding of how digitalisation unfolded in the Swedish domestic industry and

---

[66] De Geer, *På väg till datasamhället*.

[67] De Geer, *På väg till datasamhället*.

[68] Tom Petersson, "Facit and the BESK Boys: Sweden's Computer Industry (1956–1962)," *IEEE Annals of the History of Computing* 27 (2005); Tom Petersson, "Private and Public Interests in the Development of the Early Swedish Computer Industry: Facit, Saab and the Struggle for National Dominance," in *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, ed. Per Lundin, Johan Gribbe, and Niklas Stenlås (Sagamore Beach: Science History Publications, 2010); Hallberg, *IT-gryning*.

[69] For an overview of Swedish computer systems, see Hallberg, *IT-gryning*. The computer club "Datasaabs vänner" has compiled a book series on the history of Datasaab: Conny Johansson, *Tema gudar* (Linköping: Datasaabs vänner, 2002). See also Kjell Mellberg, Gunnar Wedell, and Bo Lindestam, *Fyrtio år av den svenska datahistorien: Från Standard Radiofabrik till -?: framtagen på initiativ av Veteranklubben Alfa* (Åkersberga: Veteranklubben Alfa, 1997); Per Arne Persson, "Transformation of the Analog: The Case of the Saab BT 33 Artillery Fire Control Simulator and the Introduction of the Digital Computer as Control Technology," *IEEE Annals of the History of Computing* 21 (1999). A notable study addresses the development of early control systems, Karl Johan Åström, "Early Control Development in Sweden," *European Journal of Control* 13 (2007).

[70] Barbro Atlestam, ed., *Infrastruktur för informationssamhället: Teknik och politik* (Stockholm: NUTEK (Närings- och teknikutvecklingsverket), 1995); Inga Hamngren, Jan Odhnoff, and Jeroen Wolfers, *De byggde Internet i Sverige* (Stockholm: ISOC-SE, 2009); Kaarina Lehtisalo and Ville Harilahti, *The History of NORDUnet: Twenty-five Years of Networking Cooperation in the Nordic Countries* (Hørsholm: NORDUnet, 2005).

[71] Kaiserfeld, "Computerizing the Swedish Welfare State."; Anders Carlsson, "Elektroniska hjärnor: Debatten om datorer, automation och ingenjörer 1955–58," in *Artefakter*, ed. Sven Widmalm (Hedemora: Gidlunds Förlag, 2004); Ilshammar, *Offentlighetens nya rum*. Studies on more recent industrial digitalisation processes include Ulf Sandqvist, *Digitala drömmar och industriell utveckling: En studie av den svenska dator- och tv-spelsindustrin 1980–2010* (Umeå: PhD diss.: Umeå universitet, 2010); Gary Svensson, *Digitala pionjärer: Datakonstens introduktion i Sverige* (Stockholm: Carlsson, 2000).

[72] Fredrikzon, *Kretslopp av data*; Lina Rahm, *Educational Imaginaries: A Genealogy of the Digital Citizen* (Linköping: PhD diss.: Linköpings universitet, 2019).

public sector. Nevertheless, military research is missing from the picture. FOA's computer use is mentioned in the study by Kaijser et al. but is not thoroughly analysed.[73] There are no prior historical accounts of FOA's computing – despite it being the most advanced in Sweden.

As noted by Annerstedt, FOA was one of the first government agencies in Sweden to procure an advanced IBM mainframe in 1959.[74] International Business Machines Corporation played a crucial role in early Swedish digitalisation. Out of the 20 computers procured by the Swedish Agency for Administrative Development for the Swedish government between 1961 and 1963, 17 were delivered by IBM.[75] Based on IBM-specific software such as Fortran, aggressive marketing, and large-scale state-funded orders, IBM maintained its dominant position in the Swedish computing market for decades.[76] Meanwhile, the Swedish hardware company Facit AB faced economic stagnation, ending in a takeover in 1972. Yet, the historical narrative in Sweden has largely been one of a promising domestic computer industry competing with and sometimes indeed defeating companies such as IBM.[77] The IBM computers at FOA offer an opportunity to further analyse IBM's relation to the Swedish state as well as to redirect the historiography of Swedish computing towards the economically dominant actor in terms of scientific and technical data processing: FOA.

This redirection of historical focus – from academia to industry and military, and from welfare to warfare projects – has lately gained traction.[78] Historian of ideas Fredrik Bertilsson, agriculture researcher Camilla Eriksson, and intellectual historian Jenny Ingemarsdotter have, in separate studies, explored how military preparedness permeated

---

[73] Kaijser et al., *Maktens maskiner*, 31.

[74] This was the IBM 7090 described in the opening of this chapter. Annerstedt et al., *Datorer och politik*, 129.

[75] Torsten Nybom, "Det nya Statskontorets framväxt 1960–1965," in *Statskontoret 1680–1980: En jubileums- och årsskrift*, ed. Arne Granholm; Margot Rydén (Stockholm: Statskontoret, 1980), 168.

[76] For an analysis of Fortran, see David Nofre, "The Politics of Early Programming Languages: IBM and the Algol Project," *Historical Studies in the Natural Sciences* 51, no. 3 (2021). The IBM 650 was the most common computer in Sweden already in 1959. Hallberg, *IT-gryning*, 184–86. Important studies of IBM in Europe include Petri Paju and Thomas Haigh, "IBM Rebuilds Europe: The Curious Case of the Transnational Typewriter," *Enterprise & Society* 17, no. 2 (2016). For the role of IBM in Nordic countries, see Petri Paju, "IBM Manufacturing in the Nordic Countries," in *History of Nordic Computing 3*, ed. John Impagliazzo, Per Lundin, and Benkt Wangler (Berlin, Heidelberg: Springer, 2011); Petri Paju and Thomas Haigh, "IBM's Tiny Peripheral: Finland and the Tensions of Transnationality," *Business History Review* 92 (2018); Sverrir Ólafsson, "The Presence of the IBM Branch Office in Iceland, 1967–1992," in *History of Nordic Computing 3*, ed. John Impagliazzo, Per Lundin, and Benkt Wangler (Berlin, Heidelberg: Springer, 2011).

[77] The most notable study in this genre is perhaps Magnus Johansson, "Big Blue Gets Beaten: The Technological and Political Controversy of the First Large Swedish Computerization Project in a Rhetoric of Technology Perspective," *IEEE Annals of the History of Computing* 21, no. 2 (1999). Kaijser et al. challenged this narrative by analysing the computer procurements carried out by the Swedish Agency for Administrative Development in the 1960s, Kaijser et al., *Maktens maskiner*, Ch. 5. It should also be mentioned that Annerstedt criticised IBM's major impact on Swedish government computerisation in 1970, Annerstedt et al., *Datorer och politik*.

[78] Per Lundin, Niklas Stenlås, and Johan Gribbe, eds., *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden* (Sagamore Beach: Science History Publications, 2010); Bergelin, Lundin, and Stenlås, *Det dolda universitetet*; Gribbe, *Stril 60*.

Swedish society during the postwar era. In addition, Eric Bergelin in his thesis showed how the research undertaken at FOA influenced policy-making and strategic planning in Cold War Sweden.[79] By studying computing work at FOA, this thesis not only adds a missing piece of the puzzle to the history of computing in Sweden but also contributes to these efforts to broaden the history of science and technology in Sweden, which until recently has overlooked the significance of military research.

1.4 Theoretical Framework

The central analytical concept in this thesis is *computing work*. Work is a common word used arbitrarily in a wide range of situations. In this thesis, I use *computing work* as an umbrella term in various contexts to denote all efforts to plan, execute, and interpret the computations made at the data processing centres I study. To distinguish between different kinds of work and their conditions, I use Hannah Arendt's theories of work, labour, and action. She developed these theories in *The Human Condition* (1958), which was a critique of the consumption society, based on capitalism and technological progress, which Arendt argued prevented a truly democratic society from thriving.

Work and Labour in Mainframe Computing

Hannah Arendt follows Aristotle's categorisation of human behaviour, which means differentiating between work and labour by considering what the human effort is intended to achieve.[80] The end goal of labour is to maintain life.[81] Labour is tied to survival and achieved through activities such as eating or healing, but more often by earning money to buy food and medicine. In this sense, the expression "being in labour" becomes quite literal – giving birth to a child is perhaps the utmost case of labouring. Instead, the end goal of work is to manipulate matter, to construct or mend a material object for the sake of something other than one's survival.[82] The temporal dimension of work also differs from that of labour. While labour is cyclical – you labour, spend your salary on food, eat the food, go back to labouring – work is something lasting. The end products of work are artefacts that can be used again and again: chairs, books, computer programs.

---

[79] Bertilsson and Eriksson, "Totalförsvarets livspolitik."; Jenny Ingemarsdotter and Camilla Eriksson, "'Vi får klara oss själva': Hotbild och självbild i den svenska försörjningsberedskapen 1962–2002," *Scandia Tidskrift för historisk forskning* 89 (2023); Bergelin, *Planeringsforskningens genombrott.*

[80] Arendt, *The Human Condition*, 12. Here, she departs from the Marxist tradition to view work as a human activity that changes nature, while labour is the work being appropriated and sold for an exchange value. Karl Marx et al., *Capital: Critique of Political Economy. Volume 1* (Princeton: Princeton University Press, 2024 [1867]).

[81] Arendt, *The Human Condition*, Ch. 3.

[82] Arendt, *The Human Condition*, Ch. 4.

When it comes to an individual job, it is often hard to separate work and labour. Did the employees at FOA perform their tasks primarily to survive or to build an artificial world? Who knows how they felt? In this thesis, the separation between the two is not made at an individual level. I view work and labour as two different aspects of the combined efforts to perform computations at data processing centres. Work (being the more common word) is the primary concept. Labour, on the other hand, is used to highlight that the cyclical translation and transportation of data through the mainframe was a different procedure than building computer systems aimed at accumulating computing knowledge over time. The mainframe consumed data, and this consumption was maintained through human labour. Cards were punched, translated to tapes, processed, translated to result lists, and returned to the customer, who then ordered new cards to be punched, translated, etc. The results of all these computations lasted, but the data flow was essentially cyclical. It was a necessary part of operating a data centre, something we risk losing sight of if we only study programming.

The distinction between work and labour enables a power analysis as labour is not valued as highly as work. Labour is primordial, cyclical, and thus never progressing. In the history of science, the word "labour" is often used to account for the depreciated and invisible tasks performed by technicians, assistants, and instrument-makers.[83] Labour is often linked to femininity (bear in mind the expression of being in labour), as shown by historian of technology Corinna Schlombs in her exploration of women labouring with data management in postwar West Germany.[84]

Computing historians such as Janet Abbate, Mar Hicks, Nathan Ensmenger, and Jeffrey Yost have from different angles analysed computing labour, which is distinguished by its physical nature as well as its gendered and racialised characteristics.[85] In a recent anthology, Janet Abbate and Stephanie Dick argue that the tensions between physical and logical work, abstractions and embodiments in computing, need to be historicised.[86] These tensions are also the topic of a recent issue of the history of science journal *Osiris*, where programming is analysed in terms of "crafting" and "coding".[87] Coding is what we might think of when we hear the word programming today. It is the rule-based construction of logical systems that requires mathematical and problem-

---

[83] For an overview, see Morus, "Invisible Technicians, Instrument-makers and Artisans."

[84] Schlombs, "Built on the Hands of Women." Peter Galison's studies of the "scanning girls" at the particle physics centre Cern represent another insightful example of this. Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago: University of Chicago Press, 1997), Ch. 5.8.

[85] Abbate, *Recoding Gender*; Hicks, *Programmed Inequality*; Yost, *Making IT Work*; Nathan Ensmenger, "The Environmental History of Computing," *Technology and Culture* 59 (2018).

[86] Janet Abbate and Stephanie Dick, *Abstractions and Embodiments: New Histories of Computing and Society* (Baltimore: Johns Hopkins University Press, 2022).

[87] James Evans and Adrian Johns, "Introduction: How and Why to Historicize Algorithmic Cultures," *Osiris* 38 (2023).

solving skills and a mindset that could be called either rational, nerdy, or withdrawn. Crafting, on the other hand, represents another side of programming. The trial-and-error processes, the intuitive patching of different parts of a system, the bug-fixing search for a solution that might not be comprehensible but simply does the trick. The crafting nature of programming is made visible by studying the boundaries, errors, and exceptions stemming from the physical manifestations of algorithms and data.[88]

Computing historians focusing on a wide range of fields – the IT service industry, big data, gendered professions, environmental impacts of computing – have begun exploring the interplay between physical labour and logical work found within computing. As Abbate and Dick put it, "The question of who has a mind and who has a body – who will be remembered for their ideas and who will be remembered for their physical labor – is always at once a historical, a technical, and a social question."[89]

Following Arendt, this is also a philosophical question. Arendt's theory of work and labour adds another layer to the ongoing discussions on computing labour. In her theory, work and labour represent two domains of human activity. To work is to build an artificial, lasting world, which is closely tied to the construction of technologies.[90] Labour refers to the much less glorious, yet necessary, maintenance of life. Maintaining life is to this day seen as something primitive and feminine, while constructing technologies is seen as something progressive, modern, and masculine. Tracing the historical interpretations of some tasks at data processing centres as labour and others as work, in Arendt's sense of these words, thus highlights the philosophical underpinnings of the uneven power distribution in mainframe computing.

Militarisation as Action

According to Arendt, both work and labour attain meaning from human *action*, the final category of human activities besides work and labour. Human action signifies the unique speech and acts used by people to convey who they are and what they believe in.[91] It is the foundation for politics in a democratic society and should, according to Arendt, be superior to both work and labour. The consumption society that already in 1958

---

[88] Salem Elzway, "Armed Algorithms: Hacking the Real World in Cold War America," *Osiris* 38 (2023).

[89] Janet Abbate and Stephanie Dick, "Thinking with Computers," in *Abstractions and Embodiments: New Histories of Computing and Society*, ed. Janet Abbate and Stephanie Dick (Baltimore: Johns Hopkins University Press, 2022), 13.

[90] Arendt herself uses words such as artefact, thing, and object more frequently than technology, Arendt, *The Human Condition*. However, I view technologies as all sorts of material artefacts that humans use to fulfil specific purposes, following Edgerton, *The Shock of the Old*. Dictionary definitions of technology describe it as scientific knowledge applied in practice to fulfil a human need. However, Ruth Oldenziel has highlighted that the concept of technology after the Industrial Revolution became narrower and more linked to engineering: female-coded household tools were not considered technologies in the same way as male-coded engineering tools. Oldenziel, *Making Technology Masculine*.

[91] Arendt, *The Human Condition*, Ch. 5.

threatened to alienate people and destroy the environment is built on labour – a cyclical, endless production of things to be consumed. An overly rational society is built on work, on the construction of solutions to societal problems, whose deeper meaning is neglected. A truly democratic society, according to Arendt, should be built on action.[92]

In this thesis, I use action to account for the interpretations, purposes, and visions surrounding the computing work performed at the data centres. The researchers at FOA certainly had ideas of what they were doing and why, but their activities were conditioned by the aims and visions related to Swedish computing in general. These require some further commenting.

A key aspect of the political action conditioning Swedish computing work during the mainframe era is undoubtedly the prioritisation of military research in Cold War Sweden, which enabled a military research institution such as FOA to make major investments in computing technologies. Wilhelm Agrell uses the concept of *militarisation* to argue for the increased influence of military goals and methods in Swedish research during the Cold War. According to Agrell, the militarisation of research is a process in which "the entire research community, albeit with some exceptions, placed its knowledge and working capacity at the disposal of the national goals and mobilisations."[93] This resulted in new ways of organising and conducting research. Agrell identifies the bureaucratisation of research as the most important consequence. Planning and carrying out research were made subordinate to pre-determined goals and methods. Science became more goal-oriented.

Swedish militarisation was less obvious than the corresponding process in the US, which historian Michael Sherry claims permeated the entire American society in the 20th century.[94] After all, Sweden claimed neutrality, while the US played the leading role in the Cold War. At the same time, however, the militarisation of research might have been easier to implement in Sweden than in the US. Historian Laura McEnaney highlights the cultural resistance to militarisation in 1950s America, where individualism and nuclear family ideals made it hard to realise far-reaching cooperation for the sake of national security.[95] Sweden, on the other hand, with its strong Social Democracy and considerable public trust in state-led projects and expertise was perhaps more attuned to such cooperation.

---

[92] Arendt, *The Human Condition*, 220–22.

[93] Agrell, *Vetenskapen i försvarets tjänst*, 40. The term militarisation was developed and spread by John R. Gillis, ed., *The Militarization of the Western World* (London: Rutgers University Press, 1989); Michael S. Sherry, *In the Shadow of War: The United States Since the 1930s* (New Haven: Yale University Press, 1997).

[94] Sherry, *In the Shadow of War*.

[95] Laura McEnaney, *Civil Defense Begins at Home: Militarization Meets Everyday Life in the Fifties* (Princeton: Princeton University Press, 2000).

Following Per Lundin and Niklas Stenlås, the reasons for this smooth and somewhat invisible militarisation of Swedish research might be the "historical myths" of modernity and neutrality.[96] The Social Democratic Party presented modernity as a vision in the 20th century: a strong industry, extensive welfare, practical architecture.[97] After World War II, neutrality appeared as a complement and prerequisite for modernity. Thanks to Sweden's neutrality in the war, Swedish factories had not been bombed, and Swedish trade was not hindered by any military alliances but continued to produce welfare and affluence for the population.[98] The neutrality paradigm – the policy to keep Sweden out of any military alliances – was the dominant foreign policy in Sweden throughout the Cold War.[99]

The strong Swedish military, necessary for both the domestic industry and foreign policy, was concealed by the Swedish self-conception as a modern, neutral country. This dynamic is mirrored in the peculiar naming of a Swedish 1990s weapons system. A major anti-aircraft robot system, designed to shoot down hostile aircraft, was named after the beloved Swedish cartoon figure Bamse. Bamse is the strongest bear in the world, but he is also the kindest. All the other cartoon characters know that he can lift them up and dangle them in the air whenever he wants to. Yet this violence is never called out as violence since the myth of Bamse presents him as kind, peace-loving and innocent.

In this thesis, I view the visions of neutrality and modernity as part of Swedish political action, while the militarisation of research serves as an enactment of this political action. The militarisation of research presented new goals for scientific and

---

[96] Per Lundin and Niklas Stenlås, "Technology, State Initiative and National Myths in Cold War Sweden: An Introduction," in *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, ed. Niklas Stenlås Per Lundin, Johan Gribbe (Sagamore Beach: Science History Publications, 2010). The argument draws on the concept of "collective identity" presented in Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity After World War II* (Cambridge, Mass.: MIT Press, 1998).

[97] For analyses of the government-industry relationship, see Mats Fridlund, *Den gemensamma utvecklingen: Staten, storföretaget och samarbetet kring den svenska elkrafttekniken* (Eslöv: B. Östlings bokförl. Symposion, 1999); Pettersson, *Handslaget.*

[98] For a lengthier discussion on modernity, its conditions, and its role for Swedish Social Democracy, see Francis Sejersted, *Socialdemokratins tidsålder: Sverige och Norge under 1900-talet* (Nora: Nya Doxa, 2005).

[99] In 2001, historian Hans Weinberger suggested that the Swedish history of military technology during the Cold War – containing joint war scenarios, weapons collaborations, and knowledge transfer with Western countries – could point to covert military cooperation with the US. Hans Weinberger, "The Neutrality Flagpole: Swedish Neutrality Policy and Technological Alliances, 1945–1970," in *Technologies of Power: Essays in Honor of Thomas Parke Hughes and Agatha Chipley Hughes* ed. Michael Thad Allen and Gabrielle Hecht (Cambridge, Mass.: MIT Press, 2001). This has subsequently been confirmed by others. See, for example, Robert Dalsjö, *Life-Line Lost: The Rise and Fall of "Neutral" Sweden's Secret Reserve Option of Wartime Help From the West* (Stockholm: Santérus Academic Press Sweden, 2006); Wilhelm Agrell, "In the Innermost Sanctum: Reflections on the Mythology of Sweden's Neutrality Policy and the History of Questioning," in *The Swedish Success Story?*, ed. Kurt Almqvist and Kay Glans (Stockholm: Axel and Margaret Ax:son Johnson Foundation, 2004). A study focusing more on politics, with a more sympathetic attitude towards the neutrality paradigm, is Ulf Bjereld, Alf W Johansson, and Karl Molin, *Sveriges säkerhet och världens fred: Svensk utrikespolitik under kalla kriget* (Stockholm: Santérus, 2008). On the other hand, journalist Mikael Holmström presents a radical critique of Swedish foreign policy during the Cold War in Mikael Holmström, *Den dolda alliansen: Sveriges hemliga NATO-förberedelser* (Stockholm: Atlantis, 2011).

technological development while also conveying a new story of Sweden's national strengths. It enabled and directed computing work and labour at FOA by giving them a purpose.

Although *The Human Condition* is a text that seldom shows up in the history of computing, I argue that it addresses the same questions posed by historians of gender and computing, scientific computing practices, and computer use regarding the dual nature of programming: on the one hand, logical coding, and, on the other, physical crafting. Through the concept of action, it is also possible to combine the study of contingent work practices and professional hierarchies with a political perspective that captures the role of military research in society, which is definitely needed in the Swedish history of science and technology.

Technologies are material tools constructed through work. However, they must also be political since a tool gets its meaning through action. It is created to fulfil a purpose. The task of the historian is to ask: Whose work and to what purpose?[100] The answers to this question may reveal multiple relationships between technology and society: the gendering of artefacts and professions, the academisation of knowledge, and geopolitical incentives in research politics.

1.5 Methods, Sources, and Scope

Two different kinds of analyses are mixed throughout this thesis. On the one hand, I study the larger epistemological, economic, and political conditions for the data processing centres. On the other hand, I focus on the concrete work within these centres, including job sharing, practices, priorities, and administrative management. How computing work was carried out at FOA is mainly answered by the latter level of analysis, while the other two questions – how it was conceptualised and organised – necessarily demand an analytical mix of the two levels. My choices of source material, methodologies, and scope, explained below, originate from this analytical mix.

Source Material

My study is primarily based on previously unstudied archival documents. The two most important archives in this study are the QZ archive at the Swedish National Archive and the FOA archive at the Swedish Military Archive. The QZ archive is quite small

---

[100] This is similar to the calls made by David Noble already in the 1980s. In relation to the progress enabled by industrial automation, he urged us to ask "What kind of progress? Progress for whom? Progress for what?" David F. Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Oxford University Press, 1986), 13.

and neatly ordered. FOA's archive is larger. Most of the relevant documents in the FOA archive are sorted under general data processing matters from 1960 to 1974, but the personal archives of Directors-General Martin Fehrm (who held the position 1957–1968) and Torsten Magnusson (1968–1974) also contain relevant files, as do FOA's annual reports. Some of these documents are classified, but I have received permission to look at all the relevant documents.

The archives of the Swedish Agency for Administrative Development and the Board for University Data Processing Centres are also used but to a lesser extent since the two data processing centres I study only make up a small part of their holdings.[101] IBM's Swedish subsidiary does not have an archive. This means that IBM's perspective on the computer deals made with FOA in 1959 and the Swedish Agency for Administrative Development in 1965 is outside the scope of this thesis. However, FOA's internal documentation of these negotiations is quite encompassing.

However, the FOA archive, as well as the other government archives presented above, do not represent the entire past.[102] The archival documents are often bureaucratic or technical in nature – there is not much personal correspondence, no diaries or work logs. The FOA researchers and civil servants who compiled these documents worked in an environment characterised by an ideal of rationality and an awareness of potential political conflicts. The latter is especially obvious when it comes to the Swedish nuclear research programme at FOA – surrounded as it was by major political debates.[103] Thus, a critical perspective regarding the sources is necessary. Internal discussions at FOA most likely differed quite a lot from formal inquiries and memos.

To get a fuller understanding of the role of FOA, I have in some cases cross-analysed archival sources with other sources, such as the Swedish Government Official Reports and government bills. Press coverage is also used to some extent, primarily since the establishment of the QZ led to a major debate in Swedish media. News articles offer an important perspective – a view from outside FOA.

I have also conducted nine interviews with people working with early scientific computing, either at FOA or at Swedish university data processing centres. The interviewees were chosen to represent a broad experience of computing work in the relevant era and capture both an inside and an outside perspective on the data processing

---

[101] The Board for University Data Processing Centres was tasked with administrating and funding Sweden's six university data processing centres, which were located in Stockholm, Gothenburg, Lund, Uppsala, and Umeå.

[102] For a discussion on the relation of archives to the past, see Carolyn Steedman, *Dust: The Archive and Cultural History* (New Brunswick: Rutgers University Press, 2002); Arlette Farge and Thomas Scott-Railton, *The Allure of the Archives*, trans. Thomas Scott-Railton (New Haven: Yale University Press, 2013 [1989]).

[103] Jonter, *The Key to Nuclear Restraint.*

centres that I study. Hence, some of them worked at university data processing centres in cities other than Stockholm. The interviews were semi-structured, inviting the interviewees to talk openly about their lives, careers, and experiences of computing. I have used the interviews as complements to archival sources, not to prove facts – facts are notoriously hard to remember – but to contribute with personal views and opinions.[104] The witness seminars organised in 2007–2009 to collect memories from Swedish computing pioneers have also been a valuable source.

Methodological Problems

Financial frameworks, hardware choices, and machine setups are quite easily obtained from the archives of the data processing centres. The everyday work in the past, however, is much more elusive. Although some information can be retrieved from archives and databases – manuals, job descriptions, recruitment ads – many aspects of everyday work go unnoticed in the workplace archives. I address this methodological problem in two ways. First, by analysing the spatial organisation of the data processing centres, derived from drawings of interior design and buildings, and, second, by cross-analysing archival documents with other sources, such as interviews and newspaper articles.

In his article "Screening Science" (1998), historian of science Jon Agar shows how the spatial organisation of a radio observatory in the United Kingdom reveals which kind of work was prioritised and who was deemed sufficiently important to get access everywhere.[105] Spatial setups and architecture reflect power and authority. Office spaces expose internal hierarchies, whereas institutional authority is also inscribed in facades and yard dimensions.[106] By stepping into the data processing centres through maps, inventory lists, and rebuilding plans, I gain some of the tacit everyday experience of work that is lost when the workplace is shut down. Other aspects of this work are made available through the combined analysis of archival documents, newspaper coverage, and interviews.

However, some methodological problems linked to these sources persist. The employees who make their voices heard in the archives, as well as in the interviews I have conducted, all had quite privileged positions in the work hierarchies at the data

---

[104] Donald A. Ritchie, *Doing Oral History* (New York: Twayne Publishers, 1994).

[105] Jon Agar, "Screening Science: Spatial Organization and Valuation at Jodrell Bank," in *Making Space for Science: Territorial Themes in the Shaping of Knowledge*, ed. Crosbie Smith and Jon Agar (London: Palgrave Macmillan UK, 1998).

[106] See, for example, Peter Galison and Emily Ann Thompson, *The Architecture of Science* (Cambridge, Mass.: MIT Press, 1999). For a Swedish example, see Sven Widmalm, *Det öppna laboratoriet: Uppsalafysiken och dess nätverk 1853–1910* (Stockholm: Atlantis, 2001), 287–302.

processing centres. Blue-collar workers seldom leave personal archives behind. Even their names are hard to come by since they are rarely cited in official yearbooks or internal memos. This is a methodological problem in history in general and which is also prevalent in this study.[107] For example, if someone were to look for protagonists in a history of computing and gender in this thesis, they would probably find the group of well-educated, upper-middle-class women performing skilled coding work at FOA in the 1960s. Even though their stories have not been told before, computing work is much broader than the skilled programming they performed. I address this uneven representation of actors by analysing tasks and occupational groups, not just individual people. By highlighting the importance of tasks other than programming and the division of work in the entire workforce, it is still possible to problematise the relationship between computing work and programming.

The Mainframe Era

This thesis takes place in the mainframe era. The starting point for the study is 1955, since this is the approximate date when computing diffused and diversified beyond the Swedish Board for Computing Machinery, which built and operated the first two computers in Sweden. From the mid-1950s, computing expanded beyond domestic hardware and absolute government control. The first IBM computer was introduced in Sweden in 1956 – and what set the standards for Swedish digitalisation was IBM machines rather than computers made in Sweden. By the mid-1950s, FOA's computer use had also intensified, and the idea of an in-house data processing centre saw the light of day.

The thesis ends in 1975. This is partly because the mid-1970s brought a transition in computing work at FOA. Bengt Olsen replaced Björn Kleist as head of operations in 1973, marking a shift in leadership style. That same year, the IBM 360 mainframe was replaced by a DEC 10, which signified a transition from the top-down IBM system to a more flexible one. FOA was restructured in 1974–75, an institutional change marking the role of FOA in the new geopolitical landscape. During the 1970s, the Swedish Agency for Administrative Development gradually lost its major influence on Swedish academic computing. By 1975, the conditions for computer research at FOA had changed decisively.

A more important aspect, however, is that the mainframe era was coming to an end. The room-sized machines requiring a centralised organisation were gradually replaced by small, individualised computers. With the spread of personal computers, computing

---

[107] For a discussion on the archive as a representation of power, see Steedman, *Dust*, Ch. 1.

work became more fragmented, and studying it requires other sources and more diverse historical sources than mine. This means that I do not follow the QZ's operation after 1975 – the centre operated for almost two additional decades – but leave the subsequent transformations of computing work in Swedish research for future studies.

1.6 Thesis Outline

This thesis begins with the plans to establish the FOA data processing centre. The justification for buying the advanced IBM 7090 mainframe is the topic of Chapter 2. Starting in the mid-1950s, the chapter traces the narratives underpinning the government's decision to invest in computing and the work procedures at FOA leading up to the hardware and software choices finally being made in 1959. The chapter answers the question of how computing work was conducted at FOA prior to the purchase of the IBM 7090 and why the overall organisational framework for the FOA data processing centre was chosen.

The arguments for government investments in computing show the major importance of the Cold War threats in terms of organising computing work at FOA. These threats justified major investments in military technology. The internal discussions at FOA indicate the prioritisation of nuclear calculations in military research in general and computing technology in particular. Had it not been for the attempts to build Swedish nuclear weapons, FOA would most likely have procured a less advanced computer or joined a data processing collaboration effort with other governmental institutions. Thus, Chapter 2 makes it clear that militarisation was the most decisive political action for designing the organisational framework for computing work at FOA. This work centred around the IBM 7090 mainframe, and this remarkably advanced machine conditioned not only how that work was conducted but also how it was conceptualised.

The subsequent third chapter focuses on the everyday work carried out at the FOA data processing centre. It maps the administrative organisation at the centre, analyses the occupational groups in terms of gender and class, and explains the establishment and development of work routines and programming practices. I here argue that crucial decisions on how to structure work at the data processing centre were based on spatial and practical boundaries.

The organisation of everyday work at the FOA data processing centre was based on visions of automation and efficiency. Data flooded the centre and this was considered problematic. The goal was to reduce the time and effort used to handle data – in other words, to reduce the labour spent on cyclical data management. Chapter 3 clearly shows that programming work – primarily performed by the female team at the physics calculation division at FOA – was considered essential at the FOA data processing centre, while labour aimed at transporting and translating data was seen as something that should preferably be completely eliminated.

Chapter 4 deals with the transition from the FOA data processing centre to the Stockholm data processing centre, called the QZ, and which was shared by FOA, the Royal Institute of Technology, and Stockholm University. This shared ownership marks another breakpoint in the organisation of computing work at FOA. The political action was shifting, now favouring academic research to a greater extent than before, and the computing pioneers at FOA managed to tap into the generous government funding for university data processing centres proposed in 1964. I analyse the internal power struggles between FOA and the universities regarding the organisational structure of the new data processing centre, which took place in 1963–1968 and spurred a major media debate.

Although the QZ was formally a university data processing centre, the military research institute FOA was the dominant actor in terms of getting it established. This was due to the fact that only FOA researchers had any experience organising and running such an advanced data processing centre. Secrecy regulations also played a role here. FOA's specific privacy needs were deemed more important than the universities' requirements. The position of FOA as Sweden's most advanced military research institution thus once again had an impact on the organisation of the new data centre, albeit not as straightforwardly as in the establishment of the FOA data processing centre.

The fifth chapter then turns to the work environment at the QZ. Here, the changing conceptualisation of computing work plays a key role. Between the mid-1950s and mid-1970s, computing went from being a hands-on practice, learned by experience rather than in school, to a respected profession requiring theoretical knowledge and academic degrees. I link this process to the breakthrough of systems thinking, a cross-disciplinary research approach originating from other fields of military research. This approach was not only prevalent at FOA but also influenced the emergence of computing classes and programmes at the Royal Institute of Technology and Stockholm University. Systems thinking made computing work more abstract, which obscured the labour required to maintain the data flow, which was still a material, organisational problem.

This chapter thus shows another (indirect) consequence of the initial political decision to invest in advanced computing technology for military research purposes. Placing the IBM 7090 at FOA made them experts on computing work organisation. This, in turn, gave them authority over the university data processing centre known as the QZ, where a metaphor rooted in military ambitions to control a chaotic world became the dominant way of conceptualising what a computer actually was and who was most suited to work with it.

2 Reaping the Benefits of Swedish Nuclear Negotiations, 1955–1961

In 1961, around midsummer – the Swedish summer holiday when people eat herring and sing drinking songs – the Swedish Defence Research Agency held its own celebration in Stockholm. It was far from traditional; they celebrated the inauguration of a giant computer. FOA had bought analogue computing machines before, but the IBM 7090, which was delivered in June 1961, was the first of its kind at the agency. At the time, it was one of the most advanced computers in the world. Another copy of the mainframe was placed at the NASA Langley Research Center in the US, where it provided crucial calculations for the famous Project Mercury that launched John Glenn into Earth's orbit in 1962.

This machine alone cost the Swedish state 13,3 million Swedish krona in 1959.[1] The price corresponded to half the working budget of FOA's entire operation that year.[2] Compared to previous computing investments in Sweden, the cost of the IBM 7090 was tenfold.[3] FOA researchers had performed computing work ever since the agency was established in 1945, but how that work was conducted and organised profoundly changed when the FOA data processing centre was established around the 7090. When the Swedish government invested that huge amount of money in a single mainframe, computing work at FOA got a unified framework, a complex and systematic organisation, and an outstanding status in the Swedish computing community. If you wanted to be at the forefront of scientific Swedish computing in the early 1960s, the FOA data processing centre was the place to be.

---

[1] Corresponding to 2,6 million US dollar in 1959.

[2] With additional memory components etc, the total cost for the system landed closer to 15 million Swedish krona, or 2,8 million US dollar, spread out over six financial years. Agreement between IBM and FOA, 29 June 1959, FOA Ö, Administrativa Byrån (AdmB), FIIa:11, KrA. The total working budget for FOA during financial year 1958/59 was 26 million Swedish krona, see Draft to the King in Council, 30 May 1959, FOA Ö, AdmB, FIIa:10, KrA.

[3] In the early 1950s, two million krona were granted for the construction of Sweden's first computers, the domestically built Bark and Besk. From 1956 to 1959, 26 other computers were introduced in Sweden, ten of which were IBM 650s sold for just under one million krona. The most advanced machine was the Ferranti Mercury, bought by the atomic energy corporation AB Atomenergi but placed at the Royal University of Technology. It had been developed for the Norwegian counterpart of FOA, and it cost around two million krona. Hallberg, *IT-gryning*. See p 185 for a list of computers in Sweden during the 1950s, p 197 for approximate prize of an IBM650. For further discussions on Bark and Besk, see De Geer, *På väg till datasamhället*.

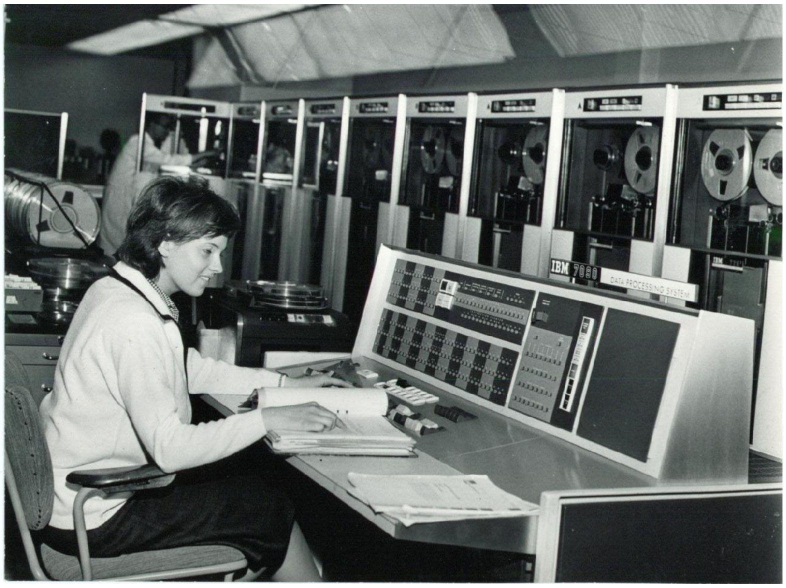

Figure 1: Photo of the IBM 7090 and FOA employee Eva Lindsten reading off result lists. Courtesy of Björn Kleist.

Why did FOA get such an advanced mainframe? How was computing work at FOA conducted and organised before the inauguration of the FOA data processing centre, and what motivated its establishment? This chapter traces the political negotiations and technical investigations preceding the purchase of the IBM 7090: the central node of computing work at FOA between 1961 and 1968. The aim is to understand the origin of computing work at FOA in the mainframe era.

The overall organisation of the FOA data processing centre – the hardware choice, the financial structure, the administration of services – set the standards for how to conduct and conceptualise computing work at FOA in the future.[4] The process leading up to the inauguration of the IBM 7090 is the natural beginning of my investigation of computing work at FOA.

FOA's computing experts made many administrative and technological choices for the new data centre. They gained expertise in close contact with Swedish computing pioneers from academia and industry and with an international computing community. Although their efforts are presented in this chapter and analysed as important parts of the work required to establish the FOA data processing centre, I argue that what really enabled the establishment was the government's decision to meet FOA's computing requirements in the late 1950s. This decision was motivated by the conception of a technologically advanced defence as the key to national prosperity. It was prompted by

---

[4] For example, when the QZ was eventually established, the overall organisation was inspired by the FOA data processing centre. See Chapter 4 and 5.

the Cold War foreign policy of Swedish neutrality and handled by the government through major investments in military research and a general strengthening of the defence. The most decisive factor was the development of a Swedish nuclear weapons programme, whose theoretical predictions demanded major computing capacity.

In Wilhelm Agrell's account, the redistribution of resources from defence material and personnel to defence research is symptomatic of this age. He calls this development within the military a *scientification*, defined as an increasing awareness of the value of science within the military, which led to the integration of science in military organisations and a rising influence from the scientific community on military matters.[5] Scientific and technological development was prioritised within the military, and Agrell argues that the Swedish defence was profoundly reshaped by scientific expertise after World War II. This correlates with the simultaneous militarisation of research – where research in general is increasingly becoming subordinated to national security goals and bureaucratic organisation.

In this chapter, I use the concepts of scientification and militarisation to explain the favourable conditions for investing in computing technology at FOA in the late 1950s. My empirical investigation provides an example that strengthens Agrell's claims and contributes to the growing literature on Swedish military research.[6] On the one hand, the militarisation of Swedish research provided huge resources to FOA. On the other hand, the scientification of the military directed these resources towards technologically advanced areas like computing. This chapter traces both the negotiations and conflicting interests within FOA, and the shifting political landscape that FOA found itself in.

FOA's IBM 7090 was ordered in the summer of 1959. But the story of how, and why, it ended up in the basement of the FOA premises in Stockholm began a couple of years earlier. This chapter first explores the computing work performed at FOA before the IBM 7090 was inaugurated. Then, the process leading up to the purchase of the IBM 7090 is explained chronologically and contextualised through analyses of computing knowledge transfer and domestic political power struggles.

---

[5] Agrell, *Vetenskapen i försvarets tjänst*, 41.

[6] Bergelin, *Planeringsforskningens genombrott*; Fredrik Bertilsson, "Biopolitisk beredskap: Den beteendevetenskapliga försvarsforskningens betydelse i den svenska krisberedskapen," *Historisk tidskrift (Stockholm, Sweden)* 142 (2022); Bertilsson and Eriksson, "Totalförsvarets livspolitik."; Bergelin, Lundin, and Stenlås, *Det dolda universitetet.*

2.1 Machines for Military Mathematics

In April 1950, Sweden's first digital computer, Bark (*Binär automatisk reläkalkylator*), was inaugurated, making Sweden the fourth country worldwide with a computer.[7] It was built by the Swedish Board for Computing Machinery, established in 1948 and led by Edy Velander (1894–1961), managing director of the Royal Swedish Academy of Engineering Science. Although the need for a Swedish computer was broad and varied, military institutions were crucial for the planning process.[8]

One of Sweden's most computationally heavy military institutions during World War II was the National Defence Radio Establishment. It gathered intelligence for the Swedish military by performing advanced radar signalling and cryptography. Prompted by intel on the US and British computer developments during the war, the National Defence Radio Establishment and the Royal Swedish Navy Board began to explore options to acquire a computer. In his thesis, Jan Annerstedt showed how they coordinated the calculation needs of the defence, before the formal inquiry resulting in the establishment of the Swedish Board for Computing Machinery was set up.[9] The newly established military research institute FOA participated in that coordination.

FOA was founded in 1945 as a government agency answerable to the Ministry of Defence. The task was to perform and coordinate research for military purposes. Until 1945, Swedish military research was scattered in different institutions: the Defence Chemicals Establishment, established in 1937, the Technical Preparedness Committee, established in 1940, and the Swedish Institute of Military Physics, established in 1941. In 1943, amidst World War II, a board was set up to gather different defence research initiatives and plan for their coherence in the future.[10] Their work resulted in establishing the Swedish Defence Research Agency, where the three above-mentioned research institutions became independent departments: FOA 1 for chemistry, FOA 2 for physics and explosives, and FOA 3 for radar and electronics research.

Calculations were crucial for FOA's research in all areas, although especially in physics. The physics department was headed by Torsten Magnusson (1907–1987). Magnusson held a PhD in physics from Uppsala University and soon advanced to the position of *laborator* (approximately associate professor) at the Royal Swedish Academy of Engineering Sciences. In the 1940s, he worked at the Swedish Institute of Military Physics and transferred to FOA 2 in the 1945 merger. Atomic energy physics was one

---

[7] De Geer, *På väg till datasamhället*, 25. The expression "digital computer" refers to the fact that Bark was digital but relay-based, whereas the machines we call "computers" today are digital electronic machines.

[8] De Geer, *På väg till datasamhället*; Annerstedt, *Staten och datorerna*.

[9] This is described in Annerstedt, *Staten och datorerna*.

[10] Conflicts and disciplinary competition soon complicated the board's work, see Agrell, *Vetenskapen i försvarets tjänst*, 103–07.

of Magnusson's areas of expertise. When FOA was reorganised in 1958, he moved on to the newly established department for nuclear physics, which he supervised until 1968 when he was appointed Director-General of the entire agency. He retired in 1974.

It was Torsten Magnusson who, in 1946, represented FOA in the first discussions on the procurement of digital computing technology in Sweden. Although he was not part of the formal commission of inquiry on Swedish computing set up in 1947, he did contribute to the computing coordination and planning efforts initiated by the National Defence Radio Establishment preceding the commission.[11]

The formal commission following these discussions brought together representatives from higher education, business and industry, and the defence.[12] They stressed the scientific and industrial need for a digital computer in Sweden and suggested the establishment of the Swedish Board for Computing Machinery. Its mission was to lead the procurement of digital calculation equipment in Sweden. When the initial plans to import a computer from the US failed, the board decided to focus on domestic production, which resulted in the computer Bark in 1950.[13]

By 1950, plans for constructing a more robust electronic machine were already in action. In charge of the project was Erik Stemme (1921–2007), previously research engineer at FOA. It took him and his team of engineers three years to construct Besk (*Binär elektronisk sekvenskalkylator*). It was a proper Swedish-built digital electronic computer, with an impressive calculation speed.[14]

Computing historians have stressed the importance of Besk for early Swedish computing.[15] The Board for Computing Machinery held the first programming courses in Sweden at the Besk data centre, and computing pioneers soon gathered there. Besk was placed in the old buildings of KTH, at Drottninggatan 95A in Stockholm. For many computer users, Besk's machine hall was where they first encountered a computer. Or, as it was still called in Sweden at the time, *matematikmaskin*, a mathematics machine.[16]

---

[11] From there on, Edy Velander from the Royal Swedish Academy of Engineering Science took the lead to set up a commission of inquiry on computing procurement for the Swedish state. Annerstedt, *Staten och datorerna*, 20–23.

[12] De Geer, *På väg till datasamhället*, 22. The chairman was Stig H:son Ericsson, from the Royal Swedish Navy Board. The other members were Torbern Laurent, professor in telecommunications at KTH, Nils Zeilon, professor in mathematics at Lund University, Gustav Adolf Widell, under-secretary of state at the Ministry of Defense and Edy Velander, CEO at the Royal Swedish Academy of Engineering Science.

[13] It proved impossible to obtain an export license due to the secrecy surrounding this inherently military technology. Instead, five young engineers travelled to the US to acquire the necessary expertise. See De Geer, *På väg till datasamhället*, Ch. 1.

[14] It has often been said that Besk for a while was the fastest computer in the world. Hallberg, *IT-gryning*, 167. The digital electronic computer will henceforth just be called computer.

[15] See for example Hallberg, *IT-gryning*, 163. A study of the user community at Besk is found in Kaijser et al., *Maktens maskiner*, Ch. 3.

[16] The Swedish term "dator" was coined by Börje Langefors, Sweden's first professor in information processing at KTH.

Regarding runtime, the top three users of Besk during the years 1955–58 were the aircraft and car manufacturer Saab (often contracted for military projects), the National Defence Radio Establishment, and the Royal Swedish Air Force Board.[17] This is surely evidence of the military origin of Swedish computing. However, Kaijser et al. explain how runtime isn't everything.[18] Users who almost vanished in comparative lists of total runtime sometimes gained crucial experiences from computing specific problems on Besk. FOA was one of them.[19]

It was mainly the calculation division of the physics department at FOA that performed calculations at Besk. The division had been set up in 1948, and initially, it consisted of only three people: mathematician Birger Jansson (1921–1998) in charge of two conscripts.[20] The newly hired Birger Jansson had 1948 just finished his studies in mathematical statistics, and he would stick to the field of computations and statistical modelling for his entire career. Jansson was one of the leading actors in establishing the FOA data processing centre. Later, he moved to a new FOA department, inaugurated in 1958 and aimed at strategic planning (FOA P). There, he performed mathematical modelling and technologically mediated planning.

Jansson's calculation division grew over the years. Mathematician Elsa-Karin Boestad-Nilsson (1925–2020) was one of the first to join in 1949, and in 1958 she became head of the division.[21] For Jansson, Boestad-Nilsson, and the others performing calculations at Besk, the simple knowledge of what a computer could do was groundbreaking.[22] Back then, coding was still a somewhat obscure business. In the early 2000s, several FOA computer pioneers remembered their occupation as "missionary work," with the mission to spread awareness of what a computer could do.[23] Some were sceptical. "The engineers, the guys, told me I was insane and should be careful not to drown in zeros and ones", Elsa-Karin Boestad-Nilsson remembered in 2005.[24] This reply was probably influenced by Boestad-Nilsson being a female scientist, an

---

[17] The numbers are compiled from the time period January 1955 to June 1958. Kaijser et al., *Maktens maskiner*, 37.

[18] Kaijser et al., *Maktens maskiner*, Ch. 3.

[19] In between 1955 and 1958, FOA used Besk for 210 hours or about 2 % of the total runtime. Kaijser et al., *Maktens maskiner*, 37.

[20] This was division FOA 225, at first a division aimed at numerical analysis of automatic control engineering. Johan Gribbe, ed., *Att modellera slagfältet: Tidig databehandling vid FOA 1954–1966. Transkript från ett vittnesseminarium* (Stockholm: Tekniska museet, 2007), 9.

[21] Boestad-Nilsson is introduced further in Section 3.1.

[22] Per Lundin, ed., *Att arbeta med 1950-talets matematikmaskiner: Transkript av ett vittnesseminarium* (Stockholm: Tekniska museet, 2005), 16.

[23] For example Elsa-Karin Boestad-Nilsson in Gribbe, *Att modellera slagfältet*, 15–16. Another example is found in Göran Waernér in Per Lundin, ed., *Tidig programmering: Transkript av ett vittnesseminarium* (Stockholm: Tekniska museet, 2006), 23.

[24] Elsa-Karin Boestad-Nilsson in Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 15.

uncommon sight among engineers. Nonetheless, computing started as a small side business at FOA. In the late 1950s, things had changed.

Besk was a meeting point for the very first Swedish computer users. In daytime, the Swedish Board for Computing Machinery held coding courses and assisted customers with computations. During evenings and nights, computer users who could handle the computer themselves came to run their programs on Besk. Some would later establish their own data processing centres, as FOA did.[25] They were military scientists, mathematicians, physicians, meteorologists, engineers, and technicians. In the waiting rooms outside the machine hall, computer pioneers from all over sat down and discussed their work, their coding problems, or the latest gossip.

Boestad-Nilsson highlighted the importance of this experience in retrospect: "Besk came to be very important for the development at FOA. To start calculating on Besk and realise that we didn't have enough capacity, we had to have more and more."[26] This continuous urge for more and more computing capacity led to the idea of an in-house computer, a machine of their own choosing. But the choice turned out to be a long and complicated process.

2.2 Big Blue and the Importance of Travel

1956 is a turning point in Swedish computing history. The blueprints of Besk were sold to commercial manufacturers, and from that year onwards, copies started to appear. A slower version called Smil was installed in the physics department at Lund University. The company AB Åtvidabergs Industrier (later Facit AB) recruited the engineering team behind Besk and began producing the commercial copy Facit EDB, leaving the Board for Computing Machinery weakened and reduced.[27] Around the same time, Svenska Aeroplan Aktiebolaget, Saab, contracted Åtvidabergs to build their first computer, Sara.[28]

The Swedish Board for Computing Machinery was no longer the sole administrator of (digital) data processing centres in Sweden. However, the domestic production of computers was also challenged by a company with outstanding resources compared to

---

[25] A prominent example here is the Swedish Meteorological and Hydrological Institute, who was among the first users of Besk and eventually became leading in numerical analysis on their own. See Kaijser et al., *Maktens maskiner*, 45.

[26] Elsa-Karin Boestad-Nilsson in Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 42.

[27] Petersson, "Facit and the BESK Boys."

[28] For an overview of Swedish computer systems, see Hallberg, *IT-gryning*. The computer club "Datasaabs vänner" has compiled a book series over Datasaab's history: Johansson, *Tema gudar*. See also Mellberg, Wedell, and Lindestam, *Fyrtio år av den svenska datahistorien*; Persson, "Transformation of the Analog." A notable study deals with the development of early control systems, Åström, "Early Control Development in Sweden."

the small-scale Besk producers: International Business Machines Corporation (IBM), nicknamed "Big Blue".

The Computing-Tabulating-Recording Company, later International Business Machines, was founded in 1911. It got its contemporary name in 1924 and soon specialised in punched card tabulating systems.[29] IBM was world-leading in electronics production long before the advent of the first digital computer. Still, after World War II, the company rapidly picked up the research and development race in the emerging field of commercial computing.

IBM established essential connections to the US military in the early 1950s. IBM's most prominent research project for the US military was the Semi-Automatic Ground Environment project (Sage), an air defence system developed at Massachusetts Institute of Technology. Even though the system itself became obsolete before it was launched, when long-range missiles replaced the bombers it was designed to shield off, Sage contributed enormously to the development of computers and control systems.[30] The Whirlwind, the IBM-produced computer at the centre of Sage, became the first machine to process general information instead of simply performing specific calculations, like its precursor, the Eniac, had done. The Sage project pushed IBM into a new era of computing development and gave it a favourable position in the emerging computing market.[31]

The mainframe model IBM 650, inaugurated in 1956, sold 2000 copies in the early 1960s.[32] It is sometimes called the first mass-produced computer. Some of these machines found their way into Sweden that year: the insurance company Folksam bought one, and soon after, the Royal Swedish Air Force Board did the same.[33] The latter was situated in Arboga, a small town 150 kilometres from Stockholm.

By then, the calculation division at the physics department at FOA had expanded from the original three employees to a workforce of 20 people. They received computation requests not only from their colleagues at the physics department, but from the entire agency. The IBM 650 was not unfamiliar to them. In July 1956, before the first 650 mainframe arrived in Sweden, Birger Jansson visited IBM's headquarters in Paris and used the 650 to compute a meteorological problem that was hard to program

---

[29] Hermann Hollerith, inventor of the electric tabulating machine for punched card reading, was one of the founders of the original holding company. For an overview of IBM's history, see Pugh, *Building IBM*.

[30] See Hughes, *Rescuing Prometheus*, Ch. 2.

[31] For an analysis of IBM's importance for global computing development, see Campbell-Kelly et al., *Computer*, Ch. 7.

[32] Pugh, *Building IBM*, 182.

[33] Hallberg, *IT-gryning*, 185.

and run on Besk.[34] When the Royal Air Force Board installed their IBM 650 in Arboga, the computing pioneers at FOA soon paid visits there too. They were impressed. Birger Jansson, still head of the calculation division in 1956, described coding on the IBM 650 as a revelation for FOA. According to him, it was with that computer that they began to "use computers for almost all calculations".[35]

The key was the machine's flexible language. When equations are translated to code, each step requires work. The coder must break down an infinite integral into a fixed series of executable additions. A sinus value is computed through its Taylor series, which is also based on simple additions. Every number must be converted to binary representation. The time it takes to code a given mathematical problem depends on how many conversions the coder must perform, and how many exist as subroutines or work packages. The IBM 650 did much more of this work than Besk did. It made the scope of problems to solve much wider.

Universality was a favourable feature of digital electronic computers, often lacking in the analogue machines still used in the 1950s. FOA's radar and electronics department had an analogue differential analyser, Freda, frequently used to solve equations.[36] Freda could compute advanced problems, such as trajectories for robotic weapons, but it could only solve differential equations. Digital electronic computers were more universal but had more complicated hardware. In the mid-1950s, digital and analogue computing machines existed in parallel. However, digital computers prevailed when multi-million-dollar projects such as Sage urged the development of the former and not the latter.

Universality and flexible software were also important to the computing pioneers at FOA. The processing speed of Besk was, in fact, higher than that of the IBM 650, but the programming speed was not. According to Jansson, the 650 was "exceptionally easy to program […] thanks to a refined interpretative coding system".[37] Scholars analysing IBM's success have also attributed it to their unusually early focus on developing user-friendly software.[38] With a smooth translation from equations to executable code, the range of problems to be solved on a computer expanded.

However, complicated problems still needed to be solved. After all, many small calculations *could* be solved manually. More extensive calculations, such as predictions

---

[34] The input data to the computation was partly graphical curves, which were very hard to code into punched cards. In Paris, there was a curve reader connected to the 650. Travel report 2524–003, 22 July 1957, FOA Ö, Avdelning 2 Expeditionen (Avd 2 Exp), F1:62–66, KrA.

[35] Travel report 2524–003, 22 July 1957, FOA Ö.

[36] Annual report 1954/55, FOA secret archive (FOA H), Administrativa Byrån (AdmB), B4a:11, KrA.

[37] Travel report 2524–003, 22 July 1957, FOA Ö. The coding system Jansson mentions here was called SOAP (Symbolic Optimal Assembly Program).

[38] Campbell-Kelly et al., *Computer*, Ch. 6.

of missile trajectories, assessments of weaponry effects, or reconnaissance disturbances, could not.[39] Moreover, time-consuming computations in new military fields were lining up. The most important ones were war simulations used to predict attack scenarios and plan defence strategies, and nuclear calculations needed to understand the construction and effects of atomic weapons.

War simulations and strategic planning gathered under the umbrella term operations research, first developed during World War II as an attempt to base strategic decisions on scientific knowledge. After the war, the subject developed and spread through applications of game theory, computing, and systems analysis. It became the major business of the think tank Rand Corporation, established in 1948 to provide research and analysis for the US Armed Forces. At Rand, researchers tried to predict and compare future war scenarios. In the 1950s, operations research as a peacetime strategy spread within FOA, and FOA researchers had close connections to Rand researchers.[40] With new planning techniques, the Swedish defence explored various crisis scenarios, prospective defence structures depending on varying finances, and future weapons systems designs.[41] Mathematical models and numerical stochastic methods were key planning techniques within operations research.

Nuclear research, too, relied on advanced numerical methods for probability prediction since the chain reaction in an atomic bomb is essentially unpredictable. In the mid-1950s, the construction of Swedish atomic weapons was an outspoken goal for the military.[42] A major political debate on nuclear armament (see Section 2.3) was awaiting, but throughout the 1950s, nuclear research remained a high priority for the Swedish defence. The advanced scientific underpinnings of nuclear war made FOA crucial in acquisition.

In 1958, two new departments were established at FOA: FOA 4 for nuclear research and FOA P for strategic planning. Torsten Magnusson headed the nuclear department, and his old colleague from the Swedish Institute of Military Physics, Carl Gustav Jennergren (1918–2013), headed the planning department.[43] Birger Jansson was responsible for computations at FOA P, and at FOA 4, Per Svenonius (b. 1926) had a

---

[39] Annual report 1958/1959, FOA H, AdmB, F1a:5, KrA.

[40] Bergelin, *Planeringsforskningens genombrott*, 123.

[41] Arne Kaijser and Joar Tiberg, "From Operations Research to Futures Studies: The Establishment, Diffusion, and Transformation of the Systems Approach in Sweden, 1945–1980," in *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, ed. Agatha C. Hughes and Thomas P. Hughes (Cambridge, Mass.: MIT Press, 2000), 392.

[42] Agrell, *Svenska förintelsevapen*, Ch. 11–12.

[43] Carl Gustav Jennergren studied physics and worked at the Swedish Institute of Military Physics in the 1940s. When it merged into FOA, he continued as a research engineer at FOA 2. In 1956, he became responsible for planning issues at FOA and was appointed head of FOA P when it was established. He remained there until the department was reorganised in 1974.

corresponding position. Svenonius held a degree in mathematics, chemistry, and mechanics. He started at FOA's physics department after having done his military service there as a research technician. When the FOA data processing centre was established, he became head of operations. In 1965, he left FOA to become chairman of the Board for University Data Processing Centres – an influential position within the Swedish Agency for Administrative Development.

Svenonius and Jansson – like Jennergren and Magnusson – thus both started in FOA 2, the physics department, and moved to two new promising fields of defence research, each requiring unprecedented computational capacity. Large core memory and short operational times were key to simulating war games and solving nuclear equations on a computer. Therefore, the fast but not very easily managed Besk was the best option nearby. The IBM 650 in Arboga, slower in computational speed but much easier to program, was better for the other, smaller computations stacking up at the physics calculation division at FOA. In March 1957, both these computers approached full capacity.

At that time, Jansson and Svenonius proposed a thorough investigation of procuring a computer for FOA.[44] They outlined the possibility of establishing an in-house service bureau like the one surrounding Besk, where customers coded their own problems. In such a scenario, a data processing centre at FOA could function as a service centre for the entire defence, whose computational needs were steadily rising. Ideally, the mainframe would combine the merits of Besk with those of the IBM 650: advanced hardware and manageable software, computational speed and programming speed. But as Jansson stated in the summer of 1957: "We don't know if that machine exists".[45]

In the domestic computer market in Sweden in 1957, it didn't exist. Facit and Saab had only produced copies of Besk so far, but Saab eventually developed a series of advanced mainframes for scientific computing that competed with international companies like IBM. The first commercial model – the D21 – was introduced in 1962.[46] Although Saab delivered many D21 mainframes to Swedish government agencies in the 1960s, the researchers at FOA don't seem to have considered Saab an adequate alternative. The thorough investigation of computers proposed in March 1957 resulted in a market investigation entirely focused on international companies.[47] Perhaps it was

---

[44] Memo by Per Svenonius and Birger Jansson, 6 March 1957, FOA H, AdmB, ÖVII:6, KrA.

[45] Travel report 2524–003, 22 July 1957, FOA Ö.

[46] For the story of the D21, see Viggo Wentzel, *Tema D21* (Linköping: Datasaabs vänner, 1994).

[47] Travel report 2524–003, 22 July 1957, FOA Ö.

due to bad timing. In the late 1950s, Saab only produced two computers that were developed for internal use.[48] The D21 was just a bit too late.

The international computer market, on the contrary, was buzzing with activity in the late 1950s. However, the software was not yet standardised, and experience with various brands was scarce. The giant, expensive mainframes were still quite unique, and it was hard to figure out how they would work just from looking at technical specifics or marketing ads. To buy something from a brochure was considered risky.[49] Choosing a computer required travelling to selected machines and trying them out.

These circumstances turn FOA's planning for a data processing centre into an example of the importance of transnational knowledge exchange in scientific development.[50] Computing knowledge was not achieved through individual studying but through travelling, practical testing, and interactions with other computer users, with scientists from different disciplines, machine technicians, businessmen, etc.

The FOA computing pioneers went on a handful of trips to investigate what mainframe was most suited to their needs in the late 1950s.[51] The most serious ones were made in 1957, but the search had started earlier. In 1955, Birger Jansson visited his first European data processing centres on FOA's account, to learn data processing and compare different computers.[52] That FOA would eventually need their own computer was no strange idea to the people working with the agency's computations.

In the late 1950s, the computing researchers at FOA travelled to data processing centres for two interconnected reasons: to compute their problems, and to search for a future computer. IBM's European headquarters in Paris was where the two ambitions merged. FOA employees went there to solve complicated problems while obtaining hands-on experience with new IBM mainframes that might fit FOA.[53] The new model launched in 1957 was the 704.

---

[48] The first was Sara, Saabs automatiska räkneapparat, and the second Datasaab D2, a transistorised model aimed for aircraft navigation.

[49] This is explicitly noted in the travel report by Birger Jansson. Travel report 2524–003, 22 July 1957, FOA Ö.

[50] In Cold War science studies, this perspective is brought forward by Jeroen van Dongen, *Cold War Science and the Transatlantic Circulation of Knowledge* (Leiden: Brill, 2015); John Krige, *How Knowledge Moves: Writing the Transnational History of Science and Technology* (Chicago: University of Chicago Press, 2019). These studies are inspired by a longer tradition in history of science, see James A Secord, "Knowledge in Transit," *Isis* 95, no. 4 (2004); Peter Galison and Bruce William Hevly, *Big Science: The Growth of Large-scale Research* (Stanford: Stanford University Press, 1992).

[51] B Jansson to the UK and France in July 1955; B Jansson to France in July 1956; B Jansson, U Jismarck and P Svenonius to the UK, Germany and France in May 1957; B Jansson, U Jismarck and P Svenonius to the UK and France in September 1957. In September 1958, a mainframe was chosen. See Annual report 1955/56, FOA H, AdmB, B4a:12, KrA; Annual report 1956/57, FOA H, AdmB, B4a:13; Annual report 1957/58, FOA H, AdmB, F1a:1, KrA.

[52] In the summer of 1955, Birger Jansson visited the UK and France to study computers. See Annual report 1955/56, FOA H.

[53] This was for example the case with the visit to the 650 mainframe in July 1956, described above. From December 1958 to June 1959, about ten more trips to IBM's French office was undertaken by FOA researchers, but by then Svenonius and Jansson had already settled on recommending an IBM machine for FOA's part.

The IBM 704 was one of the machines Svenonius and Jansson tested and evaluated in their investigation.[54] However, a broad and thorough investigation of brands other than IBM also occurred. In May 1957, Jansson, Svenonius and Ulla Jismark (1932–2016), a technician at FOA physics calculation division, visited computers produced by Zuse KG (the famous computer pioneer Konrad Zuse's business), Remington Rand (producing the Univac), and Ferranti (producing the Pegasus). The FOA delegates brought five representative mathematical problems, already evaluated at IBM 650 in Arboga, to run on the computers they visited and then use as evaluation data in their ongoing investigation.[55]

In the travel report, Svenonius and Jansson compared computers produced in-house by small companies, like the Zuse and the Ferranti, to mass-produced machines shipped from large factories, like Remington's Univac. They praised the former for their producers' more profound knowledge – to build one's own computer is "a different thing entirely [than] to suddenly catch a machine falling from the sky, appended with the experiences of others".[56]

However, the FOA computing pioneers already had experience with IBM machines. The 650 was used as a reference in their comparison and evaluation process. In 1959, one-third of all Swedish computers were IBM 650s.[57] The Swedish IBM subsidiary multiplied its personnel by a factor of four between 1940 and 1958.[58] It was a time of rapid expansion.

The 704 was the first computer to use Fortran, the earliest high-level programming language, which is still used in scientific data processing to this day.[59] As a 704 customer, you also got a membership in IBM's computer users' group Share, which has been described as a community of great importance for developing, spreading, and standardising software.[60] The 70-series was developed to make the transition between subsequent models as smooth as possible.[61] Given the fast development of computing in the late 1950s, standardisation was a significant advantage. New mainframes soon became outdated, or overloaded – this happened with Besk and the IBM 650 belonging to the Royal Swedish Air Force Board – and the work to translate code from one computer to another was usually immense.

---

[54] The delegates did travel to Paris to include the 704 in their market investigation journey in May 1957, but the machine had just been inaugurated and was not possible to test then. They came back in September to evaluate the machine. Travel report 2524–003, 22 July 1957, FOA Ö; Annual report 1957/58, FOA H.

[55] Travel report 2524–003, 22 July 1957, FOA Ö.

[56] Travel report 2524–003, 22 July 1957, FOA Ö, 15.

[57] The statistics are a bit uncertain in 1957–59, see Hallberg, *IT-gryning*, 185.

[58] Hallberg, *IT-gryning*, 186.

[59] Pugh, *Building IBM*, 195.

[60] Akera, *Calculating a Natural World*, Ch. 7.

[61] Pugh, *Building IBM*, 194–95.

When IBM 1958 launched its first transistorised model, the 7070, this further strengthened the conception of IBM as forward-looking and modern. The 700-series had logic circuitries built by vacuum tube amplifiers, which made them unreliable.[62] If any of the thousands of tubes in the computer broke, it resulted in errors. The 7070 took IBM mainframes into the second computer generation. Moreover, it had a number representation based on floating arithmetic. Floating arithmetic bridged the gap between fast but hard-managed machines like Besk and IBM 704, using binary representation, and slow but easily coded machines like IBM 650 and the UNIVAC, using fixed decimal numbers.[63]

In that sense, the 7070 must have seemed like the machine whose existence Jansson had pondered over in July 1957. A machine that could cover both minor problems, requiring easy coding, and complicated problems, requiring fast runtime. In September 1958, Per Svenonius presented the IBM 7070 as the solution to the problem of FOA's – and the entire military's – rising computational need.[64]

2.3 Means for Protecting Sweden

As scientific and technical computing experts, Svenonius and Jansson indeed had much influence over what computer to buy. But no matter what computer brand or model they would have considered, it would have been a significant investment. In the late 1950s, computers cost millions of Swedish krona. The resources required to consider purchasing an advanced mainframe in 1958 were out of FOA's internal scope. Svenonius and Jansson – as well as their bosses, Magnusson and Jennergren – were part of a much bigger political game. It revolved around Sweden's position in the Cold War, the extent and direction of the Swedish military, and the development and use of nuclear weapons.

In the years when the FOA researchers tried out different mainframes, the Swedish defence budget went through significant changes. In the financial year 1956/57, the total Swedish defence budget was 2280 million Swedish krona, a five per cent increase from

---

[62] Pugh, *Building IBM*, 177.

[63] The number representation in a mainframe computer is crucial for the speed of calculations. Fixed-point representations dominated at this time, in decimal or in binary format. Decimal format uses a fixed number of non-zero decimals, making the accuracy for very big or very small numbers unnecessary large, which slows down complicated calculations. Binary representations work with a fixed accuracy too, but the scaling factor is a power of two instead of ten, so the problem is not as prominent. It is however harder to code mathematics in binary form. Floating-point arithmetic, which uses the power of ten but shifts accuracy according to size of the number involved, resolved this problem. It does however require more complicated hardware, and therefore did not break through until the 1960s.

[64] Svenonius said this during a meeting, which is reported in a memo by Martin Fehrm to KG Linden, 6 November 1958, FOA Ö, AdmB, FIIa:8, KrA.

the year before.[65] The sum constituted 4,8 per cent of Sweden's Gross National Product. The budget for 1957/58 was set to 2242 million krona, but it landed on 2612 million, resulting in a 14 per cent increase from the previous year and making up 5,4 per cent of GDP.[66] These new, higher levels of military resources were solidified through a defence decision made in 1958, aimed at declaring goals and future strategies for the Swedish military. The budget for 1958/59 was set to 2700 million krona, with a planned annual increase of 2,5 per cent.[67] This allocation increase was to compensate for inflation and advancing technological development.

The government bill for this defence decision stressed the need for a technologically advanced military: "The technological progress has resulted in an expanding significance of equipment for the defence. Technical factors increasingly determine organisation, tactics, and great power strategy."[68] The bill suggested extensive savings in other areas, such as military education and army supply. Resources should be moved from the army to military research and technology development. Such a re-direction is part of what Wilhelm Agrell calls a scientification of the military – the expertise and methods are shifted from traditionally military areas and values to scientific ones.[69]

It would take some time before FOA saw the concrete consequences of this political process, but in the financial year 1959/60, FOA's total working budget nearly doubled compared to 1956/57.[70] It was a good time to invest in advanced technology.

The 1958 defence decision was made amid a raging debate. Its topic was the construction of Swedish nuclear weapons. The first full-scale strategic plan for nuclear armament in Sweden was proposed in 1949. By then, Sweden already had an atomic energy organisation up and running. A governmental advising agency for nuclear research was set up in 1945, and the corporation AB Atomenergi, established in 1947, started to extract atomic fuel from Swedish mines. In 1946, the physics department at FOA got a division for nuclear research, headed by Sigvard Eklund (1911–2000). The nuclear department, established in 1958, was an expansion of this division. FOA's role was to promote reactor building and examine the construction, effects, and protection against an atomic bomb.[71] The first Swedish nuclear reactor, the research reactor R1 at KTH, started in 1954.

---

[65] Statistiska Centralbyrån, Statistisk årsbok för Sverige 1959, 300.

[66] Kungl. Maj:ts proposition nr 110, 1958, 110, 94.

[67] Kungl. Maj:ts proposition nr 110, 57.

[68] Kungl. Maj:ts proposition nr 110, 96.

[69] Agrell, *Vetenskapen i försvarets tjänst*.

[70] In 1956/57, FOA's total working budget was 18 million SEK. 1957/58, it was 20 million, 1958/59, 26 million, and 1959/60, it reached 33 million. Draft to the King in Council, 30 May 1959, FOA Ö. See also Lundin and Gribbe, *Att följa pengarna*.

[71] Agrell, *Svenska förintelsevapen*, 57. An overview of the nuclear research policies in Sweden at the time is given in Lindström, *Hela nationens tacksamhet*.

That year, Nils Swedlund (1898–1965), the Supreme Commander of the Swedish Armed Forces, publicly presented arguments for the procurement of a Swedish atomic bomb.[72] However, nuclear armament soon became a major source of conflict within the Social Democratic government.[73] Defence Minister Torsten Nilsson (1905–1997) was positive, while Foreign Minister Östen Undén (1886–1974) and Finance Minister Gunnar Sträng (1906–1992) opposed it. This disagreement would continue to grow within the party.

In 1956, the so-called "Swedish line", an atomic energy programme formally aimed at both energy supply and military preparedness, was launched.[74] The Social Democratic Women's Association soon organised petitions and open campaigns against nuclear armament. When Supreme Commander Swedlund in 1957 publicly announced both the necessity of and the ongoing plans for the construction of Swedish nuclear weapons, the opposition was no longer possible to brush aside.[75] A fierce debate arose in the media and the Swedish parliament.[76] Director-General of FOA, Hugo Larsson (1906–1986), joined in Swedlund's arguments for Swedish nuclear armament. In February 1958, Prime Minister Tage Erlander (1901–1985) received a petition against nuclear weapons signed by 95 000 Swedes.

Erlander was caught in a difficult position. The highest military leaders pleaded for nuclear armament, as did strong voices in the Social Democratic Party.[77] At the same time, not only a significant number of his voters, but the Women's Association as well as several of his own closest ministers, loudly opposed nuclear armament. It was an issue that divided the Social Democratic Party in a way that threatened to break it apart completely.[78] And everything played out in public – despite Erlander's efforts to smooth it over. The political opposition was eager to exploit Erlander's inability to unite his party.

The immediate political context surrounding the defence decisions was Sweden's neutrality in the Cold War, which rested on a strong military. The neutrality paradigm, set up in 1949 by the Social Democratic Party as a foreign policy goal, aimed to keep

---

[72] He did so in the report ÖB-54.

[73] Thomas Jonter has written extensively about the Social Democratic Party and the question of nuclear armament: Jonter, *The Key to Nuclear Restraint.*

[74] Agrell has shown how the Swedish line was in fact prepared almost entirely for military ambitions, see Agrell, *Svenska förintelsevapen*, Ch. 11–12.

[75] Swedlund presented his arguments in ÖB-57, which is published in ÖB-utredningarna, *Studie – utredningar – ÖB förslag 1957 jämte försvarsgrenschefernas yttranden och ÖB slutord* (Stockholm, 1957).

[76] The right-wing parties were more unanimous in agreement with Swedlund, whereas the Social Democratic party was divided. Famous media personalities in Sweden, like Herbert Tingsten, chief editor of Sweden's biggest newspaper *Dagens Nyheter*, participated in the debate.

[77] Agrell calls the ÖB-57 "pleading" in tone, Agrell, *Svenska förintelsevapen*, 154.

[78] Jonter, *The Key to Nuclear Restraint.*

Sweden independent and free from military alliances.[79] Neutrality was used to justify armament: a country without allies must be able to fend for itself. With time, historians have shown how Sweden, in fact, had far-reaching military cooperations with the US and the Western sphere during the Cold War.[80] But even if neutrality was mostly rhetoric – a foreign policy façade intended to win domestic support – Sweden's position in the Cold War as a small US ally claiming to be neutral still required a strong military. A strong military gave Sweden leverage, and a strong military in the late 1950s was a nuclear-armed military.

In 1958, military concerns were high on the agenda in many countries. On the 4th of October in 1957, the metallic sphere named Sputnik left its launch site in the Soviet Socialist Republic of Kazakhstan to revolve around the planet 1500 times. If a Soviet satellite could leave the Earth, where on Earth could their missiles not reach? The launch of the Sputnik in turn launched major military research initiatives. The Advanced Research Projects Agency was established in the USA in April 1958, and the National Aeronautics and Space Administration in July 1958.[81]

The reorganisation of FOA in 1958 (resulting in the new departments for nuclear research and strategic planning) and the defence decision proposing more resources and more research as the way forward for the Swedish military can be seen as a response to the international crisis sparked by the Sputnik launch. But most of all, it was conditioned by Sweden's neutrality paradigm.

On the one hand, neutrality – crucial for the Social Democratic Party – seemed to require the construction of nuclear weapons. On the other hand, approving such construction could cost Erlander half his party. The question of nuclear weapons had so much weight in 1958.

In December 1958, a committee was set up to solve the issue. The committee secretary was Olof Palme (1927–1986), who would eventually become one of Sweden's most famous Prime Ministers. Palme and Erlander together managed to reach a clever compromise. It was a plan aimed at pleasing everyone. Funds were allocated for military nuclear research, but the goal was changed from the *construction* of weapons to the *protection* from weapons. The dividing line between the two remained flexible.

---

[79] In 1949, two potential alliances fell through: Swedish membership in Nato, and a military alliance between Sweden, Denmark, and Norway. The paradigm was formally maintained by the Swedish government as far as 2003, when neutrality as a Swedish foreign policy goal disappeared from the Social Democratic party program. For an overview interpreting the neutrality paradigm as quite genuine, see Bjereld, Johansson, and Molin, *Sveriges säkerhet och världens fred*.

[80] See for example Agrell, "In the Innermost Sanctum."; Weinberger, "The Neutrality Flagpole."; Dalsjö, *Life-line Lost*.

[81] Both are very famous. ARPA was to support early-stage research that could lead to new military technologies – their most famous creation is the ARPANET, predecessor to the Internet. NASA was to research and explore space through orbital satellites, probes to the moon and the planets, and manned space flights.

At FOA, Hugo Larsson had been replaced by Martin Fehrm (1910–2001) as Director-General. Fehrm was an electrical engineer who had worked for the Royal Swedish Air Force Board and the Royal Swedish Army Board. He was head of FOA 3, the radar and electronics department, from its establishment in 1945 and held the position of Director-General for the agency from 1957 to 1968. He then moved on to the Technical Preparedness Committee and later started a consulting business.

Under Fehrm's guidance, FOA proposed two alternative research programmes in the summer of 1958: the S-programme, aimed at nuclear protection studies; and the L-programme, aimed at constructing small atomic weapons. The L-programme was entirely in line with Supreme Commander Swedlund's directives in his 1957 report. The S-programme was branded altogether differently, but it did still contain most of the elements necessary to construct nuclear weapons. In Wilhelm Agrell's words: "Protective research was defined as an activity requiring three-quarters of the work to build a Swedish nuclear prototype before it could begin".[82] Martin Fehrm played the political game well. The L-programme was declined, but the S-programme was funded in the financial year of 1959/60.[83]

The money pouring into military research also depended on Sweden's financially stable position. The late 1950s were a quite prosperous period for many Western European countries recovering from the war, and Sweden had not even been in the war.[84] The annual average increase in Gross National Product was eight per cent in Sweden in the late 1950s.[85] Thus, the defence budget's share of GDP remained quite steady, around five per cent, from 1955 to 1960. The Defence Government Bill of 1958 explicitly mentioned this. The 14 per cent increase of the defence working budget was presented as an "economic contribution that cannot be said to exceed a fair amount of the national economic resources".[86]

However, neither economic prosperity nor the neutrality paradigm can hide the fact that Sweden in the late 1950s highly prioritised military matters. The nuclear weapons issue and its political solution bear signs of the ongoing militarisation. National security was on top of the political agenda in 1958. Despite the significant public and political opposition against nuclear armament, measures to achieve it were pushed through (or sneaked in, perhaps more adequately expressed). It wasn't until the mid-1960s that

---

[82] Agrell, *Svenska förintelsevapen*, 163. The only significant differences in research conditions and directions between the L-program and the S-program were personnel costs.

[83] ÖB Nils Swedlund continued to argue for implementing the L-program during this time. The decision in 1959/60 applied to a more general cause, but in practice, the S-program received funding through it.

[84] Historian Tony Judt calls this period "The age of affluence" in Tony Judt, *Postwar: A History of Europe Since 1945* (New York: Penguin Press, 2005).

[85] Statistiska Centralbyrån, Statistisk årsbok för Sverige 1962, 309.

[86] Kungl. Maj:ts proposition nr 110, 55.

research practice actually followed rhetoric in the nuclear area, and the plans for constructing Swedish atomic weapons were finally terminated. In 1968, Sweden signed the Non-Proliferation Treaty on international nuclear armament, which foreign minister Östen Undén had worked to achieve for a decade.[87]

This odd piece of Swedish history – taking the lead in international disarmament plans while at the same time domestically performing the research necessary for nuclear armament – was made possible by the militarisation of society and the simultaneous scientification of the military. If the military is based on science, prioritising military matters is much easier to hide.[88]

The computer that Per Svenonius and Birger Jansson searched for was purchased in the summer of 1959, after the S- and L-programmes had been presented but before either was approved. Although uncertainty still surrounded FOA's nuclear weapons research, it wasn't as far-reaching as before. The Social Democratic Party finally had a plan to handle the nuclear weapons debate, and FOA swiftly adjusted to it. Should the construction research decline, there was the safety research to fall back upon. Torsten Magnusson, just appointed head of the new nuclear department at FOA, was in a position where he could take the suggestions of a new and expensive mainframe very seriously.

2.4 The Value of New Scientific Insights

In FOA's annual report of 1958/59, the numerical treatment of the equations of motion in a compressed metal shell is said to have "essential significance" for calculating the critical dimensions of weak fission charges.[89] This numerical treatment was too complicated for the computers at hand, let alone manual calculations. That charges with such critical dimensions will enable an atomic bomb explosion was not mentioned in the report – it was to be read between the lines, understood by those who were already in the loop, who knew that rightly dimensioned weak charges are key to the construction of small atomic weapons.

Expressions like these repeatedly recur in the documents concerning FOA's computer needs. Nuclear research was formally explained in either very vague terms – "a planned series of physical calculations" – or in a strict technical way – atomic

---

[87] The intense debate over nuclear armament within the Social Democratic party was however over in 1959. Agrell, *Svenska förintelsevapen*, 264.

[88] The same argument is used in analyses of the space program during the Cold War, for an overview, see Jon Agar, *Science in the Twentieth Century and Beyond* (Cambridge: Polity Press, 2012).

[89] Annual report 1958/59, FOA.

explosions were called “heavily overcritical systems”.[90] The annual reports speak of nuclear research in terms of “protection”, “effects”, and “defence” – not “construction”, “prerequisites”, and “attack”.[91] On the front page of a draft of FOA’s allocation request for the financial year 1960/61, there is a note telling the reader to take caution with the formulations used, especially regarding the nuclear programme.[92] The political climate and the ongoing societal debates on nuclear weapons caused unease at FOA. The anxiety over the official framing of FOA’s nuclear research went hand in hand with the public protests against atomic bombs and the Swedish politicians’ involvement in international disarmament movements.

However, in the annual report of 1958/59, nuclear research is given the highest priority.[93] The nuclear research programme had to proceed, and computational capacity was key to successful nuclear research.

Svenonius and Jansson had found the IBM 7070 – but in 1958, the estimation was that FOA would only occupy 25 to 50 per cent of such a computer, so maintaining it on their own would be unnecessarily expensive.[94] The computing pioneers at FOA started looking for partners with whom to share a data processing centre. At a meeting held at the Ministry of Defence in September 1958 to coordinate the military’s computing needs, Svenonius and Jansson presented the IBM 7070 as “the only machine of interest, around which a cooperation could be built”.[95] No other machine could meet their strict capacity requirements. The other attendees were asked to consider their interest in sharing the machine.[96]

The Civil Defence Board did so, asking for a 20 per cent ownership. Since that wasn’t enough, the offer extended to a civilian institution, the National Statistical Bureau. A proposition was made to split the IBM 7070 between these three institutions.[97] The Civil Defence Board handled administrative matters for the Swedish military: financial accounting, personnel registers, and military service benefits. The National Statistical Bureau produced and communicated national statistics, in fields ranging from demography to business and industry. These two institutions had computational needs quite different from FOA’s. Whereas FOA mostly performed scientific and technical

---

[90] The first quotation from memo by Martin Fehrm to KG Linden, 6 November 1958, FOA Ö; the second from an official letter from FOA to the Minister of Defence, 15 August 1960, FOA H, AdmB, F1a:11, KrA.

[91] The annual reports of the years between 1957/58 to 1960/61 are found in FOA H, AdmB, F1a:1, 5, 11, 19, KrA.

[92] Draft to the King in Council, 30 May 1959, FOA Ö.

[93] Annual report 1958/59, FOA H.

[94] Memo by Per Svenonius, 19 December 1958, FOA H, AdmB, ÖVII:6, KrA.

[95] Memo by Martin Fehrm to KG Linden, 6 November 1958, FOA Ö.

[96] Memo by Martin Fehrm to KG Linden, 6 November 1958, FOA Ö.

[97] According to the ratio 5:2:3 between the National Statistical Bureau (SCB), the Civil Defence Board (FCF), and FOA, respectively. Memo by Per Svenonius, 19 December 1958, FOA H.

calculations, the Civil Defence Board and the National Statistical Bureau primarily performed administrative data processing. This is one of the reasons that the cooperation fell through.

Buying a computer in the late 1950s was not easy.[98] The delivery time alone was usually a couple of years, and during that time, the computational need might have rushed past the capacity of the mainframe ordered. When the computer finally arrived, it needed much space. Machine halls were several hundred square metres big. The operation cost was high, especially if the computer was rented, a common alternative to buying. It would be an economic disaster to be stuck with a computer that wasn't used. Predictions of future runtime occupation were therefore crucial. The proposed partnership between FOA, the Civil Defence Board, and the National Statistical Bureau was designed through runtime predictions.[99]

The ownership ratio had to reflect the respective use of the mainframe three years ahead of the signing of the deal. And it wasn't easy to predict future computer usage in mainframe runtime hours. There was no unambiguous link between machine capacity and runtime, and new software was constantly popping up, as well as new scientific problems to solve. When it came to the nuclear problems that the Swedish military wanted to solve, there weren't any manuals on how to solve them. The development of small nuclear weapons was at the forefront of international military research.[100] Such computations had the highest level of secrecy, so methods and results were generally not shared between countries.[101]

The discussions on future runtime predictions at FOA are marked by uncertainty and anxiety over being stuck with an inadequate computer. The procurement plans changed swiftly.

In December 1958, Per Svenonius reported that the IBM 7070 – the machine he himself had praised two months before – only had "moderate calculation speed", so a cooperation around such a machine would "be relatively short-lived on FOA's behalf".[102] Svenonius proposed the faster IBM model 709 instead, and a larger share of the machine for FOA.[103] He also urged for the mainframe to be placed at FOA.

The 709 was about 50 per cent more expensive than the 7070 and had higher computational speed, although it belonged to the older non-transistorised series. For

---

[98] See Haigh, "The Chromium-Plated Tabulator."

[99] Memo by Per Svenonius, 19 December 1958, FOA H.

[100] In a report, Svenonius refers to the scientists at Los Alamos and their struggle with the same equations. Report CH 2004–2018, 3 February 1959, FOA H, Avdelning 4 Rapportcentralen (Avd 4 RapportC), B2:1, KrA.

[101] See Daniels Mario and John Krige, *Knowledge Regulation and National Security in Postwar America* (Chicago: University of Chicago Press, 2022).

[102] Memo by Per Svenonius, 19 December 1958, FOA H.

[103] 35:25:40 instead of 5:2:3 for SCB:FCF:FOA.

FOA, the new proposal meant faster problem-solving and more runtime. On the other hand, it wasn't as much of an upgrade for the Civil Defence Board and the National Statistical Bureau. The cost of the new proposal increased by 43 per cent, so the National Statistical Bureau diminished its share by 43 per cent. Administrative data processing wasn't as dependent on computational capacity as scientific data processing. The cost mattered much more.

When Director-General of FOA, Martin Fehrm, addressed the financial situation in a memo to the Ministry of Defence concerning FOA's computer procurement plans, he remarked that it was impossible to do a profitability analysis for scientific data processing.[104] Such an analysis could be done for administrative data processing, which aimed to speed up processes previously performed manually. If a computer enabled scientific calculations that had never been performed before, there was nothing to compare. Efficiency lost its meaning. Can you put a price on new scientific insights?

For the National Statistical Bureau, a computer provided streamlining. A more rational organisation of work and diminished personnel costs. To a certain extent, computer capacity was of course important, but factors such as manageable output systems or existing programming knowledge mattered more. At FOA, computers enabled calculations that had never been computed before. The advantages were more binary; either the calculations could be made or not. Capacity was therefore key. Other aspects of the machine in question could pose problems, but these could be solved, whereas it would be impossible to remedy a mainframe too slow for its purpose.

While the Civil Defence Board and the National Statistical Bureau were content with the procurement plans, FOA kept changing them. In March 1959, Svenonius proposed a 7090 – again, the new model, to be released in December that year – instead of the 709.[105] Compared to the other institutions, FOA had the most specific requirements. Without enough capacity, they could not solve their equations. FOA also accessed IBM's latest mainframes and heard about new model releases during their visits to the IBM European office in Paris. Between September 1958 and June 1959, when the deal between FOA and IBM was sealed, FOA representatives undertook three trips to IBM's Paris office.[106] Birger Jansson participated in all of them. The reasons for these trips were foremost to compute problems so time-consuming and complicated that they couldn't be solved efficiently on Swedish computers.[107]

---

[104] Memo by Martin Fehrm to KG Linden, 6 November 1958, FOA Ö.

[105] Report C 2019–2018, 16 March 1959, FOA Ö, Avd 4 RapportC, B2:1, KrA.

[106] B Jansson & L Bowallius, December 1958; B Jansson & U Jismarck, February 1959; B Jansson, O Carlstedt, B Engström & H Brändström, June 1959, Annual report 1958/59, FOA H.

[107] These are described as operations research problems in the travel announcements. See for example To Statsrådet och Chefen för försvarsdepartementet, 3 November 1958, FOA Ö, AdmB, FIIa:1, KrA.

Jansson thus had first-hand experiences of the improvements in each IBM model – the 709 was launched in the fall of 1958 and the 7090 marketed shortly thereafter – and the effects on his own research from such improvements. It wasn't strange to yearn for the next generation mainframe. This yearning, in combination with the priority given to the nuclear research programme, would result in the fall-through of FOA's cooperation with the Civil Defence Board and the National Statistical Bureau, and the procurement of an IBM 7090 for FOA to administer alone.

2.5 Finding a Solution in the Nuclear Research Programme

In the late 1950s, many research areas at FOA craved computational capacity. Calculations of trajectories for ballistic robots, supreme aircraft command, reconnaissance disturbance, predictions and statistical analyses within operations research.[108] The possibilities opened up by advanced computers attracted researchers at all FOA's departments.

But in the end, if the choice of computer for the FOA data processing centre was reduced to the solution of one equation, that would be the Boltzmann equation. Devised by Ludwig Boltzmann in 1872, it describes the motion of chaotic particles. Particles outside the calm orderliness of thermal equilibrium, taking part in violent processes where heat flows from hot to cold regions, and probability is the only certainty there is. There are no practicable analytic solutions to Boltzmann's equation because there is no exactness in such processes.[109] To predict the development, one must resort to numerical methods – rows upon rows of numbers desperately needing data processing.

In February 1959, Per Svenonius wrote a report on the data processing required to solve this equation, which is fundamental for constructing small nuclear weapons.[110] Small atomic bombs – designed to be attached to missiles, for example – were in the late 1950s a topic of theoretical exploration, in the US, the Soviet Union, and Sweden. The bombs that destroyed Hiroshima and Nagasaki in 1945 were developed from the same fundamental equations as smaller nuclear weapons. Still, the initial conditions and the numerical processes were not the same. For the FOA researchers, the unknown parts of this theoretical framework made the predictions of its implementation uncertain. The computational scale of this type of research risked suddenly skyrocketing. This is what Svenonius had just observed.

---

[108] Annual report 1958/59, FOA H.

[109] Exact solutions only exist in very special cases, see for example Philip T. Gressman and Robert M. Strain, "Global Classical Solutions of the Boltzmann Equation with Long-Range Interactions," *Proceedings of the National Academy of Sciences* 107, no. 13 (2010).

[110] Report CH 2004–2018, 3 February 1959, FOA H.

His report was sent to Martin Fehrm, the planning department FOA P, and the selected divisions of the physics and nuclear departments FOA 2 and 4. Svenonius reported on the critical size of the fission charges, the following reactor process, and the thus induced chain reaction in an atomic bomb explosion. He estimated the runtime required to solve the equations in question on two computers: the Facit EDB (a copy of Besk, used as a reference) and the IBM 709, the computer planned to be split by FOA, the National Statistical Bureau, and the Civil Defence Board. Based on his own research and discussions with colleagues, Svenonius concluded that even the IBM 709 – a 10 million Swedish krona mainframe, five times faster than the Swedish-built Facit – was too slow.[111] He called the 709 "on the verge of being unacceptable".[112]

A single calculation would take 70 hours to solve. This meant that the nuclear calculations alone would fill up, and in fact exceed, the entire runtime on FOA's 709-share. Furthermore, such long runs would be practically inconvenient in a jointly owned data processing centre:

> Out of consideration for other runtime consumers, it can be challenging to carry out 10 to 100-hour-long runs if the establishment cannot operate 24 hours a day when needed. In practice, this means that a transition to several run shifts will soon be urgent. In terms of costs, significant benefits could be achieved if the entire establishment was purchased from the start.[113]

Access to the computer only 40 per cent a day, which was FOA's planned share of the 709, was not viable when 100 hours of long calculations were made.[114] Svenonius didn't mention secrecy issues, but surely such calculations would have been surrounded by secrecy, making cooperation with the civilian National Statistical Bureau inconvenient.

A fear of wholly occupying the mainframe too soon also shines through in Svenonius' report. Several run shifts were expensive, due to maintenance, personnel, and the bigger premises required to host the extra staff. And when all shifts were occupied, yet another, more powerful, more expensive computer had to be bought. No one doubted the rise of FOA's future computer needs.

In Svenonius' report, the IBM 709 was discarded as inadequate, even if FOA were to dispose of the computer alone. Around the same time the report was issued, IBM

---

[111] The cost of mainframes depended on a variety of choices, the size of the external memories being the most decisive. The sum of 10 million Swedish krona is taken from the procurement plans for the shared data processing centre, including a specified external memory.

[112] Report CH 2004–2018, 3 February 1959, FOA H, 5.

[113] Report CH 2004–2018, 3 February 1959, FOA H, 6.

[114] In a later report, Svenonius estimates that between 30 and 100 of the most time-consuming computations had to be done per year. Report C 2019–2018, 16 March 1959, FOA Ö.

announced a new mainframe to be released later that year.[115] The 7090 was a transistorised, updated version of the 709, six times faster than its predecessor. This machine would finally suffice for Svenonius.

March 16, 1959, Svenonius issued another report centred on computing.[116] He suggested that FOA drop the cooperation with the National Statistical Bureau and the Civil Defence Board and purchase an IBM 7090 for themselves. Neither of the two other institutions had investment capital – the idea from the Civil Defence Board was to apply for funding from the defence budget.[117] As described above, the National Statistical Bureau was reluctant to spend money and would have preferred the much cheaper 7070 mainframe.[118] Svenonius thus proposed that the investment capital be taken from FOA's budget, split over five financial years and covered by the S-programme for nuclear research.

The S-programme was the safety programme, formulated to appease the nuclear weapons opponents in the Social Democratic Party, yet substantially overlapping with the L-programme for the construction of Swedish atomic bombs. In March 1959, the Swedish nuclear weapons debate still raged, and the funding of the L-programme was undetermined. The S-programme, however, had broader political backing and would be fully funded in the financial year 1959/60.

Svenonius noted that an IBM 709 had the capacity for around 30 of the most time-consuming nuclear computations per year. He commented:

> Such computations must be executed in the S-programme, and the limitation to 30 cases a year should approximately satisfy the need. However, one ought to notice that the IBM 709 cannot be regarded as overly fast. It is tailored for the S-programme tasks as we apprehend them today. For an effective L-programme, the IBM 709 is inadequate.[119]

It was the L-programme that required an IBM 7090, enabling 100 instead of 30 of the most demanding computations a year. But Svenonius ascertained that it was reasonable to let the S-programme fund the 7090, which was more than three million Swedish krona more expensive than the 709. An advanced computer was still required for the S-programme, which would probably be funded, while the future of the L-programme was more uncertain. Hence, the S-programme could pay for the L-programme

---

[115] The first IBM 7090 was installed in November 1959 and placed at Sylvania Electric Products Inc. in Needham, Massachusetts. Pugh, *Building IBM*, 235.

[116] Report C 2019–2018, 16 March 1959, FOA Ö.

[117] This is described by Svenonius in Report C 2019–2018, 16 March 1959, FOA Ö.

[118] The National Statistical Bureau ended up buying an IBM 7020 in 1959.

[119] Report C 2019–2018, 16 March 1959, FOA Ö, 5.

computer. The extra millions were cleverly hidden in the financial plan Svenonius proposed.[120] Since additional equipment like external memories was costly, a mainframe purchase provided flexibility regarding initial investment capital. The final cost of such a computer system could differ as much as a couple of million krona depending on the choices made, and capacity-enhancing add-ons could always be purchased later. Moreover, a mainframe could be partly bought and partly rented, thereby distributing the investment capital over different financial years.

Svenonius' report was sent to Martin Fehrm, who apparently liked the idea, since he proposed a similar arrangement to the Swedish government on 30 May 1959.[121] By then, discussions with IBM on renting and purchasing conditions had resulted in a final sum of 15 million Swedish krona for the IBM 7090 with desired add-ons.[122] This sum was split over six financial years, from 1958/59 (which was approaching its very end) to 1963/64. The financial request from FOA to the Swedish government was five million krona – the rest could be covered by the budgets already made.[123] In the request, Fehrm emphasised the computational demands of FOA's nuclear research as the motivation to buy the computer.

On the 26th of June 1959, FOA ordered the 7090 from IBM, to be delivered two years later.[124] An arrangement like this for such a tremendously expensive mainframe would have been much more complex for other Swedish public administration branches. FOA had an unusual level of autonomy within the Swedish military and the Swedish state overall. The Supreme Commander of the Armed Forces formally had directive power over the administrative military agencies and the armed services – but not over FOA.[125] Even though the Supreme Commander had suggested this should also apply to FOA, his proposal never made it into the revised instructions for all military agencies that followed the 1958 defence decision.[126] Regarding budget issues, FOA answered directly to the government, unlike almost all other military institutions.[127]

While officials from the Civil Defence Board suggested requesting the investment capital for a shared data processing centre from the defence budget, the FOA researchers had a straighter line to receive financial means. In the summer of 1959, the economic situation at FOA seemed very promising, especially for FOA 2 and 4, the physics and nuclear departments. Their budgets tripled from 1958/59 to 1961/62,

---

[120] Report C 2019–2018, 16 March 1959, FOA Ö.
[121] Draft to the King in Council, 30 May 1959, FOA Ö.
[122] The negotiations between FOA and IBM are found in FOA Ö, AdmB, FIIa:11, KrA.
[123] Draft to the King in Council, 30 May 1959, FOA Ö.
[124] Agreement between IBM and FOA, 29 June 1959, FOA Ö, AdmB, FIIa:11, KrA.
[125] SOU 1960:12, Krigsmaktens högsta ledning: Betänkande avgivet av 1958 års försvarsledningskommitté, 171.
[126] SOU 1960:12.
[127] SOU 1960:12, appendix 8.

whereas FOA 1 and 3 (chemistry and electronics) had steady expenses during the same time.[128]

The Swedish military prioritised military research and technology development – the scientification process of the military put FOA in a privileged position. Resources flowed from the Army Supply and the compulsory military service to large-scale military-industrial projects and research institutes like FOA, and especially, despite the political turmoil, to nuclear research.[129]

However, the civilian collaborator that FOA abandoned in March 1959 wasn't entirely sidelined. The National Statistical Bureau eventually purchased an IBM 7020, thus contributing to the Swedish government's early interest in IBM mainframes.[130] Although slower and cheaper than the 7090, the 7020 turned the National Statistical Bureau into a hotspot for administrative data processing – and one not dependent on FOA. Advanced data processing was in no way exclusive to military research.

But a military research institute like FOA had much freedom in terms of technical choices. Unlike scientific and technical data processing, administrative data processing within the Swedish state was supposed to be coordinated by the Data Processing Committee, set up in 1955. Its mission was to spread computing knowledge, connect interested parties, and direct the organisation of data processing centres.[131] FOA's data processing was out of the committee's scope and expertise. In May 1959, Torsten Magnusson and Per Svenonius simply reported their plans to purchase an IBM 7090 to the Data Processing Committee.[132] No further discussions or reviews were needed.

The computer itself, the IBM 7090, was also tied to advanced military research in several ways. Not only did it calculate trajectories for NASA's space race, but it was also produced because of a major cooperation between IBM and the United States Atomic Energy Commission. In the so-called "Project Stretch," IBM was contracted to develop a supercomputer for the Los Alamos Scientific Laboratory, the famous US site for research on and construction of atomic bombs.[133] The project led to the development of the transistorised 7000-series, which was quite successful commercially (and not constrained to military research). The first model out was the 7090, which was first installed in November 1959 at the US corporation Sylvania Electric Products for use in

---

[128] See Lundin and Gribbe, *Att följa pengarna*, 43.

[129] SOU 1960:23, Besparingar inom försvaret: Betänkande avgivet av 1959 års besparingsutredning för försvaret. See also Agrell, *Vetenskapen i försvarets tjänst*, 147.

[130] Kaijser et al., *Maktens maskiner*, 51.

[131] SOU 1962:32, Automatisk databehandling: Betänkande avgivet av kommittén för maskinell databehandling, 11–13.

[132] From Kommittén för maskinell databehandling to FOA, 31 July 1959, FOA Ö, AdmB, FIIa:11, KrA.

[133] Pugh, *Building IBM*, 232–36. See also Donald MacKenzie, "The Influence of the Los Alamos and Livermore National Labs on Supercomputing," *Annals of the History of Computing, IEEE* 13, no. 2 (1991).

a warning system for ballistic missiles. Although the supercomputer eventually delivered to Los Alamos was a 7030 (called "the Stretch"), seven times faster than the 7090, the entire 7000-series owed its existence to US military research.[134]

FOA also had major knowledge exchanges with US military research institutes. In his thesis, Eric Bergelin mapped the connections between FOA and Rand Corporation and interpreted them as parts of a transnational circuitry of knowledge.[135] Head of FOA's nuclear department Torsten Magnusson actively participated in this network-building. For example, in 1960, he went to the US for a 64-day-long trip where he visited Rand and discussed the development of small nuclear weapons.[136]

Science and technology played significant roles in the relations between Sweden and the US during the Cold War.[137] Travels and personal relationships often constituted the foundation of scientific and technical knowledge exchange, while export restrictions functioned as a brake shoe.[138] IBM machines were, however, commercial computers. Although they were part of highly secretive military operations, they could also be used for entirely different things. Purchasing a 7090 mainframe provided calculation possibilities, but no aid in formulating, coding or executing specific calculations. The universality of computers in 1959 made them very different from military technologies like missiles, whose import regulations were far more dependent on political negotiations and Swedish-US relations.[139]

Although nuclear computations were central in the process leading up to the purchase of the IBM 7090, the computer itself was not seen as a nuclear technology. For the FOA researchers, the 7090 opened up possibilities in many different research fields. The operations research team at FOA went to the Paris IBM office six times between August 1959 and June 1960, to run their programs on a computer similar to the one they had ordered.[140] The travels were described as necessary – the computations were so time-consuming and advanced that running them on Swedish computers was

---

[134] Pugh, *Building IBM*, 235.

[135] Bergelin, *Planeringsforskningens genombrott*. See also John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe* (Cambridge, Mass.: MIT Press, 2006).

[136] Travel announcement for Torsten Magnusson and Per Svenonius, FOA H, AdmB, F1a:12, KrA.

[137] The question of Sweden's dominating foreign policy during the Cold War, the freedom from military alliances, was for example elucidated by scholars analysing the technological cooperations between Sweden and the Western countries. See for example Dalsjö, *Life-line Lost*; Weinberger, "The Neutrality Flagpole."

[138] See for example Mikael Nilsson, *Tools of Hegemony: Military Technology and Swedish-American Security Relations, 1945–1962* (Stockholm: PhD diss.: Kungliga tekniska högskolan, 2007). Tore Li, *Government and Research: The Evolution of Involvement in Europe and the United States* (Oslo: Linquiry publications, 2017).

[139] Nilsson, *Tools of Hegemony*.

[140] U Jismarck August 1959; B Jansson September 1959; B Jansson & P O Nilsson December 1959; B Jansson, E K Boestad-Nilsson & P O Nilsson February 1960; B Jansson, P O Nilsson, M Ekbohm, L Grape, G Persson, March/April 1960; B Jansson, G Galvenius, M Ekbohm, L Grape, E Sundin, G Persson, H Hansson, June 1960. Annual report 1959/60, FOA H, AdmB, F1a:11, KrA.

no option.[141] This shows that nuclear computations were far from the only computations at FOA that required a powerful computer.

When computing pioneer Elsa-Karin Boestad Nilsson in 2007 remembered the internal negotiations leading up to the procurement of the IBM 7090 at FOA, she described Torsten Magnusson as: "the strongest one, so the nuclear physics calculations were prioritised".[142] Rather than being a testimony of Magnusson's character, her comment indicates the prioritisation within the Swedish government at this time. Nuclear research had escaped the growing opposition against atomic bombs and was therefore attracting the money necessary for the computer that everyone at the calculation divisions at FOA wanted for their own reasons. Motivating the computer's significance for nuclear research enabled its procurement.

2.6 Conclusion

Computing work was part of FOA's operation from the agency's establishment in 1945. The three original departments – centred on physics, chemistry, and radar and electronics – all had significant computational needs. The FOA data processing centre, inaugurated in 1961, marked a decisive change in computing work organisation, rather than a starting point. Before establishing the centre, FOA had both computing technologies, such as the differential analyser Freda, and institutionalised teams dealing with computing. The calculation division at the physics department was from 1948 home to FOA's first computing pioneers. The physics department, and later on its two spinoff departments for nuclear research and strategic planning, were most active in establishing the FOA data processing centre.

While Freda was the most essential in-house computing machine, most computing work at FOA was initially performed at Besk, administered by the Swedish Board for Computing Machinery, and at the IBM 650 belonging to the Royal Air Force Board. This chapter shows how the experiences of coding the IBM 650 were decisive for FOA's computing pioneers. The 650's flexible code interpreter and manageable number representation led FOA to an IBM-specific path.

The purchase of the IBM 7090 marks the end of an era. The Swedish computer industry stepped down and opened the scene to Big Blue, a powerful multinational company. IBM won market shares by pioneering the standardisation of machines – mass-producing models like the 650 – and developing universal software like Fortran.

---

[141] Annual report 1958/59, FOA H.

[142] Elsa-Karin Boestad-Nilsson in Gribbe, *Att modellera slagfältet*, 17.

The European IBM office in Paris was an important place for FOA researchers. There, they got access to the most recent and advanced IBM mainframes and learned how to handle them practically. I have shown how travel and practical handling of computers were crucial both in the planning process for the data processing centre and in the accumulation of computing knowledge necessary for running such a centre.

Although the desire to have their own computer emerged earlier, the plans for a data processing centre at FOA were consolidated in 1957. When Besk and the IBM 650 began to be fully occupied, computing capacity became a scarce resource. That conception would stick. The fear of lacking capacity made Svenonius and Jansson change their procurement plans several times. This is linked to the nature of scientific and technical data processing. Such data processing not only sped up data management, like administrative data processing did, but also enabled new problems to be solved.

The purchase of such an advanced mainframe as the IBM 7090 was made possible by the political situation in Sweden at this time. I argue that the resources given to computing technology at FOA were made available by the Social Democratic Party's handling of the Cold War threats and by its internal power struggles. Allocating resources to protective nuclear research was a compromise everybody could agree upon, with enough flexibility to encompass other kinds of research too.

It was the L-programme, the research programme for constructing Swedish nuclear weapons, that required the advanced 7090 mainframe. In Swedish military history, several studies have focused on FOA's atomic research programme and the cleverly concealed plans for continuous construction of nuclear weapons, despite the strong political opposition against it.[143] Although my findings in general fit well with these conclusions, they do not primarily contribute to that scholarly discussion. When the IBM 7090 was ordered in the summer of 1959, neither the weapons construction nor the nuclear safety programme (the S-programme) had been approved by the government. Instead, the 7090 purchase indicates FOA's favourable position in the late 1950s and the FOA researchers' pragmatic attitudes to politics. Nuclear research – whether directed to weapons development or protection – had wind under its sails in 1959. FOA's nuclear research department was the most resourceful at the agency – why not use those resources to get the best computer available? The exact formulations on what it was intended for could be tailored to the situation, and its actual use would remain to be seen.

Without the generous funding for nuclear research, FOA would not have afforded such an expensive computer. A data processing centre could have been established in

---

[143] Agrell, *Svenska förintelsevapen*; Jonter, *The Key to Nuclear Restraint.*

such a scenario, but it is more likely that it would have been shared and centred around the cheaper 7070 or the 709 instead. Therefore, I identify the militarisation of Swedish research and the scientification of the Swedish military as key explanations for the organisation of computing work at FOA.

These two historical processes are, in turn, enactments of political action that present the image of Sweden as a strong, neutral country. Swedish neutrality has also been much debated by historians – to what extent the rhetoric of freedom from military alliances reflected the foreign policy conducted in practice – but the key point in this analysis is that neutrality was such a robust conception in postwar Sweden. If Sweden was an essentially neutral country, any armament – even nuclear – was a means to protect the Swedish people. The political action stemming from the myth of neutrality, captured by the militarisation and scientification processes described here, resulted in the concrete design of the FOA data processing centre.

The IBM 7090 turned FOA into a critical node of the rapidly expanding computing community. The mainframe also turned out to be crucial for how work was conducted, organised, and conceptualised within the FOA data processing centre. Its large capacity required a constant flow of data. The next chapter will follow this flow, and the people who enabled it.

3 Serving the Mainframe at the FOA Data Processing Centre, 1961–1968

During the inauguration of the FOA data processing centre in 1961, the head of the centre, Per Svenonius, held a speech. Many years later, a member of the audience that day remembered Svenonius saying: "This computer has the same capacity as one million calculation assistants, the difference is that the computer is possible to manage".[1] A striking picture: one million women – calculation assistants were almost invariably female – hiding inside the metal boxes of the mainframe, all obedient and perfectly synched. Possible to manage, as Svenonius put it.

Although the levers and switches of the IBM 7090 installed in FOA's basement at Linnégatan 89 in Stockholm never argued with each other or opposed instructions, the machine had its problems. It heated up and then shut down if it wasn't appropriately cooled. Despite its carefully designed environment, every vibration and little speck of dust posed serious threats to the operation. The mainframe's calculation rate turned out to be vastly higher than the speed with which one could give it stuff to calculate. The advanced mainframe often stood there unused, silently mocking its owners. And whenever the tiniest loophole was left in the code inserted into the machine, an error appeared.

Soon it became apparent to everyone involved that the IBM 7090 couldn't really do anything on its own. As Thomas Haigh put it, "The only thing that early computers could be relied on to do was break down."[2] Getting this wondrous new machine to function required a lot of human work. Some of it was performed by the same calculation assistants the computer was intended to replace; some by new employees, such as operators, secretaries, and mathematicians. This chapter is about their work. How was a computing problem handled, and who did what with it? What were considered problems in the daily operation, and which goals guided it? The aim is to understand how computing work developed at the FOA data processing centre. Work practices, the practical organisation of work, and conceptualisations of computing are all at play here.

---

[1] Björn Kleist remembered the inauguration speech in Lundin, *Tidig programmering*, 19. The "calculation assistants" were called *räknebiträden* in Swedish, and the English term is therefore a somewhat rough but direct translation. The proper English word for this workforce was "computer."

[2] Haigh, "The Chromium-Plated Tabulator," 88.

The period I study is 1961 to 1968, when the QZ replaced the FOA data processing centre. I show that it wasn't the brute calculation capacity of the IBM 7090 that rendered the data centre inadequate, but everything besides the mainframe: the difficulties ordering runs, the long waiting time when administering data input and output, the inconvenient premises, the heat. The establishment of the QZ, the topic of the next chapter, was not primarily caused by the need for a better mainframe, but by the need for a better-organised data centre.

Whereas I analyse the organisation of work, the historical actors themselves were more concerned about the organisation of data. As many historians have shown, data is messy.[3] In the 1960s, data was also heavy. A box full of punched cards weighed ten kilos, and data transportation required a system of elevators, dispatch cars, and strong hands. When someone dropped a box, the logistical chain broke down.

Such obstacles to a planned outcome are sometimes described as *friction*. It is a metaphor borrowed from physics, where work is defined as the movement of matter and friction as the resistance to movement stemming from the local particularities of the surface on which matter moves. Philosopher Ludwig Wittgenstein used the friction metaphor to account for all the obstacles to linguistic communication: misunderstandings, interpretational confusion, misspellings, and untranslatable expressions.[4] However, his aim was not to highlight the hindrance of an otherwise smooth transfer of information, but rather to show that friction is the existential condition of human communication. Without linguistic friction, language would be empty and drained of meaning. Since then, anthropologist Anna Tsing has continued this path, by seeing friction as a driving force to interhuman understanding in a global world.[5]

When it comes to data transfers, historian of science Paul N. Edwards uses friction to account for all the misfortunes and obstacles that occur along the way. To Edwards, *computational friction* represents the events in which energy and information that could have been used to produce scientific knowledge are instead irretrievably lost: coding errors, number conversions, heat dissipating from the machines.[6] A notable sub-category of computational friction is *data friction*, corresponding to the time and energy

---

[3] See for example Aronova, "Geophysical Datascapes of the Cold War."; Strasser and Edwards, "Big Data Is the Answer … But What Is the Question?"

[4] Ludwig Wittgenstein, *Philosophical Investigations*, trans. Anscombe Wittgenstein, 3 ed. (Oxford: Blackwell, 1968 [1953]), § 107.

[5] Anna Lowenhaupt Tsing, *Friction: An Ethnography of Global Connection* (Princeton: Princeton University Press, 2005).

[6] Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, Mass.: MIT Press, 2010). The tradition to denote human misfortunes as friction goes back to war philosopher Carl von Clausewitz in the early 19th century, Carl von Clausewitz et al., *On War* (Princeton: Princeton University Press, 1989).

slippages related to data administration: input, output, transfer, and storage.[7] In Edward's terminology, dropping a box full of punched cards is an example of data friction.

In this chapter, I use Edwards' notion of computational and data friction to explain the motivation for reorganising work at the FOA data processing centre. While Edwards primarily sees friction as a hindrance to producing scientific results, I am instead inspired by Wittgenstein and Tsing's interpretation of friction as a driving force to development. Data friction at the FOA data processing centre was handled mainly by working-class occupational groups such as punched card operators, machine operators, assistants, and office guards, etc. They were *labouring* in the common use of the world: performing manual and quite depreciated work. They also laboured in Hannah Arendt's sense since their efforts maintained the mainframe's cyclic consumption of data. When interpreting data friction as a driving force to development, the human labour dealing with this friction becomes an integral part of a data processing centre's operation.

Rediscovering the importance of such professions is a relatively recent scholarly mission. Peter Galison was one of the first to value the work of the so-called "scanning girls" at experimental physics labs, and he did so by showcasing the skill set required to evaluate scanned images.[8] The use of the word "girls" here is telling: scanners were a feminised workforce. So were the "systems service girls" dealing with data input and output in US data processing centres during the Cold War, that Janet Abbate noticed.[9] Wherever women are found in computing history, there is a historical tendency to categorise their work as mechanical and insignificant, and a scholarly response to look for its creative and intellectual aspects.[10] Low-paid women working with data were not only sorting cards but also creating logical systems for data handling.[11]

This chapter presents a group of female FOA employees quite unlike Galison's scanning girls. Many had formal merits and high salaries and did not primarily deal with data friction. They performed work, not labour, in Arendt's terminology. At the FOA data processing centre, labour was not tied to femininity.

After first providing an overview of the institutional organisation and use of the FOA data processing centre, this chapter explores the work team that coded most internal computing jobs and mainly consisted of women. Next, the chapter moves into

---

[7] Edwards, *A Vast Machine*, 84.

[8] Galison, *Image and Logic*, Ch. 5.8.

[9] Abbate, *Recoding Gender*, 63.

[10] See Abbate, *Recoding Gender*; Hicks, *Programmed Inequality*; Hicks, "The Baby and the Black Box."; Ensmenger, *The Computer Boys Take Over*.

[11] See for example Schlombs, "Built on the Hands of Women." This goes back to the re-interpretation of the skills of the all-female team working with the Eniac, Light, "When Computers Were Women." See also Grier, *When Computers Were Human*; Abbate, *Recoding Gender*; Haigh, Priestley, and Rope, *ENIAC in Action*.

the machine hall and follows the transformation from code to input data and output data to results. Finally, it explores the operational evaluations performed by employees of the centre and the changing user distribution.

3.1 Financial, Administrative, and Spatial Organisation

The IBM 7090 was ordered in the summer of 1959. It was to be delivered two years later. In the meantime, the formal organisation of the new data processing centre was planned at FOA. On May 20, 1960, Birger Jansson and Elsa-Karin Boestad-Nilsson established the 7090 council, a board and discussion forum for the new data processing centre.[12] Jansson had by then transferred from FOA 2 to FOA P, the planning department. Elsa-Karin Boestad-Nilsson (1925–2020) began working at FOA in 1948, after studying mathematics and physics, and stayed there for 42 years. During that time, she advanced from research engineer to head of the mathematics and data processing department, established in 1974. Boestad-Nilsson has recently been celebrated as a feminist pioneer, encouraging female colleagues to seek promotions and actively engaging in the women's liberation movement.[13]

In 1960, Boestad-Nilsson led the calculation division at FOA 2, the physics department, where Jansson had also started his FOA career. He was then responsible for computations at FOA P. The other members of the 7090 council were Per Svenonius, Stig Ek (1921–2001), and Lars Henning Zetterberg (1925–2017). Svenonius was then head of numerical analysis at FOA 4, the nuclear department. Stig Ek was chief engineer at FOA 1, the chemistry department, and Lars Henning Zetterberg was *laborator* (corresponding to associate professor) at FOA 3, the electronics department. Both positions were highly esteemed. The council's chairman was Torsten Magnusson, head of the nuclear department and to-be Director-General for the entire agency. Jansson and Boestad-Nilsson also invited a member of the Defence Council to attend their meetings.[14]

The participants in the 7090 council meetings varied – if someone couldn't make it, a substitute attended the meeting. If topics on the agenda concerned someone else at

---

[12] Memo by Birger Jansson and Elsa-Karin Boestad-Nilsson, 20 May 1960, FOA Ö, CentralK, F7a:1, KrA.

[13] See for example Ulla Karlsson-Ottoson, "Binär pionjär," *Teknikhistoria*, 2015; Joanna Rose, "Kvinnorna bakom datorernas genombrott," *Forskning & Framsteg*, 2015; Gunnar Wetterberg, *Ingenjörerna* (Stockholm: Albert Bonniers förlag, 2020). In witness seminars, where Boestad-Nilsson is described as strict: Gribbe, *Att modellera slagfältet*, 23. In interviews with Boestad-Nilsson's friends and co-workers Margareta Franzén, 4 March 2021, and Lena Jönsson, 12 October 2021, Boestad-Nilsson was described as very loyal to her friends but also very "pushy" when it came to career development.

[14] His name was Holger Andersson. Memo by Birger Jansson and Elsa-Karin Boestad-Nilsson, 20 May 1960, FOA Ö.

FOA, they usually stopped by.[15] The council dealt with organisational issues and personnel matters at the data processing centre, but also discussed conferences, collaborations, and software or hardware-related questions. All members were computing experts in different fields. In 1968, the 7090 council was replaced by a data processing council and a programming council, thereby differentiating operational and administrative issues from software coordination and development.[16]

All FOA's departments were represented in the 7090 council. If the nuclear department came across as the most influential in the mainframe procurement process in the previous chapter, the 7090 council reveals an alternate order. Data processing was an activity that concerned the entire research agency in the early 1960s.

The first meeting of the 7090 council took place on 28 September 1960.[17] Several questions had to be sorted out. Who would use the computer? The military, yes, but others too? How should these users access the data centre, and at what cost?

From the beginning, it was evident that the users would pay for runtime on the mainframe. In 1960, Boestad-Nilsson and Jansson stated that "the IBM 7090 will turn FOA into a public enterprise".[18] They compiled a background study for the data centre's financial plan. This study built on their experiences from the three data processing centres they had used in the 1950s: IBM's French headquarters in Paris; the Besk centre in Stockholm, run by the Swedish Board for Computing Machinery; and the Royal Air Force Board's centre in Arboga.[19] All three centres charged users for runtime.

The potential profit from selling data processing was quite spectacular: early (and overly optimistic) estimates neared 40 million Swedish krona annually, comparable to the data centre's investment costs of about 15 million.[20] FOA never became quite so economically successful, but the charging of runtime foreshadowed the commission-based financing that would eventually dominate the agency.[21] Unlike appropriations-based funding, where the government provides revenues, the commission-based model relies on the market. FOA prices and sells its services in the marketplace – usually to the government. The financial model thus functions as another form of government funding.

---

[15] The meeting minutes are found in FOA Ö, CentralK, F7a:1, KrA.

[16] Their tasks are further analysed in Chapter 5, Section 5.3. Minutes programming council no. 1, FOA Ö, CentralK, F7a:7, KrA.

[17] Minutes 7090 council no. 1, FOA Ö, CentralK, F7a:1, KrA.

[18] Memo by Birger Jansson and Elsa-Karin Boestad-Nilsson, 20 May 1960, FOA Ö, 6.

[19] Memo by Birger Jansson and Elsa-Karin Boestad-Nilsson, 20 May 1960, FOA Ö.

[20] The calculation was based on a three-shift (18 hours a day) operation and an hourly cost of 5000 crowns/mainframe hour. Both these assumptions were overly optimistic. Memo by Birger Jansson and Elsa-Karin Boestad-Nilsson, 20 May 1960, FOA Ö.

[21] The funding system was one of many areas that were reorganised over time at the agency, Bergelin, *Planeringsforskningens genombrott*.

Unlike a public enterprise, FOA did not profit directly from the data processing centre. The earnings went to a government fund, from which FOA could apply for reimbursements to cover operational expenses or invest in more equipment or personnel.[22] The centre was financially separated from the rest of the agency – computer users within FOA were charged 540 krona per hour, and the rest of the military would pay "the same price as is applied within FOA, if possible".[23] The appended "if possible" indicates uncertainty. All financial plans were based on runtime predictions that were notoriously hard to compile.[24]

According to an agreement between FOA and the Swedish Board for Computing Machinery, scientific institutions could use the data processing centre for free up until 1963. Then, the Swedish Agency for Administrative Development replaced the Board for Computing Machinery as the government agency overseeing computing equipment.[25] FOA got compensation for the cost price of the academic usage of runtime. For other civilian users, mainframe runtime costs ranged from 2100 to 4500 krona per hour.[26]

Big earnings came from civilian customers, and big earnings in the revenue fund meant favourable conditions for further investments and maintenance work. But civilian customers brought issues too. A meeting protocol from the 7090 council in December 1961 says "[w]ith regards to the secrecy regulations, as few outsiders as possible should be inside the machine hall".[27] "Outsiders", that is, civilian customers, strolling around the data processing centre where secret computer programs lay waiting to be run, might endanger military operations.

The organisation of the data centre had long been a subject of contestation. Should it be a so-called "open shop" or "closed shop"?[28] An open shop was a self-service model: customers prepared their programs and handled (at least some) machines themselves. A closed shop was based on more extensive customer service, where

---

[22] Excerpt from regulation letter, *Statsliggaren* 1961/62, Riksdagsbiblioteket.

[23] Minutes 7090 council no. 9, 31 October 1961, FOA Ö, CentralK, F7a:1, KrA.

[24] In the process leading up to the purchase of the IBM 7090, runtime predictions kept changing (see Chapter 2). This uncertainty lingered after the opening of the data processing centre too, see for example memo by Per Svenonius, 9 December 1963, FOA Ö, CentralK, F7a:14, KrA.

[25] This is mentioned in the minutes of the 7090 council. In the excerpt from the regulation letter in *Statsliggaren* 1961/62 it is said that FOA together with the Board for Computing Machinery should discuss giving scientific institutions free runtime, a suggestion later to be approved by the King in Council.

[26] The prices depended on how regular the customer was and how fast they required delivery of results. For comparison, a monthly salary for a programmer was about 2000 crowns in 1961. Minutes 7090-council no. 9, 31 October 1961, FOA Ö.

[27] Minutes 7090 council no. 10, 5 December 1961, FOA Ö, CentralK, F7a:1, KrA.

[28] The FOA researchers used the English notions of open shop and closed shop when discussing this. This question is presented in the background information given to the 7090 council in May 1960. Memo by Birger Jansson and Elsa-Karin Boestad-Nilsson, 20 May 1960, FOA Ö.

personnel at the data processing centre did much of the coding and all machine handling.

The organisation at Besk, the computer that personnel at FOA used in the 1950s, had been a mix of the two. During the daytime, Besk was a closed shop, where inexperienced customers handed in their problems and received finished results. At night, Besk opened up to the customers who wrote and ran their own programs.[29] Elsa-Karin Boestad-Nilsson and Birger Jansson from FOA belonged to the latter group. So did Stig Comét (1908–1981), mathematician at the National Defence Radio Establishment and member of the Board for Computing Machinery. In a witness seminar, another board member remembered how Comét came at night, turned everyone out, locked the doors, and ran his secret statistical analyses and crypto computations on Besk.[30]

Boestad-Nilsson, Jansson, and the others in the 7090 council used their experiences from Besk when organising their own data processing centre – but they also collected new experiences from abroad. In April 1961, a few months before the installation of the IBM 7090, Per Svenonius and technical manager Åke Götharson visited five European data processing centres. The purpose was to study the different solutions to the "organisational problems" concerning advanced computers.[31]

IBM's French and British offices were on the list. The other data centres belonged to institutions balancing between military and civilian missions: CEN Saclay, part of the French atomic energy programme; the Central Electricity Generating Board, managing Britain's power supply and therefore crucial for the civil defence; and the European subatomic physics centre Cern in Switzerland, an essential node in international nuclear research.[32] The British Atomic Weapons Research Establishment had also been on the itinerary for the FOA representatives, but they weren't granted access there.

Apart from the British IBM office open shop, these centres were either entirely closed or a mix. Svenonius also visited the Rand Corporation in the spring of 1961 – the famous US military research think tank also had a closed data processing centre.[33]

In the travel reports, the question of secrecy does not appear.[34] Svenonius presented the arguments for one organisational principle or another in terms of the most effective use of the mainframe. For example, he noted that Rand's setup benefited program

---

[29] This is remembered by Boestad-Nilsson, see Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 15.

[30] Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 22.

[31] Report A4193–428, April 1961, FOA, Avd 4 RapportC, B1:V8, KrA.

[32] The interconnections between different institutions concerned with French nuclear research, and the tensions between civilian and military interests in the research program, are mapped in Hecht, *The Radiance of France*. For an analysis of Britain's military research and its connection to civilian projects, see Edgerton, *Warfare State*.

[33] Report C4128–0049, August 1961, FOA Ö, CentralK, F7a:14, KrA.

[34] I'm referring to Report A4193–428 and Report C4128–0049, see above.

quality but generated queues.[35] The internal discussions on how to organise the FOA data processing centre are marked by a distanced rationality: economic estimates, predictions of efficiency, and quantitative comparisons of programming time and machine costs. But in the end, practical delimitations determined the organisation of the FOA data processing centre.

A closed shop – where only FOA personnel had access to the machine hall – wasn't proven to enable the most efficient organisation; it was the only practical way to uphold the secrecy regulations at FOA. Since the machine hall was placed in the basement of the north wing at the FOA headquarters, all visitors had to pass several security doors to get there.[36] People without clearance – civilian customers – could easily visit the guard at ground level, but to pass that point would require a whole new system of keys and checkpoints. The FOA data processing centres thus became a closed shop operation.

Customers handed in their orders and picked up the results at ground level, while those employed in the machine hall in the basement had to go through security background checks. Had the location of the machine hall been another – or the spatial form of the security system different – it's not sure that the data processing centre would have been closed to civilian customers. But a FOA data centre was much harder to make flexible for both civilian and military users than a data centre run by the Swedish Board for Computing Machinery. It's easier to get people out of a civilian room – like Stig Comét from the National Defence Radio Establishment did at Besk's machine hall – than to let people into a military room. The debate over an open versus a closed system for the FOA data processing centre is an example of the contestations following secrecy regulations of scientific activities. As historian of science Alex Wellerstein notes, secrecy and science have always been hard to combine, and doing so has led to new and highly contested scientific regimes.[37]

In FOA's case, the secrecy regulations influenced the organisational framework for scientific computing. When the FOA data processing centre was inaugurated in 1961, Per Svenonius became head of operations and its roughly thirty employees.[38] They were responsible for customer programming and administration, data handling and machine operation, and program optimisation.

The FOA data processing centre was, formally, a computation service centre for the Swedish military. Internal FOA computations made up almost three-quarters of the total

---

[35] Report C4128–0049, August 1961, FOA Ö.

[36] A map of the different facilities at the FOA headquarter is available in "Forskarträff på FOA-dag," *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 1 (1963). The passage of security doors was remembered by Björn Kleist during an interview on zoom, 1 October 2021.

[37] Alex Wellerstein, *Restricted Data: The History of Nuclear Secrecy in the United States* (Chicago: University of Chicago Press, 2021).

[38] More about them in Section 3.3. Draft by Björn Kleist, 17 December 1963, FOA Ö, CentralK, F7a:14, KrA.

runtime in 1963.[39] The remaining runtime was split equally between military and civilian users, although that demarcation is notoriously hard to make. The FOA data processing centre's regulation letters applied different guidelines for users "within the Ministry of Defence's field of activity" and "other" users.[40] But how far did that field of activity reach? Some of the data centre's users were part of the Swedish military. For example, the Royal Air Force Board used it to solve computing problems that were too advanced for their own IBM 650.[41] Others, like the industrial company Tuab or the telecom company Teleutrednings AB, were civilian but contributed to military technological development.[42] Then, there were civilian users with civil defence missions, such as the Swedish State Power Board and the Swedish State Railways.

Academic users of the FOA data processing centre amounted to one-tenth of the total external runtime.[43] They came from the Royal Institute of Technology, Stockholm University, Uppsala University, Chalmers University of Technology, and Karolinska University Hospital. The most common users were from inorganic chemistry and theoretical physics departments, but some social scientists visited the centre too.[44] Besides the academic users, one other organisation was allowed free runtime at the 7090: IBM. This was part of a deal between IBM and FOA. IBM lent out technical specialist Björn Kleist to FOA, and in turn got free runtime on the 7090 to spend on demos and test runs.[45] They were given about the same amount of runtime as the universities.[46]

A diverse set of users thus frequented the FOA data processing centre. Even individual clients could use the FOA data processing centre if they went through the Swedish Board for Computing Machinery.[47] In that sense, the centre resembled Besk: a computer intended for military use, but with a broad mix of industrial, academic, and military users.[48] However, most orders at the FOA data processing centre still came from within FOA. The execution chain for these computations looked a bit different. Usually, before they reached the data centre, they had passed through FOA's physics calculation division, led by Elsa-Karin Boestad-Nilsson.

---

[39] "Kostnader och intäkter för FOA datacentral 1963/64," FOA Ö, CentralK, F7a:15, KrA.

[40] The Swedish formulation was "Försvarsdepartementets verksamhetsområde." *Statsliggaren*, 1961/62.

[41] For a full list of users at the FOA data processing centre, see "Förteckning över kunder vid datacentralen 1961/62," 18 July 1962, FOA Ö, CentralK, F7a:14, KrA.

[42] Both these companies contributed to military aircraft development. In the 1960s, the biggest military research project in Sweden was the development of the fighter aircraft Saab 37 Viggen, and this project involved numerous different companies and military institutions. See Dörfer, *System 37 Viggen*; Gribbe, *Stril 60*.

[43] "Förteckning över kunder vid datacentralen 1961/62," 18 July 1962, FOA Ö.

[44] The social scientists came from the State Council of Social Sciences.

[45] Contract between IBM and FOA, 28 April 1961, FOA Ö, CentralK, F7a:14, KrA.

[46] "Förteckning över kunder vid datacentralen 1961/62," 18 July 1962, FOA Ö.

[47] The Swedish Board for Computing Machinery had in 1962 placed an order of 3000 minutes for non-governmental clients, which wasn't further specified. "Förteckning över kunder vid datacentralen 1961/62," 18 July 1962, FOA Ö.

[48] See Kaijser et al., *Maktens maskiner*, Ch. 3.

3.2 The Female Enclave in Swedish Military Research

In a 1963 FOA company paper, two pages were dedicated to the women employed at the agency. The reader encountered nine female experts in various research fields, whose presence at FOA was described as "a bit surprising given the somewhat 'warlike' activity pursued". [49] One of them was Elsa-Karin Boestad-Nilsson, wittingly named "the Calculating Woman", and head of the physics calculation division that Jansson pioneered in 1948.

There were initially three calculation divisions at FOA: Jansson and Boestad-Nilsson's team, performing numerical analysis of automatic control engineering; Per Svenonius' additional team at the physics department, in charge of nuclear computations; and a division at the electronics and radar department, FOA 3, aimed at electrotechnical computations. When the engineers themselves were increasingly handling the specific problems in automatic control engineering – they had access to an analogue computer in the 1950s – Jansson's division broadened their scope and began solving numerical problems from all over the agency.[50] This group was the one regularly using Besk and the IBM 650 at the Royal Air Force Board in the 1950s.

When the new departments FOA P and FOA 4 (for planning and nuclear research, respectively) emerged in the 1958 reorganisation of the agency, Boestad-Nilsson took over the physics calculation division that in practice had become FOA's first computing division. If a FOA researcher had a mathematical problem too complex to be solved directly – either manually or with the computing technologies available at the home department – they usually turned to Boestad-Nilsson's division for help. The team there analysed the numerical methods required to solve the problem and broke down these methods into executable code, translated equations into computer programs. These programs were then brought to the punched card operators at the data processing centre, where they were prepared for execution (more about this in Section 3.3). The results returned to the calculations team, whose expertise was needed to interpret the long lists of numbers that (hopefully) contained the answer to the initial question.

From 1960 to 1970, the physics calculation division doubled its employees from around 20 to 40.[51] As head of the division, Boestad-Nilsson handled recruitment. Years later, she remembered having recruited women almost exclusively, without really reflecting on it.[52] She knew female mathematicians, and they in turn knew other female

---

[49] Åke Olsson, "Ett uppslag för kvinnor," *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 3 (1963).

[50] This is remembered in Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 14–15.

[51] Gribbe, *Att modellera slagfältet*, 9.

[52] Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 16.

mathematicians. “I therefore wonder if all groups consisting of men are results of subconscious processes?” Boestad-Nilsson remarked in 2005.[53]

It was not only Boestad-Nilsson who fondly remembered the unusually feminine atmosphere of the calculation division. The mathematician Lars Odén, for example, recounted how he had asked for his wife’s advice on what to do during the division lunches when all the women knitted while chatting.[54] Why don’t you knit, you too, she said, and taught him crocheting.

In the 1963 interview with Boestad-Nilsson for the FOA company paper, she said, “FOA is a pioneer when it comes to recruiting women to positions where they usually have little representation. […] I, and surely many female colleagues with me, am indeed grateful to FOA for this freedom from prejudice.”[55] It is worth lingering on the positions Boestad-Nilsson was talking about here.

In various scientific and technical work environments at this time, female-dominated teams performed numerical and graphical analysis. Peter Galison recounts how scanning images of particle trajectories in physics labs was a feminised work task. It was conducted by women and considered routine work despite the sometimes advanced interpretation and decision-making required to turn data into images.[56] In 19th and 20th century astronomy, women often compiled numerical tables, categorised stars, and calculated distances.[57] Some of these women have now become famous for discoveries initially attributed to someone else: Henrietta Swan Leavitt, who found a way to measure distances in space, or Katherine Goble Johnson, who calculated the trajectory of NASA’s spaceships during the space race.[58] In computing history, the female Eniac operators have received a similar revival.[59]

Female-dominated occupational groups performing numerical analysis were called computers before the advent of the machine that took over their name.[60] Although the machine did not substitute their work, it transformed their daily practices. They went from performing manual calculations to coding and operating computers. This

---

[53] Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 16.

[54] Gribbe, *Att modellera slagfältet*, 34.

[55] Olsson, "Ett uppslag för kvinnor."

[56] Galison, *Image and Logic*, Ch. 5.8.

[57] See for example E. Dorrit Hoffleit, "Pioneering Women in the Spectral Classification of Stars," *Physics in Perspective* 4, no. 4 (2002). For a Swedish example, see Gustav Holmberg, "Beräkningsarbete," in *Kunskap i rörelse: Kungl. Vetenskapsakademien och skapandet av det moderna samhället*, ed. Johan Kärnfelt; Karl Grandin; Solveig Jülich (Göteborg och Stockholm: Makadam förlag, 2018).

[58] See, for example, George Johnson, *Miss Leavitt's Stars: The Untold Story of the Woman Who Discovered How to Measure the Universe* (New York: W.W. Norton, 2005); Margot Lee Shetterly, *Hidden Figures: The Untold Story of the African American Women Who Helped Win the Space Race* (London: 4th Estate, an imprint of HarperCollins Publishers, 2022).

[59] One of the first to acclaim these women were Light, "When Computers Were Women." See also Abbate, *Recoding Gender*; Haigh, Priestley, and Rope, *ENIAC in Action*.

[60] See Grier, *When Computers Were Human*; Light, "When Computers Were Women."

etymological straight line between work and machine does not exist in Sweden. The computer did not receive its modern Swedish name, *dator*, until the late 1960s.[61] In Swedish, the occupational group corresponding to manual computers was called *räknebiträden*, calculation assistants. A coherent story of how they entered digital computing remains to be written.

Boestad-Nilsson's division shares some characteristics with the above-mentioned occupational groups. It mainly consisted of women, some of whom started as calculation assistants, while others entered at higher positions, such as research engineer. At the agency, they were known as the "calculation girls" (*beräkningstjejer* in Swedish).[62] This denotation falls into the same category as the wide range of computing and office-related workforces, dominated by women and derogatorily referred to as "girls".[63]

One of them was Margareta Franzén (1938–2025). She studied mathematics and physics and took a course in the IBM programming language Fortran before she started as a research engineer at FOA's calculation division in 1960. Franzén stayed at FOA for 37 years, first in the physics department and from its establishment in 1974 in the mathematics and data processing department. She was a close friend of Elsa-Karin Boestad-Nilsson and remembers her as a mentor.[64]

In an interview, Franzén recounted the early interactions between the (female-dominated) calculation division and the (male-dominated) planning department. Once, a physics engineer from FOA P came to the division with a mathematical problem. He dictated a computer program to solve it, but he didn't know much about programming, so it was nonsensical. No one commented on this, but Franzén remembered how they laughed about it afterwards.[65]

This was at the beginning of the 1960s, and the calculation division's position within the agency was about to change. People at FOA – even the physicists at FOA P – learned that their success depended on the programming skills of Boestad-Nilsson's team.[66] In a 1990s celebratory article she was chosen to write, Boestad-Nilsson described data processing as the "cement" holding FOA together.[67] This cement was not only scientific: Franzén and Boestad-Nilsson both met their husbands at FOA.

---

[61] Börje Langefors, Sweden's first professor in information processing, proposed the term in 1969.

[62] The term "calculation girls" was remembered by FOA mathematician Margareta Franzén in an interview, 2021.

[63] Abbate, *Recoding Gender*, 63, 136; Hicks, *Programmed Inequality*, 21–22, 43

[64] Franzén, interview.

[65] Franzén, interview.

[66] This is notable in interviews with both Franzén and her colleague Lena Jönsson, as well as in the witness seminar Gribbe, *Att modellera slagfältet*.

[67] Elsa-Karin Boestad-Nilsson, "Databehandlingen – 'ett kitt för FOA'," in *Försvarets Forskningsanstalt 1945–1995*, ed. Ann Kathrine Littke and Olle Sundström (Stockholm: Försvarets Forskningsanstalt, 1995).

Boestad-Nilsson was a professor's daughter, brought up in the prosperous area Lidingö in Stockholm. She was well-educated. And she recruited acquaintances and friends: Lena Jönsson (b. 1936), another mathematician who started her FOA career at the calculation division, was the smaller sister of Boestad-Nilsson's friend Inga. Jönsson, in turn, knew Franzén. Although this loose network was not confined to Stockholm's upper middle class, it is reasonable to say it was centred there. Unlike punched card operators and janitors, the coders at the calculation division often came from wealthy backgrounds. Not everyone had academic degrees, but many had attended university courses.[68]

The status of the calculation division employees also depended on the shifting attitude towards programming at FOA. In the 1950s, before the arrival of the IBM 7090, programming was still a marginal phenomenon. Few FOA researchers used a computer to solve their problems. Birger Jansson, one of the few with computing experience, stated that hands-on practice was the best way to learn programming. Through trial and error, one got to know the machine, rather than through theoretical studies.[69] Programming was a craft, and its potential was unclear.

In 1963, Per Svenonius held a lecture at the Nordic computing conference NordSAM, where he identified programming skills as the most valuable resource in computing.[70] NordSAM, the Nordic Symposium for the Use of Computers, was a meeting point for early Swedish computer users. The first conference was held in the Swedish town of Karlskrona in 1959 and gathered participants from Nordic industries, military institutions, universities, and unions.[71] Over the years, the conference grew into one of Northern Europe's most important computing communities.

Svenonius turned his NordSAM lecture into a report. It was printed in 74 copies and distributed to all FOA departments, Director-General Martin Fehrm, the atomic energy corporation AB Atomenergi, and the Research Officer (administrating research matters for the Swedish military). This unusual reach indicates NordSAM's value to a FOA researcher like Svenonius and the broad interest in the report's topic: how to manage a data processing centre most efficiently.

According to Svenonius, the key to a well-functioning data processing centre was to "[g]ive the programmers as much support as possible".[72] Advanced subroutines would occupy the mainframe longer, facilitating the programmers' work and freeing up their valuable time. Similarly, an organisation of work that diminished waiting times would

---

[68] Lundin, *Tidig programmering*, 41.

[69] Travel report 2524–003, 22 July 1957, FOA Ö.

[70] The lecture is found in Report A4333–428, October 1963, FOA Ö.

[71] See Hallberg, *IT-gryning*, 259–65.

[72] Report A4333–428, October 1963, FOA Ö, 2.

make debugging much faster and should be prioritised. At FOA, the people whose time was so valuable were primarily (although not exclusively) the employees of Boestad-Nilsson's calculation division.[73] This is another indication of their high esteem at FOA.

The manual computers that became programmers at FOA nuance a computing history centred around discrimination and feminisation. Women like Lena Jönsson and Margareta Franzén achieved respect and high positions at FOA in the 1960s. Both were, for example, at different times chairs of the programming council at the agency. In retrospect, both attribute their success partly to Elsa-Karin Boestad-Nilsson.[74] She pushed them and others in her division to apply for positions not usually possessed by women. She was active in the women's liberation movement, although from a liberal rather than the more common Social Democratic point of view. And she repeatedly refused to follow the code of conduct for women of her time: she dressed her children in rainwear before dinner (to facilitate cleaning), demonstrated her vacuum cleaner at a dinner party, told people off, cried at meetings – she constantly made other people uncomfortable.[75]

Although personal memories of a mentor and friend might be distorted, one thing is clear: without Boestad-Nilsson, the history of FOA's female programmers would be entirely different. She was the spider in the web, the founder of the female enclave that was held in an unusually high esteem at FOA for several years. However, as numerous equality projects relying on the commitment of singular individuals rather than institutional structural changes have shown, building long-term institutional equality is difficult. The success of the female FOA programmers in the 1960s is a parenthesis in a longer history of gender and computing – but that history falls outside the scope of this thesis.

The employees of the calculation division at FOA handled most of the agency's internal programming tasks. Sometimes they also helped outside clients with projects: Lena Jönsson, for example, did a significant project for the Swedish Air Forces' weather service.[76] When they finished a programming task, they went to the data centre's punched card station to prepare their data and code for execution. There, the spatial and material aspects of the FOA data processing centre manifested themselves most clearly.

---

[73] The data processing centre also had inhouse programmers – see Sections 3.3 and 3.4.

[74] Interview, Franzén, 2021 and Jönsson 2021.

[75] Interview, Franzén, 2021 and Jönsson 2021.

[76] Interview, Jönsson, 2021.

3.3 Computational Friction as a Driving Force for Expansion

The punched card was a cardboard card, about twenty centimetres long and ten centimetres wide. Its predefined positions for the presence or absence of a punched hole – representing the digital data of the computer program – was perhaps its most defining visual feature. Each card held 80 signs, corresponding to one line of code. A whole computer program thus amounted to a stack of cards. The input data – numbers, tables, etc – comprised an additional stack. Punched card operators prepared, sorted and controlled the cards. It was too time-consuming to insert punched cards directly into the 7090, so the smaller IBM 1401 was installed. It transformed punched cards into magnetic tapes, a data input format that the 7090 could handle faster. Machine operators mounted the tapes on the IBM 7090 and executed the programs. Then, the process repeated backwards: the 1401 transformed tapes into paper result lists, which were returned to the programmer or customer.[77]

Two times a day, the punched card operators at the FOA data processing centre opened their station for new, incoming projects. The data flow was a cyclic process. A constant circulation of punched cards, magnetic tapes, and result lists that kept the data processing centre operating. Without it, nothing would have been calculated and no

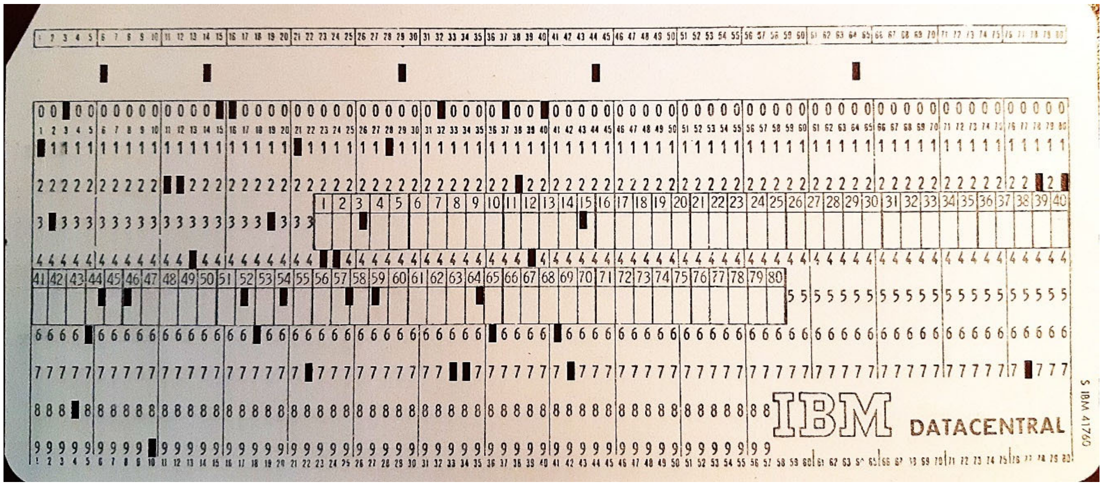

Figure 2: A picture of an IBM punched card of the same type used in the IBM 7090.
Courtesy of Gustav Holmberg.

---

[77] This procedure is for example described by Jacob Palme in Julia Peralta and Sofia Lindgren, eds., *Datacentralerna för högre utbildning och forskning: Transkript av ett vittnesseminarium* (Stockholm: Tekniska museet, 2008), 15–17.

scientific progression based on computational results achieved. Still, the data flow was seen as a necessary evil. For the programmers, it was a process marked by waiting. Margareta Franzén remembered the constant queuing and the frustration when the daily punching deadline had just passed.[78] Usually, the turnaround time for a computation (the wait starting at the punched card station and ending with the distribution of result lists) exceeded four hours.[79]

In his 1963 conference lecture, Per Svenonius compiled statistics on the distribution of mainframe runtime at the FOA data processing centre: 200 computing jobs a year required above one hour on the 7090, to be compared with 20 000 smaller jobs, with an average runtime of five minutes.[80] 60 per cent of all tasks fell below two minutes. Yet, turnaround times stretched to five hours. Queues were everywhere: short programs usually lay waiting to be run for a couple of hours, since they were bundled together in packages occupying the mainframe for about an hour at a time. When they finally passed the mainframe, the results had to wait to be translated from magnetic tapes to readable printouts, which in turn needed sorting before being distributed.[81]

Before returning to these apparent bottlenecks in the data flow at the centre, something needs to be said about the short runtimes. The nuclear research programme at FOA motivated the purchase of the IBM 7090 (see Chapter 2). Extremely time-consuming physics computations required an advanced mainframe – had it not been for the nuclear research programme, another, slower mainframe might very well have been procured.

The nuclear department, FOA 4, was indeed a major user of the FOA data processing centre. In 1965, the nuclear department accounted for 42 per cent of the total runtime hours on the IBM 7090 and 68 per cent of the runtime hours used by FOA.[82] Next in line came the physics department, and to a somewhat lesser extent, the planning department and the electronics department. The chemistry department utilised the 7090 least. However, the dominance of nuclear computations depends on the quantitative measure of use. The only thing measured was mainframe runtime, which meant that a few, time-consuming computations became much more visible in the statistics than numerous short computations. Had the number of runs been measured instead, the spread of computer use across FOA's departments might have looked different.[83] Svenonius' conference report states that computations with short runtimes – not

---

[78] Interview, Franzén, 2021.

[79] Report A4333–428, October 1963, FOA Ö.

[80] Report A4333–428, October 1963, FOA Ö.

[81] Report A4333–428, October 1963, FOA Ö.

[82] "Utnyttjad 7090-tid," 1 December 1964 to 30 November 1965, FOA Ö, CentralK, F7a:16, KrA.

[83] I haven't been able to find such statistics.

advanced nuclear computations – dominated everyday work at the FOA data processing centre.

Furthermore, the most time-consuming computations diminished over time. In 1964, Svenonius commented on the "striking stagnation" of physics and nuclear computations at the FOA data processing centre.[84] This coincides with the stagnation of the Swedish atomic weapons project.[85] This had several reasons: access to nuclear fuel was problematic, partly because nuclear fuel production fell outside the protective nuclear research programme that got political backing in the late 1950s. The civil nuclear power project also diverged from its military counterpart, despite their shared origin in the so-called "Swedish line". A large extent of nuclear research continued in Sweden, but it was more clearly directed to nuclear power, rather than constructing nuclear weapons.[86]

In the mid-1960s, the opposition to atomic weapons had reached the highest political level in Sweden and even snuck into the military. Torsten Rapp, the new Supreme Commander of the Armed Forces, was considerably more ambiguous about Swedish atomic weapons than his predecessor, Nils Swedlund.[87]

Although the nuclear research programme at FOA continued until 1968, when Sweden signed the Non-Proliferation Treaty on international nuclear armament and the programme reached its end, it had lost momentum years before. In the financial year 1963/1964, resources to FOA diminished sharply, in parallel with the critique against nuclear weapons research.[88]

70-hour nuclear computations brought the IBM 7090 to FOA, but once it was in place, two-minute calculations in all sorts of areas changed the work organisation around it. The long waiting times were a constant problem. Every small calculation blocked the research progress for hours. Debugging was very time-consuming: if a program had an error (and most programs do the first time they run), four or five hours were wasted, and the problem-solving time at best doubled. Programmers lost energy.

When Paul N. Edwards introduces the concept of friction in *A Vast Machine* (2010), he refers to the physical phenomenon: "Machines transform energy into work; friction reduces the amount of work they can do with a given input".[89] In the same way, computational friction and data friction oppose the transformation from data to knowledge.

---

[84] Memo by Per Svenonius, 29 September 1964, FOA Ö, CentralK, F7a:15, KrA.

[85] For an overview, see Jonter, *The Key to Nuclear Restraint.*

[86] See Jonas Anshelm, *Mellan frälsning och domedag: Om kärnkraftens politiska idéhistoria i Sverige 1945–1999* (Eslöv: B. Östlings bokförl. Symposion, 2000).

[87] Agrell, *Svenska förintelsevapen*, Ch. 29.

[88] Lundin and Gribbe, *Att följa pengarna*, 42–44.

[89] Edwards, *A Vast Machine*, 83–84.

An efficient work organisation at a data processing centre has low computational friction, and a smooth data flow has low data friction. The goal is to reduce friction. This is clear in Per Svenonius' 1963 conference lecture, entitled "Time and cost efficiency when operating a fast computer".[90] The problems at the FOA data processing centre were the ubiquitous queues in the data flow, the long process to correct an error, and the complex prioritisation of runs. Svenonius regarded the last task as a mathematical optimisation problem of its own: "Since the problem in all aspects is a problem of streamlining, it would be outdated to try to solve it through an increase in personnel. An up-to-date solution would be to use computers to solve the task."[91] Svenonius gave voice to a widespread idea: computational friction is reduced – and ideally eliminated – by more computing.

As Edwards pointed out, it's impossible to get rid of computational friction and data friction altogether. The thermodynamical reference (friction as a resistance to the production of work in a machine) does however indicate an ideal process, without any friction. Friction is a depreciated force in physics, and most metaphorical use of the word passes on its negative aspects. It signifies wasted time and energy and resistance to the production of knowledge.

Wittgenstein, however, saw friction as a driving force for philosophical discussion. Linguistic friction breeds philosophy because it creates questions of meaning. This side of friction can also be supported by physics: in a friction-free world, there would be no working machines since all objects would drift around constantly, and the gears would just slide against each other. "' Friction' is a metaphor, of course, but it is an apt and a deep one", as Edwards put it.[92]

Computational and data friction drove the organisation of work at the FOA data processing centre. Efforts to diminish this unwanted friction led to *expansions*, rather than *reductions*, of the workforce, buildings, and equipment. At FOA in the 1960s, friction was not merely resistance to knowledge production but a driving force for organisational development.

In December 1963, a FOA survey suggested that the 31 employees of the data processing centre should increase to 42 people in half a year.[93] Most of these new hires would occupy themselves with computational and data friction: a secretary assisting the head of operations, a customer receptionist, four assistants for sorting and controlling punched cards, an operator managing input data at the 7090, and another punched card operator. Around the same time, the newly appointed head of operations, Björn Kleist,

---

[90] Report A4333–428, October 1963, FOA Ö.

[91] Report A4333–428, October 1963, FOA Ö, 6.

[92] Edwards, *A Vast Machine*, 83.

[93] Memo by Björn Kleist, 6 December 1963, FOA Ö, CentralK, F7a:14, KrA.

proposed expanding the running shifts from the occasional two-shift to a permanent three-shift.[94]

Björn Kleist (b. 1933) studied aviation engineering, and the heavy computations in that field led him to the Swedish IBM subsidiary in 1959. When the 7090 mainframe was inaugurated in 1961, IBM sent Kleist to FOA to assist with technical expertise on site. In 1963, he formally left IBM and succeeded Per Svenonius as head of operations at the FOA data processing centre. When the QZ replaced the FOA data processing centre in 1968, Kleist continued as head of operations until 1974. He then left public administration and worked in the private sector and as a consultant.

Kleist's first task in 1963 was the data centre's expansion, prompted by the long waiting times for short programs. The workforce was growing. Table 1 shows the different professions at the FOA data processing centre. They are ordered according to the 1960s standardised wage levels of the Swedish public administration. It sorted personnel in sections A1–30 and B1–10, with rising salaries. In 1963, only two per cent of all employees – almost no women – belonged to the upper section B.[95] Director-Generals, professors, rectors, and chief physicians had B-level salaries. Section A had a larger variety: cleaners at A3, teachers and policemen at A13–A16, and most priests at A19–23.

The FOA data processing centre's working class comprised people dealing with data friction and other material aspects of the data centre: punched card operators, cleaners, secretaries, and office guards. While the office guard was typically male, the other professions were female-dominated. In 1963, 80 per cent of all female state employees in Sweden worked at levels A1 to A12.[96] I haven't found any gender statistics on salaries at the data centre, but it is reasonable to believe that this distribution followed the patterns in Swedish society at large. As described in the previous section, the exception was probably the women in the physics calculation division. They were not employed at the data centre, so their professions are missing from the above table. Inexperienced calculation assistants belonged to the lower wage levels, but mathematicians had salaries of A19 to 23, which were unusually high levels for women in Sweden in general. When the position as head of another FOA calculation division was advertised in 1963, the wage level was A27.[97] It indicates Elsa-Karin Boestad-Nilsson's level.

---

[94] FOA data processing centre was always open from 8 am to 17 pm, thus one shift, but sometimes longer runs were performed during nights or weekends. Three shifts were in fact never introduced – see Section 3.4. Draft by Björn Kleist 17 December 1963, FOA Ö.

[95] Statistiska Centralbyrån, *Tjänstemän inom statlig och statsunderstödd verksamhet år 1963*, Sveriges officiella statistik, arbetsmarknad samt arbets- och löneförhållanden, (Stockholm, 1965), 25.

[96] Statistiska Centralbyrån, *Tjänstemän inom statlig och statsunderstödd verksamhet år 1963*, 26.

[97] It was published in *Svenska Dagbladet*, 26 April 1963, FOA, AdmB, ÖI:V1, KrA.

Wage level	**Functional titles**	**Monthly salary in Swedish krona, 1961**
A3	Cleaner, unexperienced punched card operator (office assistant)	1010
A7	Punched card operator, office guard, secretary (receptionist, 1401 operator)	1240
A9	Machine hostess, machine operator	1380
A12	Experienced machine operator	1610
A15	Chief operator (program librarian, 7090 operator, programming assistant)	1880
A17	Systems programmer	2080
A19-23	Mathematician (programmer)	2320–2840
A23	Head of operations	2840
A26	Head of systems	3320
A31	Head of section	4284

Table 1: List of professions at FOA data processing centre in 1961, ordered according to wage levels in the Swedish public administration (compared with monthly salaries in 1961 Swedish krona). Job titles that appeared later than 1961 at the centre are placed in parentheses.[98]

Academic merits separated different ends of the wage level list from one another. Assistant, secretary and most operator jobs didn't require a university education, and the job ads called for characteristics like carefulness, swiftness, and organisational talent.[99] The target group for such advertisements was young people. The working environment was presented as "stimulating and youthful" and the work tasks as "varied and interesting".[100] It thus resembles Janet Abbate and Mar Hicks' findings in their analysis of gendered computing in Britain and the US.[101] Hicks and Abbate interpret job ads like these, referring to a youthful work environment and asking for characteristics like swiftness, as primarily intended to attract young women.

The Swedish titles for computing jobs requiring academic merits varied. Mathematician, engineer, and programmer were all used in the early 1960s, and their work was often hard to distinguish. However, academic merits always coincided with higher wage levels and a stronger inclination towards logical work.

---

[98] For a list of the initial workforce, see "Maskintidpriser vid FOA:s datacentral," November 1961, FOA, CentralK, F7a:14, KrA. Additional jobs are found in various newspaper job ads, collected in FOA Ö, Administrativa Byrån (AdmB), Ö1:1, KrA.

[99] Job ads are collected in FOA Ö, AdmB, ÖI:1, KrA.

[100] Quotes from a job ad for office personnel in *Dagens Nyheter* 27 May 1964, FOA Ö, AdmB, ÖI:1, KrA.

[101] See Hicks, *Programmed Inequality*; Abbate, *Recoding Gender*.

The lowest wage workers taken aside, two occupational computing groups formed at FOA: a so-called "systems group" and an "operations group".[102] This hierarchical division of work reached the level of managers, as the head of systems was superior to the head of operations. The systems group contained academically trained mathematicians, programmers, and engineers, with salaries around level A20. The operators, assistants, and office personnel in the operations group instead had salaries around level A12.

The 1963 reorganisation of the FOA data processing centre resulted in an expansion of the operations group. Plans for additional equipment – to facilitate data input and output – were made but never realised since the establishment of the new data centre eventually overshadowed them.[103] Nevertheless, available space became scarce at the FOA data processing centre in 1963. In September, Svenonius stated: "The main problem is that it has become too cramped in practically all stages of preparatory work".[104] Data literally flooded the centre. Punched cards, magnetic tapes, paper lists – there wasn't room for everything. Svenonius proposed setting up barracks adjoining the machine hall. The small space also made the machine hall too warm. The computers risked shutdown when the temperature exceeded 26 degrees.[105]

In several memos and reports from 1963 and 1964, Per Svenonius and Björn Kleist discussed the inadequate premises of the data processing centre. The lack of space wasn't the only issue; the spatial organisation was problematic too. Some offices were located on the fifth floor, whereas the machine hall was in the basement. The physics calculation division, responsible for most internal computer programs, was high up in the north wing of the FOA buildings. Six stairs separated them from the machine hall. Both Jönsson and Franzén remembered these stairs, 60 years later.[106] The distance and the sharp daily deadlines at the punched card station made a frustrating combination. In a memo in December 1963, Kleist argued that "all personnel must be grouped centrally around the machine equipment" in order to "rationally use the capacity of the data processing centre".[107] For an overview of FOA's premises in 1963, see Figure 3.

Spatial issues were not limited to the data processing centre, however. FOA grew from 754 to 1551 employees in the years 1955 to 1963.[108] Everyone was crowding into

---

[102] Systems programming is analysed in Chapter 5. See also Section 3.4. The division into these two groups are for example made in Memo by Björn Kleist, 6 December 1963, FOA Ö.

[103] An additional IBM 1401 and a disk storage IBM 1301 was planned for delivery in 1965. This however changed when the plans for Stockholm data processing centre took shape. Official letter to the king, 14 February 1964, FOA Ö, CentralK, F7a:15, KrA.

[104] Memo by Per Svenonius, 24 September 1963, FOA Ö, CentralK, F7a:14, KrA, 1.

[105] Memo by Per Svenonius, 24 September 1963, FOA Ö.

[106] Interview, Franzén 2021, and Jönsson, 2021.

[107] Draft by Björn Kleist, 17 December 1963, FOA Ö, 2.

[108] Agrell, *Vetenskapen i försvarets tjänst*, 135.

too small offices, laboratories, and dining halls. FOA's headquarters were rebuilt later in the 1960s, but before that, spatial changes were hard to achieve. "When not even improvisations can be achieved without major nuisances, it is understandable that the personnel are growing tired", Svenonius commented, unusually frustrated.[109] Improvisations often affected others, though. Spatial reorganisations were topics of fierce debate at FOA in the mid-1960s.

In 1964, the data processing centre got a bit of extra space, and some of its employed programmers could move down several stairs. However, researchers from the electronics department had to give up their labs and move to smaller offices to enable the move.[110] Head of the electronics department, Nils-Henrik Lundquist (1919–1997),

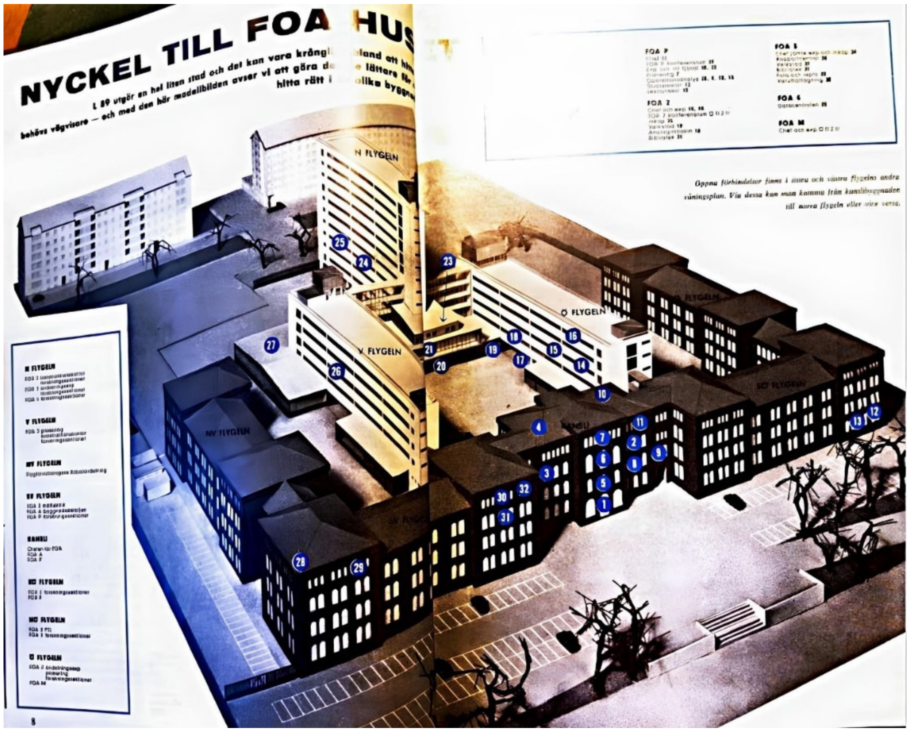

Figure 3: Overview of FOA's premises in 1963. The data processing centre is marked by number 23, and the physics calculation division was located in the north wing ("N Flygeln" in the picture).[111]

---

[109] Memo by Per Svenonius, 24 September 1963, FOA Ö, 2.

[110] "Lokalbehov för utvidgning av FOA datacentral," 31 March 1964, FOA Ö, CentralK, F7a:15, KrA.

[111] *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 1, 1963.

called the temporary adjustments a “repulsive construction”.[112] Torsten Magnusson defended the reorganisation and won that particular battle. The conflict highlights the data processing centre’s position within FOA: apparently, Director-General Martin Fehrm, recipient of this critique and defence, deemed the data centre important enough to grant Magnusson’s wishes. In the end, the person for whom this reshuffle felt the most was probably the FOA 3 secretary, who was forced to give up her office for a desk in the nook of a corridor.[113]

3.4 Occupying the Mainframe

The personnel increase in 1963 and the temporary spatial extension in 1964 were not the only ongoing expansions of the FOA data processing centre. The number of computing orders also steadily increased. In FOA’s archive, lists of every program run at the centre are stored in heavy folders wrapped in brown paper. These folders were three times as thick in December 1963 as in December 1961, when the centre was only three months old.[114] Other than that, it’s difficult to make sense of these lists. They hardly contain anything but numbers: numbers of punched cards used, numbers of minutes on the mainframe and the adjacent machines, customers’ numbers, commission numbers. My guess – which I base on the tape keeping the brown paper in place – is that I’m the first person to open these folders since they were so carefully wrapped.

In the 1960s, however, the systems group at the data centre designed and studied these documents attentively. The “systems approach” to programming gained influence in the 1960s when complex software like operating systems spread and computing was linked to theoretical education.[115] Regarding the computer as a system provided an overview of the connections of all its parts: subroutines, programs, hardware, telecommunications to other machines. In Chapter 5, I historicise this turn in the Swedish context. For now, it suffices to say that the system programmers at the FOA

---

[112] Lundquist had been an engineer at Saab before starting at FOA in 1946, where he advanced to head of the electronics department in 1957 and to Director-General in 1974. "Lokalbehov för utvidgning av FOA datacentral," 31 March 1964, FOA Ö.

[113] This consequence is described in "Lokalbehov för utvidgning av FOA datacentral," 31 March 1964, FOA Ö.

[114] October–December 1961: FOA Ö, Avdelning 4 Datacentralen (Avd 4 DataC), H1:1, KrA; October–December 1963: FOA, Avd 4 DataC, H1:7, KrA.

[115] The systems approach has been linked to the cybernetic movement and the emergence of planetary views, see Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, Mass.: MIT Press, 1996); Hughes, *Rescuing Prometheus*; Edwards, *A Vast Machine*; Akera, *Calculating a Natural World.* The emergence of the systems approach in computing was a result of power struggles and deliberate rebranding of the programming profession, see Atsushi Akera, "Engineers or Managers? The Systems Analysis of Electronic Data Processing in the Federal Bureaucracy," in *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, ed. Agatha C. Hughes and Thomas P. Hughes (Cambridge, Mass.: MIT Press, 2000); Abbate, *Recoding Gender.*

data processing centre were responsible for aiding customers with debugging and program optimisation and evaluating the overall operation of the centre.

Runtime statistics were crucial for the organisation of work at the FOA data processing centre. Efficient use of the centre – the number one goal for its leaders – required in-depth knowledge of the daily operation. For Svenonius and Kleist, this knowledge was to a large degree quantified. The number of punched cards showed the burden at the punched card station and the 1401 input data machine. The list of customers and their scale of charge implicated both the spread in usage and the centre's financial situation. And above everything else, the mainframe runtime revealed how efficient the data centre was.

The costs of keeping the data centre running were very high. Punched cards alone cost as much each year as an employed programmer.[116] In 1963, Svenonius commented that one minute of the precious runtime on the IBM 7090 corresponded to a one-day assistant salary – therefore "[t]he data processing centre is at all times obliged to utilise the equipment as effectively as possible".[117] The users of the data processing centre should strive to keep the mainframe occupied. The way to achieve that was to constantly feed the machine with data.

Mainframe runtime was also the most critical resource at the FOA data processing centre. As anthropologist Sharon Traweek showed in her classic study of high-energy particle physics, access to the most advanced equipment in a research centre can reveal its internal hierarchies.[118] The distribution of beamtime in the particle colliders that Traweek studied corresponds to the distribution of mainframe runtime in a data processing centre.

The governmental regulations for the FOA data processing centre provided the freedom to distribute runtime according to FOA's needs. The data centre should primarily see to the computational needs of FOA and the Armed Forces. Still, additional capacity could be used by others if agreed upon by FOA and the Swedish Board for Computing Machinery.[119] The judgment of the extent of runtime that the Armed Forces would need was solely laid upon FOA.

In the 7090 council minutes, there is no record of any discussions concerning the runtime distribution.[120] Yet, that was the forum for planning and guiding the centre's

---

[116] Punched cards cost 40 000 Swedish crown each year at the data processing centre, compared to a monthly salary of around 2700 crowns with 25 per cent overhead costs. See "Maskintidpriser vid FOA:s datacentral," November 1961, FOA Ö.

[117] Report A4333–428, October 1963, FOA Ö, 6.

[118] Sharon Traweek, *Beamtimes and Lifetimes: The World of High Energy Physicists* (Cambridge, Mass.: Harvard University Press, 1988).

[119] Excerpt from regulation letter for the use of FOA data processing centre in *Statsliggaren*, 1961/62.

[120] The minutes are found in FOA Ö, CentralK, F7a:1, KrA.

operation, where such discussions should have occurred. Torsten Magnusson chaired the council, Elsa-Karin Boestad-Nilsson acted as secretary, Per Svenonius and Björn Kleist attended, as did other users.[121] It is reasonable to believe that Svenonius and Kleist had most to do with the runtime scheme. They often wrote the archived reports on the efficiency and statistical use of the centre, and they oversaw daily operations.

In an interview, Kleist recalled his time at the FOA data processing centre as the most fun period of his career.[122] When the computer was off shifts, without customer jobs to execute, Kleist and his colleagues could use it freely. During the day, they helped customers debug and structure their code. At night, they tinkered with the operating system and developed their own system for runtime measurements that made both statistics and charging possible. "We were like kings, we could fix everything," Kleist recalled.[123] In this circle, there were no women. Were they on the operations or systems side of things? They moved in between, performing hands-on technical adjustments that affected the most profound logic of the computer system they worked with. Kleist refers to them as the "computer nerds" at the data centre.[124]

Despite the rationality and efficiency paradigm structuring the organisation of the FOA data processing centre, it thus continued to be an open, free space for some. Despite the diminishing nuclear research funding, the agency was still well-funded in the mid-1960s, staying above 0,2 per cent of the total state budget.[125]

Nuclear research diminished, but the 7090 kept busy. In 1967, civilian users comprised 25 per cent of the total mainframe runtime.[126] In 1963, that number had been only 12 per cent.[127] The FOA data processing centre thus opened up to civilian users in an effort to keep the 7090 mainframe occupied. The agency's share of the total runtime diminished, but the actual runtime used remained relatively constant. The civilian and military usage of the 7090 increased, while FOA's computational needs stayed the same.

This made the work at the data processing centre more varied. Both Björn Kleist and Lena Jönsson remembered the intellectually stimulating environment at FOA.[128] Computing problems came from various fields, and solving them often included learning a bit about a new topic. FOA's data processing centre thus resembles the business trades Galison interprets as so-called trading zones, where people speaking

---

[121] These roles are not explicit in the minutes, but Magnusson is always opening the meeting, and Boestad-Nilsson is taking notes.

[122] Interview, Kleist, 2021.

[123] Interview, Kleist, 2021.

[124] Interview, Kleist, 2021.

[125] Lundin and Gribbe, *Att följa pengarna*, 42.

[126] "Statistik körtid 7090," 1966/67, FOA Ö, CentralK, F7a:1, KrA.

[127] "Kostnader och intäkter för FOA datacentral 1963/64," FOA Ö, CentralK, F7a:15, KrA.

[128] Interview, Kleist, 2021, and Jönsson, 2021.

different languages (literally and metaphorically) meet and establish a common ground for communication.[129] All that waiting time for computer jobs to finish wasn't just frustrating. Years later, many Swedish computing pioneers spoke fondly of the community in the waiting rooms of the early data processing centres and the feelings of novelty and excitement.[130]

Similar to Besk, the IBM 7090 at FOA was an important gateway for institutions and researchers later establishing their own data processing centres.[131] The FOA data processing centre was crucial, not least for the Stockholm universities and the Swedish IBM office, which used it for free.

The 7090 gave IBM a favourable position since computer users from all over Stockholm encountered the company's most advanced mainframe at FOA. Students and researchers from Stockholm's most computationally heavy academic fields learned how to program in Fortran, IBM's programming language. According to the contract made when Kleist moved to FOA, IBM could even showcase the 7090 for prospective buyers. During the 1960s, IBM acted strategically in marketing and distributing its products. Historians of technology Thomas Haigh and Petri Paju trace these strategies in post-war European computing and analyse the market dominance they resulted in.[132] Through building transnational IBM user groups and investing in European subsidiaries, such as the French IBM headquarters where the FOA employees went regularly in the 1950s, IBM established itself as the most rational technological option. IBM also very eagerly courted their customers. Torsten Magnusson and Nils Henrik Lundquist were, for example, invited to demonstrations and show-offs of new IBM systems.[133]

3.5 Conclusion

The FOA data processing centre was the first of its kind at the agency. It entailed a significant restructuring of computing work: FOA researchers no longer had to visit other data processing centres but instead received customers themselves. A thorough planning process, involving field trips and written reports, preceded the data centre's establishment. Premises, personnel, administration, and financial guidelines structured

---

[129] Galison, *Image and Logic.*

[130] Lundin, *Att arbeta med 1950-talets matematikmaskiner*; Peralta and Lindgren, *Datacentralerna för högre utbildning och forskning.*

[131] See Kaijser et al., *Maktens maskiner*, 35–36.

[132] Paju and Haigh, "IBM Rebuilds Europe."

[133] Invitations in FOA Ö, CentralK, F7a:15, KrA.

the computing work from the beginning. However, the work organisation at the FOA data processing centre changed in response to perceived problems in the daily operation.

Those in charge of the centre had to handle three major problems: the difference between civilian and military customers, the inadequate premises, and the massive data friction. Since the machine hall was in the basement, there was no accessible way into it for civilian users who lacked security clearance. In response, the FOA data processing centre became closed, customers handed in their problems to a ground-level office, and the centre's employees took care of everything from then on. Internally, the data processing centre was open. The employees in the calculation division, who did much of the programming, visited the data centre daily and could easily pass the security checkpoints. While the FOA data processing centre was a service centre aimed at military computing, and the computationally heavy FOA nuclear department dominated runtime statistics, civilian users increased, especially between 1964 and 1968, along with the diminishment of the nuclear research programme.

The inadequate premises were an issue for the FOA data processing centre and the entire agency. The limited space led to an inefficient spatial organisation of the data centre as personnel and computer users were scattered all over the institute. The 1964 relocation of some offices improved the situation, but it didn't solve the overarching problem.

The cramped space was flooded with data. From the beginning, the centre leaders considered data friction problematic. They implemented different solutions for this problem: buying additional machines for data input and output, hiring more assistants in data preparation, and automatising the prioritisation of runs. In a broader sense, computational friction – including data friction, spatial limitations, and secrecy issues – caused reorganisations of the centre. The many references to *efficiency* in the archival documents I have studied reflect this computational friction. Svenonius and Kleist justified organisational changes by efficiency. This often meant reducing friction, the time and energy spent sorting punched cards, waiting for results, debugging a program, or mounting data onto a machine.

It was expensive to keep the mainframe running, and mainframe runtime was the most critical resource at the centre. Although everything besides the mainframe dominated daily work at the centre, mainframe runtime was the primary measure of computer usage. The overarching operational goal was to keep the mainframe constantly occupied. The FOA data processing centre was organised to serve the IBM 7090 with computations.

This attitude reveals the different conceptualisations of computing work present at the FOA data processing centre. The tasks performed by, for example, Boestad-

Nilsson's calculation division were highly valued since they enabled the continuous production of computational results. These results were accumulated, carried out of the data centre and into the concrete military research and development at the agency. This is work, as Arendt defines it. The tasks connected to data management, on the other hand, were instead quite depreciated. They were seen as cyclic and repetitive instead of progressive, and therefore possible to automate. This could be called *data labour* – to highlight its dependence on the materiality of data and the conceptualisation of it as something more primitive than computing work.

Data labour and computing work were gendered in complex and varying ways at FOA. Although Boestad-Nilsson's team was called "calculation girls", they were not comparable to the punched card operators at the data centre. These – probably female – operators had more in common with the – probably male – office guards than the women at the calculation division. This chapter shows the importance of considering how gender and class interact when analysing computing work.

The expansion of the FOA data processing centre in terms of personnel and computations, combined with the spatial limitations, led to the establishment of the QZ in 1966. In 1968, the new mainframe IBM 360/75 replaced the IBM 7090 at FOA, although the latter continued to be used until 1971. Major conflicts were to cloud the inauguration of the new data processing centre.

4 “The War of Computing Machinery” at the QZ, 1963–1968

On March 7, 1968, the citizens of Stockholm could open their newspapers and read about a “[n]ew attack in the war of computing machinery.”[1] It was yet another episode in a debate that had raged for some time.

The media fuzz was about the new data processing centre in Stockholm, commonly called the QZ, shared between FOA, the Royal Institute of Technology (KTH), and Stockholm University (SU).[2] The media debate began when two researchers at SU publicly criticised the Swedish Agency for Administrative Development – responsible for government computing purchases – for choosing inadequate computing machinery for the centre. The machinery in question was an IBM 360 system. The debate was rather technical, full of exotic words like “multi-programming” and “main storage units”. In Jan Annerstedt’s analysis, it was a hardware conflict between academic researchers with righteous demands and narrow-minded bureaucrats from the Swedish Agency for Administrative Development.[3] FOA was barely mentioned.

Yet, FOA was responsible for both the operation and administration of the QZ. The machine hall was located on FOA’s premises, in the courtyard of FOA’s headquarters at Linnégatan 89 – the same address as the FOA data processing centre. People working at the FOA data processing centre continued to work at the QZ, where the IBM 360/75 mainframe was simply a new machine from the same company that provided the mainframe for the previous data centre. The two data centres were inseparable for these employees, even though the QZ was a university data processing centre while its predecessor had been a military service centre. The QZ was governed by the Swedish Higher Education Authority and intended to be a service centre for the academic institutions in Stockholm.

Why did FOA end up running a university data processing centre? Whose priorities and needs determined the administrative and practical organisation of the QZ – and

---

[1] This chapter builds on a Swedish text I wrote for an anthology, Julia Ravanis, "Datamaskinkriget: Stockholms datacentral QZ och militärforskningens osynliggörande," in *Det dolda universitetet: Militär forskning i kalla krigets Sverige*, ed. Eric Bergelin, Per Lundin, and Niklas Stenlås (Lund: Nordic Academic Press, 2025). The newspaper quote is from Arne Karsberg, "Ny attack i ’datamaskinkriget’, Forskares krav ströks ned 50%," *Dagens Nyheter*, 7 March 1968.

[2] The story of where this nickname came from is found in Chapter 5, Section 5.5.

[3] Annerstedt et al., *Datorer och politik*, 159–63.

especially the much-debated hardware system? The aim of this chapter is to understand how and why computing work was reorganised at FOA during the establishment of the new data processing centre, which in practice replaced the FOA data processing centre as the heart of all computing work at FOA. The chapter thus explicitly deals with FOA's role in the process leading up to the inauguration of the QZ.

When focusing on the organisation of computing work at FOA, the story of the hardware conflict changes. Behind the technical details and agitating headlines in Swedish 1960s media dwells a more complicated history of institutional tensions and strategic choices. In this chapter, I show that FOA researchers significantly influenced the planning process for the new data processing centre. I explain their influence through the theory of *technological momentum* – another metaphor borrowed from physics.[4] Historian of technology Thomas P. Hughes used technological momentum to account for the changing nature of large technological systems.[5] In the early phase, such a system is, to a large degree, shaped by societal forces. With time, the system acquires momentum and instead begins to shape society. Characteristics of technological momentum are "acquired skill and knowledge, special-purpose machines and processes, enormous physical structures, and organisational bureaucracy."[6] These properties of technological systems increase their inertia, making them harder to push in new directions.

The FOA researchers could set the terms for the QZ because the FOA data processing centre had given FOA technological momentum. The organisation of computing work at FOA had grown large and developed in a specific direction, while computing work at the Stockholm universities was scattered and limited in comparison. Only FOA researchers had the skills required to operate an advanced mainframe. The cooperation was asymmetrical from the beginning. With telephone lines and computer terminals, the new data processing centre connected FOA to the university campuses in Stockholm. Still, FOA remained the central site and the central actor.

The origin of FOA's technological momentum was the purchase of the advanced IBM 7090 mainframe, enabled by the priority given to Swedish military research in the

---

[4] Momentum measures the combined effect of mass and speed in, for example, collisions: a heavy and fast-moving object bumping into something lighter and slower will knock it in a given direction and continue its own path relatively unscathed.

[5] Hughes first made use of the notion in 1969 but has since then further developed the theory, Thomas P. Hughes, "Technological Momentum in History: Hydrogenation in Germany 1898–1933," *Past and Present* 44 (1969); Thomas P. Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (Cambridge, Mass.: MIT Press, 1987); Thomas P. Hughes, "Technological Momentum," in *Does Technology Drive History?: The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge, Mass. : MIT Press, 1994).

[6] Hughes, "Technological Momentum," 108.

early Cold War.[7] The operation of the IBM 7090 made FOA a favourable partner in academic computing, since the expertise required to administer and operate an advanced service centre for scientific and technical data processing was scarce in Sweden. As a result, FOA once again benefited from the government's ambition to computerise Sweden, even though the Social Democratic party had in the mid-1960s started to turn away from military research and favour academic research.[8]

The militarisation of Swedish research in the late 1950s thus resonated throughout the 1960s – in an era when Swedish political action was changing. The aims of state-financed computing work diversified. National security through nuclear armament, which enabled the 7090 investment, was sidelined by ambitions to turn Sweden into a more rational and technological country, through the computerisation of higher education and research. By exploring FOA's technological momentum and its effects on the establishment of the QZ, this chapter adds a crucial part to the history of computing work and early digitalisation in Sweden. Clearly, the organisation of computing work was important in the mainframe era. It conditioned not only the practical work at one data processing centre, but also future institutional cooperations and the division of power within them.

I first present the background to the decision to establish a new data processing centre in Stockholm, following both the internal discussions at FOA and the coordination of computing needs within Swedish universities. Next, the chapter turns to the 1965 choices of ownership, cooperation, and hardware. The criticism of these choices is then analysed and contextualised: the medial debate took place in a time marked by student protests and critique of capitalism and state bureaucracy. Finally, I argue that the technological momentum stemming from the FOA data processing centre, built partly through FOA researchers' unique experience of operating advanced computers and partly through FOA's position in the Swedish research community, brought the IBM 360-system to the QZ.

4.1 A New Standard

In 1963, two crucial processes for the establishment of the QZ began: planning a university data processing centre in Stockholm and preparing for an expansion of the FOA data processing centre. In the beginning, these processes proceeded independently.

---

[7] See Chapter 2.

[8] Lundin and Gribbe, *Att följa pengarna.*

The Swedish Board for Computing Machinery had been the coordinator of computer production and use in Sweden since 1948. It had been quite successful, not least in developing the technically advanced computer Besk in 1953. But in the late 1950s, things started to change.[9] The Board for Computing Machinery relied on domestic engineering skills, and the major users of Bark and Besk were military.[10] By the end of the 1950s, commercial computing had consolidated, and computers spread to diverse academic and industrial environments.

The Swedish Agency for Administrative Development took over responsibility for Swedish computer coordination from the Board for Computing Machinery in 1963. The agency's task was to find and implement the most rational organisation for various state activities. These ranged from cleaning to producing medals and administering community homes.[11] The agency had previously focused on streamlining smaller, technical parts of the public administration, but was 1960 assigned to implement large-scale and often technically advanced changes within the Swedish state.[12] One of them was the computerisation of essential state functions.

The national registration was one of Sweden's biggest administrative state projects at the time. After a long and complicated procurement procedure, the contract was split between Saab and International Business Machines.[13] Other significant projects supervised by the Agency for Administrative Development in the 1960s were the computerisation of national insurance and taxation, and the establishment of Swedish university data processing centres.[14] In Stockholm, researchers had turned to the data processing centres at FOA or the Atomic Energy Corporation to perform complex calculations for some years, but in 1963, direct access to computers seemed crucial for advancing Swedish academic research.[15]

In July 1963, the Swedish Agency for Administrative Development set up an expert council to investigate scientific data processing and research. In the council were representatives from Swedish universities and research institutes, computationally heavy industries like Saab, and the newly established Swedish Higher Education Authority,

---

[9] There is a lot written about the stagnation of the Swedish Board for Computing Machinery and the reasons behind it. Annerstedt has most harshly criticised the political premises for the board, but Nybom and De Geer also highlights its provisional setup as an important factor in its downfall. De Geer, *På väg till datasamhället*, 41; Nybom, "Det nya Statskontorets framväxt 1960–1965," 162.

[10] Kaijser et al., *Maktens maskiner*, 37.

[11] Reports from assignments in 1965, protocol no 129, 24 June 1965, Statskontoret archive 1961–1970 (Statskontoret), A1:4, Riksarkivet (RA).

[12] Nybom, "Det nya Statskontorets framväxt 1960–1965," 148.

[13] This process started in 1949, before the Agency for Administrative Development got responsibility for computing purchases. It was however finalised by Minister of Finance Gunnar Sträng, who had close ties to the agency. The process is detailed in De Geer, *På väg till datasamhället*, Ch. 4–7.

[14] For overviews of these projects, see Kaijser et al., *Maktens maskiner*, Ch. 5.

[15] SOU 1962:32, 158–72. SOU 1963:76, Högre utbildning och forskning i Umeå II, 49.

which had just replaced the Ministry of Education, Science, and Culture as the governing agency for higher education in Sweden.[16] Per Svenonius, chief engineer at FOA, was appointed secretary of the expert council in October 1963. The council's first task was to investigate the need for data processing in Swedish research.

While this investigation proceeded, the employees of the FOA data processing centre felt more and more frustrated. The summer of 1963 had been hot, and the air conditioning was not working.[17] As was described in Chapter 3, the machines shut down, waiting times were long, and there was no space for anyone. In September 1963, Per Svenonius requested bigger premises for the data centre and opened an investigation into the future calculation needs of the agency.[18] He found that FOA would need a new mainframe as early as 1966 to meet the predicted demand for computations within the Swedish military.[19]

The invitation from IBM to Per Svenonius and Torsten Magnusson for a display of their new 360 system in April 1964 was therefore quite timely.[20] Svenonius and Magnusson had worked closely together for years, first in the physics department and since 1958 in the nuclear department. Both dealt with FOA's computing. Magnusson was the head of the 7090 council, governing the FOA data processing centre. Svenonius had been head of operation at the centre until 1963, when he took up the post in the expert council and Björn Kleist replaced him.

A couple of days after the demonstration at IBM, a meeting was held in the 7090 council, where representatives from the different departments at FOA discussed questions regarding the data centre and the mainframe IBM 7090. In the minutes, the line "Chief engineer Svenonius thought one should" has been crossed over and replaced by "Since IBM had now presented their new 360-series, one should reassess and instead […] consider a solution where the capacity of the 7090 is in principle doubled through the purchase of a 360 system model 50".[21]

This is the first documentation of plans to procure a new mainframe at FOA. Previously, the 7090 council had only planned to buy additional terminals for their data

---

[16] Members of the council were Germund Dahlquist (KTH), Martin Fehrm (FOA), Carl-Erik Fröberg (Lund Univeristy), Tord Ganelius (Gothenburg Univeristy), Axel Klintsell (Swedish Employers' Confederation), Håkan Linderholm (Umeå University), Gunnar Lindström (Saab), Per-Olov Löwdin (Uppsala University), Ingvar Ohlsson (the National Statistical Bureau), Hans Poppius (the Swedish Higher Education Authority). From the SAPM, either Ivar Löfqvist, Lars Lindmark, Åke Pernelid or Hans Riesel participated. Protocol 43, 22 August 1963, Statskontoret, A1:2, RA.

[17] Minutes 7090 council no 20, 4 September 1963, FOA Ö, CentralK, F7a:1, KrA.

[18] Memo by Per Svenonius, 24 September 1963, FOA Ö.

[19] "Prognos beträffande försvarets maskintidsbehov," 9 December 1963, FOA Ö, CentralK, F7a:14, KrA.

[20] Invitation from IBM, 17 April 1964, FOA Ö, CentralK, F7a:15, KrA.

[21] Minutes 7090 council no 24, 22 April 1964, FOA Ö, CentralK, F7a:1, KrA.

centre. To Per Svenonius – the man whose opinions were interchangeable with the stance of the whole council – IBM's 360 system seems to have been an evident choice.

The 360 system was a solution to a rising problem within IBM. Martin Campbell-Kelly et al. describe this problem as the "mishmash of incompatible product lines that threatened its dominance of the industry."[22] IBM sold seven different computer models in 1960, each with different customer target groups, marketing teams, and, above all, different software packages. When a company replaced its computer, the old programs were incompatible with the new model, even if it came from the same brand. All applications had to be reprogrammed. The standardisation we are used to today was still just a fantasy, merely a vision for IBM's research and development team. If new models were software compatible with old ones in the same series, customers would be locked to IBM. The costs in time and money for reprogramming were immense, so if they could be avoided, companies would avoid them.

Although software was still machine-specific, IBM's data input and output system was already standardised.[23] Punched card machines and other peripherals worked with many different IBM mainframes. Following historian of science Matthew Eddy, punched cards can be seen as paper technologies.[24] Just like standardised notetaking in 19th century astronomy, punched card management in the data processing centres of the 20th century functioned through machinic papers. For IBM – an old punched card company – the revelation of standardised punched card technologies inspired the vision of standardised software.

To materialise this vision turned out to be one of the most extensive civilian research and development projects thus far in the US.[25] Within IBM, some considered it madness. Misdirected, since IBM's best-selling products were small machines like the 1401. Perhaps not even possible to achieve, technically, and far too expensive. The development, however, progressed, backed as it was by the top leadership of IBM. In April 1964, the 360 product line was launched in fifteen countries on the same day. IBM held 63 press conferences in the US alone. Such a major research project had to be followed up by lavish and aggressive marketing.

There is no record of the IBM 360 launch in Stockholm that Magnusson and Svenonius attended, but the Swedish marketing group most likely conveyed the same

---

[22] Campbell-Kelly et al., *Computer*, 124.

[23] Campbell-Kelly et al., *Computer*, 125.

[24] Anke te Heesen, "The Notebook: A Paper-Technology," in *Making Things Public: Atmospheres of Democracy*, ed. Bruno Latour and Peter Weibel (Cambridge, Mass.: MIT Press, 2005). Matthew Eddy uses the notion paper machines, but the analysis is similar to that of paper technologies. Matthew Eddy, *Media and the Mind: Art, Science, and Notebooks as Paper Machines, 1700–1830* (Chicago: University of Chicago Press, 2023).

[25] One of the classical descriptions of this process is Pugh, *Building IBM*, Ch. 18.

message as in the US. The 360 was described as a revolution, unlike all other computers.[26] It rendered all reprogramming and incompatibility problems obsolete.

For Svenonius and the others at FOA, reprogramming and incompatibility were well-known phenomena. All the computers they'd used since the mid-1950s had different software packages: Besk, the IBM 650, 704, and 7090. But at least IBM had its own programming language – Fortran – making the basic construction of programs similar in models like the 7090 and the 360. During the years of operating the FOA data processing centre, IBM-specific competence grew at FOA. Technological momentum had gathered. Operators knew how to handle IBM data input and output machines, and programmers knew Fortran. Switching to another brand would have been a nuisance.

The computer pioneers at FOA also came to value software more and more. They focused on hardware while planning to set up the FOA data processing centre. While running the data centre, they realised that the data flow was a bottleneck, hindering smooth operations. If, finally, that problem could be sorted out, good software seemed most crucial.[27] A similar turn from hardware to software is noticeable in international computer history around this time.[28] IBM, with its tremendous resources and multinational networks, captured this shift. The 360 system was their most significant success for many decades to come.

In Sweden, the first 360 system was installed by the electricity company Asea in 1965.[29] Asea played a major role in the electrification of the Swedish industry and pioneered administrative data processing and industrial automation. Asea's early computing history is strikingly similar to FOA's. In 1959, they ordered an IBM 7070 (one of the models FOA contemplated buying before settling on the more advanced 7090) for administrative data processing. In the early 1960s, new goals for the production process were set up and rapidly implemented at Asea. Central to these organisational changes was the flow of materials down on the shop floor. According to Asea's managing director, the engineering work performed there should be planned to minimise the supply storage.[30] Computerisation went hand in hand with visions of streamlined production at Asea – visions that, like within FOA, pinpointed the material flow through the shopfloor and the organisation of work as the most critical components.

---

[26] Pugh, *Building IBM*, 275.

[27] See Chapter 3.

[28] See for example Campbell-Kelly et al., *Computer*, Ch. 8. For a longer discussion on the so called "software crisis" within the computer user community in the middle of the 1960s, see Abbate, *Recoding Gender*.

[29] Kaijser et al., *Maktens maskiner*, 104.

[30] Kaijser et al., *Maktens maskiner*, 100.

Although the 7070 did not diminish administrative work as much as expected – old routines lingered long after the introduction of the IBM mainframe – Asea managers soon set their sights on a new, more advanced computer.[31] In 1965, Asea chose an IBM 360 system.

4.2 The Right Time to Join Forces With the Universities

When the 7090 council first discussed IBM's 360 system, the suggestion was simply to replace the 7090 with a 360 model. In April 1964, it was just an update of the FOA data processing centre. The idea of cooperation between FOA and the higher education institutes in Stockholm did not emerge until the fall of 1964.

The expert council of the Swedish Agency for Administrative Development finished their investigation of academic computing requirements in October 1964. The conclusion was that all universities should have access to advanced computers.[32] Large, shared data processing centres were deemed to be the best option. However, since the Swedish Telecommunications Administration could not ensure connections across large distances, the centralisation of academic computing had to be confined to the level of cities. The expert council proposed five university data processing centres: Umeå, Uppsala, Stockholm, Gothenburg, and Lund. One organisation in each city should, "for practical reasons", oversee operations.[33] Some of these cities already had university data processing centres, like Lund, and some, like Stockholm, lacked them.

At the same time, at the FOA data processing centre, a new prognosis of the calculation needs of the military was made. According to that, the equipment in the machine hall would suffice until the end of 1967.[34] The immediate time pressure loosened up. In Svenonius' earlier prediction, he had overestimated the computational needs of FOA's nuclear research programme.[35] Due to the diminishing political and military support for Swedish nuclear weapons development, the ambitious nuclear research project within FOA did not evolve as Svenonius anticipated in 1963.[36]

FOA had seen a significant funding increase in the financial years 1958/59 to 1961/62, thanks to the nuclear research programme.[37] Two years later, funding for the nuclear project diminished. Again, FOA's entire budget decreased as a result. Another

---

[31] Kaijser et al., *Maktens maskiner*, 103.

[32] "Datamaskiner för utbildning och forskning vid universitet och högskolor," letter to the King, 14 October 1964, Statskontoret, B5:1, RA.

[33] "Datamaskiner för utbildning och forskning vid universitet och högskolor,"14 October 1964, Statskontoret.

[34] "Prognos rörande beläggningen vid FOA datacentral," 29 September 1964, FOA Ö, CentralK, F7a:15, KrA.

[35] "Prognos beträffande försvarets maskintidsbehov," 9 December 1963, FOA Ö, CentralK, F7a:14, KrA.

[36] See Chapter 3, Section 3.4 for more details.

[37] Lundin and Gribbe, *Att följa pengarna*, 42–43.

tendency is noticeable when looking at state-funded research in Sweden throughout the 1960s. The funding for universities and higher education increased from the middle of the decade.[38] State laboratories, dominated by military research institutes like FOA and atomic energy research institutes, received most of the total government funding until 1966/67, when academic institutes became the biggest recipients of research funds for the first time.

This development also parallels the FOA data processing centre. As described in Chapter 3, the number of civilian users at the FOA data processing centre increased in the mid-1960s while the nuclear computations decreased. Overall, the conditions for the FOA data processing centre had shifted slightly. It depended more on civilian users than before, and the nuclear department's hold over the data processing centre slowly eroded.

Following the discussion in both the expert council at the Swedish Agency for Administrative Development and at the FOA data processing centre, Svenonius suddenly saw a new solution to the problem of a soon-outdated centre. FOA might be able to get their new IBM system – maybe even a better, more expensive model – by joining forces with the Stockholm universities. IBM had generous university discounts. FOA's activities were also similar to those of the universities. They were all research institutes, sharing methods, tools, and the need to develop their work to reach the research frontiers. Many FOA employees had academic backgrounds and/or continued their careers within academia.[39] The exchange with the engineering departments at KTH in Stockholm was pervasive. FOA researchers regularly held seminars with invited academic guests and participated in discussions of new educational initiatives in Stockholm.[40] Several people also did their PhDs at FOA throughout the 1960s. The idea of making a common cause with SU and KTH in computing was reasonable.

When presenting this new idea to the 7090 council, where other members had previously emphasised the importance of FOA having its own data processing centre, Svenonius asserted that FOA would be in charge of operations.[41] After all, only FOA had experience running an advanced data centre, and confidential operations required the staff to be under the jurisdiction of the military. It was also likely that FOA would significantly influence the choice of machinery. However, it was deemed "inappropriate for competitive reasons to assume that the mainframe should be of the IBM 360 type."[42]

---

[38] Lundin and Gribbe, *Att följa pengarna*, 37.

[39] In May 1963, FOA had 1500 employees, of which 300 held academic degrees. "Forskarträff på FOA-dag."

[40] Documentations of such seminars are found in FOA Ö, CentralK, F7a:7, KrA.

[41] Minutes 7090 council no 26, 27 October 1964, FOA Ö, CentralK, F7a:1, KrA.

[42] "FOAs roll vid inrättandet av en datacentral för forskning och högre utbildning i Stockholm," 29 September 1964, FOA Ö, CentralK, F7a:15, KrA.

These two arguments – FOA's experience and secrecy requirements – eventually convinced the concerned parties to place the shared data centre at FOA. The reports said that secrecy could only be maintained if "all operating personnel can be subject to a defence authority," and that "[t]he Swedish Defence Research Agency possesses the greatest experience in the country regarding the operation of large computers." Therefore, it seemed "appropriate to seek to link the operation of the large Stockholm plant to FOA."[43] To them, it was the most rational way to organise things.

Björn Kleist, head of operations at the FOA data processing centre from 1963, became responsible for investigating the choice of machinery for the new data centre. The task Kleist got in the fall of 1964 was to compare mainframes. After a year of testing and comparing computers, he concluded that IBM's new 360 system was the best choice for all parties involved. On December 17, 1965, such a system was ordered for approximately 12 million Swedish krona.[44] The final bill, including terminals and other peripheral machines, amounted to 19 million, making it the most expensive computer for academic use in Sweden.[45]

The Swedish Agency for Administrative Development set up a new fund, called the State Computer Fund, to handle the large-scale finances of university data processing centres. The Stockholm Data Processing Delegation, a council with experts on data processing, was also established and intended to govern the data centres eventually. In the end, however, a different board became responsible for governing the university data processing centre.[46] Most of the Data Processing Delegation members came from academia, but Per Svenonius and Torsten Magnusson were members too.

The State Computer Fund purchased the computing machinery, and then the users – FOA and the universities, mainly – rented machine time from the fund. One can assume that the researchers at FOA were satisfied with the choice of machinery. As stated in the background documents for the meeting where the collaboration between FOA, SU, and KTH was approved: "In principle, it is not a disadvantage for the academic institutions that the machine is to be linked to FOA."[47]

4.3 Academic Resistance

As it turned out, the researchers from Stockholm's higher education institutes did see many disadvantages in placing their data processing centre at FOA. In February 1965,

---

[43] Notice of meeting, 2 November 1964, FOA Ö, CentralK, F7a:15, KrA.

[44] Protocol no 329, 17 December 1965, Statskontoret, A1:4, RA.

[45] Agreement between IBM and FOA, 1 February 1967, Stockholms datorcentral QZ archive (QZ), F4:3, RA.

[46] This was the Board for University Data Processing Centres. See Section 4.4.

[47] Protocol no 329, 17 December 1965, Statskontoret.

the rectors of the universities made a call to relocate the data centre to the SU campus. They pointed out that they, "on grounds of principle", had difficulty supporting a setup where FOA was responsible for both operation and administration.[48] The universities' independence was in jeopardy.

And perhaps the independence of SU and KTH wasn't the only thing at stake here. Already in the 1964 investigation of data processing for Swedish research, academics from various universities feared that an excessive zeal for efficiency would force free research in the wrong direction. According to the investigation's report, the university data processing centres should be operated entirely "business-like," and follow an economic system that "promotes cost awareness."[49] But should basic research at universities really be as cost-effective as possible? Tord Ganelius, researcher at Gothenburg University, tried to emphasise other guiding principles:

> This is not a symptom of some aversion to rationalisation or economic thinking, but rather a conviction I have, that it is impossible to consistently apply such an approach to university teaching and research, where what is produced lacks measures of value or efficiency, and where investments must, therefore, be made based on other principles.[50]

However, the caveat at the beginning of this quote is telling. It was challenging to criticise an arrangement presented as the most rational one. Although the academic researchers managed to implement small changes in the governing economic system over time, such as discounts for night runs and compensation not only for processing time but also for data handling and programming time, the significant changes failed to appear.[51] Machine time at university data processing centres was distributed through a system of tokens that assessed all research types based on the same value and efficiency metrics.

The researchers from FOA involved in this affair don't seem to have had any objections. FOA, of course, played a relatively small part in the national organisation of university data processing centres. After all, FOA was just one institution, and the only one outside of academia. It wasn't really their fight.

But there might be another reason for the FOA researchers' silence. When Agrell discussed the simultaneous militarisation and scientification of research in Cold War

---

[48] Letter to the Swedish Agency for Administrative Development, 8 February 1965, FOA Ö, CentralK, F7a:16, KrA.

[49] "Datamaskiner för utbildning och forskning vid universitet och högskolor," 14 October 1964, Statskontoret.

[50] "Datamaskiner för utbildning och forskning vid universitet och högskolor," 14 October 1964, Statskontoret.

[51] Personal correspondance with Ingemar Dahlstrand, 7 September 2023.

Sweden, he pointed out bureaucratisation as a key part.[52] Two world wars had shown the importance of temporary technical advantages in military battles – the atomic bomb was the most extreme example, but far from the only one. Such benefits were not achieved by chance, but by careful planning and strict tenacity. For this reason, Agrell identified goal-orientation and bureaucratic planning as two characteristics of the militarisation of research.[53]

Military research can, of course, include free searching, and academic research can be clearly goal-oriented.[54] But in terms of measures of value, which Ganelius mentioned, there is a difference between the two. Ganelius spent his life investigating analytic functions. Analytic functions are special mathematical expressions, showing up in various mathematical and physical fields: trigonometry, electromagnetism, and thermodynamics. However, a mathematician studying analytic functions does not deal with specific thermodynamical problems. They study the essential properties and analytical solutions of all such functions, to appease their curiosity and/or push the research frontier forward.

Svenonius worked a bit with analytic functions too, but he used them to solve strictly specified problems, in the end aimed to construct nuclear weapons. Such computations are based on numerical treatment of functions and equations. The exact, analytical solutions that interested mathematicians like Ganelius are too complex to be useful in military research, where the overarching value of research is determined by its applicability for the military. As Peter Galison shows, numerical methods such as Monte Carlo simulations become powerful frameworks not only for solving specific problems but also for scientific thinking and community building.[55] The point is that numerical methods provide an alternative approach to scientific problems compared to analytical methods. Numerical methods are pragmatic ways to reach pre-determined goals, while analytical methods are investigations of pure mathematics, with intrinsic values. These differences in value measures might help explain why the FOA researchers adopted the streamlined business model for the university data processing centres more quickly than the academic researchers.

The next source of concern for the Stockholm academic computer users was the technical equipment to be purchased. Everyone had their specific needs in terms of hardware. The people from the physics department at SU wanted a computer

---

[52] Agrell, *Vetenskapen i försvarets tjänst*, 40.

[53] Agrell, *Vetenskapen i försvarets tjänst*, 40.

[54] The US think tank Rand corporation is perhaps the most famous example of military research aimed at basic science, see for example Alex Abella, *Soldiers of Reason: The Rand Corporation and the Rise of the American Empire* (Boston: Mariner Books, 2009).

[55] Peter Galison, "Computer Simulations and the Trading Zone," in *From Science to Computational Science*, ed. Gabriele Gramelsberger (Zürich: Diaphanes, 2011).

compatible with the European particle physics laboratory Cern in Switzerland, to facilitate collaboration with them.[56] Particle physics had wind under its sails in the 1960s. In Sweden, this too was partly due to the diminishing nuclear research programme. For fundamental physicists, nuclear research had been a safe bet in terms of funding in the late 1950s. When these conditions started changing, people started looking elsewhere.[57] Particle physics seemed like a promising new field.

Since software standardisation was still years ahead in the mid-1960s, compatibility with collaborators' software was a paramount concern. Researchers from KTH did not express clear wishes for the mainframe brand or model. Instead, they highlighted the need for a high-speed terminal on their premises.[58] A sufficient terminal would make them more independent by enabling distance programming, and it would also facilitate experimental work that required proximity to the labs at KTH.

The machine selection was based on tests designed by FOA's Björn Kleist, and he chose to focus on fast setup times for short runs.[59] Undoubtedly, he based that decision on his experiences from the FOA data processing centre, where the data input/output procedures and the slow setup times for short runs had been the major issues.

The IBM 360 system was presented as a flexible yet systematic set of machines, with easy input and output mechanisms. After testing mainframes from different brands, Kleist ranked the IBM model 360/75 as the best option for the new data processing centre. It was also slightly cheaper than the competitor, a CDC 6600, made by Control Data Corporation and preferred by the SU physicists seeking compatibility with Cern's computing team. IBM's cheaper offer appealed to the Swedish Agency for Administrative Development.[60]

With an IBM mainframe, choosing terminals from other brands was almost impossible. The physicists from SU had to abandon their requirement for compatibility with Cern. As for the advanced terminals that the KTH researchers wanted, they were dismissed internally at FOA. The 7090 council found it "highly doubtful that it would be appropriate," and instead outlined a setup with an advanced mainframe and two smaller terminals.[61] Neither Stockholm University nor the Royal Institute of Technology

---

[56] Minutes 7090 council no 30, 2 June 1965, FOA Ö, CentralK, F7a:1, KrA.

[57] For an overview of this transition, and others, in Swedish physics, see Thomas Kaiserfeld, Marika Hedin, and Svante Lindqvist, *Center on the Periphery: Historical Aspects of 20th-century Swedish Physics* (Canton: Science History Publications, 1993).

[58] Minutes 7090 council no 30, 2 June 1965, FOA Ö.

[59] To Databehandlingsdelegationen in Stockholm, 9 September 1965, QZ, F4:3, RA.

[60] To Databehandlingsdelegationen in Stockholm, 9 September 1965, QZ.

[61] Minutes 7090 council no 30, 2 June 1965, FOA Ö.

got what they wanted. “Conflicts of interest can therefore be expected,” Kleist expressed at a FOA meeting in November 1965.[62]

By the beginning of 1966, the atmosphere had deteriorated to the point where researchers at FOA contemplated abandoning the collaboration and managing the IBM system, which had already been ordered, on their own, despite missing out on the university discount.[63] But it wasn't until the summer of 1967 that things heated up. The chosen mainframe and the somewhat vague contract signed with IBM were heavily criticised by two researchers: Janis Bubenko (1935–2022) and Tomas Ohlin (b. 1934).[64]

Both had backgrounds in engineering – Bubenko came from mechanical engineering at the Chalmers University of Technology and Ohlin from electrical engineering at the KTH. In the 1960s, both held positions at KTH. Together with a few others, they started the first data processing education in Sweden. It became a cross-institutional cooperation between KTH and SU, where Bubenko and Ohlin taught. While Bubenko stayed in academia, eventually becoming a professor of the new information systems discipline, Ohlin engaged in various data processing policy and research funding initiatives. He was, for example, director of the Board for Technical Development (later Vinnova), and an expert member of the Swedish committee for data legislation in the 1970s.

Bubenko and Ohlin sent a formal protest of the hardware choice for the QZ to the Swedish Agency for Administrative Development. The Swedish daily *Svenska Dagbladet* picked up on the incipient conflict, and at FOA, Björn Kleist was worried about a negative public opinion due to the press coverage.[65] He wanted to “start operations without too many academic discussions.”[66] Instead, this academic discussion transformed into a media debate where the Swedish Agency for Administrative Development and IBM were portrayed as villains.[67]

The Agency for Administrative Development was accused of being stingy. The researchers needed a CDC 6600 but were forced to settle for an inferior mainframe since it was slightly cheaper. IBM had promised more than they could deliver in terms of performance and had written a deliberately vague contract. According to Lars Gunnar

---

[62] Minutes 7090 council no 32, 10 November 1965, FOA Ö, CentralK, F7a:1, KrA.

[63] Minutes 7090 council no 34, 14 January 1966, FOA Ö, CentralK, F7a:1, KrA.

[64] Annerstedt et al., *Datorer och politik*, 160.

[65] "Ny schism om statlig datamaskin," *Svenska Dagbladet*, 18 July 1967.

[66] Minutes 7090 council no 41, 20 September 1967, FOA Ö, CentralK, F7a:1, KrA.

[67] See for example "Expertkritik avvisas av IBM i dataaffären," *Göteborgs Handels- och Sjöfartstidning*, 12 August 1967; Sign. G L-E, "Det är inte för sent än att byta till ett annat märke " *Göteborgs Handels- och Sjöfartstidning*, 20 July 1967; Arne Karsberg, "Rektorerna stöder forskarna i angreppen på datamaskinkö," *Dagens Nyheter*, 9 March 1968; Arne Karsberg, "Datamaskinkriget går vidare, Expertdelegation underkände," *Dagens Nyheter*, 16 Mai 1968. An exception is the positive report on the inauguration of the data processing centre: Sign.: WERP, "Flinkaste datamaskinen i Norden installeras hos FOA på Östermalm," *Svenska Dagbladet*, 9 January 1968.

Sillén, professor in chemistry at KTH, the process was likened to "buying a pig in a poke and throwing good money after bad."[68]

When Sillén wrote this in the summer of 1968, the mainframe had already been delivered, but the operating system was delayed, causing a reduction in capacity. This was not entirely uncommon. The 1960s computer market was an arena where companies consistently put up future offers for sale, which the research and development departments did not always realise in time.

The performance of the IBM 360/75 mainframe continued to be criticised. Several influential academics, including Ohlin and Bubenko, signed a formal protest, demanding comprehensive performance tests of the mainframe.[69] "But I'm afraid that the Swedish Agency for Administrative Development, with its usual tactics of exhaustion, will still enforce its own will," one of the signatories told *Göteborgs Handels- och Sjöfartstidning* in March 1968.[70] Around this time, journalist Arne Karsberg named the conflict "the war of computing machinery."[71]

The Agency for Administrative Development was the crook in the play. The heroes were the members of the Stockholm Data Processing Delegation, the expert council tasked to assist the agency with data processing knowledge. Thus, Torsten Magnusson, chairman of the 7090 council that chose the 360 system already in 1964 and designed the setup with an advanced mainframe and smaller terminals, was on the heroes' side of the infected hardware conflict. As part of the Data Processing Delegation, he was one of the good guys, whose actions or standpoints were not criticised in the media. When the delegation demanded performance tests of the machines, Magnusson and Kleist performed them. They highlighted several positive indications but concluded that the mainframe didn't quite meet expectations.[72]

On September 15, 1968, Karsberg reported that the war was over. The Swedish Agency for Administrative Development acknowledged that the performance fell short, but the mainframe was already in place and IBM promised to improve various aspects.[73] In the newspaper article, Ohlin summarised it all: "The discussion in recent years has primarily concerned who should influence the treatment of the matter, the decision-making body – the Swedish Agency for Administrative Development – or the computer users."[74]

---

[68] Lars Gunnar Sillén, "Stordata, forskning och pengar," *Svenska Dagbladet*, 17 June 1968.

[69] Annerstedt et al., *Datorer och politik*, 162.

[70] Göran Licke, "Fruktan att Statskontoret med utmattningsmetoder driver igenom sin vilja," *Göteborgs Handels- och Sjöfartstidning*, 7 March 1968.

[71] Karsberg, "Ny attack i 'datamaskinkriget', Forskares krav ströks ned 50%."

[72] Arne Karsberg, "Fint resultat i dataprovningen, Expertstrid fortsätter," *Dagens Nyheter*, 20 April 1968.

[73] Arne Karsberg, "Datamaskinsbataljen över men eftersmaken är besk," *Dagens Nyheter*, 15 September 1968.

[74] Karsberg, "Datamaskinsbataljen över men eftersmaken är besk."

4.4 An Unholy Alliance

Two computer users, however, were granted significant influence over decision-making regarding QZ: Per Svenonius and Björn Kleist. Together, Kleist and Svenonius directed the FOA data processing centre. Both were curious researchers. Yet, they became representatives of the foremost enemies of free research: square bureaucracy and unscrupulous corporate conglomerates.

Yngve Sundblad (b. 1943), a teacher at the department of numerical analysis and early computer user at KTH, was not very active in the QZ debate himself but still pointed out in an interview that "it was a bit strange that Kleist, who had been employed by IBM, was involved in the decision process between IBM and Control Data".[75] The media presented this fact as a corrupting circumstance.[76] IBM indeed employed Björn Kleist between 1959 and 1962, although he was positioned at FOA for most of that time, first dealing with the preparations for the delivery of the IBM 7090 and then overseeing operations at the new mainframe. This fact alone wasn't necessarily evidence of corruption, in any case. It wasn't unusual to contract experts from big companies like IBM when doing major computer deals, and loyalty with such companies stretched far beyond their employees.[77]

Regardless, Kleist's background at IBM made him a representative of the multinational computer company that symbolised the power of capital more than anyone else. By the mid-1960s, IBM dominated the computer market in the Nordic region. When the first IBM computer was installed in Sweden in 1956, the company had manufactured punched cards at a Swedish subsidiary for almost 30 years. Petri Paju identifies this production as key to understanding IBM's success in the Nordic countries.[78] As was told in the introduction to this thesis, the Swedish Agency for Administrative Development chose IBM in 17 out of 20 computer purchases between 1961 and 1963.

Thomas Haigh and Petri Paju further argue that IBM's successes in Europe were made possible by successful subsidiaries and transnational user networks.[79] The importance of user networks also shines through in the expert council's investigation of data processing in Swedish research. It says "[w]hen a computer becomes obsolete […]

---

[75] Interview, Yngve Sundblad, 10 May 2022.

[76] G L-E, "Det är inte för sent än att byta till ett annat märke ".

[77] IBM put a lot of marketing efforts into customer relationships, and got famous for the persuasion tactics "No one ever got fired for choosing IBM," see Campbell-Kelly et al., *Computer*, 138.

[78] Paju, "IBM Manufacturing in the Nordic Countries."

[79] Paju and Haigh, "IBM Rebuilds Europe."

it primarily means that the development and the community with other facilities are lost."[80]

IBM also used more dubious tactics to maintain its market monopoly. For example, historian of science David Nofre shows how IBM aggressively marketed its programming language, Fortran, in Western Europe during the 1960s to eliminate the competing language Algol.[81] Algol was born out of an international research collaboration and was intended to be a scientific standard language, while Fortran was an IBM-specific language for technical and scientific programming.

For the researchers who had just started teaching data processing at SU and KTH, Algol was often the first choice for programming tasks. The Swedish education in data processing was at this time divided into numerical analysis, headed by Germund Dahlquist (1925–2005); and administrative data processing, headed by Börje Langefors (1915–2009).[82] The most substantial criticism of the IBM purchase came from the administrative side – both Bubenko and Ohlin were based there. IBM's Fortran was not suitable for their students. It is worth noting that whenever numerical and administrative computer users had to share one computer – which was often the case in the 1960s when computers were still so expensive – conflicts on hardware as well as software were common. With or without an IBM machine, debates might have risen.

But IBM's aggressive marketing strategies and seemingly inexhaustible resources gave it a reputation for being unbeatable in market competition. Politicians and leading data experts were regularly invited to marketing events, dinners, and demonstrations of new IBM systems. Tomas Ohlin recalls an exclusive lunch in New York during a visit on behalf of a Swedish governmental investigation, hosted by IBM.[83] For the researchers criticising the IBM 360 system purchased for QZ, it was easy to blame the Swedish politicians for favouring IBM in a corrupt way.

Insinuations that the Finance Minister, Gunnar Sträng, chose IBM circulated. Sträng had made a name for himself in computer affairs before. For example, he garnered attention in 1963 when he led the procurement of computers for population registration and taxation.[84] Furthermore, the Swedish Agency for Administrative Development was, in a way, Sträng's personal creation. The agency was subordinated to the Ministry of Finance, many of its leading figures were handpicked by Sträng himself, and the ideal of

---

[80] "Datamaskiner för utbildning och forskning vid universitet och högskolor," 14 October 1964, Statskontoret.

[81] Nofre, "The Politics of Early Programming Languages."

[82] In Chapter 5, the development of computing education in Stockholm is outlined.

[83] Interview, Tomas Ohlin, 3 May 2022.

[84] The two main competitors for delivering this large-scale state machine system were IBM and the Swedish company Saab. The purchase was surrounded by fierce debate, both within the Swedish parliament and in media. Sträng decided to compromise and chose a system consisting of both IBM and Saab computers. He was praised for his actions, although the public debate did not cease entirely. Annerstedt et al., *Datorer och politik*, 145.

rationalisation infused in the agency embodied Sträng's vision of an optimally organised country.

In a 2006 article about the QZ conflict, data pioneer Kerstin Anér wrote, "Beforehand, it gave the impression that the project already was decided. IBM would be the winner." She then explained how IBM convinced the politicians – ultimately the Finance Minister himself – that their system was the best.[85] Through its composition, the expert council that investigated academic data processing in 1964 contributed to the conspiracy against the honest academics, as "[a]dministrators and politicians were in the majority, and researchers were in the minority."[86]

The rumours of corruption were, however, probably exaggerated. Sträng did approve the IBM purchase, but Svenonius, Kleist, and the others at FOA chose the system and lobbied for it. Testimonies like Anér's are still telling, in any case. The conflict was between free scientists and bureaucratic politicians. After all these years, both Yngve Sundblad and Tomas Ohlin are still visibly content to have stood on the same side as that minority of researchers who fought against the rigid bureaucracy.[87]

In the 1960s, the computer was associated with control, surveillance and loss of individual freedom and integrity. As Paul N. Edwards puts it, the computer became a symbol for "the closed world" of the Cold War, where technologies and discourses of national security limited individual freedom.[88] Protest against Cold War politics and especially the Vietnam War raged in the US. The 1964 Berkeley student protests sparked transnational anti-war movements. In the US, these culminated on the Bloody Thursday of 1969, when California governor Ronald Reagan sent the state National Guard to quell the violent protests, leading to casualties and injured people.

However, the counterculture born from the 1960s youth rebellions adopted the computer as a symbol of digital freedom and cybernetic limitlessness, rather than of oppression.[89] Stewart Brand and the others involved in the influential Whole Earth Catalogue called for a return to individualistic and independent lifestyles, aided by digital technologies.

In Sweden, the anti-war movements were strong in the late 1960s. Such protests found their way into the highest political circles. Olof Palme, Prime Minister from 1969

---

[85] Kerstin Anér, "The A-computer system conflict," in *ICT for People: 40 Years of Academic Development in Stockholm* ed. Janis Bubenko (Stockholm: Dept. of Computer & Systems Sciences, Stockholm University and Royal Institute of Technology, 2006), 406.
[86] Anér, "The A-computer system conflict," 406.
[87] Interview, Sundblad, 2022 and Ohlin, 2022.
[88] Edwards, *The Closed World.*
[89] Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006); Patrick McCray, *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (Princeton: Princeton University Press, 2013).

to 1976 and from 1982 to his murder in 1986, became famous for his protests against the Vietnam War.[90] Palme's 1972 Christmas speech on the war troubled diplomatic relations between Sweden and the US.[91]

Palme's position in the anti-war movement didn't hinder critique against the Swedish government's standpoint on digital integrity, however. Jan Annerstedt called for a political awakening regarding the computerisation of Swedish society in his book *Datorer och politik* (1970).[92] For him, massive data collection and market monopolies allowed big businesses and banks to set the agenda for naive politicians and betray citizens in a profoundly non-democratic way. From this perspective, IBM and the Swedish Agency for Administrative Development formed an unholy alliance between capitalists and apolitical rationalisation technocrats.

The counterculture that embraced digital technologies in the US did not gain as much influence in Sweden. In 1973, Sweden became the first country in the world to legislate on registering personal information to maintain the population's integrity.[93] Kerstin Anér, writer of the article criticising the hardware choice of QZ, was one of the key actors in finalising the 1973 integrity law.

In a British context, Jon Agar argues that the mechanisation of government activities developed in parallel with the emergence of decision-making based on external expertise in the 20th century.[94] When technical experts are given political authority, the government apparatus appears more like a machine, rational but impersonal and somewhat intimidating. It is reminiscent of the Swedish Nobel Prize-winning physicist Hannes Alfvén's 1966 science fiction novel *Sagan om den stora datamaskinen*, where the entire organisation of society has been handed over to computers.[95] When the machines suddenly start breaking down, people have no choice but to try to reinvent their forgotten knowledge, the remnants of which can only be found in the relics kept in museums. Alfvén reminds us that total rationalisation always carries an existential threat.

For the academics concerned with the university data processing centres, this threat was posed by the Swedish Agency for Administrative Development. Per Svenonius, secretary of the agency's expert computing council and previously chief engineer at a military research department for nuclear physics, appeared to be the perfect technocrat. To debaters like Annerstedt, he was the authoritarian technical expert whom an

---

[90] For an analysis of Palme's life and role in Swedish politics, see for example Henrik Berggren, *Underbara dagar framför oss: En biografi över Olof Palme* (Stockholm: Norstedt, 2010).
[91] See Bjereld, Johansson, and Molin, *Sveriges säkerhet och världens fred.*
[92] Annerstedt et al., *Datorer och politik.*
[93] Ilshammar, *Offentlighetens nya rum.*
[94] Agar, *The Government Machine.*
[95] The book was written under psedonym: Olof Johanneson, *Sagan om den stora datamaskinen: En vision* (Stockholm: Albert Bonniers Förlag, 1966).

ideologically convinced and elected politician should replace.[96] To the academic researchers, he was the square bureaucrat who should be replaced by a representative of fundamental research. Per Svenonius was perhaps first and foremost a military researcher: scientifically trained, strategically minded and goal-oriented.

Criticism of the Swedish Agency for Administrative Development and its role in university data processing also flared up in other Swedish cities. In both Lund and Gothenburg, debates arose over the procurement of mainframes for the data centres. In Lund, the lines of conflict were very similar to those in Stockholm. The academics preferred a Control Data machine, but their wishes were overruled by the Agency for Administrative Development, which had decided that Lund should take over the IBM 360 system that was no longer adequate in Gothenburg. The criticism of IBM in Lund echoed the same arguments used in Stockholm. The company was accused of fiddling with performance, and they couldn't live up to the promises made on delivery. Ingemar Dahlstrand (b. 1932), a mathematician with a background in the computer industry and from 1968 head of the Lund University data processing centre, remembered in an interview that IBM's machines weren't suited for academic work and that this fact was sometimes hidden behind temporary adjustments.[97] *Dagens Nyheter* also reported on the conflicts in Lund and Gothenburg.[98]

Academic scholars from all over the country also opposed the financial system for data centres proposed by the Swedish Agency for Administrative Development. Although market-based thinking and quantitative standardised research measures were considered adequate in some ways, the academic community was sceptical about whether the economy was the most critical aspect of their work. Ingemar Dahlstrand remembered how the rigid financial rules hindered flexibility and research opportunities.[99]

Paradoxically, this massive criticism of the organisation of the university data processing centres led to an organisational change that, instead of protecting the autonomy of the universities, undermined it even more. The data processing delegations set up in each city to oversee operations were dissolved, and the management of the data processing centres was centralised. In 1968, the Board for University Data

---

[96] Annerstedt doesn't mention Svenonius explicitly, but the criticizes the computing expert consultants to the Agency for Administrative Development and their connections both to the military and to IBM, Annerstedt et al., *Datorer och politik*, 134–35, 50. In a Swedish cultural journal, Annerstedt and Lars Dencik further sharpened their critique on technocrats, see Jan Annerstedt and Lars Dencik, "Koloniseringen av framtiden," *Ord & bild*, no. 6 (1971). See also Gustav Holmberg, "Framtiden: Historikerna blickar bakåt," in *Beredd till bådadera: Lunds universitet och omvärlden*, ed. Gunnar Broberg and David Dunér (Lund: Lunds universitet, 2017).

[97] Interview, Ingemar Dahlstrand, 8 June 2022.

[98] "Statskontoret till attack i tvisten om datamaskiner," *Dagens Nyheter*, 18 July 1966.

[99] Interview, Dahlstrand, 2022.

Processing Centres was set up under the Swedish Higher Education Authority in Stockholm to coordinate the use of computers at Swedish universities and to handle personnel matters and machine rental. Per Svenonius, who had left FOA to become head of the data department at the Swedish Agency for Administrative Development, was elected chairman of the board by then. At the same time, Björn Kleist became head of operations at QZ.

4.5 Experience and Secrecy

In the mid-1960s, Per Svenonius balanced on the borderline between government bureaucracy and military research. He gradually moved from nuclear research at FOA to data coordination at the Swedish Agency for Administrative Development. Björn Kleist had similarly balanced between IBM and FOA a few years earlier. In the debate on QZ, Svenonius and Kleist became representatives of the Agency for Administrative Development and IBM, respectively, instead of FOA. It was the former that the academics were fighting against.

I argue, however, that it was as FOA researchers that both Svenonius and Kleist gained such great influence over the organisation of QZ. To understand the establishment of QZ, you have to go back to the FOA data processing centre, where Svenonius and eventually Kleist headed operations. The 7090 council was crucial to developing the Stockholm data processing centre QZ.

The 7090 council at FOA was allowed such a vast influence over the establishment of QZ because they were the only ones in Stockholm – and in Sweden generally – with experience running advanced data processing centres. The researchers at FOA had not only technical expertise in large computers, but also administrative expertise. For example, they knew what was required to make the turnaround times of the runs manageable, and they had written software to charge the data centre's customers for their runtime. The latter was quite complicated, as several programs were running simultaneously, and it was unclear how runtime was best measured – in the number of seconds the computer's central processing unit was working? Or in total machine load? FOA was given responsibility for the day-to-day finances at the QZ because FOA's postal giro account had to be used "for accounting purposes".[100] The infrastructure for debiting customers somehow depended on FOA's specific postal giro – or it might have been easier to keep to the old habits.

---

[100] "Föredragningslista allmänna administrativa frågor," 2 June 1967, QZ, A5A:1, RA.

The FOA data processing centre was inaugurated in 1961. It had only been operating for a couple of years when the planning process for the QZ started. Yet, it had already gathered technological momentum. The customer debiting process was too complicated to change. The data flow had been optimised at the FOA data processing centre, so why change it now? The organisational structure of the FOA data processing centre was resistant to change because Stockholm had no alternative structures. No other data centre of equal complexity was open to the public; therefore, FOA's way of organising computing work rapidly solidified into the optimal one.

The changes that were made, were also based on experiences from the FOA data processing centre. This experience was crucial in several practical decisions regarding QZ. The data processing centre was placed in the middle of the courtyard at Linnégatan 89 (see Figure 4), partly because FOA's other buildings were already too crowded, but also because it was important for the calculation groups in FOA's various departments to be close both to the data centre and to their respective departments.[101] With the data centre in the middle, everyone could remain in their departments and still be close to the computer.

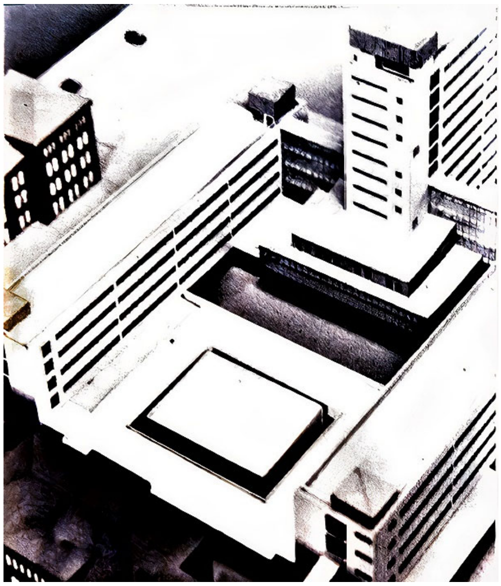

Figure 4: Model showing the location of QZ, in the middle of FOA's courtyard at Linnégatan 89.[102]

---

[101] Memo from FOA 3 to the 7090 council, undated but probably 1965–1966, FOA Ö, CentralK, F7a:16, KrA.

[102] Picture from *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 3 (1965).

The design of QZ's premises involved painstaking estimates of exact turnaround times for programs given different spatial configurations. The walking distances between the offices and the punch card lift, or the reception and the punching station, were carefully included.[103] Such measurements resemble other spatial and temporal optimisation efforts in Cold War Sweden. For example, historian of science and technology Boel Berner shows how Swedish housewives in the 1950s were encouraged to time and plan every hour of their day to achieve optimal efficiency.[104] The Home Research Institute, established in 1944, advised housewives on how to spatially organise and work ergonomically in their kitchens.[105] Rational planning prevailed in people's homes, as well as in research institutes.

At FOA, the goal was to structure the new data processing centre in an entirely rational way. Everything missing from the FOA data processing centre would now be implemented: proper ceiling height, insulation to facilitate air conditioning, a longer counter for customer reception.[106] The machine hall was even built on a floating concrete slab to dampen vibrations, as the FOA data centre had problems with core memories getting destroyed when Sweden's Television blasted tunnels for its TV cables on Linnégatan.[107]

For the programmers in the calculation groups at FOA's departments, establishing QZ did not entail any radical change in their work. In interviews, both mathematicians Lena Jönsson and Margareta Franzén find it difficult to remember whether something happened at FOA's data processing centre or QZ – one IBM computer was replaced by another, but they still handed their punch cards to the same receptionist and followed the same work procedures as before.[108]

The FOA researchers' experience was also crucial in choosing the machine for the new data processing centre. Björn Kleist designed his machine tests after having monitored the runs on FOA's IBM 7090 for several years. His standard problems and assessment criteria were coloured by his experience of trying to run a large data processing centre on behalf of the Swedish Armed Forces as efficiently as possible.

---

[103] "Utredning av lokalalternativ för Stockholms datacentral," undated but probably 1965–1966, FOA Ö, CentralK, F7a:16, KrA.

[104] Boel Berner, *Sakernas tillstånd: Kön, klass, teknisk expertis* (Stockholm: Carlsson, 1996), 248–49.

[105] For an analysis of the Home Research Institute, see Britta Lövgren, *Hemarbete som politik: Diskussioner om hemarbete, Sverige 1930–40-talen, och tillkomsten av Hemmens forskningsinstitut* (Stockholm: PhD diss.: Stockholm University, Almqvist & Wiksell International, 1993).

[106] These improvements were specified by Björn Kleist, 17 December 1963, FOA Ö.

[107] Interview, Kleist, 2021.

[108] Interview, Jönsson, 2021 and Franzén, 2021.

The second argument, besides experience, used to justify FOA's influence over QZ was the need to guarantee security when classified programs were run. Secrecy settled the question of where to place the data processing centre.

Everyone involved wanted the mainframe nearby. In the 1960s, programming still required direct contact with the machine. If the mainframe was not close by, it was harder to adapt the programs, setup times were longer, and bugs took longer to fix. A famous anecdote in computing history is when the operators found a moth in the hardware of one of the earliest computers, a physical bug causing programming issues.[109] While this event did not give rise to the notion "bug" – that word has a much longer history – it is still symbolic of early programming. To get the right results, you had to be close to the machine so you could clear the bugs. In the expert council's investigation of university data processing centres, FOA representatives argued that the data centre should be located at FOA, while the academics wanted it to be at SU.

Both sides had practical and research-specific arguments. Researchers at FOA wanted to be able to guarantee that classified military research was kept secret. In contrast, those at SU and KTH wanted to connect laboratory equipment directly to the computer and have an open exchange between the data centre staff and their researchers.[110] The expert investigation found that the specific needs of the military researchers were more important to fulfil.

The secrecy surrounding the research performed within FOA had several practical consequences. For example, all employees at QZ were bound by professional confidentiality after leaving their service, numerous runtime slots were dedicated to secret runs, and this special handling of confidential runs demanded extra administration.[111] Yngve Sundblad remembered that the researchers of Stockholm's higher education considered the security practices at QZ absurd.[112]

Other complications arose when confidential military research met the open, academic research world. For example, it was possible to do a PhD at FOA, but if some parts of the research were classified, those who wanted to apply for academic positions after their PhD could not refer to any concrete merits. In 1960, such a case occurred within FOA, when Bengt Holmberg applied for a professorship at Chalmers and wanted to refer to secret nuclear physics calculations that he had made at FOA in his application. The case was brought to the attention of FOA's Director-General Martin Fehrm, who

---

[109] This story was popularised by Grace Hopper, Grace Hopper, "The First Bug," *Annals of the History of Computing, IEEE* 3, no. 3 (1981).

[110] "Datamaskiner för utbildning och forskning vid universitet och högskolor," 14 October 1964, Statskontoret.

[111] "Föredragningslista personalfrågor," QZ, A5B:1, RA.

[112] Interview, Sundblad, 2022.

concluded that it would be possible to assess Holmberg's secret work, as long as it was presented as a set of general scientific problems.[113]

The practices of secrecy also extended spatially as well as materially. It was present in the lead-encapsulated cables at QZ, and even more in the pedestrian tunnel built under the new machine hall. To enter into FOA, you had to pass a guard, and the troubles caused by this were described in Chapter 3. The solution to this problem was to build a separate entrance to the QZ for external users while allowing the FOA employees to use another, unguarded entrance.

Although the QZ was presented as a "service bureau for the university, higher education in Stockholm and other interested parties within state or private businesses," its location on military ground determined its design.[114]

4.6 Conclusion

This chapter has shown that FOA played a decisive role in establishing the university data processing centre QZ. The conditions for the cooperation between FOA on the one hand and the Stockholm universities on the other were primarily worked out by FOA's 7090 council. The choice of the IBM 360 mainframe was made internally within FOA as early as the spring of 1964, before the Swedish Agency for Administrative Development recommended it.

The agency allowed FOA to take on such a leading role at the QZ for two reasons: the FOA researchers' unique experience of administering and operating such an advanced data processing centre, and the secrecy requirements surrounding military calculations. I've explained the first argument in terms of technological momentum.

Work procedures, personnel, programming standards, administrative regulations, etc, could simply be transferred from the FOA data processing centre to the QZ. The alternative – to have an institution without experience organising all this from scratch – was never even considered, although the rectors of the Stockholm universities did ask for it. FOA's momentum also had hardware and software aspects. IBM-specific competence had grown at the FOA data processing centre for years. Machine operators were used to the 7090, and programmers knew Fortran. Changing the mainframe brand at the new data processing centre would require a major re-learning period. Choosing an IBM system made sense.

For the FOA researchers, the establishment of QZ was a chance to reorganise computing work at the agency more efficiently. At the FOA data processing centre, the

---

[113] From Martin Fehrm to Bengt Holmberg, 31 March 1960, FOA H, AdmB, Ö VII:1, KrA.
[114] "QZ informationsblad," QZ, F4:2, RA.

bottlenecks in the data flow had been material and spatial. There wasn't enough space, and data input and output procedures were time-consuming. They needed a new mainframe – the 7090 was approaching full capacity – but new and bigger premises were perhaps even more eagerly awaited. The detailed comparisons of walking distances between different locations in the QZ show how vital the spatial design of the new data centre was.

The QZ's spatial design solved perceived problems in the daily operation at the FOA data processing centre. This is an essential link between two data processing centres which, from a historical perspective, otherwise easily pass as separate entities: a military computing service centre and a university data processing centre. Yet, they belong together. The QZ had never been organised the way it was – including the criticised hardware – had not Swedish research been militarised in the 1950s. The operation of the IBM 7090, bought for money from the well-funded nuclear research programme, gave FOA the momentum to take the lead in planning the QZ. This, in turn, probably spurred the militarisation of research. The military research institute FOA set standards for academic computing, since Sweden's biggest university data processing centre lay on their premises. One of the most apparent consequences of the QZ's location was the measures taken to maintain secrecy. Maintaining secrecy required sacrifices in other areas: complicated architectural designs, neglected university requirements, and complex recruitment procedures.

Despite immense critique of the practical choices made when establishing QZ, the institution responsible for these choices remained quite invisible in the media debate. The protests by Janis Bubenko and Tomas Ohlin held the Swedish Agency for Administrative Development and IBM accountable, not FOA. Svenonius and Kleist personally received criticism, but they were primarily seen as representatives for the above-mentioned institutions, although both were FOA researchers. FOA disappeared in the gap between academic research and state bureaucracy.

This is emblematic of Swedish militarisation. The ascendency FOA gained over Swedish research was largely invisible, hidden behind Swedish political action. Lundin and Stenlås argue that neutrality and modernity marked the conception of Sweden as a country in the postwar era.[115] While the political action connected to neutrality dominated the establishment of the FOA data processing centre – see Chapter 2 – the establishment of QZ instead relied on the myth of modernity. The idea of Sweden as a technologically advanced, rational and efficient state was enacted through the Agency for Administrative Development. According to the agency, giving FOA custody of the

---

[115] Lundin and Stenlås, "Technology, State Initiative and National Myths in Cold War Sweden."

QZ didn't reflect the direction of Swedish research in general; it was just the rational thing to do. The fact that a military research institute controlled Sweden's most prominent university data processing centre was made invisible.

As a result of the conflicted process of uniting the Stockholm universities with FOA, the QZ became an interdisciplinary computing service centre, where academic and military researchers met and cooperated, shared expertise, and confronted similar problems. The next chapter investigates the QZ and analyses the changing perceptions of computing work circulating there.

5 The Systems Revolution in Computing Work, 1955–1975

In a 1971 article in IBM's Swedish journal, Björn Kleist proudly proclaimed: "At the QZ, the staff includes experienced systems men, who undertake programming assignments and program optimisation. The latter service is rather unusual at service bureaus."[1] At the time, Kleist was head of operations at the QZ – a computing service bureau not only for the Stockholm universities and FOA, but also for external customers. It was probably those Kleist wanted to attract with his claim.

Program optimisation by trained experts was something rather new, just like Kleist claimed. It was a sign of a crucial change in the perception of computing work. Fifteen years earlier, in the late 1950s, "programming" had merely been a process of trial and error, performed in close contact with the machine by anyone interested in the matter.[2] The 1960s were a time of standardisation and unification of programming languages and computing practices. It was a decade marked by attempts to professionalise programming – the most famous example is the international "software crisis" of 1968, where the perceived lack of efficient multi-task software and people capable of developing it led to the establishment of the "software engineer" as a professional identity.[3] Such requirements were more straightforward to postulate than implement.[4] Yet, by 1971, programming work had transformed from a hands-on practice to a logical activity, that Kleist and many others believed was best handled by "systems men". Simultaneously, computing became increasingly synonymous with programming.

Through exploring how this transition unfolded at FOA, this chapter aims to shed light on how conceptualisations of computing work influence professional hierarchies and work environments. How did the conceptualisation of computing work differ from

---

[1] "QZ-Stockholms datamaskincentral," *IBM Nytt* 4:1971, QZ, F4:2, RA.

[2] The word programming wasn't that common in the late 1950s, and programming practices were also harder to separate from other computing practices.

[3] The term "software crisis" was coined at the Nato Software Engineering conference in 1968. Janet Abbate interprets the crisis as one of a gendered professional identity, rather than lack of programming skills, Abbate, *Recoding Gender*.

[4] Although those requirements were easier postulated than implemented – Donald MacKenzie calls the software engineer merely "a slogan" at this time. Donald MacKenzie, "A Worm in the Bud? Computers, Systems, and the Safety-Case Problem," ed. Agatha C. Hughes and Thomas P. Hughes, *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After* (Cambridge, Mass.: MIT Press, 2000).

the FOA data processing centre to the QZ, and what did this transformation lead to? The early digitalisation of Sweden was conditioned not only by the distribution of research funds and data management, but also by the metaphors used to describe what computing was. As Sharon Traweek and historian of science Evelyn Fox Keller show, metaphors used in research don't just describe or convey scientific results – they direct them.[5]

I argue that the metaphorical understanding of the computer as a system directed computing work at the QZ. While the "systems approach" originated as a way of designing and controlling weapons during World War II, it rapidly spread to other fields and, in the 1960s, became a method to tackle a wide range of phenomena.[6] STS scholar Lars Ingelstam identifies the systems approach as a method or scheme to plan future actions or classify objects.[7] The "system" is a perspective, a way of seeing something material as a set of components relating to each other and thus forming a whole, which is bounded and separated from the environment it interacts with. Constructing or operating a system directs how different components relate to each other and the outside environment.

When the computer is seen as a system, computing becomes a question of organising software and hardware efficiently, rather than achieving a series of individual computational results. This shift had profound implications for computing work. Historian of technology Atsushi Akera has discussed how the skills and merits of computer workers changed following the introduction of systems thinking in electronic data processing at the US Federal Bureaucracy.[8] Operating a computer system required not only technical skills but also managerial skills. The quality of software was also brought into view by the systems approach. As sociologist Donald MacKenzie has shown, software efficiency and reliability of large computer systems were a major cause of concern in the US throughout the postwar era.[9]

In Sweden, scholarly work on the systems approach has instead focused on its origin and application for societal governance. Arne Kaijser and Joar Tiberg describe how postwar Sweden's intellectual tradition of systems thinking emerged from operations research within the military and spread to policy analysis and future studies.[10] Eric

---

[5] Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge, Mass.: Harvard University Press, 2003); Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth-century Biology* (New York: Columbia University Press, 1995); Traweek, *Beamtimes and Lifetimes.*

[6] For an overview of the systems approach and its connections to expertise, engineering, management, and computing, see Hughes and Hughes, *Systems, Experts and Computers.*

[7] Lars Ingelstam, *System: Att tänka över samhälle och teknik* (Eskilstuna: Statens energimyndighet, 2002), 18–19.

[8] Akera, "Engineers or Managers?"

[9] MacKenzie, "A Worm in the Bud?"

[10] Kaijser and Tiberg, "From Operations Research to Futures Studies."

Bergelin further explores how operations research – the systematic analysis of operating systems or operations – developed within FOA, and traces how methods and strategies devised for specific military research projects were disseminated in the Swedish state. On the contrary, the systems approach in computing has not been studied. This chapter contributes to the above efforts by mapping the consequences of systems thinking in FOA's computing.

Systems thinking was a way of implementing order in a messy world. Computerisation was key to such ordering. Computer models and simulation of chaotic systems like the global climate enabled, as Paul N. Edwards has shown, interpolation between scarce data points, smoothing out discrete and sometimes contradictory data.[11] Yet, the computer systems themselves were pretty messy.[12] The mainframe at the QZ still required a constant stream of punched cards flowing through the data processing centre and thus still relied on data labour. The computing development enabled more subroutines and parallel processing, making the computations more complex. Analysing systems thinking in a data processing centre like the QZ is an entry point into exploring the tensions between materiality and abstraction, chaos and order, inherent in computing work.

Although these tensions have always existed, their conceptualisation has changed. In the mid-1950s, computing work at FOA was still an obscure business according to Elsa-Karin Boestad-Nilsson, associated with abstruse cardboard cards and long lists of numbers.[13] In 1975, the emblematic computing worker at the QZ had become the systems man: logical, managerial, and academically trained. Two years before the inauguration of the QZ, the first academic divisions for data processing had been established in Stockholm. When the new university data processing centre opened its doors to students and scholars in the Stockholm area in 1968, computing was no longer simply an employment of a research tool, but a research discipline in its own right. Computing work was seen differently.

The chapter begins with an overview of the systems approach, its origin within the military and applications in other fields, especially computing. Next, I explore how the spatial layout and work practices at the QZ were designed in response to (and sometimes despite) the conceptualisation of the computer as a system. The chapter then turns to the advent of academic computing, including systems analysis as well as more practical

---

[11] Paul N. Edwards, "The World in a Machine: Origins and Impacts of Early Computerized Global Systems Models," in *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, ed. Agatha C. Hughes and Thomas P. Hughes (Cambridge, Mass.: MIT Press, 2000).

[12] This messiness explains the risk for crashes etc that MacKenzie analyses in MacKenzie, "A Worm in the Bud?"

[13] Recount how Elsa-Karin Boestad-Nilsson remembers being cautioned against "drowning in zeroes and ones" by others at FOA, which was described in Chapter 3, Elsa-Karin Boestad-Nilsson in Lundin, *Att arbeta med 1950-talets matematikmaskiner*, 15.

data processing, to show how the new education inspired new perspectives on computing work. Next, the work environment at the QZ is analysed in terms of educational cultures and gender codes. The chapter ends with a reflection on the profound, forthcoming changes within computing that this thesis leaves for another study: the introduction of the personal computer that ended the mainframe era.

5.1 A World of Systems

The "systems men" were one of several professional titles for computing work relating to systems in Sweden, and at the QZ, in the 1960s. Others were systems programmers, systems analysts, and systematisers (*systemerare* in Swedish). The word "system", meaning the same in Swedish as in English, requires some commenting.

The origin of the systems approach to scientific and technological development and operation is often located in World War II. However, the systems approach saw the light of day in office workplaces much earlier. "Systematisers" revolutionised offices in the United States in the late 19th century.[14] The systematiser was a scientific manager, tasked to implement the same changes in office spaces as Frederick W Taylor (1856–1915) advocated on the shop floor. Everything from filing systems to interior design should be organised rationally, according to the early systematisers. Machines were central to this ambition. Before the computer, typewriters and other office machines formed the administrative system needing rational organisation.

When computers started to arrive in offices, the systems approach had consolidated into a delimited and explicit set of methods for organising technological systems. Historian David Mindell finds the roots of the systems approach in efforts to control gunfire in the US military during World War II.[15] Scientists and engineers argued that gunfire control should be seen as a unified system, including human operators, instead of only separate technologies. Around the same time, British military researchers developed operations research as a method to optimise radar air defence systems.[16] Common to these initiatives, which would later gather under the umbrella term of systems thinking, was the conception of a technological system where both material and human components interacted.

The simultaneous control of weapons, on the one hand, and the human beings who directed these weapons, on the other hand, was thus a core aspect of the systems

---

[14] Campbell-Kelly et al., *Computer*, 19.

[15] David Mindell, "Automation's Finest Hour: Radar and System Integration in World War II," in *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, ed. Agatha C. Hughes and Thomas Hughes (Cambridge, Mass.: MIT Press, 2000).

[16] Joseph F. McCloskey, "The Beginnings of Operations Research: 1934–1941," *Operations Research* 35, no. 1 (1987).

approach. The air defence system Sage – central to early computing development – was in the 1950s one of the major projects in which the systems approach was carried out.[17] Systems thinkers considered human control of technological systems like Sage a weak link. Soldiers make mistakes. They constantly blink, and they get tired and restless, and on top of it all, they risk being manipulated or threatened into doing something quite disastrous. Automation became an ideal for systems thinkers.[18]

The cybernetic movement further explored the links between humans and machines and societal and technological organisations by interpreting them as assemblages of information, functioning through feedback loops that momentarily decrease entropy. Norbert Wiener, one of the leading figures in the cybernetic intellectual tradition, saw the human body as a unity of diverse but connected organs and limbs, comparable to a computer's collection of wires and plates all working together to complete the task.[19] Indeed, a living organism and a machine had been comparable since Descartes' 17th century treatises. Still, from the cybernetic viewpoint, this comparison no longer demystifies or dethrones the living as it elevates the machine to a higher level of life.

During the late 1960s, cybernetics emerged amid the youth-driven counterculture, wanting peace in Vietnam and romanticising self-sufficiency and countryside life. Institutions like *The Whole Earth Catalogue* advocated ideals of liberal individualism instead of subordination to military control systems.[20] It was a somewhat paradoxical development. A worldview born within the military control systems of the early Cold War was now used to criticise the military system, which is said to be in control of the world. The same systems thinking that made regulation of military aircraft possible became an imperative for protecting the environment when applied to natural sites like a forest.

Two scientific fields where systems thinking had a significant influence were climate modelling and future studies. Paul N. Edwards finds the most important legacy of the systems approach in climate modelling to be the concept of the world as a system where social and physical components constantly interact.[21] Systems thinking became a key principle in emerging scientific fields such as earth system science, where the idea that social forces affect not only social entities but also natural entities, permeated research agendas. Departing from systems metaphors, Edwards has also connected the worldview in postwar USA to technological systems developed within Cold War military

---

[17] Hughes, *Rescuing Prometheus*, Ch. 2.
[18] Mindell, "Automation's Finest Hour."
[19] For an overview of early cyberneticians and their influence on research agendas and social science, see Steve J. Heims, *The Cybernetics Group* (Cambridge, Mass.: MIT Press, 1991).
[20] Turner, *From Counterculture to Cyberculture.*
[21] Edwards, "The World in a Machine."

research.[22] Future studies, on the other hand, have a more obvious connection to military research. The famous military research think tank Rand Corporation pioneered operations research, future studies, and policy analysis. Rand researchers advocated systems analysis as a foundation for making strategic choices, applicable as well in the social sciences as in politics.[23] As Jenny Andersson shows, Cold War policy making and strategic planning were indeed influenced by Rand systems thinking.[24]

Both climate modelling and future studies mapped and predicted notoriously unpredictable and elusive phenomena – the climate and the future – and both relied on heavy computations. Computing was not just another field to which systems analysis was applied, but a necessary premise for systems thinking to be applicable in practice. Cyberneticians, climate modellers, and Rand's operations researchers all turned to computers for metaphorical inspiration and implementations. To many, the computer was the ideal *system*.

The systems approach as a programming principle was employed in the Sage project. The task of developing software for the IBM-produced Whirlwind computer controlling the air defence system required establishing a new organisation, operated by Rand Corporation and named System Development Corporation.[25] In systems programming, as in other systems sciences, the key was the relations between a specific piece of code and the surrounding software environment. Writing a computer program can be relatively straightforward. Typically, the problem is broken down into a series of steps to be executed one after the other, and these steps are then translated to and implemented in the chosen programming language. It is a chronological and isolated process. On the contrary, systems programming is characterised by parallel procedures and a constant influx from other parts of the code. In large projects like Sage, such an influx conditioned the software requirements from the very beginning.

In less complex computing environments beyond systems thinking nests like the Rand Corporation, however, the introduction of systems programming was slower and more scattered. Mats-Åke Hugoson (b. 1934), a computer pioneer hired as "head of systems" in the city of Gothenburg in 1966, remembers that the systems approach to programming emerged in the early 1960s in Sweden, although professional distinctions

---

[22] Edwards, *The Closed World*.

[23] Roger Levien, "RAND, IIASA, and the Conduct of Systems Analysis," in *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, ed. Agatha C. Hughes and Thomas P. Hughes (Cambridge, Mass.: MIT Press, 2000).

[24] Jenny Andersson, *The Future of the World: Futurology, Futurists, and the Struggle for the Post-Cold War Imagination* (New York: Oxford University Press, 2018).

[25] For an overview of its missions and influence, see Campbell-Kelly et al., *Computer*, 176–77.

between systems men, programmers, and others were not always made then.[26] At FOA, such distinctions were made early on. A systems group was employed at the FOA data processing centre at the beginning of the 1960s.[27]

In chapter three in this thesis, I show how FOA researchers like Per Svenonius perceived the organisation of code and data as a problem at the data centre. When he argued that the data centre required a more systematic organisation, he referred to the escalating data flow and turnover times. It is an argument that returns in testimonies from computing pioneers, too: when computing complexity grew, systems programming was needed. In a 2007 witness seminar on Swedish systems development, several interviewees remember the importance of efficiency in early systems programming.[28] FOA mathematician Margareta Franzén points out in an interview that the problem of early programming wasn't mathematical or numerical issues, but the scarce main storage capacity.[29] Using subroutines ordered according to systems thinking made memory usage more efficient. Similarly, Janis Bubenko and Tomas Ohlin identified inefficient data management as the main problem of 1960s computing in a textbook published in 1975.[30] They presented the operating system as the solution.

An operating system is an intermediary between the computer's hardware and software. It consists, for example, of a compiler, which translates symbolic programming languages such as Fortran or Algol to machine code. The operating system schedules incoming tasks and allocates the processor's calculation resources to each program according to some predetermined principle. In their textbook, Bubenko and Ohlin describe the transition from so-called "*operators'* systems" (my emphasis, *operatörssystem* in Swedish) – where the ordering of runs and in the beginning also the translation to machine code were performed by operators and programmers – to *operating* systems, where pre-stored programs instead performed these processes.[31] Here, the automation ideal put forward by systems thinkers is echoed.

Of course, the programming performed at an institution like FOA increased in complexity from 1955 onwards, thus requiring systematic organisation. At Besk, in the beginning, the computer users had to code everything that was to be executed. Whenever a sinus value was used in a more extensive calculation, the Taylor series leading to a numerical answer had to be coded into the machine.[32] Programming

---

[26] Per Lundin, ed., *Administrativ systemutveckling i teori och praktik, 1960–1980: Transkript av ett vittnesseminarium* (Stockholm: Tekniska museet, 2007), 9.

[27] See Table 1 in Chapter 3.

[28] Lundin, *Administrativ systemutveckling i teori och praktik*, 7—8.

[29] Interview, Franzén, 2021.

[30] Janis Bubenko and Tomas Ohlin, *Introduktion till operativsystem*, Del 1, (Lund: Studentlitteratur, 1975), 145.

[31] Bubenko and Ohlin, *Introduktion till operativsystem*, 134.

[32] Gribbe, *Att modellera slagfältet*, 11.

changed quite radically with the IBM 7090 at the FOA data processing centre. Subroutines for many different operations were written, stored in disk memories, and registered in a program library. Whenever a sinus value was calculated, the correct disk was mounted in the machine hall and the answer was imported to the program calling for it. While the program library grew, so did the possibility of countless errors. What if a program used radians as the standard angle unit, and the subroutine interpreted the incoming variable as an angle in degrees? What if two subroutines were called by a program and executed in the wrong order, due perhaps to the physical order of the disks at hand?

Faced with this tricky situation, the FOA researchers were in a position quite unique in Sweden. In-house at the agency, there was a research group pioneering a systems approach in Sweden: the planning department, FOA P. As Eric Bergelin has shown, the contacts between FOA P researchers and Rand members were close and significantly influenced FOA's research strategies.[33] Even Herman Kahn (1922–1983), physicist and Rand celebrity, visited Stockholm in 1963, invited by the strategic planners at FOA P.[34] Bergelin argues that Swedish systems thinking was formed at FOA before it spread to policy analysis and future studies. The research group that formed it had close contact with the data processing centres at the agency. Birger Jansson, who undertook many of the travels related to computer purchases at FOA, was, for example, employed at FOA P.

When Per Svenonius, as described in chapter three, advocated a rational organisation of the FOA data processing centre and envisioned automatic control of the data flow, it is reasonable to say that he was inspired by the systems thinking permeating FOA P.

5.2 A New Order

While the FOA data processing centre never underwent all the organisational changes that Svenonius proposed, the QZ was designed according to them and according to an ideal image of the data processing centre as a bounded system.[35] The different ownership structures surrounding QZ also pushed the operation towards a systemic organisation. This organisation was, among other things, spatial. As historian of ideas Sven Widmalm has noticed, spatial designs and building architecture can reveal how scientific work is conducted and conceptualised.[36] By counting doors and analysing

---

[33] Bergelin, *Planeringsforskningens genombrott*, Ch. 6.

[34] Bergelin, *Planeringsforskningens genombrott*, 205–06.

[35] See Chapter 4.

[36] Widmalm, *Det öppna laboratoriet*, 287.

office locations at two 19th-century research institutes in Uppsala, he draws conclusions on scientific ideals and hierarchies.

Similarly, a spatial tour of the QZ reveals the efforts to distinguish between different kinds of computer users. People entered the data processing centre QZ through a tunnel below the FOA premises. It was an architectural solution to the problem of civilian computer users regularly visiting the country's most advanced military research institution. QZ was placed at FOA but was reachable without having to set foot at FOA. After entering through the underground tunnel, the newcomers turned right, and the regulars turned left (see Figure 5). To the right was the customer reception, where a receptionist registered the incoming job and either received the program and data or offered the support of the centre's professional programmers to help with the coding. To the left was the so-called "civilians' customer room", where the computer users could feed their program into the punched card reader themselves.[37]

While the FOA data processing centre primarily had been a closed centre – external customers did not run their own code – the QZ was more open. Computer experience among customers had grown over the years. The QZ also had a more complex ownership structure: civilian organisations indeed shared the centre with FOA. If students and researchers from KTH and SU were to be able to use the QZ freely, it had to have a more open structure. This, however, required more complex ways of separating military and civilian users.

As the name states, the civilian's customer room was intended for civilian users. They had their own entrance (FOA personnel had a direct entrance to their surrounding buildings), their own customer room, and their programs were marked differently from FOA's, to enable a separate treatment of calculations surrounded with secrecy.[38]

However, it soon became apparent that the boundaries between civilian and military users were fluid. In the beginning, before a security gate with a key card reader was installed in the FOA entrance, the military researchers too used the tunnel entrance. And throughout time, they used the civilians' customer room – it was "the fastest and simplest way to get a job processed".[39] While FOA's internal entrance was in the corner of the premises, the tunnel entrance was central. Moreover, the civilians' customer room had direct access to the machine hall, making it an essential node in the workflow. The spatial design of the QZ shows the prioritisation of civilian customers, which in turn nuances the history of Swedish research militarisation.

---

[37] Björn Kleist to Stockholm datacentral QZ, 24 April 1967, FOA Ö, CentralK, F7a:12, KrA.

[38] This marking of secrecy was connected to the customer's number, which all programs were registered with. Björn Kleist i *IBM Nytt*, 1971, QZ.

[39] Minutes FOA programming council no 1, 13 June 1968, FOA Ö, CentralK, F7a:7, KrA.

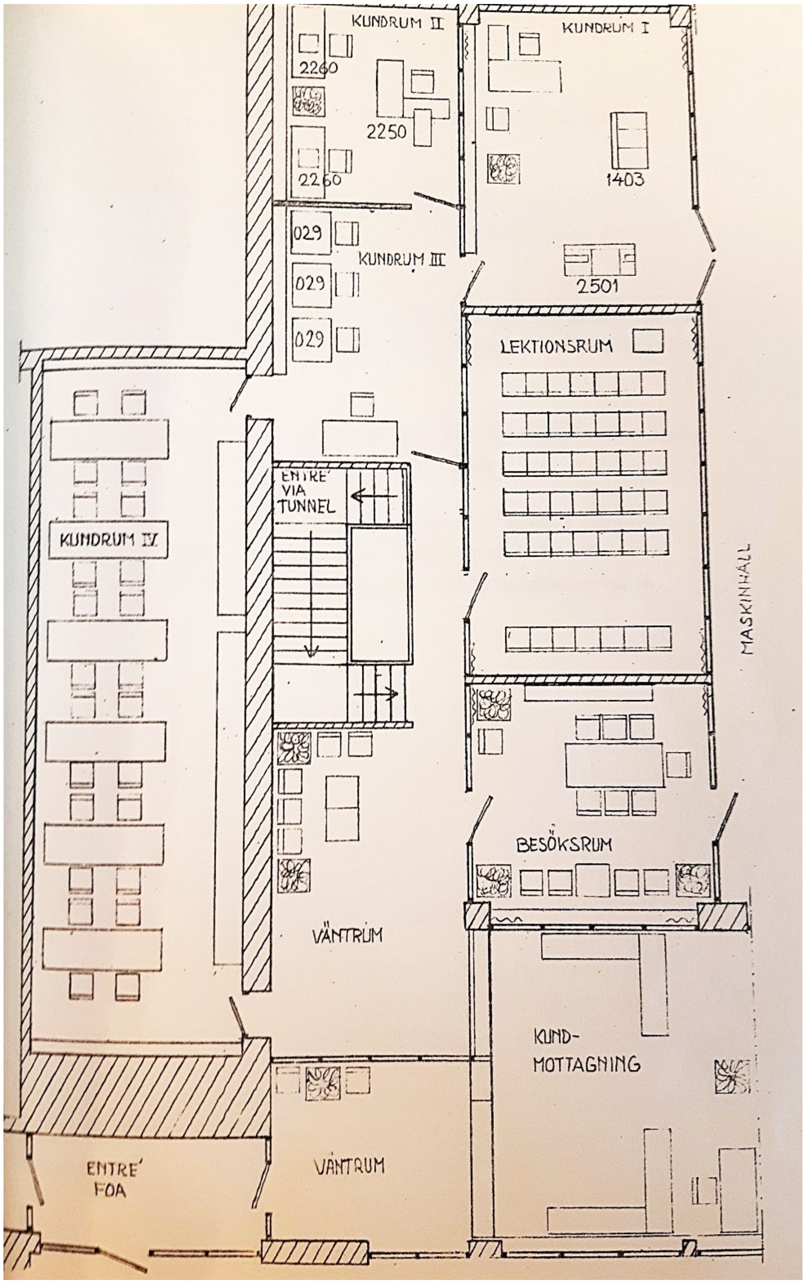

Figure 5: Layout of the QZ data processing centre. "Kundrum I" was informally called the civilians' customer room.[40]

---

[40] Björn Kleist to Stockholm datacentral QZ, 24 April 1967, FOA Ö.

A short program initiated from the civilians' customer room could indeed be finished relatively quickly, and the results were picked up from the line printer next to the punched card reader. The results came as a long list of numbers to be scrutinised over a cup of coffee in one of the armchairs in the waiting room. The short turnaround times resulted from a deliberate struggle to render computing more effective. The memory of waiting hour after hour for the results of a two-minute calculation was fresh in the minds of the people used to the FOA data processing centre.[41]

Many different measures to shorten turnaround times had been taken since then.[42] The spatial layout was optimised through precise measurements of walking distances between crucial machines in different spatial setups. Better equipment for the input and output of data was installed, and a new system for prioritising and ordering the runs. Short runs were prioritised over longer ones. The ground for placing a program in the runtime queue was no longer only the time it would occupy the processor, but also an evaluation of the memory used and the possible need for extra equipment such as additional magnetic tapes.[43] Four packs of disk storage containing subroutines and a basic programming framework were the standard setup.

The entire computational procedure was thus considered when setting up this system. When the FOA data processing centre was established, the operational planning process had focused on the overall organisational framework. Should the centre be open or closed? How many running shifts were needed? For the QZ, every relation between every machine in every computation step was predicted and accounted for. This reveals a change in perspective: the machines at the QZ were to a higher degree seen as parts of a complex system, whose ability to produce computational results depended on how smoothly information could flow from one part to another.

The new computational procedure had diminished setup times to below 15 minutes – at least for some. The average turnaround time was much longer than 15 minutes for those working remotely from KTH and SU. Two batches of punched cards and result lists were transported between the QZ and the Stockholm universities every day, so you'd have to catch one of these and wait for it to return before you could analyse your results.[44] The IBM 360 mainframe at the QZ had so many jobs coming through – in 1971, it was 1200 a day – that the academic computer users were strongly encouraged

---

[41] See Chapter 3. Short turnaround times is described as an absolute requirement in for example "Orientering om Stockholms Datacentral," Börn Kleist, FOA Ö, CentralK, F7a:16, KrA.

[42] See Chapter 4.

[43] Björn Kleist to Stockholm data processing centre, 24 April 1967, FOA Ö.

[44] Minutes FOA programming council no 6, 15 January 1969, FOA Ö, CentralK, F7a:7, KrA.

to batch together their runs in the organised transports, instead of strolling down to the data centre themselves and make use of the civilians' customer room.[45]

Academic scholars thus criticised the same runtime organisation that was praised within FOA. Years later, researcher at KTH, Hans Riesel (1929–2014) remembers this problem and reflects on its causes: "It wasn't with evil intent, but when these computers suddenly got such a huge capacity, it simply was the only solution they came up with to pass through thousands of small jobs per day. And then the operation became so extensive that it was impossible to have everyone running around pushing the buttons themselves".[46]

The passing through of all these small jobs was actually the result of a very deliberate analysis of the data processing centre as one big system. But this analysis was made within FOA, drawing the system boundaries around FOA. In the measurement of walking distances between crucial halts in a single computation, the long walk between the Stockholm campuses and FOA's courtyard is not included.[47] The terminals at KTH and SU don't appear in FOA's systemic organisation. Yet, Riesel's comment shows that this was conceived not as a conscious strategy, but as a natural consequence of the increasing complexity of data processing.

The number crunching wasn't the only thing that had increased in complexity. So had the administration of the data processing centre. The QZ was part of a centralised system of university data processing centres. FOA handled the daily economics, but the Swedish Agency for Administrative Development and the State Computer Fund managed the overall financial steering. The Agency for Administrative Development was responsible for all Swedish university data processing centres (the four others located in Lund, Gothenburg, Uppsala, and Umeå). The State Computer Fund managed employment of personnel and purchases of new equipment, but only after they had been approved by the Board for University Data Processing Centres.

The executive committee of the board thus had a significant impact on the everyday work of the university data processing centres in Sweden. They were tasked with proposing budgets and dealing with organisational issues and overarching goals for the service centres.[48] The executive committee chairman was Per Svenonius, previously head of operations at the FOA data processing centre. The remaining members came

---

[45] The number of runs is mentioned in Kleist i *IBM Nytt*, 1971, QZ. Experiences of academic computer users are remembered in Sofia Lindgren and Julia Peralta, eds., *Högre datautbildningar i Sverige i ett historiskt perspektiv: Transkript av ett vittnesseminarium*, 18 vols. (Stockholm: Tekniska museet, 2008).

[46] Lindgren and Peralta, *Högre datautbildningar i Sverige i ett historiskt perspektiv*, 35.

[47] "Utredning av lokalalternativ för Stockholms datacentral," undated but probably 1965–1966, FOA Ö.

[48] "Instruktion för styrelsen för universitetens datamaskincentraler," 24 June 1970, Universitetskanslerämbetet archive (UKÄ), Planeringsbyrån 1964–1976 (PlanB), AIII:1, RA.

from the universities involved, the Agency for Administrative Development and the Higher Education Authority.[49]

The centralised organisational framework undoubtedly led to a more substantial bureaucracy at the QZ than the FOA data processing centre. A significant difference was the stricter restrictions on when and how to use the computers. Björn Kleist remembers, for example, that a higher level of freedom characterised his time at the FOA data processing centre compared to the QZ.[50] The new data centre's rules were stricter for the personnel, and the administration was more extensive. To run some small program just for fun was no longer as easy as it had been. All users had to apply – and pay – for runtime. University and FOA users applied for runtime through the Board for University Data Processing Centres, and research projects from outside academia had to fill in a form overlooked by the administrators at the Swedish Higher Education Authority instead.[51]

However, the centralised system was working financially. In the first years the QZ was running, it yielded a profit of about one million Swedish krona yearly (the turnover was ten times that).[52] The rates of charge for computer usage were continuously diminished, from 4000 Swedish krona per hour in 1968 for education and research (other customers paid 6000) to 2800 Swedish krona in 1971.[53]

Following the new system for runtime distribution, customers at the data processing centre not only paid for mainframe time but also for used memory, programming aid, program descriptions, and data saving on DRAM memories or magnetic tapes.[54] The most expensive of these extra costs was using the light pen on the IBM 2250, a pencil allowing its user to draw graphs on a light-sensitive screen that could be used as input to a calculation.

This cost scheme is another indication of the new perspective on computing that prevailed at the QZ. Computing depended not only on mainframe occupation, but on all the instances that maintained the data flow. If you wanted to compute something, you had to pay for all the different parts of the process. The computer was no longer synonymous with the mainframe – it was a system of interconnected parts.

---

[49] The members were P. Svenonius and member of the Defence Council H. Andersson from Stockholm, professor A. Engström and member of the University Council S. Hammar from Lund, director H. Häggquist, professor G. Lundgren and director L. Mårdell from Umeå, director S. Ströberg from Gothenburg, and member of the University Council G. Wijkman from Uppsala. The heads of operation from each data processing centre were also invited to the committee's meetings.

[50] Interview, Kleist, 2021.

[51] Application of computer runtime, UKÄ, PlanB, AIII:1, RA.

[52] Annual report for Swedish university data processing centres 1969/70; Annual report for Swedish university data processing centres 1970/71, UKÄ, PlanB, FV:2, RA.

[53] Price list, 21 March 1968, QZ, F7a:12, RA; Annual report for Swedish university data processing centres 1970/71, UKÄ.

[54] Price list, 21 March 1968, QZ.

The centre itself was no longer a sole institution but a mere part of a larger system of university data processing centres. The annual report combined yearly statistics from all five centres in Sweden, and its layout was clearly not based on the QZ (the only centre with a steering partner from outside academia). For example, FOA is categorised as an "external user" in these reports.[55] The only "internal users" are the university users, contributing 54 per cent of the total usage. All others are external users, divided into four groups: FOA, contributing with 17 per cent of the usage, "local government" with below 1 per cent, "others within the state" with 14 per cent, and "private" with almost 16 per cent.

Among "others within the state", the major users were the National Statistical Bureau, the Central Committee for Real Estate Data, and the Planning Institute for Health and Social Care.[56] As for the university users, the most common disciplines were computational chemistry and mathematical physics, alongside numerical analysis and the emerging information processing field that formed during these years. But linguists, too, did use the computer – although in smaller amounts.[57]

Although the computer users at QZ came from various disciplines, they were in some ways less varied than those at Besk, the first computer service centre in Sweden, and the FOA data processing centre. Besk attracted computer pioneers from literally all corners – in the mid-1950s, no other place in Sweden offered computer-based calculations. In the 1960s, computing had spread as a practice, and the cost of computers had diminished rapidly. This most likely resulted in a differentiation of Swedish computing, particularly a stronger division between administrative and technical/scientific data processing.

By 1968, private companies and government authorities with administrative data processing needs procured their own computers, machines both tailored and marketed for rational data administration. In QZ's information flyers, it is stated that although the QZ is mainly intended for technical and scientific purposes, they also welcome administrative programming tasks.[58] The mere mentioning of this fact indicates that a general shift in Swedish computing had occurred. Computers and computing workers increasingly belonged to specific niches, and some niches were more valued than others.

---

[55] Annual report for Swedish university data processing centres 1969/70, UKÄ.

[56] Annual report for Swedish university data processing centres 1969/70, UKÄ.

[57] Lindgren and Peralta, *Högre datautbildningar i Sverige i ett historiskt perspektiv*, 36.

[58] "QZ informationsblad," QZ, F4:2, RA.

5.3 Computing Experts

Although the computer users at the QZ didn't always run their programs, many did write them.[59] Therefore, the personnel at the QZ dealt more with logical programming guidance than sheer coding, which had been more common at the FOA data processing centre. The new organisation of the overall operation at the QZ reflected this shift. At the FOA data processing centre, the 7090 council oversaw operations at the centre. In 1968, when the QZ was inaugurated, the 7090 council was dissolved and replaced by two new internal FOA councils: the data processing council and the programming council. While the data processing council would continue the work of the 7090 council – overseeing computing operations and equipment – the programming council got a new task.[60] They would standardise programming at FOA, especially program documentation, establish a program library, and work to solve larger programming issues by gathering specialised computing knowledge.[61]

The leading figures of the 7090 council – Elsa-Karin Boestad-Nilsson, Torsten Magnusson, and Birger Jansson – transferred to the data processing council. The programming council got two new leaders: Lena Jönsson, who was chair, and Jacob Palme, who was secretary. Lena Jönsson (b. 1936) was recruited to the calculation division at FOA's physics department in 1961, after being a trainee there the previous year. In 1967, Jönsson was promoted to head of the chemistry calculation division at FOA, and in 1987, she moved to Linköping and headed the military research division for data fusion there until her retirement in 2001. Jacob Palme (b. 1941) studied engineering at KTH and was employed as a researcher at FOA in 1964. He got a licentiate degree in information processing at KTH in 1968, while working at FOA, and became a professor in systems and computer science at KTH in 1984. By then, he had transferred to QZ.

FOA's programming council had representatives from all the agency's departments.[62] It was a FOA internal council, so the universities were not represented. However, since FOA administered the QZ, the council's work focused on the IBM 360/75 mainframe.[63] The main task for the programming council was to *organise* programming at the new data centre. Although systems thinking was not always explicitly mentioned in the council's discussions, it shines through in their objectives and assumptions. A

---

[59] Björn Kleist i *IBM Nytt*, 1971, QZ.

[60] "Förslag till utvidgning av 7090-rådet," 1967, FOA Ö, CentralK, F7a:V1, KrA.

[61] Minutes programming council no. 1, 13 June 1968, FOA Ö, CentralK, F7a:7, KrA.

[62] The members shifted over time, but from the beginning, the following people were members: Lena Jönsson (FOA 3, chair of the council), Jacob Palme (FOA P, secretary), Monica Palme (FOA A), Lars Odén (FOA 2), Bo Arfvén (FOA 4), Ingemar Widegren (FOA 1).

[63] Minutes from the programming council from 1968 to 1975 are found in FOA Ö, CentralK, F7a:7, KrA.

program library was deemed necessary not primarily because it made subroutines available – the library only contained descriptions of programs, and instructions on where to find copies of them – but because it ordered them in a system that provided an overview and a hierarchisation of programs.[64] At a 1972 FOA seminar on the program library, the discussions concerned documentation and categorisation of programs, rather than content.[65] The researchers – Lena Jönsson was one of the speakers – considered it a problem that the library contained too many subroutines, some of which overlapped, and that not enough changes were made. Every update of the library was registered by filling in a form.[66]

If the main problem at the FOA data processing centre was to organise data, the corresponding problem at the QZ was to organise code. This code was still material – programs and data continued to be stored on punched cards – but the organisational problem was abstracted. It concerned documentation of subroutines and lists of programs rather than the actual programs.

The staff specialised in logical programming guidance was the group Kleist bragged about to the IBM journal in this chapter's opening quote. What he called "systems men" is probably the team of systems programmers and managers that in the salary lists are delimited from "support programmers", "operation engineers", and, of course, the "machine operators" whose hands were still needed (for example, to replace one disk memory with another).[67] For a complete list of functional titles at the QZ, see Table 2.

As seen in Table 2, the program librarian had a rather high position at the QZ. Although one might think that such a position would have resembled those of secretaries or receptionists, it was in fact more like those of mathematicians or managers. The wage level was A19 – the same as for the mathematicians employed at the FOA data processing centre.[68]

It is also noticeable that at wage level A24/25, a managerial level, the "systems programmer" shares space with both the "support programmer" and the "superior CPU operator". Despite the operating systems in place at the QZ, operators were still needed. Someone still had to mount and switch these essential, manifestly material, programs onto the computer. The operating systems were physically stored at the bottom of the pile of disks comprising the computer's memory. Regular users at the QZ never tampered with these. Spatially, they were hidden beneath the interchangeable disk memories containing the subroutines each computer user chose from the program

---

[64] Minutes programming council no. 1, 13 June 1968, FOA Ö.

[65] "Seminarium och diskussion om programbibliotek," 4 September 1972, FOA Ö, CentralK, F7a:7, KrA.

[66] Such a form for the financial year of 1971/72 is found in FOA Ö, CentralK, F7a:7, KrA.

[67] Annual report for Swedish university data processing centres 1969/70, August 21 1970, UKÄ.

[68] See Chapter 3.

library. Formally, the information on them was only allowed to be changed by the superior CPU operators.

Wage level	**Functional titles**	**Monthly salary in Swedish krona, 1967**
A9	Puncher, office guard, office messenger, assistant, telephone operator	1550
A11	Office supervisor, receptionist	1718
A13	Machine operator, administrative assistant, controller, superior receptionist	1906
A15	Secretary, archivist, experienced machine operator	2112
A17	Operation assistant, superior machine operator, financial director's assistant	2341
A19	Program librarian	2596
A24/25	Support programmer, systems programmer, assistant operational systems specialist, superior CPU operator	3360
A30	Operational systems specialist, operations engineer, systems manager	4580
B5	Financial director, superior operational systems specialist	4967
B7	Operational systems manager	5508
C1	Head of operations	5615

Table 2: List of professions at the QZ in 1967, ordered after wage levels, low to high, in the Swedish public administration. As a reference, monthly salaries in 1967 currency are also given.[69]

The systems programmer was not formally higher in the QZ's professional hierarchy than the programmers who performed task-oriented support work or the operators responsible for handling the operating system and making the crucial back-ups of stored programs. However, I argue that they were informally considered more valuable. Firstly, they had higher education levels. Job ads for systems programmers required degrees in mathematics or engineering physics, and later on, once a complete education was

---

[69] Agenda A1/2, 24 January 1967, QZ, A5A:V1, RA.

established in information systems in 1977, such a degree was needed.[70] Torgny Hallenmark (b. 1946), systems programmer at the Lund University Computing Centre for many years, remembers being part of the group that did the most advanced work at the data centre.[71]

Secondly, the systems team at a data processing centre like the QZ was marketed as an expert group whose presence was highly beneficial for all customers. This strategy shines through in the IBM journal's story on the QZ.[72] The valuation of systems programmers at FOA also becomes visible in the discussions regarding the IBM user group Share. Share had members from data processing centres with IBM mainframes worldwide and held annual conferences to discuss programming standards and software solutions. The members were systems programmers and managers rather than support programmers. Share was a forum for experts and was thus highly influential in consolidating the identity of such experts.

In media scholar Fred Turner's language, Share can be regarded as a *network forum*: an organisation in which actors from different communities met and "exchanged ideas and legitimacy, and in the process synthesised new intellectual frameworks and new social networks".[73] Share was not only a forum where new contacts were established, but one where *legitimacy* was constructed and shared too. Members of Share established common standards, which conditioned local computing work in a wide range of member institutions. New ideas and entire paradigms circulated and consolidated within the annual conference meeting. One of the most important intellectual legacies of Share was, according to Atsushi Akera, the introduction and dissemination of systems thinking.[74]

Share was perhaps not the first institution to introduce systems thinking to the researchers at FOA. After all, they had contacts within Rand, the global centre of that intellectual tradition. Like Rand, Share was held in high esteem at FOA, and thus likely promoted systems thinking in the agency's computing work. In 1961, Per Svenonius informed his colleagues that "at the Share conferences, the participants are a number of very prominent systems mathematicians […] Many systems mathematicians within Share surely would deserve increased international fame."[75] Birger Jansson and Elsa-

---

[70] Various press cuttings, 1960–1970, FOA Ö, AdmB, ÖI:1, KrA. The first educational program in information systems was called "Applied systems science" and situated at SU. Janis Bubenko, ed., *ICT for People: 40 Years of Academic Development in Stockholm* (Stockholm: Dept. of Computer & System Sciences, Stockholm University and Royal Institute of Technology, 2006), 174.

[71] Interview, Torgny Hallenmark, 17 November 2023.

[72] "QZ-Stockholms datamaskincentral," *IBM Nytt* 4:1971, QZ, F4:2, RA.

[73] Turner, *From Counterculture to Cyberculture*, 72.

[74] Akera, *Calculating a Natural World*, 264. See also Atsushi Akera, "Voluntarism and the Fruits of Collaboration," *Technology and Culture* 42, no. 4 (2001).

[75] "Redogörelse för tjänsteresa till USA och Frankrike," Per Svenonius, 1961, FOA Ö, CentralK, F7a:14, KrA.

Karin Boestad-Nilsson suggested the employment of a systems mathematician "at the absolute top level, for participation in the Share committee".[76]

Clearly, membership in Share came with requirements to sharpen FOA's computing competencies. This was achieved by adding the word "systems" before the more common occupational title "mathematician". When, a decade later, mathematicians were replaced by programmers, the systems programmer was still associated with a higher level of expertise.

In practice, however, it wasn't always easy to distinguish between systems programming and other types of programming. In the 1974 Swedish Government Official Report *Data och näringspolitik*, it is stated that "[t]he notions systems man and programmer are essentially in practice often blurry."[77] And all kinds of programming still relied on material data managed by machine operators and punchers. Yet, the depreciation of work related to data input and output – what I've called data labour – continued.

In 1969, Jacob Palme discussed the future of computers. He said:

> The biggest bottleneck of present data processing is the transfer of data. Right now, this is an expensive manual process – punching cards – with relatively high error risks. In the future, computer systems will be integrated into other technical systems so that information can be gathered with a minimum of human mediation.[78]

Data labour would be automated in the future, so why appreciate it? In another FOA official letter around the same time, it was stated that qualified programming personnel were critically scarce.[79] People who could manage the expanding system of code at data processing centres like the QZ were much sought-after.

5.4 The Advent of Academic Computing

In 1960, the business magazine *Affärsekonomi* published an article aimed at recruiting people for data processing jobs. The author of the text, Gunnar Andersson from the National Statistical Bureau, recommended that the candidates have academic degrees in mathematics, physics, or business administration.[80] At the same time, he stated that the

---

[76] Memo from Birger Jansson and Elsa-Karin Boestad-Nilsson to Stig Ek, Lars Henning Zetterberg and Per Svenonius, 20 May 1960, FOA Ö, CentralK, F7a:1, KrA.

[77] SOU 1974:10, Data och näringspolitik, 256.

[78] "Datorer i framtidens samhälle," by Jacob Palme, 7 September 1969, FOA Ö, CentralK, F7a:18, KrA.

[79] "Om ADB-utveckling," 29 August 1969, FOA Ö, CentralK, F7a:18, KrA.

[80] Gunnar Andersson, "Tänker Ni bli EDP-man?," *Affärsekonomi* 9, no. 18 (1960).

only thing it took to be a good programmer was “a normal sense of logical work”, thus anyone “with an interest in and an aptitude for mathematics” could apply.[81]

Two entirely different descriptions of what it takes to be a programmer (although this word was not used in the article, it took a while longer before it spread in Sweden) were thus presented: having a normal sense of logic or having a university degree in a renowned subject. Before 1960, the former description dominated. FOA researcher Birger Jansson, for example, summarised his view on how best to learn computing in 1957:

> One should thus have a problem that one holds as interesting, a manual, and preferably an advisor at hand who already knows the machine. Then, it won’t be long until one masters the programming technique. […] This system is, in my opinion, considerably more effective than coding courses.[82]

Come 1970, the standard view of programming had changed. Short coding courses were by then far from enough – the programming technique had to be learned through university studies. Stockholm’s first coherent academic education in computing was established in 1966. The subject was called “information processing” and was a joint effort between two computing branches: numerical analysis and administrative data processing. In the late 1970s, those two branches were once again separated into the natural science department “Numerical analysis and computer science” and the social science department “Applied systems science” (the latter renamed “Computer and systems science” a decade later).[83]

Before 1966, several computing courses had been held at KTH and SU, often as elective parts of other educational programmes. However, the first time that computing courses were packaged together in blocks comparable to an academic programme was when numerical analysis and administrative data processing merged into the department of information processing, a department split between KTH and SU.[84]

Numerical analysis had existed as a separate subject at KTH since 1962. It originated from applied mathematics, above else from numerical methods used to solve differential equations, while soon becoming linked to programming. In 1963, Germund Dahlquist (1925–2005) became the first professor of numerical analysis in Sweden. Dahlquist had previously studied mathematics and been involved in developing the early Swedish

---

[81] Andersson, "Tänker Ni bli EDP-man?"

[82] Travel report 2524–003, 22 July 1957, FOA Ö.

[83] The notion "Computer science" in the former disciplinary title was called *datalogi* in Swedish, a term sometimes translated to "datalogy" but seldom used in English.

[84] Janis Bubenko, "Information Processing – Administrative Data Processing" (paper presented at the History of Nordic Computing 2, Berlin, Heidelberg, 2009).

computer Besk, especially software development. In 1965, he became a member of the Royal Swedish Academy of Engineering Sciences. He stayed at KTH until his retirement in 1990. Besides Dahlquist, numerical analysis attracted many other Besk users at an early stage, and the subject stayed a crucial node in Stockholm's academic computing.[85]

Administrative data processing was established in 1965, as a result of a government investigation. At about the same time as an expert council was set up by the Agency for Administrative Development to investigate the grounds for establishing university data processing centres in Sweden – the investigation that eventually led to the establishment of the QZ – another committee was tasked to examine the formation of an academic discipline in administrative data processing. In 1964, their report was published, and soon three academic chairs were appointed in the subject: one in Stockholm, one in Gothenburg, and one in Lund.[86]

At KTH in Stockholm, Börje Langefors (1915–2009) got this position in 1965. He was by then a pretty famous engineer, whose work on computational technologies at big Swedish industries like Saab was considered groundbreaking. Langefors started working in aviation technology but soon specialised in computational aids and the emerging field of systems theory. He was the man who gave computers their contemporary name in Swedish: *datorer*. Together, Langefors and Dahlquist were the central figures of early academic computing in Stockholm, personally mentoring many of Sweden's computer pioneers and institutionally incorporating computing into Sweden's higher education.[87]

The 1964 report that insisted on the formation of a new administrative data processing field within academia was reviewed by several important organisations: the Swedish Higher Education Authority; the Agency for Administrative Development, and FOA, the military research agency that again and again finds itself in the middle of the crucial turns in Swedish computing history. Their reviews were handled by the computer expert council, which initiated the university data processing centres and was headed by Per Svenonius.[88]

The same Svenonius also wrote the first draft of FOA's report, before it was reviewed by the heads of all departments at FOA and finally signed by Director-General Martin Fehrm.[89] This matter was obviously deemed quite important at FOA. FOA's review –

---

[85] For memories of the importance of numerical analysis for academic computing, see Lindgren and Peralta, *Högre datautbildningar i Sverige i ett historiskt perspektiv*.

[86] *Akademisk utbildning i administrativ databehandling: Betänkande avgivet av en av kanslern för rikets universitet tillsatt kommitté*, (Stockholm, 1964).

[87] Many computer pioneers fondly remember Langefors and Dahlquist, see Bubenko, *ICT for People*, 11.

[88] "Bakgrund till expertrådets möte," 6 February 1965, FOA Ö, CentralK, F7a:16, KrA.

[89] Martin Fehrm to UKÄ, 22 January 1965, FOA Ö, CentralK, F7a:1, KrA.

like the others – focuses on the lack of competent people to recruit as operators and programmers, and an academic education as a solution to this problem.

This resembles the international calls for qualified personnel in computing that culminated in the famous (or rather infamous) "software crisis" of 1968. At the first Nato Software Engineering Conference, held in Garmisch, Germany, that year, the attendees discussed what they saw as the main problems for the computing community. The insufficient skills among the software developers resulted in inadequate software quality. The new professional title "software engineer" was launched as a crisis solution. Janet Abbate has re-interpreted this as a crisis of professional identity, rather than skills.[90] The ambitious men entering the feminised but now expanding field of software development wanted to rebrand their work as skilled and masculine – what better than to call themselves engineers?[91]

As MacKenzie has shown, the process of implementing these ideas was, however, slow and varied.[92] In the Swedish 1964 reports, engineering is not mentioned. Although it is said that Swedish computing education in the future should start already in upper secondary school, it is emphasised that the first step is to form new data processing departments at all major university sites in Sweden, at least as soon as they get their own data processing centres. Thus, establishing data processing centres and forming academic education in computing went hand in hand.

Stockholm was the first city to establish such an education, although soon followed by Gothenburg and Lund University.[93] From the start, Langefors and Dahlquist's two branches of information processing were split between KTH and SU, although most of the students originated from SU in the beginning. The first block of courses was given in 1966, as optional courses attended by approximately 70 students.[94] Two years later, the number of students had grown to 600.[95]

Partly, this almost tenfold increase in the student body was due to the growing interest in the subject, indicating that the many calls for a new education in information processing were needed. But it must also be mentioned that many European countries in the 1960s saw a tremendous increase in the number of enrolled university students overall.[96] The European economies were not yet punctuated by the 1970s oil crisis, and

---

[90] Abbate, *Recoding Gender*, Ch. 3.

[91] A classic study of the coupling between engineering and masculinity is Oldenziel, *Making Technology Masculine*. For an analysis of the engineering education history at MIT and the flexibility of the profession during the late 20th century, see Rosalind Williams, *Retooling: A Historian Confronts Technological Change* (Cambridge, Mass.: MIT Press, 2002).

[92] MacKenzie, "A Worm in the Bud?"

[93] Educations in Gothenburg and Lund started in 1967.

[94] Bubenko, *ICT for People*, 17.

[95] Bubenko, *ICT for People*, 174.

[96] Judt, *Postwar*, Ch. 12.

the young generation sought new ways of living, learning, and protesting political action. Although Sweden was far from the major hotspots of the 1968 student rebellions, student groups had increased radically in Stockholm too, and violent student protests occurred in both Stockholm and Lund.[97]

The establishment of academic computing education in Stockholm in 1966 can be seen as a result of several simultaneous processes. The spread of computing in society, the expanding student body eager to fill new classrooms, the increasing need for computing workers, and the conception of programming as something logical, theoretical, and systematic. It is the latter conception that Abbate links to the rebranding of programming as masculine in her study of the software crisis.[98]

It is also that conception, which the increasing field of systems programming is an example of, that is most clearly linked to FOA's data processing. From the beginning, FOA was one of the institutions involved in establishing academic computing education in Sweden. The agency had especially strong ties to the Royal Institute of Technology. Researchers like Jacob Palme worked at FOA while educating himself at KTH, which enabled major cooperative research projects like the development of Simula 67, a programming language pioneering computer simulation.[99] In 1963, FOA had also financed the establishment of optimisation theory and systems theory at KTH.[100] A division with four employees was set up to meet FOA's requirement of a "contemplative treatment" of certain "military matters of discretion", through computational optimisation and systems thinking.[101]

5.5 Work Environments Marked by Student Cultures

KTH got a computer engineering programme in 1983 (Linköping University was first in Sweden to establish such a programme in 1975, Lund University and Chalmers University of Technology in Gothenburg followed in 1982). It was a continuation of the courses and programmes at the department of numerical analysis and computer science, that broke off from information processing in the 1970s. This more mathematically inclined computing branch at KTH was not involved as much in the

---

[97] The Swedish student rebellion in 1968 is explored in Sven-Olof Josefsson, *Året var 1968: Universitetskris och studentrevolt i Stockholm och Lund* (Göteborg: PhD diss.: Göteborgs universitet, 1996); Kim Salomon and Göran Blomqvist, *Det röda Lund: Berättelser om 1968 och studentrevolten* (Lund: Historiska media, 1998). For an international comparison, see for example David Caute, *The Year of the Barricades: A Journey Through 1968* (New York: Harper & Row, 1988).

[98] Abbate, *Recoding Gender.*

[99] Jacob Palme, *Simula as a Tool for Extensible Program Products*, Infotech Limited (Maidenhead, 1974).

[100] "Ny institution vid KTH bekostas av FOA," *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 3 (1963).

[101] "Ny institution vid KTH bekostas av FOA."

QZ as information processing was. Partly, this was because the numerical analysis department had access to their own computer from 1970. A researcher such as Yngve Sundblad, engaged in the establishment of KTH's computer engineering programme, did not visit QZ that much.[102] However, the work environment at the QZ shared specific characteristics with engineering student cultures.

It wasn't uncommon that researchers and students working at QZ had engineering backgrounds – Kleist and Palme are both examples of that. In an interview, Björn Kleist said that what he liked best about computing work was the freedom to test various exciting technical ideas on the computer he was responsible for.[103] This technical playfulness is a recurring theme in student magazines found at engineering institutions. In the 1970s, students from KTH and SU played computer games at the QZ at night. One of them, Per Lindberg, or "The Mad Programmer" as he called himself, regularly printed "*Hackerbladet*," a student magazine full of jokes, programming tips, and satire, which he distributed to his friends.[104]

The name "QZ" comes from a typical joke among engineering students. The more conventional acronym for the data processing centre would have been SD, after *Stockholms datacentral* (Stockholm's data processing centre). The acronym SD was, however, already taken by a company in Stockholm, and someone jokingly proposed the (in Swedish) very unusual letters Q and Z instead. A colleague then faked a letter from the fictitious German "Institut für Quantitative Zoologie", claiming sole rights to the acronym QZ. The name stuck, and the funny little anecdote is fondly remembered by many.[105]

Similarly, the term "QZ-iner" (pronounced in the same way as the Swedish word for cousins, *kusiner*) was 1981 adopted as a name for the data processing centre's employees.[106] Sharon Traweek has analysed such joke names in the high-energy physics community and connected them to a typical research culture, so secure about its authority and status that it's safe to devalue personnel or technical equipment through silly nicknames.[107] The authority of such communities and institutions is often clearly masculine.

---

[102] Interview, Sundblad, 2022.
[103] Interview, Kleist, 2021.
[104] "Hackerbladet," undated but probably from the late 1970s or early 1980s, QZ, F1D:4, RA.
[105] Peralta and Lindgren, *Datacentralerna för högre utbildning och forskning*, 29. It was also mentioned in an interview, Bengt Olsen, 29 January 2020. Olsen was head of operations at the QZ between 1974 and 1985.
[106] Interview, Olsen, 2020.
[107] Sharon Traweek, "Border Crossings: Narrative Strategies in Science Studies and Among High Energy Physicists at Tsukuba Science City, Japan," in *Science as Practice and Culture*, ed. Andy Pickering (Chicago: University of Chicago Press, 1992).

One of the most telling examples of such joke names in Sweden might be KTH's old nicknames for students: Osqar and Osqulda.[108] The male variant Osqar is named after King Oscar II, who helped found the KTH student union in the early 20th century. The female variant Osqulda was added in the 1940s. It is not an established name in Sweden, but it is very similar to the word *oskuld*, meaning virgin. The names show up in drinking songs, initiation rites, and in the naming of campus streets. In 2018, after a series of complaints about the sexism inherent in such a naming, Osqulda was formally replaced by Quristina, after Christina, Queen of Sweden during the 17th century.

Although information processing was a brand new scientific discipline in Sweden in the 1960s, formally not belonging to an educational programme in engineering, many students came from well-established and high-profile subjects like engineering physics.[109] They were used to a particular culture: the exams were notoriously difficult, and the time not aimed for studying was spent on rites, jokes, and parties. It was a masculine culture and had so been from the very formation of KTH engineering education.[110]

Watching the QZ pictures that someone has carefully glued into thick photo albums and annotated with cheerful little comments, it is hard not to think of the rites and jokes that made engineering an exclusive, elite, and masculine culture. The pictures depict staff parties with beer can towers and annual rounders tournaments. One of them (see Figure 6) shows the traditional Swedish Lucia celebration, when you dress up like the saint Lucia and sing Christmas carols. At the QZ, the person in the long white (traditionally very much female) Lucia gown is a man who looks very pleased.[111]

Such pranks occasionally appear in the FOA company paper, too, as well as elaborate accounts of FOA sports events.[112] But they are more concentrated in the photos and magazines at the QZ. However, the researchers from FOA who had been fostered within the same engineering culture as the new students probably found themselves at home with the nerdy puns and various pranks at the QZ. These were predominantly male, since the engineering education in Sweden at the time had a very uneven gender distribution. The programmers in Elsa-Karin Boestad-Nilsson's work team often had degrees in mathematics, not engineering subjects.

---

[108] For an analysis of engineering culture at KTH and these nicknames, see Katarina Ek-Nilsson, *Teknikens befäl: En etnologisk studie av teknikuppfattning och civilingenjörer* (Uppsala: PhD diss.: Uppsala universitet, 1999).

[109] Bubenko, *ICT for People*, 17.

[110] See Ek-Nilsson, *Teknikens befäl*; Olle Hagman, *Nollan blir nymble: Passageriter på Chalmers tekniska högskola i Göteborg* (Göteborg: PhD diss.: Göteborgs universitet, 1984); Boel Berner, "Educating Men: Women and the Swedish Royal Institute of Technology, 1880–1930," in *Crossing Boundaries, Building Bridges: Comparing the History of Women Engineers, 1870s–1990s*, ed. Annie Canel, Ruth Oldenziel, and Karin Zachmann (Amsterdam: Harwood Academic, 2000).

[111] However, it should be said that cross dressing sometimes has occurred in Swedish Lucia celebrations, see Lena Kättström Höök, *Lucia i nytt ljus* (Stockholm: Nordiska museets förlag, 2016).

[112] These company papers, called *Foaiten*, are available at the National Library of Sweden in Stockholm.

Figure 6: Picture from a celebration of Lucia at QZ in the 1970s.[113]

Nathan Ensmenger claims that the "computer nerd" was an identity constructed at US university data processing centres in the 1960s to masculinise programming.[114] Typical masculine traits were attributed to the predominantly male engineering students who entered the feminised computing practice: creativity, competitiveness, and individualism. Even less favourable traits were cherished, as long as they distanced themselves from everything feminine: asocial behaviour, bad personal hygiene, weird clothes. The old (usually female) programmer performed routine mechanical work, like a telephone operator, and the new (usually male) programmer solved complex and previously unknown problems in ways that outsiders could not understand. The new programmer was a wizard, not a secretary.

There are parallels between the QZ and Ensmenger's account of the cultures at the 1960s university data processing centres in the US, not least in student magazines like *Hackerbladet*. Furthermore, Ensmenger identifies nighttime computing as crucial for the process of masculinising computing.[115] To spend the night at a data processing centre was much harder for female students than their male counterparts in the 1960s. In fact, one of the arguments against allowing any female engineering students in Sweden in the early 20th century was that overnight fieldwork wasn't suitable for women.[116]

---

[113] Collected photographs, QZ, F1D:2, RA.

[114] Nathan Ensmenger, "'Beards, Sandals, and Other Signs of Rugged Individualism': Masculine Culture within the Computing Professions.," *Osiris* 30 (2015).

[115] Ensmenger, "'Beards, Sandals, and Other Signs of Rugged Individualism'," 50.

[116] Berner, "Educating Men," 87–88.

Nightly stays had been part of FOA's computing work since the field trips to the IBM 650 in Arboga in 1956 – but they intensified at the QZ during the 1970s and 80s. These are, for example, fondly remembered by Bengt Olsen (b. 1941).[117] He studied mathematics and physics at Uppsala University, did his military service as a research technician at FOA in 1965 and eventually finished a PhD in physics in Uppsala. He replaced Björn Kleist as head of operations at the QZ in 1974. In an interview, Olsen recalls spending entire weekends working at the QZ.[118] Likewise, computer scholar Tomas Ohlin speaks fondly of the nights he spent playing the computer game called "Adventure" at the QZ in the 1970s.[119] However, Ohlin remembers that his wife Eva Lindencrona Ohlin (b. 1943), who studied information processing at KTH and received her PhD from Chalmers in the 1970s, also participated in nightly computer gaming.

5.6 Solving Crosswords, Controlling Systems

The more substantial connection to student cultures made the QZ into a work environment different from the one at the FOA data processing centre. Computing and engineering were brought closer together. This shift occurred parallel to the emerging conception of computing as primarily the systematisation of code and data, inherent in systems thinking. It would be easy to say that the system metaphor was tailored for people like Björn Kleist – men, with a background in engineering, who felt at home in the "computer nerd" identity.[120] But that is not an all-encompassing answer.

In an interview, Lena Jönsson talks about titles.[121] Her formal titles for most of her career were research engineer and principal technical officer, but she seldom used these titles. She describes herself as always having lacked technical knowledge, feeling afraid of follow-up questions she wouldn't be able to answer. She felt more comfortable calling herself a programmer or a systems analyst. Being the organiser of a large system was something that she felt fit her identity. Systems programmer Eva Lindencrona Ohlin also conveyed in an interview that she felt at home in systems programming.[122]

As Atsushi Akera notes, "So long as role definitions remained fluid, members of a given profession or field had ample opportunities to test the boundaries of their own authority."[123] "The system" is an abstraction. It erases particular components and highlights their connections, like a subway map seen at a distance, each station name

---

[117] Interview, Olsen, 2020.
[118] Interview, Olsen, 2020.
[119] Peralta and Lindgren, *Datacentralerna för högre utbildning och forskning*, 48.
[120] See Section 3.4.
[121] Interview, Jönsson, 2021.
[122] Interview, Eva Lindencrona Ohlin, 21 March 2023.
[123] Akera, "Engineers or Managers?," 214.

unreadable. The systems approach is fluid, flexible, since a system can be anything from a forest to a military base. Or from a database to an office archive. Office work has a long history of being feminised, conceptualised as deskilled work suitable for young, unmarried women.[124]

There is no unambiguous line between masculine and feminine work at the QZ – the "systems men" performed work quite similar to that of FOA's calculation division, where, as was told in Chapter 3, the "calculation girls" worked. Yet, in general, some of the computing professions in the 1960s and 70s were clearly gendered. Punching was dominated by women and seen as feminine work. An anecdote showing the perceived femininity of working with punched cards came up in an interview. Lena Jönsson remembered a friend at FOA's physics calculation division, who, just like Jönsson, was a trained mathematician performing skilled computing work. However, when she was out dancing, she used to say that she "handled punched cards."[125] It was an answer that rendered her more feminine and thereby attractive to the men she encountered, and she didn't have to answer follow-up questions on specific work tasks either.

Systems thinking was not just an abstraction; it also abstracted computing. The focus shifted from the individual trial-and-error process and data handling that a single computation always requires to general guidelines for how to best solve a whole range of computations. In practice, separating technical from logical work continued to be hard. Jönsson's friend did, in fact, handle punched cards, although that wasn't her principal duty. In the civilians' customer room at the QZ, computer users punched and ran programs themselves. But by describing that work as systems programming, it lost touch with the punched cards it still required.

Another transition in the conceptualisation of computing work becomes visible through analysing the systems metaphor. Not only was it conceived as something logical and abstract, but also as something general and unlimited, applicable in all sorts of situations. In the 1950s, a common metaphor for computing was solving crosswords. Janet Abbate interprets the early metaphors of computing work found in US job ads – not only crossword solving but also knitting or cooking – as tailored to the workforce deemed suitable for computing work then: young women.[126]

Unlike knitting, the crossword metaphor has now become part of popular computing history through scenes like the one in the biographical drama movie *The Imitation Game* (2014), where Alan Turing finds his collaborator Joan Clarke through a crossword test. In Sweden, the crossword metaphor echoes in the testimonies of Swedish computer

---

[124] Hicks, *Programmed Inequality*, Ch. 1–2.

[125] Interview, Jönsson, 2021.

[126] Abbate, *Recoding Gender*, 66–67.

pioneers. Sten Henriksson, working for many years at the Lund University data processing centre, remembers 1950s computing work as "a craft of sorts. Tricks and games".[127]

Likening computing to solving a crossword highlights a particular character of computing work: the craft of it.[128] Each crossword is unique. There are no general rules on how to solve a crossword – you figure it out as you go. Experience is key, but theoretical training is at best complementary. Likening computing to controlling a system highlights the exact opposite: the general rules applying to all computers. If you learn these rules, you will master computing. The systems metaphor elevated computing to a general, theoretical activity.

The computer itself was further elevated by the brain metaphor that the cybernetic movement advocated in its comparisons between humans/societies and computers/automated systems. In FOA's company papers, computers were repeatedly likened to human brains. In November 1970, an article titled "The researcher is 'replaced' by a computer" told the reader that a new research-oriented computer system "could be represented as an additional contribution to the brain of the researcher, an expansion of the brain capacity".[129] This is followed by speculation: "One may even get a computer to imitate the human thought process". Another article used the same metaphor in reverse when explaining the latest results in neurology: "The human brain is an almost unimaginably complicated machine – the complexity of its structure is evident when compared to a modern computer".[130]

Anders Carlsson showed how the metaphor describing computers as brains in 1950s Sweden sparked debates on the expertise required to control technical systems, where people advocated closer ties between computing and engineering.[131] Sweden is unique in this regard, since computers in the 1950s had not yet received their contemporary name *datorer*, but were interchangeably called *matematikmaskin* (mathematics machine, directly translated) or *elektronhjärna* (electron brain). The advent of the word *dator* in 1969 established a linguistic association between computers and data, rather than computers and brains. There is no straight line in history.

Computers were getting smaller, cheaper, and more user-friendly in the following decade. In the early 1970s, the IBM 360 mainframe, which caused fierce debates in the mid-1960s, was replaced by a new one, delivered by Digital Equipment Corporation.

---

[127] Lindgren and Peralta, *Högre datautbildningar i Sverige i ett historiskt perspektiv*, 28.

[128] For a discussion on the crafting nature of programming, see James Evans and Adrian Johns, eds., *Beyond Craft and Code: Human and Algorithmic Cultures, Past and Present*, vol. 38, Osiris (Univeristy of Chicago Press: 2023).

[129] Göran Holm, "Forskaren 'ersätts' av en dator," *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 2 (1970).

[130] Bo Sörbo, "Hjärnans mekanismer utforskas," *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 4 (1967).

[131] Carlsson, "Elektroniska hjärnor."

The primary benefit of the DEC 10 installed at the QZ in 1973 was its support for *time-sharing*, a technique enabling the simultaneous use of one mainframe for many users. IBM had been criticised for not developing time-sharing mechanisms fast enough, and at the beginning of the 1970s, the academic scholars who had failed their campaign a few years earlier to withdraw IBM's firm hold on Swedish academic computing finally got rid of it.[132] However, FOA researchers took the lead in advocating the transition to a DEC 10, primarily because it provided better opportunities for war simulations within operations research.[133]

Introducing the Digital Equipment Corporation at the QZ marked a decisive change in computing philosophy. The IBM 360 was a computer system developed to standardise hardware and software as far as possible to lock customers to IBM's machine philosophy.[134] It was aggressively marketed as a single system solution to major customers like the Swedish Agency for Administrative Development.[135] The choice and organisation of the 360 machinery at QZ were indeed based on an idea of one big centralised system: an advanced mainframe in the middle, located at FOA, and smaller terminals at KTH and SU. All machines compatible with one another, centrally governed from FOA's machine hall. The setup reflected FOA's leverage in the planning process, described in Chapter 4.

Unlike IBM, the Digital Equipment Corporation was the researchers' favourite. The DEC 10 became important for the emerging hacker culture at major university data processing centres like the ones at Massachusetts Institute of Technology and Stanford University.[136] Flexibility and decentralisation marked the machine philosophy surrounding DEC mainframes. The time-sharing technique was an obvious example of this, enabling simultaneous programming and thus destabilising the hierarchy of runs.

The purchase of the DEC 10 was a sign of the mainframe era coming to an end. It is telling that the researchers at Xerox Parc in Palo Alto, USA – famous for pioneering personal computer development and introducing the graphical user interface that inspired Apple's designs – wanted a DEC 10 in the 1970s.[137]

---

[132] See Chapter 4. For the Swedish critique of IBM's lack of time-sharing, see Lindgren and Peralta, *Högre datautbildningar i Sverige i ett historiskt perspektiv*, 35–36. This downside of the 360 system received critique globally, Campbell-Kelly et al., *Computer*, 131.

[133] This is discussed in several minutes in the data processing council, 1970–1972, FOA Ö, CentralK, F7a:4, KrA. The emergence of war simulations at FOA is analysed in Bergelin, *Planeringsforskningens genombrott*, Ch. 6.

[134] See Section 4.1.

[135] Campbell-Kelly et al., *Computer*, 130.

[136] Edgar H. Schein, *DEC is Dead, Long Live DEC: The Lasting Legacy of Digital Equipment Corporation* (San Francisco: Berrett-Koehler, 2003), 265.

[137] These wishes were not granted by the company managers, which led to debates. Eventually, the researchers developed their own computer systems instead, Michael A. Hiltzik Rutkoff, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age* (New York: HarperCollins Publishers, 1999).

Within FOA, other changes affecting computing work were also lined up. In 1974, Björn Kleist was replaced by Bengt Olsen as head of operations. While Kleist's background was within IBM and FOA, Olsen came from Uppsala University. Besides his military service, he hadn't worked at FOA before. The Swedish Defence Research Agency underwent a major reorganisation the same year Olsen replaced Kleist. A fifth department, focused on human sciences – military psychology, among other research fields – was established. The programming work at the agency, previously scattered across the different departments in calculation divisions, was also unified in the 1974 establishment of a division for applied mathematics and data processing. Elsa-Karin Boestad-Nilsson headed the new division.

FOA was reformed to fit a changing Swedish society – one where the idea of humans and machines as part of the same system had taken root. The threats against this societal system were also different. The oil crisis of 1973 put questions of military preparedness and domestic energy supply on the political agenda.[138] Weapons development based on science and technology was no longer the evident priority in the political struggle to keep Sweden safe and prosperous. Computers, on the other hand, had become a priority not only for advanced military research institutes, but for companies, universities, and even individuals, tempted by the logical but seemingly limitless order promised by digitalisation.

5.7 Conclusion

The QZ was designed in response to problems perceived by the FOA data processing centre researchers. Its managers had learned the importance of the spatial layout when handling the data flow at the FOA data processing centre. The carefulness with cost schemes and machine setup shows a consciousness of all the layers of computing work organisation, which was absent when the FOA data processing centre was inaugurated. Then, the focus was mostly on larger-scale organisational structures, such as whether the service centre should be open or closed for external users. While the operation at the FOA data processing centre developed as a strive to organise the data flow more efficiently, the operation of QZ was more focused on the organisation of code. It was handled through establishing a program library, developing more advanced operating systems, and expanding systems programming.

This reveals a view of computing work as an activity essentially coupled to programming, rather than data management. QZ still had data labourers, but they

---

[138] See Ingemarsdotter and Eriksson, "'Vi får klara oss själva'."

worked behind the scenes, while the systems men fronted the operation in public accounts and international computing communities like Share. FOA's relations to international communities like Rand and Share directed the FOA researchers towards systems thinking in the early 1960s, and by 1975, it permeated the view of computing work at QZ. The logical organisation of programs overshadowed the practical creation of code. Systems thinking was born within military research – in the Swedish case, within FOA P – and it is unsurprising to find it within FOA's data processing. It is possible that the metaphorical description of the computer as a system and computing work as a way to maintain surveillance and control of this abstract system became FOA's legacy to Swedish scientific and technological data processing.

In parallel with the expansion of the systems approach at the QZ, the formation of academic education in data processing in Stockholm created new merits to look for when recruiting personnel to the data processing centre. Years later, Elsa-Karin Boestad-Nilsson identified this change as the main reason for the changing gender distribution within computing work at FOA.[139] Her calculation division was in the early 1960s dominated by women, many of whom eventually left for other positions – or marriage and child-caring – and were replaced by recruits, who had studied information processing and who, according to Boestad-Nilsson, usually were men. Whether that really was the case remains to be seen, but it is a development that fits a pattern studied in other contexts.

The advent of academic education in a given subject, and the increasing importance of academic merits among those working with that subject, often result in an *academisation* of work. According to historian of technology Jonathan Harwood, academisation is a process in which the knowledge required to perform work loses connection to practice and is increasingly tied to the scientific knowledge created and taught in academia.[140] Academisation is contextual. It develops differently depending on the subject, institution, and political surroundings. The specific motivations behind academisation can differ, but Harwood identifies the status increase based on the subordination of practical knowledge in academia as generally important.

When computing work is seen as brain work, it is worth more. Nathan Ensmenger showed how turning computing into an academic discipline in the 1960s in the US elevated it to an activity for geniuses.[141] Early computer pioneers like John von Neumann (1903–1957) chose to identify as mathematicians and, as historian of computing Troy Astarte remarks, even compared themselves to scientific heroes like

---

[139] Boestad-Nilsson, "Databehandlingen – 'ett kitt för FOA'," 238.

[140] Harwood, "Understanding Academic Drift," 413.

[141] Ensmenger, *The Computer Boys Take Over*, Ch. 5.

Isaac Newton and Gottfried Wilhelm Leibniz.[142] Computing was thus portrayed as a highly theoretical, scientific, and superior activity. Academisation processes are often co-evolving with professionalisation – the formation of a bounded and specified occupation – and resulting in masculinisation, the transition from a feminised and depreciated activity to a higher valued one, linked to traditionally masculine attributes like rational thinking and decision-making.[143]

Mar Hicks and Janet Abbate have both connected the changing gendering of computing work to the introduction of new, well-paid job titles and debates over the grounds for computing expertise.[144] While Abbate finds the cause of women's exclusion from software work in the rebranding of computing that followed the increase of male programmers in the 1960s US, Hicks holds the disregard of female programmers' knowledge and expertise responsible for the national decline in computing hardware production within the UK during the 1970s.

In Sweden, we don't know how computing was gendered. Still, this chapter lays the ground for more comprehensive studies of how computing, gender, and expertise interacted in the mainframe era in Sweden. One thing is clear: that the data processing centre at FOA in the late 1970s no longer was a place where you had to know how to knit to be part of the lunchtime conversation – as was the case in 1964 – but a place where rounders tournaments and engineering student jokes maintained the sense of community.[145] A place more like the computing work environments we are used to today.

---

[142] Troy Kaighin Astarte, "'Difficult Things are Difficult to Describe': The Role of Formal Semantics in European Computer Science, 1960–1980," in *Abstractions and Embodiments: New Histories of Computing and Society*, ed. Janet Abbate and Stephanie Dick (Baltimore: Johns Hopkins University Press, 2022), 131.

[143] Classical studies of academisation, professionalisation, and masculinisation are Cockburn, *Machinery of Dominance*; Oldenziel, *Making Technology Masculine*. In a Swedish context, see Sommestad, *Från mejerska till mejerist*.

[144] Abbate, *Recoding Gender*; Hicks, *Programmed Inequality*.

[145] Lars Odén, working with numerical calculations and programming at FOA 1964–1970, remembers that he had to ask his wife to teach him crochet to avoid feeling left out during lunches. Gribbe, *Att modellera slagfältet*, 34.

6 Conclusions

This thesis explores computing work in Sweden in the mainframe era by studying how this work was conducted, organised, and conceptualised at the two data processing centres in the Swedish Defence Research Agency between 1955 and 1975. Chapters two and four address negotiations, plans, and conflicts regarding the establishment of the two data processing centres. Organising computing work included deciding ownership, housing, and financial plans for the data centres, and this work was closely related to political goals and research agendas. Chapters three and five, on the other hand, analyse practices and professions at the centres and how computing work was conducted and conceptualised. These chapters focus on the distribution of work tasks, the organisation of data, and how metaphorical understandings and professional identities were formed.

There are two main findings in this thesis linking the political negotiations preceding the establishment of the centres to the practical work performed within them. First, the size and standard of FOA's computing work were enabled by the prioritisation of military research in Cold War Sweden. The generous government funding resulted in FOA's computing work being extensive, advanced, and very hard to organise in practice. Second, as a result, the researchers at FOA turned to organising principles concerning automation, rationality, and abstraction, which, in turn, contributed to creating scientific computing in Sweden. My findings are discussed below and are subsequently combined in a final discussion on their broader significance.

6.1 The Militarisation of Swedish Computing

At the beginning of this thesis, I show that the nuclear research programme at FOA justified buying the advanced and expensive 7090 mainframe. The researchers at FOA had broader computational needs – nuclear equations were not the only mathematical problem requiring numerical solutions. However, FOA required an exceptionally large computing capacity, which meant that FOA's hardware requirements were more specific than those of other government agencies interested in purchasing or sharing a computer at this time. The generous government funding for nuclear research in the late 1950s provided a unique opportunity for the FOA researchers to procure an internationally outstanding mainframe.

The 7090 marked a decisive change in how computing work was conducted and organised at FOA. The new mainframe became a central node in a network, centred in but not confined to the FOA data processing centre.[1] This centre transformed computing work from a small, scattered business relying on field trips to a systematic and large-scale operation at FOA.

The premises at FOA soon became too crowded, and the entire operation began to exceed its institutional limitations. A new data processing centre appeared as increasingly necessary. QZ opened in 1968 and represented a reorganisation of the FOA data processing centre in several crucial ways. Concrete spatial issues at the FOA data processing centre guided the design of the new centre. The QZ was larger and was located in the middle of the FOA premises to ensure proximity for all FOA users, with a tunnel designed specifically to enable civilian customers to enter without having to pass several security checkpoints. The new mainframe – an IBM 360/75 – came from the same company providing the equipment used at the FOA data processing centre.

While the FOA data processing centre was a military research centre, the QZ was a joint venture by FOA, the Royal Institute of Technology and Stockholm University. This turn from military research to academic research appears as a significant shift in research priorities and institutional affiliation. However, I show in the thesis that the universities were sidelined. The unique experience among FOA researchers in terms of running an advanced data processing centre, as well as the need to maintain secrecy in military computations, gave FOA administrative and operational authority over the shared data centre. The massive resources available for FOA's nuclear research in 1959, which enabled the purchase of the 7090, eventually led to FOA's dominant position in the QZ collaboration.

This conclusion strengthens Eric Bergelin, Per Lundin, and Niklas Stenlås' hypothesis of military research institutions serving as hidden universities in Cold War Sweden.[2] I show that the major government funding to military research not only led to scientists starting their careers at FOA to then move on to academic positions but also enabled the establishment of a proper academic institute within the walls of FOA.

I take the militarisation of Swedish research in the late 1950s as a point of departure to explain FOA's privileged position in Swedish research. However, the picture that emerges is more complicated. Out of six university data processing centres in 1960s Sweden, one was involved with military research – the QZ. The QZ, located in the capital, was the largest and most advanced centre, but it was neither the first (that was

---

[1] For example, the programmers at the calculation division were not employed by the FOA data processing centre.

[2] Eric Bergelin, Per Lundin, and Niklas Stenlås, "Militär forskning och forskningens militarisering," in *Det dolda universitetet: Militär forskning i kalla krigets Sverige*, ed. Eric Bergelin, Per Lundin, and Niklas Stenlås (Lund: Nordic Academic Press, 2025).

the centre in Lund) nor necessarily the role model for other centres. How Swedish academic computing developed – and to what degree it was shaped by military research – is yet to be explored. The QZ and the FOA data processing centre were service centres for the Swedish military and the academic institutions in Stockholm, but also for other civilian customers. Those civilian customers influenced operation and administration of FOA's data centres, thus counteracting a presumed militarisation.

On the other hand, there are indications of an ongoing militarisation throughout the mainframe era. While the FOA data processing centre was closed, meaning that external customers simply handed in their problems and received results, the QZ was partially open. Experienced customers coded and ran their own problems. In so doing, they got used to the standards and work procedures developed at FOA for military computations. The data processing centres in the 1960s and 1970s served as key meeting points for computer users, who learned computing together and discussed their research. As a result, research fields previously confined to the military spread and diversified. The most telling example is perhaps the introduction of a new division for systems theory and optimisation at the Royal Institute of Technology. The division – deeply linked to numerical analysis and computing – was paid for by FOA, and the subject was based on military operations research.

Careers such as that of Per Svenonius also demonstrate the notion of military research as a hidden university. He built his career within FOA's physics and nuclear departments after which he moved on to the Swedish Agency for Administrative Development, where he served as an expert with regard to the computerisation of Swedish higher education. Among the programmers in Elsa-Karin Boestad-Nilsson's group, on the other hand, mobility was not particularly common. Boestad-Nilsson herself, as well as Margareta Franzén and Lena Jönsson, stayed at FOA for almost their entire careers. Perhaps this is an indication of the unusually welcoming work environment for female programmers offered by FOA.

By the mid-1970s, it becomes harder to argue for an ongoing militarisation of Swedish scientific computing. At the QZ, the new DEC 10 mainframe enabled distance and parallel programming. Computing work became fragmented and, in the 1980s, no longer confined to centralised data processing centres. The centralisation of computing is a prerequisite for the above arguments regarding militarisation – without a meeting point on military ground, where does the transfer of military to civilian knowledge spheres occur?

Regardless, the massive resources available to FOA in the late 1950s due to militarisation had a great impact on FOA's computing work. In 1959, FOA researchers chose to buy a very expensive IBM mainframe. In this thesis, I show how that decision affected the negotiations regarding which computer to procure for the Stockholm universities in the 1960s. However, it is reasonable to believe that their choice formed a path dependence, which guided many other procurements as well. Recall the number of IBM machines ordered by the Swedish Agency for Administrative Development between 1961 and 1963: 17 out of 20 in total. In both Lund and Gothenburg, the university data processing centres were given IBM machines too, despite critique from academic scholars.

IBM's dominant position during this era in Sweden in general, and Swedish research in particular, is rooted in FOA's relationship with the company. The decline of the domestic computer industry – which coincided with the rise of international companies such as IBM – is thus assigned a new turning point in this thesis: when FOA decided to buy the IBM 7090. By focusing on IBM, I also seek to remedy an overly nationalist focus in the historiography of early Swedish computing, which has tended to privilege the domestic computer industry over imported computing equipment.

6.2 Female Expertise and Data Labour

The position of Boestad-Nilsson's mostly female programming group at FOA might also originate from the purchase of the IBM 7090. The 7090 made a vast number of computations both possible and desirable to compute at a time when only a few FOA employees knew anything at all about digital computing. Those who knew computing – Boestad-Nilsson and her team – became much sought after. They rapidly gained a position quite rare in the history of gender and computing: a group of women in a work environment dominated by men whose expertise was valued both formally (in terms of salaries) and informally.

In a British context, for example, Mar Hicks finds much more explicit discrimination against female programmers.[3] Female computing expertise was neglected in British public administration in the 1960s, and women were pushed out from higher positions. Hicks' example of a computing work environment that truly welcomed women is the company built by Stephanie Shirley, who employed female tech workers and organised a system where they could work from home.[4] Such an organisation differs a great deal from that at FOA.

The female programmers at FOA are more like the female operators of the Eniac in that their expertise was highly valued. While the Eniac operators were neglected in the historiography following immediately after World War II, the FOA programmers were

---

[3] Hicks, *Programmed Inequality*.

[4] Hicks, "The Baby and the Black Box."

more acclaimed – albeit perhaps, at least partially, because the computers at FOA did not come anywhere near the press coverage and historical attention that Eniac received.[5]

Elsa-Karin Boestad-Nilsson and her team performed advanced logical work, and many of them had upper middle-class backgrounds. However, the data processing centres I study also relied on what I have called *data labour*: carrying punched cards, distributing result lists, mounting disk memories containing operating systems. These tasks were performed by working class occupational groups. Managing material data was key at both the FOA data processing centre and the QZ. Yet the human labour maintaining the mainframe's consumption of data was seen as less valuable. Per Svenonius claimed that it could be rationalised out of existence.

When Svenonius talked about rationalisation, he referred to the continuous reorganisation of computing work at the FOA data processing centre. This occurred in response to perceived problems in the daily operations linked to data management. Two problems were particularly important: the inadequate premises and the time-consuming data flow. FOA's inadequate premises were problematic for the entire agency and were a result of its rapid expansion. The slow data flow was a more specific problem stemming from the materiality of data and the organisational issue of pushing all that heavy data through the mainframe. New hires, equipment, and organisational schemes were introduced to accelerate the data flow, and the entire organisation expanded.

Some of the visions regarding the automation of data labour did come true – for example, the time-sharing technique at the QZ allowing sequences of programs to be executed simultaneously – but computing work still relied on material data input and a strict organisational scheme. Even though the data flow became smoother, the computer memories became larger, and the computer applications more self-governing, these tendencies were much less prevalent than the perceptions of programming alluded to. Systems thinking – interpreted as a solution to the increasing organisational burden at a data processing centre – presented the computer as an abstract system. In this new organisational scheme, the different parts of the computer were integrated not according to the laws of physical movement but according to predetermined logical rules. Operating systems should replace machine operators. Even though a data processing centre such as the QZ had machine operators whose main task was to manage the operating system, the vision of an abstract and autonomous computer system prevailed.

The consequences of systems thinking at the QZ is visible in the calls for rationalisation and abstraction, and can be situated in a broader turn towards bureaucratisation and entrepreneurialism in computing.[6] Systems thinking meant that

---

[5] For an analysis of the Eniac operators, see Abbate, *Recoding Gender*.

[6] Akera, "Engineers or Managers?"

computing became more about management. Systems thinking was also based on theory – it was introduced as a university subject in Stockholm.

The introduction of systems thinking also carries with it a strong gendered component. Previous scholarship has shown the links between management, theory-based professions and masculinity.[7] In this setting, the development of FOA and QZ both adheres to and differs from the established historiography. The work by Boestad-Nilsson and her group was formally recognized to an unusual degree and the abstract nature of their competencies were not seen as incompatible with the gender distribution within the group. Yet, as Svenonius' calls for rationalisation shows, the development at FOA and QZ mirrored broader tendencies of privileging the abstract over the material and over time came to reinforce gendered notions of what advanced computing work entailed – and who should conduct it. Nevertheless, the early years at FOA highlight the highly contingent nature of gendered computing work, and the importance of considering not only gender, but class too, when analysing scientific labour.

Another potential consequence of the introduction of systems thinking could be that computing became more tightly linked to control. Systems thinking was born within the military and was aimed at gaining control over chaotic situations – be it the aftereffects of strategic decisions or the planning of military research and weapons development. As pointed out by Paul N. Edwards, the vision of the closed, controllable world in the Cold War US was directly linked to computing technology.[8] In a Swedish context, Arne Kaijser et al. link the computerisation of Sweden to a manifestation of government power and an intention to control the citizens.[9]

I believe that further studies of computing work, particularly its organisation, could shed more light on these topics. As described at the beginning of this thesis, the question "Whose work and to what purpose?" has the potential to reveal important and hitherto unstudied parts of Swedish computing history. How was computing work gendered? How was it shaped by the emerging education in information processing and the field of computer science?

6.3 Action and the Organisation of Technology

My conclusion in this thesis is that FOA's computing work during the mainframe era was enabled and directed by political action. Militarisation is action. It is enactments based on the belief that the overarching societal goal is national security. The Swedish

---

[7] Oldenziel, *Making Technology Masculine.*

[8] Edwards, *The Closed World.* A similar link between computing and government control in a British context is identified by Agar, *The Government Machine.*

[9] Kaijser et al., *Maktens maskiner.*

government acted according to the vision of Sweden as a modern, neutral country threatened by the ongoing Cold War. The saviour was military technology, as this kind of technology protected Sweden from external threats, enabled the neutrality paradigm, and generated wealth for Swedish industries, seen as the pillars for building a modern Swedish society.

The resources made available for FOA by Swedish political action turned computing work at FOA into a highly complex organisation dominated by data management. The actions taken by the FOA researchers to make sense of this organisational work relied on visions of automation, rationality, and abstraction. The systems thinking at the QZ presented computing as an abstract and automatic activity. This conceptualisation of computing work decoupled computing from human work and, above all else, from data labour. The FOA data processing centre and the QZ were in their heydays the most advanced centres in Sweden, and the researchers at these centres were engaged in extensive exchanges with computing users both in Sweden and internationally. It is reasonable to say that the conceptualisation and organisation of computing work at FOA influenced the formation of scientific computing in Sweden in general. How FOA's legacy was maintained after 1975 remains to be studied, but the visions of automation, rationality, and abstraction born from the extensive data management at FOA bear striking resemblances to contemporary views of computing.

One of the societal problems of our time is the belief that computing technology has become so advanced that it obeys no one and is not anchored to anything.[10] This is as if computing technology acts on its own, independent of human efforts and desires. The exception is perhaps the efforts and desires of the tech entrepreneurs in Silicon Valley. They are praised for their ingenuity, creativity, and logical capabilities. They are the emblematic computing workers of our time.

However, the people in the IT service industry are also computer workers, as are the miners digging up the rare earth metals demanded by the computer hardware industry.[11] So are the assistants manually scanning book pages for Google Books, who are forced to wear bracelets in bright colours to separate them from the highly valued programmers, who (unlike the scanners) are welcome at the fancy company lunch restaurants and recreational rooms.[12] Data in all its fascinating digital shapes – high-resolution photographs, the training sets that constitute the creativity of Chat GPT,

---

[10] This view is often related to dystopian scenarios in popular culture, see for example Max Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence* (New York: Alfred A. Knopf, 2017).

[11] Yost, *Making IT Work*; Ensmenger, "The Environmental History of Computing."; Tung-Hui Hu, *A Prehistory of the Cloud* (Cambridge, Mass.: MIT Press, 2015).

[12] Laura Mallonee, "Is That a Hand? Glitches Reveal Google Books' Human Scanners," *Wired* (2019).

cryptocurrencies – will always be material. And material data requires data labour to be produced, transferred, and stored.

The crucial difference between our time and the time in which this thesis takes place is that the materialities and data labour at the 1960s data processing centres were *visible*, while their contemporary counterparts are largely *invisible*. They are hidden behind the mesmerising vision of a digital world free from bodily ailments and practical limits but sufficiently powerful to disrupt every aspect of our lives. When the entire global production chain related to computing technologies is made invisible, it becomes much harder to affect or even criticise its organisation. The only reaction possible is to suffer or savour the consequences brought about by computing technology.

As David Noble pointed out in the 1980s, "Our culture objectifies technology and sets it apart and above human affairs."[13] Arendt says that technology is a deeply human affair while emphasising that it is *below* political action. By highlighting the work that has enabled the tremendous computing developments in the last century, I hope that we can break free from the paralysing fear of artificial intelligence and consider which actions we want to take.

---

[13] Noble, *Forces of Production*, 9.

References

Unpublished References

Krigsarkivet (KrA)
  FOA open archive (FOA Ö)
    Administrativa Byrån (AdmB)
    Avdelning 2 Expeditionen (Avd 2 Exp)
    Avdelning 4 Datacentralen (Avd 4 DataC)
    Avdelning 4 Rapportcentralen (Avd 4 RapportC)
    Centralkansliet (CentralK)

  FOA secret archive (FOA H)
    Administrativa Byrån (AdmB)
    Avdelning 4 Rapportcentralen (Avd 4 RapportC)

Riksarkivet (RA)
  Statskontoret archive 1961–1970 (Statskontoret)
  Stockholms datorcentral QZ archive (QZ)
  Universitetskanslerämbetet archive (UKÄ)
    Planeringsbyrån 1964–1976 (PlanB)

Riksdagsbiblioteket
  Statsliggaren

Interviews
Ingemar Dahlstrand, 8 June 2022.
Margareta Franzén, 4 March 2021.
Torgny Hallenmark, 17 November 2023.
Lena Jönsson, 12 October 2021.
Björn Kleist, 1 October 2021.
Eva Lindencrona Ohlin, 21 March 2023.
Tomas Ohlin, 3 May 2022.
Bengt Olsen, 29 January 2020.
Yngve Sundblad, 10 May 2022.

Published References

Abbate, Janet. *Inventing the Internet.* Cambridge, Mass.: MIT Press, 1999.

———. *Recoding Gender: Women's Changing Participation in Computing.* Cambridge, Mass.: MIT Press, 2012.

Abbate, Janet, and Stephanie Dick. *Abstractions and Embodiments: New Histories of Computing and Society.* Baltimore: Johns Hopkins University Press, 2022.

———. "Thinking with Computers." In *Abstractions and Embodiments: New Histories of Computing and Society*, edited by Janet Abbate and Stephanie Dick. Baltimore: Johns Hopkins University Press, 2022.

Abella, Alex. *Soldiers of Reason: The Rand Corporation and the Rise of the American Empire.* Boston: Mariner Books, 2009.

Agar, Jon. "Screening Science: Spatial Organization and Valuation at Jodrell Bank." In *Making Space for Science: Territorial Themes in the Shaping of Knowledge*, edited by Crosbie Smith and Jon Agar, 265–80. London: Palgrave Macmillan UK, 1998.

———. *The Government Machine: A Revolutionary History of the Computer.* Cambridge, Mass.: MIT Press, 2003.

———. "What Difference Did Computers Make?". *Social Studies of Science* 36, no. 6 (2006): 869–907.

———. *Science in the Twentieth Century and Beyond.* Cambridge: Polity Press, 2012.

Agrell, Wilhelm. *Vetenskapen i försvarets tjänst: De nya stridsmedlen, försvarsforskningen och kampen om det svenska försvarets struktur.* Lund: Lund University Press, 1989.

———. *Svenska förintelsevapen: Utvecklingen av kemiska och nukleära stridsmedel 1928–1970.* Lund: Historiska media, 2002.

———. "In the Innermost Sanctum: Reflections on the Mythology of Sweden's Neutrality Policy and the History of Questioning." In *The Swedish Success Story?*, edited by Kurt Almqvist and Kay Glans, 187–97. Stockholm: Axel and Margaret Ax:son Johnson Foundation, 2004.

———. *Sprickor i järnridån: Svensk underrättelsetjänst 1944–1992.* Lund: Historiska media, 2017.

Akademisk utbildning i administrativ databehandling: Betänkande avgivet av en av kanslern för rikets universitet tillsatt kommitté. (Stockholm: 1964).

Akera, Atsushi. "Engineers or Managers? The Systems Analysis of Electronic Data Processing in the Federal Bureaucracy." In *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, edited by Agatha C. Hughes and Thomas P. Hughes. Cambridge, Mass.: MIT Press, 2000.

———. "Voluntarism and the Fruits of Collaboration." *Technology and Culture* 42, no. 4 (2001): 710–36.

———. *Calculating a Natural World: Scientists, Engineers, and Computers During the Rise of US Cold War Research.* Cambridge, Mass.: MIT Press, 2007.

Alberts, G., and Ruth Oldenziel. *Hacking Europe: From Computer Cultures to Demoscenes.* London: Springer Verlag, 2014.

Andersson, Gunnar. "Tänker Ni bli EDP-man?". *Affärsekonomi* 9, no. 18 (1960).

Andersson, Jenny. *The Future of the World: Futurology, Futurists, and the Struggle for the Post-Cold War Imagination.* New York: Oxford University Press, 2018.

Anér, Kerstin. "The A-computer system conflict." In *ICT for People: 40 Years of Academic Development in Stockholm* edited by Janis Bubenko. Stockholm: Dept. of Computer & Systems Sciences, Stockholm University and Royal Institute of Technology, 2006.

Annerstedt, Jan. *Staten och datorerna: En studie av den officiella svenska datorutvecklings- och datorforskningspolitiken.* Lund: PhD diss.: Lunds universitet, 1969.

Annerstedt, Jan, and Lars Dencik. "Koloniseringen av framtiden." *Ord & bild*, no. 6 (1971): 412–25.

Annerstedt, Jan, Lars Forssberg, Sten Henriksson, and Kenneth Nilsson. *Datorer och politik, Studier i en ny tekniks politiska effekter på det svenska samhället.* Zenitserien. Lund: Bo Cavefors Bokförlag, 1970.

Anshelm, Jonas. *Mellan frälsning och domedag: Om kärnkraftens politiska idéhistoria i Sverige 1945–1999.* Eslöv: B. Östlings bokförl. Symposion, 2000.

Arendt, Hannah. *The Human Condition: Vita Activa.* 2 ed. Chicago & London: University of Chicago Press, 1998 [1958].

Aronova, Elena. "Geophysical Datascapes of the Cold War: Politics and Practices of the World Data Centers in the 1950s and 1960s." *Osiris* 32, no. 1 (2017): 307–27.

Aspray, William, and Paul E. Ceruzzi. *The Internet and American Business.* Cambridge, Mass.: MIT Press, 2008.

Aspray, William, and Bernard O Williams. "Arming American Scientists: NSF and the Provision of Scientific Computing Facilities for Universities, 1950–1973." *IEEE Annals of the History of Computing* 16, no. 4 (1994): 60–74.

Atlestam, Barbro, ed. *Infrastruktur för informationssamhället: Teknik och politik.* Stockholm: NUTEK (Närings- och teknikutvecklingsverket), 1995.

Bergelin, Eric. *Planeringsforskningens genombrott: Försvarets forskningsanstalt och det globala kalla krigets planeringsexperter.* Uppsala: PhD diss.: Uppsala universitet, 2023.

Bergelin, Eric, Per Lundin, and Niklas Stenlås, eds. *Det dolda universitetet: Militär forskning i kalla krigets Sverige.* Lund: Nordic Academic Press, 2025.

———. "Militär forskning och forskningens militarisering." In *Det dolda universitetet: Militär forskning i kalla krigets Sverige*, edited by Eric Bergelin, Per Lundin and Niklas Stenlås, 11–42. Lund: Nordic Academic Press, 2025.

Berggren, Henrik. *Underbara dagar framför oss: En biografi över Olof Palme.* Stockholm: Norstedt, 2010.

Berner, Boel. *Sakernas tillstånd: Kön, klass, teknisk expertis.* Stockholm: Carlsson, 1996.

———. "Educating Men: Women and the Swedish Royal Institute of Technology, 1880–1930." In *Crossing Boundaries, Building Bridges: Comparing the History of Women Engineers, 1870s–1990s*, edited by Annie Canel, Ruth Oldenziel and Karin Zachmann, 75–102. Amsterdam: Harwood Academic, 2000.

Bertilsson, Fredrik. "Biopolitisk beredskap: Den beteendevetenskapliga försvarsforskningens betydelse i den svenska krisberedskapen." *Historisk tidskrift (Stockholm, Sweden)* 142 (2022): 29–50.

Bertilsson, Fredrik, and Camilla Eriksson. "Totalförsvarets livspolitik: Kunskapsförsörjningen i den svenska livsmedelsberedskapen." *Historisk tidsskrift* 144 (2024): 33–62.

Bialski, Paula. *Middle Tech: Software Work and the Culture of Good Enough.* Princeton: Princeton Univeristy Press, 2024.

Bjereld, Ulf, Alf W Johansson, and Karl Molin. *Sveriges säkerhet och världens fred: Svensk utrikespolitik under kalla kriget.* Stockholm: Santérus, 2008.

Boell, Sebastina. K. , and Janet M. Toland. "Histories of Computing in Oceania." *IEEE Annals of the History of Computing* 45, no. 4 (2023): 6–10.

Boestad-Nilsson, Elsa-Karin. "Databehandlingen – 'ett kitt för FOA'." In *Försvarets Forskningsanstalt 1945–1995*, edited by Ann Kathrine Littke and Olle Sundström. Stockholm: Försvarets Forskningsanstalt, 1995.

Bubenko, Janis, ed. *ICT for People: 40 Years of Academic Development in Stockholm.* Stockholm: Dept. of Computer & System Sciences, Stockholm University and Royal Institute of Technology, 2006.

———. "Information Processing – Administrative Data Processing." Paper presented at the History of Nordic Computing 2, Berlin, Heidelberg, 2009.

Bubenko, Janis, and Tomas Ohlin. *Introduktion till operativsystem.* Del 1. Lund: Studentlitteratur, 1975.

Burks, Alice R. *Who Invented the Computer? The Legal Battle that Changed Computing History.* Amherst: Prometheus Books, 2003.

Campbell-Kelly, Martin. *From Airline Reservations to Sonic the Hedgehog: A History of the Software Industry.* Cambridge, Mass.: MIT Press, 2003.

Campbell-Kelly, Martin, William Aspray, Nathan Ensmenger, and Jeffrey R. Yost. *Computer: A History of the Information Machine*. New York: Taylor & Francis, 2018.

Carlsson, Anders. "Elektroniska hjärnor: Debatten om datorer, automation och ingenjörer 1955–58." In *Artefakter*, edited by Sven Widmalm, 245–85. Hedemora: Gidlunds Förlag, 2004.

Caute, David. *The Year of the Barricades: A Journey Through 1968*. New York: Harper & Row, 1988.

Centralbyrån, Statistiska. *Statistisk årsbok för Sverige 1959*.

———. *Statistisk årsbok för Sverige 1962*.

Chun, Wendy Hui Kyong. *Programmed Visions: Software and Memory*. Cambridge, Mass.: MIT Press, 2011.

Clausewitz, Carl von, Michael Howard, Peter Paret, and Bernard Brodie. *On War*. Princeton: Princeton University Press, 1989.

Cockburn, Cynthia. *Machinery of Dominance: Women, Men and Technical Know-how*. London: Pluto, 1985.

Cortada, James W. *The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries*. New York: Oxford University Press, 2004.

———. *The Digital Hand. Vol. 2, How Computers Changed the Work of American Financial, Telecommunications, Media and Entertainment Industries*. New York: Oxford University Press, 2006.

———. *The Digital Hand. Vol. 3, How Computers Changed the Work of American Public Sector Industries*. New York: Oxford University Press, 2008.

Cowan, Ruth Schwarz. "The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology." In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, edited by Wiebe E. Bijker, Thomas Hughes and Trevor Pinch. Cambridge, Mass.: MIT Press, 1989.

Dalsjö, Robert. *Life-Line Lost: The Rise and Fall of "Neutral" Sweden's Secret Reserve Option of Wartime Help From the West*. Stockholm: Santérus Academic Press Sweden, 2006.

De Geer, Hans. *På väg till datasamhället: Datatekniken i politiken 1946–1963*. Stockholm: Stockholm Papers in History and Philosophy of Technology, 1992.

Dongen, Jeroen van. *Cold War Science and the Transatlantic Circulation of Knowledge*. Leiden: Brill, 2015.

Dörfer, Ingemar. *System 37 Viggen*. Oslo: Universitetsforlaget, 1973.

Eddy, Matthew. *Media and the Mind: Art, Science, and Notebooks as Paper Machines, 1700–1830*. Chicago: University of Chicago Press, 2023.

Edgerton, David. "From Innovation to Use: Ten Eclectic Theses on the Historiography of Technology." *History and Technology* 16 (1999): 1–26.

———. *Warfare State: Britain, 1920–1970.* Cambridge: Cambridge University Press, 2006.

———. *The Shock of the Old: Technology and Global History Since 1900.* New York: Oxford University Press, 2007.

———. "Time, Money, and History." *Isis* 103, no. 2 (2012): 316–27.

Edwards, Paul N. *The Closed World: Computers and the Politics of Discourse in Cold War America.* Cambridge, Mass.: MIT Press, 1996.

———. "The World in a Machine: Origins and Impacts of Early Computerized Global Systems Models." In *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, edited by Agatha C. Hughes and Thomas P. Hughes. Cambridge, Mass.: MIT Press, 2000.

———. *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming.* Cambridge, Mass.: MIT Press, 2010.

Ek-Nilsson, Katarina. *Teknikens befäl: En etnologisk studie av teknikuppfattning och civilingenjörer.* Uppsala: PhD diss.: Uppsala universitet, 1999.

Elzway, Salem. "Armed Algorithms: Hacking the Real World in Cold War America." *Osiris* 38 (2023): 147–64.

Ensmenger, Nathan. *The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise.* Cambridge, Mass.: MIT Press, 2010.

———. "'Beards, Sandals, and Other Signs of Rugged Individualism': Masculine Culture within the Computing Professions.". *Osiris* 30 (2015): 38–65.

———. "The Environmental History of Computing." *Technology and Culture* 59 (2018): 7–33.

Evans, James, and Adrian Johns, eds. *Beyond Craft and Code: Human and Algorithmic Cultures, Past and Present* Vol. 38, Osiris. Univeristy of Chicago Press, 2023.

———. "Introduction: How and Why to Historicize Algorithmic Cultures." *Osiris* 38 (2023): 1–15.

"Expertkritik avvisas av IBM i dataaffären." *Göteborgs Handels- och Sjöfartstidning*, 12 August 1967.

Farge, Arlette, and Thomas Scott-Railton. *The Allure of the Archives.* Translated by Thomas Scott-Railton. New Haven: Yale University Press, 2013 [1989].

"Forskarträff på FOA-dag." *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 1 (1963).

Fredrikzon, Johan. *Kretslopp av data: Miljö, befolkning, förvaltning och den tidiga digitaliseringens kulturtekniker.* Lund: Föreningen Mediehistoriskt arkiv, 2021.

Fridlund, Mats. *Den gemensamma utvecklingen: Staten, storföretaget och samarbetet kring den svenska elkrafttekniken.* Eslöv: B. Östlings bokförl. Symposion, 1999.

G L-E, Sign. "Det är inte för sent än att byta till ett annat märke " *Göteborgs Handels- och Sjöfartstidning*, 20 July 1967.

Galison, Peter. *Image and Logic: A Material Culture of Microphysics.* Chicago: University of Chicago Press, 1997.

———. "Computer Simulations and the Trading Zone." In *From Science to Computational Science*, edited by Gabriele Gramelsberger, 118–57. Zürich: Diaphanes, 2011.

Galison, Peter, and Bruce William Hevly. *Big Science: The Growth of Large-scale Research.* Stanford: Stanford University Press, 1992.

Galison, Peter, and Emily Ann Thompson. *The Architecture of Science.* Cambridge, Mass.: MIT Press, 1999.

Gillis, John R., ed. *The Militarization of the Western World.* London: Rutgers University Press, 1989.

Goldstine, Herman H. *The Computer from Pascal to von Neumann.* Princeton: Princeton University Press, 1972.

Gressman, Philip T., and Robert M. Strain. "Global Classical Solutions of the Boltzmann Equation with Long-Range Interactions." *Proceedings of the National Academy of Sciences* 107, no. 13 (2010): 5744–49.

Gribbe, Johan, ed. *Att modellera slagfältet: Tidig databehandling vid FOA 1954–1966. Transkript från ett vittnesseminarium*. Stockholm: Tekniska museet, 2007.

———. *Stril 60: Teknik, vetenskap och svensk säkerhetspolitik under det kalla kriget.* Hedemora: Gidlunds, 2011.

Grier, David Alan. *When Computers Were Human.* Princeton: Princeton University Press, 2005.

Hagman, Olle. *Nollan blir nymble: Passageriter på Chalmers tekniska högskola i Göteborg.* Göteborg: PhD diss.: Göteborgs universitet, 1984.

Haigh, Thomas. "The Chromium-Plated Tabulator: Institutionalizing an Electronic Revolution, 1954–1958." *IEEE Annals of the History of Computing* 23, no. 4 (2001): 75–104.

Haigh, Thomas, Mark Priestley, and Crispin Rope. *ENIAC in Action: Making and Remaking the Modern Computer.* Cambridge, Mass.: MIT Press, 2016.

Hallberg, Tord Jöran. *IT-gryning: Svensk datahistoria från 1840- till 1960-talet.* Lund: Studentlitteratur, 2007.

Hamngren, Inga, Jan Odhnoff, and Jeroen Wolfers. *De byggde Internet i Sverige.* Stockholm: ISOC-SE, 2009.

Harwood, Jonathan. "Understanding Academic Drift: On the Institutional Dynamics of Higher Technical and Professional Education." *Minerva* 48, no. 4 (2010): 413–27.

Hecht, Gabrielle. *The Radiance of France: Nuclear Power and National Identity After World War II.* Cambridge, Mass.: MIT Press, 1998.

Heims, Steve J. *The Cybernetics Group.* Cambridge, Mass.: MIT Press, 1991.

Hicks, Mar. *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing.* Cambridge, Mass.: MIT Press, 2017.

———. "The Baby and the Black Box: A History of Software, Sexism, and the Sound Barrier." In *Abstractions and Embodiments: New Histories of Computing and Society*, edited by Janet Abbate and Stephanie Dick. Baltimore: Johns Hopkins University Press, 2022.

Hiltzik Rutkoff, Michael A. . *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age.* New York: HarperCollins Publishers, 1999.

Hoffleit, E. Dorrit. "Pioneering Women in the Spectral Classification of Stars." *Physics in Perspective* 4, no. 4 (2002): 370–98.

Holm, Göran. "Forskaren 'ersätts' av en dator." *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 2 (1970).

Holmberg, Gustav. "Framtiden: Historikerna blickar bakåt." In *Beredd till bådadera: Lunds universitet och omvärlden*, edited by Gunnar Broberg and David Dunér. Lund: Lunds universitet, 2017.

———. "Beräkningsarbete." In *Kunskap i rörelse: Kungl. Vetenskapsakademien och skapandet av det moderna samhället*, edited by Johan Kärnfelt; Karl Grandin; Solveig Jülich. Göteborg och Stockholm: Makadam förlag, 2018.

Holmström, Mikael. *Den dolda alliansen: Sveriges hemliga NATO-förberedelser.* Stockholm: Atlantis, 2011.

Hopper, Grace. "The First Bug." *Annals of the History of Computing, IEEE* 3, no. 3 (1981): 285–86.

Hu, Tung-Hui. *A Prehistory of the Cloud.* Cambridge, Mass.: MIT Press, 2015.

Hughes, Jeff. "William Kay, Samuel Devons and Memories of Practice in Rutherford's Manchester Laboratory." *Notes and Records of the Royal Society of London* 62, no. 1 (2008): 97–121.

Hughes, Thomas P. "Technological Momentum in History: Hydrogenation in Germany 1898–1933." *Past and Present* 44 (1969): 106–32.

———. "The Evolution of Large Technological Systems." In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, edited by Wiebe E. Bijker, Thomas P. Hughes and Trevor Pinch. Cambridge, Mass.: MIT Press, 1987.

———. "Technological Momentum." In *Does Technology Drive History?: The Dilemma of Technological Determinism*, edited by Merritt Roe Smith and Leo Marx, 101–13. Cambridge, Mass. : MIT Press, 1994.

Hughes, Thomas P. . *Rescuing Prometheus: Four Monumental Projects That Changed the World.* New York: Pantheon Books, 1998.

Hughes, Thomas P., and Agatha C. Hughes, eds. *Systems, Experts and Computers: The Systems Approach in Management and Engineering, World War II and After*. Cambridge, Mass.: MIT Press, 2000.

Ilshammar, Lars. *Offentlighetens nya rum: Teknik och politik i Sverige 1969–1999.* Örebro: PhD diss.: Örebro universitet, 2002.

Ingelstam, Lars. *System: Att tänka över samhälle och teknik.* Eskilstuna: Statens energimyndighet, 2002.

Ingemarsdotter, Jenny, and Camilla Eriksson. "'Vi får klara oss själva': Hotbild och självbild i den svenska försörjningsberedskapen 1962–2002." *Scandia Tidskrift för historisk forskning* 89 (2023): 68–97.

Johanneson, Olof. *Sagan om den stora datamaskinen: En vision.* Stockholm: Albert Bonniers Förlag, 1966.

Johansson, Conny. *Tema gudar.* Linköping: Datasaabs vänner, 2002.

Johansson, Magnus. "Big Blue Gets Beaten: The Technological and Political Controversy of the First Large Swedish Computerization Project in a Rhetoric of Technology Perspective." *IEEE Annals of the History of Computing* 21, no. 2 (1999): 14–30.

Johnson, George. *Miss Leavitt's Stars: The Untold Story of the Woman Who Discovered How to Measure the Universe.* New York: W.W. Norton, 2005.

Jonter, Thomas. *The Key to Nuclear Restraint: The Swedish Plans to Acquire Nuclear Weapons During the Cold War.* London: Palgrave Macmillan, 2016.

Josefsson, Sven-Olof. *Året var 1968: Universitetskris och studentrevolt i Stockholm och Lund.* Göteborg: PhD diss.: Göteborgs universitet, 1996.

Judt, Tony. *Postwar: A History of Europe Since 1945.* New York: Penguin Press, 2005.

Kaighin Astarte, Troy. "'Difficult Things are Difficult to Describe': The Role of Formal Semantics in European Computer Science, 1960–1980." In *Abstractions and Embodiments: New Histories of Computing and Society*, edited by Janet Abbate and Stephanie Dick. Baltimore: Johns Hopkins University Press, 2022.

Kaijser, Arne, Per Lundin, Johan Gribbe, and Gustav Sjöblom. *Maktens maskiner: Hur stora datorer moderniserade folkhemmet.* Lund: Arkiv förlag, 2024.

Kaijser, Arne, and Joar Tiberg. "From Operations Research to Futures Studies: The Establishment, Diffusion, and Transformation of the Systems Approach in

Sweden, 1945–1980." In *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, edited by Agatha C. Hughes and Thomas P. Hughes. Cambridge, Mass.: MIT Press, 2000.

Kaiserfeld, Thomas. "Computerizing the Swedish Welfare State: The Middle Way of Technological Success and Failure." *Technology and Culture* 37, no. 2 (1996): 249–79.

Kaiserfeld, Thomas, Marika Hedin, and Svante Lindqvist. *Center on the Periphery: Historical Aspects of 20th-century Swedish Physics*. Canton: Science History Publications, 1993.

Karlsson-Ottoson, Ulla. "Binär pionjär." *Teknikhistoria*, 2015.

Karlsson, Birgit. *Svensk försvarsindustri 1945–1992*. Stockholm: FoKK, 2015.

Karsberg, Arne. "Datamaskinkriget går vidare, Expertdelegation underkände." *Dagens Nyheter*, 16 Mai 1968.

———. "Datamaskinsbataljen över men eftersmaken är besk." *Dagens Nyheter*, 15 September 1968.

———. "Fint resultat i dataprovningen, Expertstrid fortsätter." *Dagens Nyheter*, 20 April 1968.

———. "Ny attack i 'datamaskinkriget', Forskares krav ströks ned 50%." *Dagens Nyheter*, 7 March 1968.

———. "Rektorerna stöder forskarna i angreppen på datamaskinkö." *Dagens Nyheter*, 9 March 1968.

Keller, Evelyn Fox. *Refiguring Life: Metaphors of Twentieth-century Biology*. New York: Columbia University Press, 1995.

———. *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines*. Cambridge, Mass.: Harvard University Press, 2003.

Krige, John. *American Hegemony and the Postwar Reconstruction of Science in Europe*. Cambridge, Mass.: MIT Press, 2006.

———. "How Users Matter: The Co-Construction of Users and Technology." *Contemporary Sociology* 35, no. 1 (2006): 31–32.

———. *How Knowledge Moves: Writing the Transnational History of Science and Technology*. Chicago: University of Chicago Press, 2019.

Kungl. Maj:ts proposition nr 110. *1958*.

Kättström Höök, Lena. *Lucia i nytt ljus*. Stockholm: Nordiska museets förlag, 2016.

Latour, Bruno. *Science in Action: How to Follow Scientists and Engineers Through Society*. Cambridge, Mass.: Harvard University Press, 1987.

Lehtisalo, Kaarina, and Ville Harilahti. *The History of NORDUnet: Twenty-five Years of Networking Cooperation in the Nordic Countries*. Hørsholm: NORDUnet, 2005.

Leslie, Stuart. *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford.* New York: Columbia University Press, 1993.

Levien, Roger. "RAND, IIASA, and the Conduct of Systems Analysis." In *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, edited by Agatha C. Hughes and Thomas P. Hughes. Cambridge, Mass.: MIT Press, 2000.

Li, Tore. *Government and Research: The Evolution of Involvement in Europe and the United States.* Oslo: Linquiry publications, 2017.

Licke, Göran. "Fruktan att Statskontoret med utmattningsmetoder driver igenom sin vilja." *Göteborgs Handels- och Sjöfartstidning*, 7 March 1968.

Light, Jennifer S. "When Computers Were Women." *Technology and Culture* 40, no. 3 (1999): 455–83.

Lindgren, Sofia, and Julia Peralta, eds. *Högre datautbildningar i Sverige i ett historiskt perspektiv: Transkript av ett vittnesseminarium.* 18 vols. Stockholm: Tekniska museet, 2008.

Lindqvist, Svante. *Changes in the Technological Landscape: Essays in the History of Science and Technology.* Sagamore Beach: Science History, 2011.

Lindström, Stefan. *Hela nationens tacksamhet: Svensk forskningspolitik på atomenergiområdet: 1945–1956.* Stockholm: PhD diss.: Stockholms universitet, 1991.

Lundin, Per, ed. *Att arbeta med 1950-talets matematikmaskiner: Transkript av ett vittnesseminarium.* Stockholm: Tekniska museet, 2005.

———, ed. *Tidig programmering: Transkript av ett vittnesseminarium.* Stockholm: Tekniska museet, 2006.

———, ed. *Administrativ systemutveckling i teori och praktik, 1960–1980: Transkript av ett vittnesseminarium.* Stockholm: Tekniska museet, 2007.

———. *Computers in Swedish Society: Documenting Early Use and Trends.* New York: Springer, 2012.

Lundin, Per, and Johan Gribbe. *Att följa pengarna: En analys av forskningsfinansieringen i efterkrigstidens Sverige.* Score (Stockholm: 2023).

Lundin, Per, and Niklas Stenlås. "Technology, State Initiative and National Myths in Cold War Sweden: An Introduction." In *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, edited by Niklas Stenlås Per Lundin, Johan Gribbe. Sagamore Beach: Science History Publications, 2010.

Lundin, Per, Niklas Stenlås, and Johan Gribbe, eds. *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden.* Sagamore Beach: Science History Publications, 2010.

Lövgren, Britta. *Hemarbete som politik: Diskussioner om hemarbete, Sverige 1930–40-talen, och tillkomsten av Hemmens forskningsinstitut.* Stockholm: PhD diss.: Stockholm University, Almqvist & Wiksell International, 1993.

MacKenzie, Donald. "The Influence of the Los Alamos and Livermore National Labs on Supercomputing." *Annals of the History of Computing, IEEE* 13, no. 2 (1991): 179–201.

———. "A Worm in the Bud? Computers, Systems, and the Safety-Case Problem." In *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After,* edited by Agatha C. Hughes and Thomas P. Hughes Cambridge, Mass.: MIT Press, 2000.

MacKenzie, Donald A. *Mechanizing Proof: Computing, Risk, and Trust.* Cambridge, Mass.: MIT Press, 2001.

Mallonee, Laura. "Is That a Hand? Glitches Reveal Google Books' Human Scanners." *Wired.* (2019).

Marçal, Katrine. *Att uppfinna världen: Hur historiens största feltänk satte käppar i hjulet.* Stockholm: Mondial, 2020.

Mario, Daniels, and John Krige. *Knowledge Regulation and National Security in Postwar America* Chicago: University of Chicago Press, 2022.

Marx, Karl, Paul Reitter, Paul North, Wendy Brown, and William Clare Roberts. *Capital: Critique of Political Economy. Volume 1.* Princeton: Princeton University Press, 2024 [1867].

McCloskey, Joseph F. "The Beginnings of Operations Research: 1934–1941." *Operations Research* 35, no. 1 (1987): 143–52.

McCray, Patrick. *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future.* Princeton: Princeton University Press, 2013.

McElroy, Erin. *Silicon Valley Imperialism: Techno Fantasies and Frictions in Postsocialist Times.* Durham: Duke University Press, 2024.

McEnaney, Laura. *Civil Defense Begins at Home: Militarization Meets Everyday Life in the Fifties.* Princeton: Princeton University Press, 2000.

Mellberg, Kjell, Gunnar Wedell, and Bo Lindestam. *Fyrtio år av den svenska datahistorien: Från Standard Radiofabrik till -?: framtagen på initiativ av Veteranklubben Alfa.* Åkersberga: Veteranklubben Alfa, 1997.

Mindell, David. "Automation's Finest Hour: Radar and System Integration in World War II." In *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, edited by Agatha C. Hughes and Thomas Hughes. Cambridge, Mass.: MIT Press, 2000.

Misa, Thomas. "Understanding 'How Computing Has Changed the World'." *Annals of the History of Computing, IEEE* 29 (2007): 52–63.

———. *Gender Codes: Why Women are Leaving Computing.* Hoboken: Wiley, 2010.

Morus, Iwan Rhys. *Frankenstein's Children: Electricity, Exhibition, and Experiment in Early-Nineteenth-Century London.* Princeton: Princeton University Press, 1998.

———. "Invisible Technicians, Instrument-makers and Artisans." In *A Companion to the History of Science*, edited by Bernard Lightman. Chichester: John Wiley & Sons, 2016.

Mullaney, Thomas S. *The Chinese Typewriter: A History.* Cambridge, Mass.: MIT Press, 2017.

Nilsson, Mikael. *Tools of Hegemony: Military Technology and Swedish-American Security Relations, 1945–1962.* Stockholm: PhD diss.: Kungliga tekniska högskolan, 2007.

Noble, David F. *Forces of Production: A Social History of Industrial Automation.* New York: Oxford University Press, 1986.

Nofre, David. "The Politics of Early Programming Languages: IBM and the Algol Project." *Historical Studies in the Natural Sciences* 51, no. 3 (2021): 379–413.

"Ny institution vid KTH bekostas av FOA." *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 3 (1963).

"Ny schism om statlig datamaskin." *Svenska Dagbladet*, 18 July 1967.

Nybom, Thorsten. *Kunskap, politik, samhälle: Essäer om kunskapssyn, universitet och forskningspolitik 1900–2000.* Hargshamn: Arete, 1997.

Nybom, Torsten. "Det nya Statskontorets framväxt 1960–1965." In *Statskontoret 1680–1980: En jubileums- och årsskrift*, edited by Arne Granholm; Margot Rydén. Stockholm: Statskontoret, 1980.

Ólafsson, Sverrir. "The Presence of the IBM Branch Office in Iceland, 1967–1992." In *History of Nordic Computing 3*, edited by John Impagliazzo, Per Lundin and Benkt Wangler. Berlin, Heidelberg: Springer, 2011.

Oldenziel, Ruth. *Making Technology Masculine: Men, Women, and Modern Machines in America, 1870–1945.* Amsterdam: Amsterdam University Press, 1999.

Olsson, Åke. "Ett uppslag för kvinnor." *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 3 (1963).

Oreskes, Naomi. *Science on a Mission: How Military Funding Shaped What We Do and Don't Know About the Ocean.* Chicago: University of Chicago Press, 2021.

Orrghen, Anna. "Collaborations between Engineers and Artists in the Making of Computer Art in Sweden, 1967–1986." In *History of Nordic Computing 3*, edited by John Impagliazzo, Per Lundin and Benkt Wangler. Berlin, Heidelberg: Springer, 2011.

Oudshoorn, Nelly, and Trevor Pinch. *How Users Matter: The Co-construction of Users and Technologies*. Cambridge, Mass.: MIT Press, 2003.

Paju, Petri. "IBM Manufacturing in the Nordic Countries." In *History of Nordic Computing 3*, edited by John Impagliazzo, Per Lundin and Benkt Wangler. Berlin, Heidelberg: Springer, 2011.

Paju, Petri, and Thomas Haigh. "IBM Rebuilds Europe: The Curious Case of the Transnational Typewriter." *Enterprise & Society* 17, no. 2 (2016): 265–300.

———. "IBM's Tiny Peripheral: Finland and the Tensions of Transnationality." *Business History Review* 92 (2018): 1–26.

Palme, Jacob. *Simula as a Tool for Extensible Program Products*. Infotech Limited (Maidenhead: 1974).

Peralta, Julia, and Sofia Lindgren, eds. *Datacentralerna för högre utbildning och forskning: Transkript av ett vittnesseminarium*. Stockholm: Tekniska museet, 2008.

Persson, Per Arne. "Transformation of the Analog: The Case of the Saab BT 33 Artillery Fire Control Simulator and the Introduction of the Digital Computer as Control Technology." *IEEE Annals of the History of Computing* 21 (1999).

Petersson, Tom. "Facit and the BESK Boys: Sweden's Computer Industry (1956–1962)." *IEEE Annals of the History of Computing* 27 (2005): 23–30.

———. "Private and Public Interests in the Development of the Early Swedish Computer Industry: Facit, Saab and the Struggle for National Dominance." In *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, edited by Per Lundin, Johan Gribbe and Niklas Stenlås. Sagamore Beach: Science History Publications, 2010.

Pettersson, Ingemar. *Handslaget: Svensk industriell forskningspolitik 1940—1980*. Stockholm: PhD diss.: Kungliga tekniska högskolan, 2012.

Pinch, Trevor J., and Wiebe E. Bijker. "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other." *Social Studies of Science* 14, no. 3 (1984): 399–441.

Pugh, Emerson W. *Building IBM: Shaping an Industry and Its Technology*. Cambridge, Mass.: MIT Press, 1995.

Rahm, Lina. *Educational Imaginaries: A Genealogy of the Digital Citizen*. Linköping: PhD diss.: Linköpings universitet, 2019.

Ravanis, Julia. "Datamaskinkriget: Stockholms datacentral QZ och militärforskningens osynliggörande." In *Det dolda universitetet: Militär forskning i kalla krigets Sverige*, edited by Eric Bergelin, Per Lundin and Niklas Stenlås, 133–60. Lund: Nordic Academic Press, 2025.

Ritchie, Donald A. *Doing Oral History*. New York: Twayne Publishers, 1994.

Rose, Joanna. "Kvinnorna bakom datorernas genombrott." *Forskning & Framsteg*, 2015.

Rossiter, Margaret W. *Women Scientists in America: Struggles and Strategies to 1940*. Baltimore: Johns Hopkins University Press, 1982.

Rowlands, Peter. *Oliver Lodge and the Liverpool Physical Society*. Liverpool: Liverpool University Press, 1990.

Salomon, Kim, and Göran Blomqvist. *Det röda Lund: Berättelser om 1968 och studentrevolten*. Lund: Historiska media, 1998.

Sandqvist, Ulf. *Digitala drömmar och industriell utveckling: En studie av den svenska dator- och tv-spelsindustrin 1980–2010*. Umeå: PhD diss.: Umeå universitet, 2010.

Sandström, Ulf. *Det nya forskningslandskapet: Perspektiv på vetenskap och politik*. Stockholm: Swedish Institute for Studies in Education and Research, 2002.

Schein, Edgar H. *DEC is Dead, Long Live DEC: The Lasting Legacy of Digital Equipment Corporation*. San Francisco: Berrett-Koehler, 2003.

Schlombs, Corinna. "Built on the Hands of Women: Data, Automation, and Gender in West Germany's Financial Industry." *Technology and Culture* 64, no. 1 (2023): 63–89.

Secord, James A. "Knowledge in Transit." *Isis* 95, no. 4 (2004): 654–72.

Sejersted, Francis. *Socialdemokratins tidsålder: Sverige och Norge under 1900-talet*. Nora: Nya Doxa, 2005.

Shapin, Steven. "The Invisible Technician." *American Scientist* 77, no. 6 (1989): 554–63.

Sherry, Michael S. *In the Shadow of War: The United States Since the 1930s*. New Haven: Yale University Press, 1997.

Shetterly, Margot Lee. *Hidden Figures: The Untold Story of the African American Women Who Helped Win the Space Race*. London: 4th Estate, an imprint of HarperCollins Publishers, 2022.

Sillén, Lars Gunnar. "Stordata, forskning och pengar." *Svenska Dagbladet*, 17 June 1968.

Sjöblom, Gustav. "The Totally Integrated Management Information System in 1960s Sweden." In *History of Nordic Computing 3*, edited by John Impagliazzo, Per Lundin and Benkt Wangler. Berlin, Heidelberg: Springer, 2011.

Sommestad, Lena. *Från mejerska till mejerist: En studie av mejeriyrkets maskuliniseringsprocess*. Lund: Arkiv förlag, 1992.

Sorrenson, Richard. *Perfect Mechanics: Instrument Makers at the Royal Society of London in the Eighteenth Century*. Boston: Docent Press, 2013.

SOU 1960:12. *Krigsmaktens högsta ledning: Betänkande avgivet av 1958 års försvarsledningskommitté*.

SOU 1960:23. *Besparingar inom försvaret: Betänkande avgivet av 1959 års besparingsutredning för försvaret*.

SOU 1962:32. *Automatisk databehandling: Betänkande avgivet av kommittén för maskinell databehandling.*

SOU 1963:76. *Högre utbildning och forskning i Umeå II.*

SOU 1974:10. *Data och näringspolitik.*

Statistiska Centralbyrån. *Tjänstemän inom statlig och statsunderstödd verksamhet år 1963.* Sveriges officiella statistik, arbetsmarknad samt arbets- och löneförhållanden. Stockholm, 1965.

"Statskontoret till attack i tvisten om datamaskiner." *Dagens Nyheter*, 18 July 1966.

Steedman, Carolyn. *Dust: The Archive and Cultural History.* New Brunswick: Rutgers University Press, 2002.

Stern, Nancy B. *From ENIAC to UNIVAC: An Appraisal of the Eckert-Mauchly Computers.* Bedford: Digital Press, 1981.

Stevens, Hallam, and Jiahui Chan. "Computing Nanyang." In *Abstractions and Embodiments: New Histories of Computing and Societies*, edited by Janet Abbate and Stephanie Dick, 299–318. Baltimore: Johns Hopkins University Press, 2022.

Strasser, Bruno J., and Paul N. Edwards. "Big Data Is the Answer … But What Is the Question?". *Osiris* 32, no. 1 (2017): 328–45.

Švelch, Jaroslav. *Gaming the Iron Curtain: How Teenagers and Amateurs in Communist Czechoslovakia Claimed the Medium of Computer Games.* Cambridge, Mass.: MIT Press, 2018.

Svensson, Gary. *Digitala pionjärer: Datakonstens introduktion i Sverige.* Stockholm: Carlsson, 2000.

Swedish Ministry of Enterprise. *The Swedish Innovation Strategy.* Government Offices of Sweden (Stockholm: 2019).

Sörbo, Bo. "Hjärnans mekanismer utforskas." *Foaiten: Personaltidning för Försvarets forskningsanstalt*, no. 4 (1967).

te Heesen, Anke. "The Notebook: A Paper-Technology." In *Making Things Public: Atmospheres of Democracy*, edited by Bruno Latour and Peter Weibel. Cambridge, Mass.: MIT Press, 2005.

Tegmark, Max. *Life 3.0: Being Human in the Age of Artificial Intelligence.* New York: Alfred A. Knopf, 2017.

Traweek, Sharon. *Beamtimes and Lifetimes: The World of High Energy Physicists.* Cambridge, Mass.: Harvard University Press, 1988.

———. "Border Crossings: Narrative Strategies in Science Studies and Among High Energy Physicists at Tsukuba Science City, Japan." In *Science as Practice and Culture*, edited by Andy Pickering, 429–65. Chicago: University of Chicago Press, 1992.

Tsing, Anna Lowenhaupt. *Friction: An Ethnography of Global Connection.* Princeton: Princeton University Press, 2005.

Turner, Fred. *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism.* Chicago: University of Chicago Press, 2006.

Vinsel, Lee, and Andrew L. Russell. *The Innovation Delusion: How Our Obsession with the New Has Disrupted the Work that Matters Most.* New York: Currency, 2020.

Weinberger, Hans. "The Neutrality Flagpole: Swedish Neutrality Policy and Technological Alliances, 1945–1970." In *Technologies of Power: Essays in Honor of Thomas Parke Hughes and Agatha Chipley Hughes* edited by Michael Thad Allen and Gabrielle Hecht, 295–331. Cambridge, Mass.: MIT Press, 2001.

Wellerstein, Alex. *Restricted Data: The History of Nuclear Secrecy in the United States.* Chicago: University of Chicago Press, 2021.

Wentzel, Viggo. *Tema D21.* Linköping: Datasaabs vänner, 1994.

WERP, Sign.:. "Flinkaste datamaskinen i Norden installeras hos FOA på Östermalm." *Svenska Dagbladet*, 9 January 1968.

Wetterberg, Gunnar. *Ingenjörerna.* Stockholm: Albert Bonniers förlag, 2020.

Widmalm, Sven. *Det öppna laboratoriet: Uppsalafysiken och dess nätverk 1853–1910.* Stockholm: Atlantis, 2001.

Williams, Rosalind. *Retooling: A Historian Confronts Technological Change.* Cambridge, Mass.: MIT Press, 2002.

Wittgenstein, Ludwig. *Philosophical Investigations.* Translated by Anscombe Wittgenstein. 3 ed. Oxford: Blackwell, 1968 [1953].

Yost, Jeffrey R. *Making IT Work: A History of the Computer Services Industry.* Cambridge, Mass.: MIT Press, 2020.

Åström, Karl Johan. "Early Control Development in Sweden." *European Journal of Control* 13 (2007).

ÖB-utredningarna. *Studie – utredningar – ÖB förslag 1957 jämte försvarsgrenschefernas yttranden och ÖB slutord.* Stockholm, 1957.