X-0 to X-8*

A brief history of the first Dutch computer industry, Electrologica

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Contents

1 Introduction

In 1956, two cultures of early computing in the Netherlands came together towards a common goal, to develop an advanced computer. Life insurance company Nillmij founded Electrologica to acquire a computer and realize its ambition of automating its office operations and life insurance calculations. The Mathematical Center joined in Electrologica for the continuity of its computer construction group. The research center kept its dream alive of a very large computer, but could not afford the construction group solely for that purpose.[1].

Despite moderate expectations, Electrologica's first computer, the X-1, was a success. During the first two years, while the total number of computers in the Netherlands grew from five to eleven (Cf.

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[1]Gerard Alberts and Huub de Beer, 'De AERA: gedroomde machines en de praktijk van het rekenwerk aan het Mathematisch Centrum te Amsterdam', *Studium* 1 (2008), 101–127

Table 2), Electrologica received no less then ten orders for an X-1[2]. Eventually Electrologica built and delivered 34 X-1 computers.

Once beyond startup phase, Electrologica planned the development of a successor to the X-1. Or rather it explored the development of two successors, one computer aiming at administrative applications, the X-0, and another dedicated to scientific computing, the X-2. In both directions the design took more time than anticipated. However, when customers for the X-2 lost their patience and started looking for a computer elsewhere, Electrologica did react and moved swiftly. Within one month, Electrologica announced an improved version of the X-1, eight times faster, hence named X-8. Even though the X-8 had more options for connecting peripherals than the X-1, it was primarily appreciated in circles of scientific computing. Commercially the X-8 was unable to match the success of the X-1.

In 1960, on a total number of 34 computers in the Netherlands, Electrologica's market share was over 10% (Cf. Table 2). By 1963, while the number of computers had increased more than sixfold, its market share had dropped below 7.5%. By contrast, IBM's market share had grown from 32% to 60%. Electrologica was unable to compete, in particular in the field of administrative computers. When IBM introduced their System/360 "family of computers" in 1964, Electrologica made a desperate attempt to enter the same market and announced a family. To no avail. The company's losses continued to mount. In the same year Nillmij incorporated Electrologica. In 1965, Philips did take a share in Electrologica, but only 40%. A year on, Electrologica turned out to be in such bad shape that Philips was forced to take over the entire company. It may be considered a mark honour that Philips Computer Industry renamed itself Philips Electrologica.

Abstract Key to the history of Electrologica was the internal struggle to unite two cultures of computing in one company. The successful manufacturing of the X-1 did not suffice to gain a stable foothold in the market for administrative computers. Still, the very struggle to make a machine for scientific computing suitable for office applications did result in a remarkably innovative computer, the X-1.

The founding of Electrologica appeared as a logical step for both Nillmij and Mathematical Center. While it was only natural to conceive of a computer as a calculation device, the requirements of administrative use deeply influenced the design of the X-1. Moreover, efforts were made to develop proprietary peripherals as a point of attraction for customers in the administrative field. Even so, the X-1 came with a Bull card reader and an IBM typewriter. High ambitions and diverging aims for the successor to the X-1 caused considerable postponement. However, once forced to deliver, Electrologica quickly decided for the X-8.

By the time of manufacturing the X-8, system programs were called "software". In a cooperative effort university costumers and Electrologica installed a committee Z8, in Dutch pronounced "zacht", meaning "soft" as in software. The user-led initiative produced compilers for ALGOL and FORTRAN, an operating system ELAN, and the famous THE multiprogramming system.

Electrologica's story ended dramatically in the eventual acquisition by Philips.

2 Towards Electrologica's founding

The history of Electrologica's founding in 1956 revolves around two early enthusiasts for computers in their fields, Johannes J. (Jojo) Engelfriet, director of the life insurance company "Nillmij van 1859" in The Hague, and Adriaan (Aad) van Wijngaarden, head of the computation department of the Mathematical Center in Amsterdam. It was Nillmij's quest to automate the life insurance administration. Mathematical Center constructed a series of computers in support of its computing work. Founding

[2]N.V. Electrologica, 'Jaarverslag 1957' in: 'Nota aan H.H. Gedelegeerde Commissarissen van "Ned. Nillmij" en "Arnhem", 13 november 1958', 1. 'Oud Archief AEGON. Afd. Documentatie nr. 165', X.003.3:657.372

Electrologica was the outcome of the encounter of the two men and brought both organizations together in their efforts to be at the forefront of computers in their fields.

Modernizing Nillmij In 1952, life insurance companies "Nillmij van 1859" and "Arnhem" had merged into a single company, Nillmij. Upon the merger, Engelfriet became one of its directors. He seized the opportunity of the merger to integrate and modernize the separate administrations.[3] In the 1950s, setting up a modern administration implied reaching beyond a system of mechanical punched card machines towards an electronic calculator. Engelfriet was particularly interested in performing large-scale insurance-related calculations on an electronic computer. In order to determine how best to do this, he addressed three manufacturers of office machinery, IBM, Remington Rand, and Bull, with a request to run a test job for Nillmij.[4] Writing to Van Wijngaarden as well, he asked Mathematical Center for advice and suggested the possibility of building for Nillmij an automatic calculator with a magnetic memory of two to four thousand digital numbers.[5]

Responses were disappointing. IBM did not respond at all. Remington's reply was unsatisfactory: they would be able to perform the test job, but it would take too long. Better news came from the third manufacturer, Bull. Using the Bull GAMMA 3 calculator, they could run the test job.[6] Nillmij decided to order a Bull GAMMA 3 and, simultaneously, migrated its administration to Bull punched card machinery.[7] If by the choice for Bull, Nillmij seemed have dropped its interest in having a computer built at Mathematical Center, Engelfriet advised his company otherwise. Fascinated by the idea of a memory drum and desiring 'to have a hand in any further developments in this special electronic field (...). We have placed a preliminary order with the [Mathematical] Center to build a machine capable of performing automatic correspondence and all kinds of typing work'.[8]

Nillmij canceled the preliminary order, but did maintain an interest. In 1954, it organized talks between Nillmij, Bull, Philips, Mathematical Center, and "Nederlandse Handelsmaatschappij". Although nothing tangible came out of these talks, the Nillmij board observed 'that people now realize what value [collaborating] holds for them. So much knowledge in this field is available in the Netherlands, that it may be expected that Dutch parties will find common ground'[9]. And so it happened. In 1955, two of these parties did find each other. Talks between Nillmij and Mathematical Center evolved into serious negotiations on the establishment of a Dutch computer industry, Electrologica.

Building computers at Mathematical Center From its founding in 1946, Mathematical Center held ambitions in the realm of so-called "automatic calculating machines". When a plan to build such computing machines in collaboration with partners from Belgium and France[10] fell through, Mathematical Center decided to continue on its own. In August 1947 two physics students, Bram Loopstra and Carel Scholten, were hired to build a modern computing machine.[11] Van Wijngaarden traveled

[3] D. de Wit, 'Wat niet te verzekeren valt: Electrologica als casus uit de opbouw van een Nederlandse computerindustrie (1956–1967)', in: *Jaarboek voor de Geschiedenis van Bedrijf en Techniek*, volume 9 (Amsterdam: NEHA 1992), 261–291, here: 267–268

[4] 'Rapport Directie te Djakarta betreffende Mechanisatie' ('s-Gravenhage, 20 juli 1953). 'Oud Archief AEGON. Afd. Documentatie nr. 251', X.046.1:658.564

[5] 'Brief van J. Engelfriet aan de directie van het Mathematisch Centrum van 25 Maart 1953'. 'Oud Archief AEGON. Afd. Documentatie nr. 172', X.009.02

[6] 'Rapport Directie te Djakarta betreffende Mechanisatie' ('s-Gravenhage, 20 juli 1953). 'AEGON:251', X.046.1:658.564

[7] 'Nota dd. 27 Juli 1953 aan de Directie te Djakarta'. 'AEGON:251', X.046.1:658.564

[8] 'Nota dd. 27 Juli 1953 aan de Directie te Djakarta'. 'AEGON:251', X.046.1:658.564

[9] 'Extract uit brief van de directie te 's-Gravenhage (w.g. J. Engelfriet) aan Hr. Dek d.d. 24 Maart 1954', 1. 'AEGON:251', X.046.1:658.564

[10] 'Vierde Curatorenvergadering van het Mathematisch Centrum te Amsterdam op Maandag 7 Juli 1947 te 10.00 u. op de kamer van den Wethouder van Onderwijs, Mr. A. de Roos ten stadhuize'. 'Rijksarchief in Noord-Holland, Archief van de Stichting Mathematisch Centrum (RAHN, SMC), 1946–1980', inv, nr, 4

[11] 'Jaarverslag Mathematisch Centrum' (1946), 10

the UK and the US to explore the various efforts to construct computing machinery. Upon return he set up Mathematical Center's Computation Department, hired a team of young ladies to actually perform numerical calculations and appointed Loopstra and Scholten to head the computer construction group. Their machine under construction was dubbed ARRA, "Automatische RelaisRekenmachine Amsterdam". By 1950 a first prototype was able to spit out a table of inverse squares. Midsummer 1952, a completed ARRA was ready to play a part in the inauguration of the Mathematical Center's new building. In front of the official invitees, the ARRA produced a list of random numbers. That first public appearance was also ARRA's last contribution to the calculations of the Mathematical Center.[12]

Little later, in the fall of 1952, Gerrit Blaauw joined the computer construction group. Blaauw had taken his PhD under the supervision of Howard Aiken at Harvard in Cambridge, Massachusetts. The subject of his dissertation was the design of a part of the Harvard Mark IV computer. Upon return from the US he brought electronic parts, and much more importantly, engineering expertise. The computer construction group now including Blaauw built a reliable computer, again called ARRA.[13] From early 1954 Mathematical Center had a working ARRA at its disposition.

Besides Nillmij another Dutch industry, aircraft manufacturer Fokker, showed an interest in having a computer built by Mathematical Center. In May 1954, Fokker and Mathematical Center agreed that a copy of the ARRA be built for Fokker. In under a year, the computer construction group built an improved version of the second ARRA. Upon delivery on April 1st, 1955, Fokker renamed the machine FERTA.[14]

By that time, in April 1955, the working ARRA had become outdated and on top of that Mathematical Center expected a further growth in service calculation work. Although Van Wijngaarden dreamt of building a truly large computer for the Mathematical Center, the AERA, research and development for that ambitious computer would take too long. Instead, Mathematical Center decided to build an intermediate machine, the ARMAC.[15] It took a year for the computer construction group to finish the ARMAC. The new computer was so much faster and more reliable than the ARRA, that it allowed Mathematical Center to decommission the old computer as well as its IBM punched card machines which it had been using to perform a good portion of the actual calculations in service of third parties.

With the ARMAC completed the computer construction group was at a crossroads. It embodied expertise built up over a decade, but Mathematical Center could not afford to keep it working. When different members from the group received offers from other institutes and manufacturers, from the Netherlands and abroad, it seemed that the breakup of the group was imminent.[16] In a confidential memorandum, the board of directors of Mathematical Center stated that such a course of events would 'imply a major loss of scientific and technical potential for Mathematical Center in particular, and for our country in general'. While, being a research center, not envisaging the commercial production of computers, Mathematical Center was looking for ways to prevent such loss.[17] Throughout 1955, they worked on a solution together with Nillmij: Establishing a Dutch computer industry, Electrologica.[18]

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[12] Alberts and De Beer, 'De AERA: gedroomde machines en de praktijk van het rekenwerk aan het Mathematisch Centrum te Amsterdam', 25

[13] Only in later publications the two ARRA's were distinct and called ARRA I and ARRA II respectively. Ibid., 25–27

[14] Ibid., 30

[15] Ibid.; 'ARRA, FERTA, ARMAC, AERA. Verslag van machines met het oog op de curatorenvergadering van 15 April 1955'. 'RAHN, SMC', inv. nr. 91

[16] "Vertrouwelijk memorandum d.d. 18 september 1956, inzake de werkgroep voor de constructie van electronische rekenmachines van het Mathematisch Centrum', 1. 'RAHN, SMC', inv. nr. 52; 'Notulen der 16e Curatorenvergadering van het Mathematisch Centrum op Dinsdag 7 Februari 1956 in het gebouw van het M.C., 2de Boerhaavestr. 49', 5. 'RAHN, SMC', inv. nr. 4

[17] "Vertrouwelijk memorandum d.d. 18 september 1956, inzake de werkgroep voor de constructie van electronische rekenmachines van het Mathematisch Centrum', 1. 'RAHN, SMC', inv. nr. 52

[18] "Notulen der 16e Curatorenvergadering van het Mathematisch Centrum op Dinsdag 7 Februari 1956 in het gebouw van het M.C., 2de Boerhaavestr. 49', 6. 'RAHN, SMC', inv. nr. 4.

Founding Electrologica Before Nillmij officially founded Electrologica on June 21st, 1956, Mathematical Center and Nillmij had engaged in firm negotiations on the terms of cooperation.

On behalf of Electrologica, i.e. Nillmij, the computer construction group at Mathematical Center would be commissioned to 'design and construct electronic computers of high value, which might also be of interest to third parties.'[19] In return, Nillmij guaranteed to safeguard Mathematical Center from any financial risk issuing from its participation.[20]

A start-up period was agreed of two years, during which the construction group remained part of Mathematical Center and was to build all computers. For their work Electrologica was to pay fl 150,000 spread over two years, plus 4% of Electrologica's annual turnover with a minimum of fl 50,000 up to fl 100,000 a year. Furthermore, Mathematical Center was to receive 4% of the first fl 12,500,000 turnover, 3% of the next fl 12,500,000, and 2% over the rest. Finally, Mathematical Center would be allowed to purchase computers from Electrologica at cost.[21]

After the agreed two years of start-up, the computer construction group was to be transferred to Electrologica and Mathematical Center would cease building computers. The research center could continue fundamental research in this field, but it was not allowed to disseminate its computer construction knowledge and experience to third parties unless Electrologica agreed. Finally, all patents relating to computers developed by the center would be owned by Electrologica.[22] It remained unclear what the agreement meant for developments in the area of software.

Although Nillmij and Mathematical Center signed the agreements on June 25th, 1956, Nillmij agreed to make them retroactive from April 1st, 1956. [23] From that date, Loopstra was appointed technical director of Electrologica. Meanwhile, Scholten stayed at Mathematical Center to head the computer construction group. He immediately set his team to work developing the prototype of Electrologica's computer, X-1.[24]

3 Electrologica X-1

The history of the X-1 started with the development of the prototype for Nillmij. Unsurprisingly, the first designs were similar to those of the computer finished a year before, the ARMAC. Yet, in order to accommodate Nillmij's need for a computer to run its administration, the computer construction group transformed from a small in-house research and development team for scientific computers into a much larger computer manufacturing team with a focus on administrative computing.

From the founding of the company, Electrologica had trouble to keep up with the unexpected success of the X-1 and its ambition to cater the field of administrative computing. The company set out to build all kinds of peripherals, promising its customers peripherals outperforming the competition. None of these were completed, certainly not in time. And what was finally delivered, was often a single prototype built by Electrologica. The exception was the fast punched tape reader, the EL-1000.

Reliable hardware was no longer the sole selling point for a computer. Customers wanted to know what software came with it. In the absence of a software department Electrologica could lean on

[19]'Vertrouwelijk memorandum d.d. 18 september 1956, inzake de werkgroep voor de constructie van electronische rekenmachines van het Mathematisch Centrum', 1. 'RAHN, SMC', inv. nr. 52; 'Notulen der 16e Curatorenvergadering van het Mathematisch Centrum op Dinsdag 7 Februari 1956 in het gebouw van het M.C., 2de Boerhaavestr. 49',. 5. 'RAHN, SMC', inv. nr. 4

[20]'Garantie-overeenkomst' (Amsterdam, 25 juni 1956). 'Rijksarchief in Noord-Holland, Archief van de Stichting Mathematisch Centrum (RAHN, SMC), 1946–1980', inv. nr. 52

[21]'Overeenkomst tussen Electrologica en Stichting Mathematisch Centrum, 25 juni 1956'. 'RAHN, SMC', inv. nr. 52

[22]'Overeenkomst tussen Electrologica en Stichting Mathematisch Centrum, 25 juni 1956', 2. 'RAHN, SMC', inv. nr. 52

[23]'Vertrouwelijk memorandum d.d. 18 september 1956, inzake de werkgroep voor de constructie van electronische rekenmachines van het Mathematisch Centrum', 2. 'RAHN, SMC', inv. nr. 52

[24]'Notulen van de 19e Curatorenvergadering van het Mathematisch Centrum op Dinsdag 16 October 1956 te 14.45 uur in het gebouw vanhet Mathematisch Centrum, 2de Boerhaavestraat 49 te Amsterdam', 6. 'RAHN, SMC', inv. nr. 4

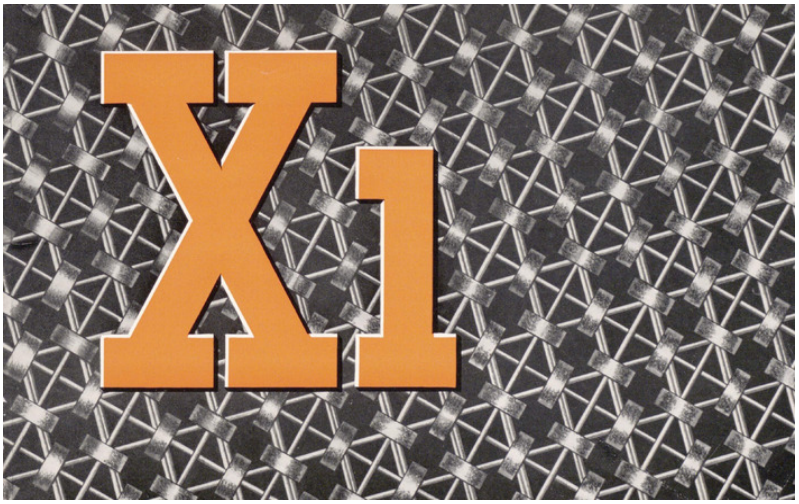

Figure 1: Cover of an Electrologica X-1 brochure from the early 1960s. The X-1 logo is laid out on a background with a stylized ferrite core memory.
(Source: 'Rijksarchief in Noord-Holland, Archief van de Stichting Mathematisch Centrum (RAHN, SMC), 1946–1980', inv. nr. 51.)

Mathematical Center for the scientific computing part of software development. On the administrative side of things, Electrologica struggled.

3.1 Developing the prototype for Nillmij

In January 1957, the computer construction group at Mathematical Center reported that 'the design for the new machine, the X-1, is completed'[25] Six months on, part of the machine was developed and built. In the meantime, other parties were showing an interest in the X-1, even foreign research institutes.[26] Another six months later, early 1958, most of the X-1 prototype was ready to be tested. The extension of the fast memory to 4069 words was not finished. And the connection to the punched card machines at Nillmij had yet to be settled. Still, Electrologica emphatically claimed the design of the X-1 to be finished.[27]

An Electrologica brochure read: 'In its basic set-up the machine comprises the arithmetic unit, various internal registers, the control unit, etc. The physical appearance is close to a regular writing desk on top of which various control switches and indicator lights have been added. The circuits in all electronic parts are completely transistorised, resulting in a very low power demand for a machine of this size (a few hundreds of Watts.).' [28] X-1 was the first computer built at Mathematical Center that did not use any vacuum tubes. Using transistors, the machine produced less heat and was much more reliable than the ARMAC computer, completed two years before. Compared to an addition at the ARMAC taking 417 μs plus an average waiting time on the drum memory of 7 ms, the X-1 would add two numbers in 64 μs with negligible waiting time for the ferrite core memory.[29]

[25]'Notulen van de 20ste Curatorenvergadering van het Mathematisch Centrum op Donderdag 10 Januari 1957 te 10.00 uur v.m. in het gebouw van het Mathematisch Centrum, 2de Boerhaavestraat 49 te Amsterdam', 4. 'RAHN, SMC', inv. nr. 4

[26]'Notulen van de 21ste Curatorenvergadering van het Mathematisch Centrum op dinsdag 11 juni 1957 te 10.00 v.m. in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam', 9. 'RAHN, SMC', inv. nr. 4

[27]'Notulen van de 22e Curatorenvergadering van het Mathematisch Centrum op donderdag 13 maart 1958 te 14.30 uur in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam', 13. 'RAHN, SMC', inv. nr. 4

[28]Electrologica, 'Korte algemene beschrijving van de X-1', Technical report EL-1-N (1957), 1

[29]P.J. van Donselaar, 'De ontwikkeling van elektronische rekenmachines in Nederland (Een historisch overzicht van

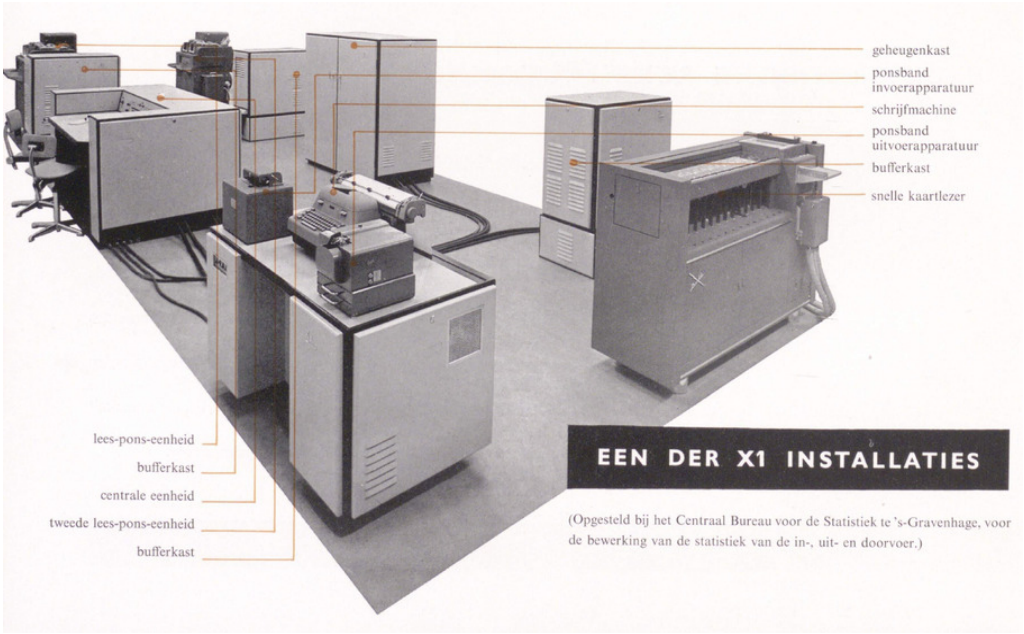

Figure 2: Setup of the X-1 installation at the *Centraal Bureau voor de Statistiek* in The Hague in an Electrologica X-1 brochure from the early 1960s.
(Source: 'Rijksarchief in Noord-Holland, Archief van de Stichting Mathematisch Centrum (RAHN, SMC), 1946–1980', inv. nr. 51.)

The X-1's memory consisted completely of magnetic ferrite core memory[30] and was divided in a small dead part and a large living part[31]. The read-only "dead" memory contained the system software of the X-1, like the communication programs, some standard programs, and also some standard subroutines. Electrologica could produce this "dead" memory much cheaper than the random-access "living" memory. To some extent, customers could customize the contents and size of the "dead" memory when they ordered an X-1. The minimal amount of "living" memory customers could order was one memory cabinet. Each cabinet fit eight memory units of 512 words of 27 bits, or 4,096 words. The "dead" memory was divided in units of 64 words. Customers could upgrade the total memory in their X-1, "dead" and "living" memory combined, to 32,768 words spread over eight memory cabinets.[32]

The X-1 contained two 27 bit registers, A and S, both of which could be used for arithmetic and logical operations. Furthermore, there was a smaller modification register B of 16 bits, that could also perform some addition operations. Finally, there were four jump operations: the additive jump, the normal jump, the counting jump, and the subroutine jump. The counting jump was used in combination with a counter in a dedicated memory location, allowing for simple iterations of a constant number of steps. With the additive jump, the contents of an address was added to the instruction counter. This construction allowed the user to jump over a, thus given, number of addresses in memory.

An instruction of 27 bits was divided into five parts: an address on the first 15 bits (hence the maximum memory of 32,768 words), followed by six bits to specify the operation, and three groups of two bits each to configure that operation. For example, one possibility was to specify an operation to

Nederlandse computers)', Technical report (Amsterdam: Stichting Het Nederlands Studiecentrum voor Administratieve Automatisering en Bestuurlijke Informatieverwerking July 1967), 19–24

[30] See Figure 1 for a stylized look of a ferrite core memory. This memory consisted of magnetic rings of ferrite, knitted together with copper wire.

[31] In Dutch they called it "dood" (dead) and "levend" (living) memory. In B.J. Loopstra, 'The X-1 Computer', *The Computer Journal* 2:1 (1959), 39–43, here: 39, Loopstra called them "passive" and "active" memories, respectively. In modern terms, the "dead" memory is ROM, Read-Only Memory, and the "living" memory RAM, Random Access memory.

[32] Ibid.

use the address part not as an address but instead as a number. Another possibility was to increase the address of an operation with the contents of modification register B. This change could also be written back into memory. Other possibilities were setting all sorts of conditions, like sign changes, zero tests, and so on. Furthermore, the conditional jump or conditional operation could be specified. The last six bits, those configuring the operation, made the instruction set of the X-1 significantly different from the earlier machines of Mathematical Center.[33]

Next to the arithmetical and logical instructions, 48 in all, the X-1 had so-called "communication instructions", including shift operations, normalization operations, register transport operations, quick multiplication by ten, stop operations, and operations to control all input and output peripherals.[34] For the "communication operations", the address part of the operation was always interpreted as some code that would influence how the operation worked exactly, and did not refer to an address.

The developers of the X-1 in the computer construction group were familiar with connecting a tape puncher, a tape reader, and the electric typewriter. Thus, just like with previous machines, input to the X-1 was done through a punched-tape reader. Output via a tape puncher and an electric typewriter. The operations to control these peripherals were similar to those of earlier machines. What was different this time was that Nillmij wanted to use the X-1 to automate its administration, which just a couple of years back had been standardized to Bull punched card office machinery. By consequence the computer construction group faced the task of connecting the X-1 prototype to a Bull punched-card reproducing machine.

Connecting a computer to mechanical peripherals would always create issues of synchronization. Peripherals, like punched-card readers, work at their own speed, in no way matching the clock speed of the X-1. For example, when reading and processing data from punched cards, the X-1 might be ready to process more data, while the punched card machines were still reading. Or conversely, that the X-1 might need more time to process the already read data, causing the punched card reader to wait before it could read the next card. The issue was partly resolved by using a buffer memory. However, the developers 'aimed to limit such extra buffers to a practical minimum while designing the X-1'.[35]

Unfortunately, for administrative applications, involving huge amounts of input and output of data, buffers would not suffice to solve the synchronization issue. In 1957, Anton Dek, one of the directors at Nillmij, tried to design a program for the X-1 to read and process 12 punched cards per second. He discovered that it was impossible, unless the computer construction group would introduce an interrupt mechanism to the X-1.[36] Once a punched card reader was finished reading the next card into a buffer, it should generate an interrupt signal to the X-1. The X-1, then, would pause the program it was running. Instead, it would write the data from the buffer into the X-1's "living" memory. Subsequently, once the reader-generated interrupt routine was finished, the X-1 would restore its prior state and resume running the program it had paused to handle the interrupt.[37] 'In other words, once there is work of higher priority, the X-1 is automatically "lent out" to the interrupt program, which would immediately run the "rush job". Compared to solutions without an interrupt, the actual productivity of the X-1 is

[33] Electrologica, 'Korte algemene beschrijving van de X-1'

[34] Ibid.

[35] E.W. Dijkstra, 'Verslag van de voordracht door Dr E.W. Dijkstra, gehouden op 11 december 1959. De faciliteit tot interruptie in de X1', *Mededelingen van het Rekenmachinegenootschap* 2:1 (February 1960), 3–8, here: 6; N.V. Electrologica, 'Korte algemene beschrijving van de elektronische rekenmachine X1 (EL-3)', Technical report EL-3 ('s-Gravenhage 1958), 27; B.J. Loopstra, *Input and output in the X-1 system*, in: *Information processing : proceedings of the International conference on information processing, Unesco, Paris 15-20 June 1959* (1959), 342–344

[36] E.W. Dijkstra, 'A programmer's early memories', in: N. Metropolis, J. Howlett and G. Rota, editors, *A History of Computing in the Twentieth Century: a Collection of Essays* (New York: Academic Press 1980), (URL:https://www.cs.utexas.edu/users/EWD/ewd05xx/EWD568.PDF), 563–573, here: 10; G. Alberts and H.T. de Beer, 'Interview met A.W. Dek, directeur van de Nillmij en commissaris van Electrologica, gehouden op 8 januari 2008' (2008)

[37] Electrologica, 'Korte algemene beschrijving van de elektronische rekenmachine X1 (EL-3)', 27; Loopstra, 'The X-1 Computer', 43

increased enormously, not in the least because it is now possible to have the X-1 cooperate with several mutually synchronized peripherals.'[38]

The X-1 could control multiple different peripherals via dedicated machine code instructions. Peripherals each required a separate interrupt program. The interrupt programs were divided into seven categories of increasing levels of priority. Interrupt programs with higher priority could not be interrupted by interrupt programs of lower priority. The seventh and highest category belonged to the X-1 itself, to its console (See Figure 3). This category of interrupt programs could not be interrupted by any other interrupt signal, except for signals from other programs of the seventh category.[39] Using this interrupt mechanism, Electrologica could make the X-1 more suitable for administrative applications. It even allowed running two programs at the same time.[40]

Interrupt programs, as well as subroutines to handle the interrupt mechanism, and all sorts of input and output programs and subroutines were wired into the X-1's "dead" memory. These programs were included with the computer. At Mathematical Center, the conglomerate of programs and subroutines was called the "communication program". Edsger Dijkstra wrote the communication program for the X-1, like he had been doing for the computers built by the computer construction group before the X-1. He worked as a programmer at Mathematical Center since 1952, and had gained experience writing such programs close to the machine.[41]

The introduction of the interrupt drastically changed the situation for Dijkstra. Because the communication program was wired into the "dead" memory, possible errors could only be resolved by replacing whole physical units of dead memory. To make matters worse, Dijkstra could not test his communication program in advance.[42] He shied away from the non-deterministic nature of the X-1 that was the consequence of the interrupt mechanism. Upon closer inspection Dijkstra found that the interrupt as it had been presented to him, could not work. After improving the design, Dijkstra started working on his communication program and finished it early 1958.[43] In 1959, he received his doctorate on this subject at the University of Amsterdam submitting the thesis *Communication with an automatic computer*.[44]

Using the communication program, users could call on various input and output programs running independently. Each of these programs was started pressing the so-called "auto start buttons" on the console (See Figure 3). The X-1 had eleven such auto start buttons, each started a different program, for example to read from punched tape, or to type the contents of an address on the electric typewriter, or to put a sequence of addresses in memory, or to start a program, etc. Parameters to these auto started programs could be entered using switches on the console. The console itself, in turn, was controlled by the communication program.

Most of the functionality available through the auto start buttons was also available calling on subroutines. For example, a programmer could call the typewriting subroutine to lay out a page with numbers and then print those numbers. But a programmer could also control punching the tape. Finally, there were some facilities to control the interrupt mechanism itself. [45]

Next to Dijkstra's communication program, further interrupt programs for punched card equipment and other administrative peripherals were written by programmers from Electrologica, employed by Nillmij. By the end of 1958 the status of these supplementary programs was still unclear. Would it be

[38] Electrologica, 'Korte algemene beschrijving van de elektronische rekenmachine X1 (EL-3)', 27

[39] Ibid., 27–29

[40] Loopstra, 'The X-1 Computer', 43

[41] The later term "system software" is avoided here in an effort to stick to the terminology of the day. In retrospect Dijkstra characterised his working relation to the computer construction group as 'feeling like a contract.' Dijkstra, 'A programmer's early memories', 10

[42] Ibid.

[43] Ibid.

[44] E.W. Dijkstra, 'Communication with an automatic computer', Ph. D thesis, Universiteit van Amsterdam (1959)

[45] Ibid., 62–121

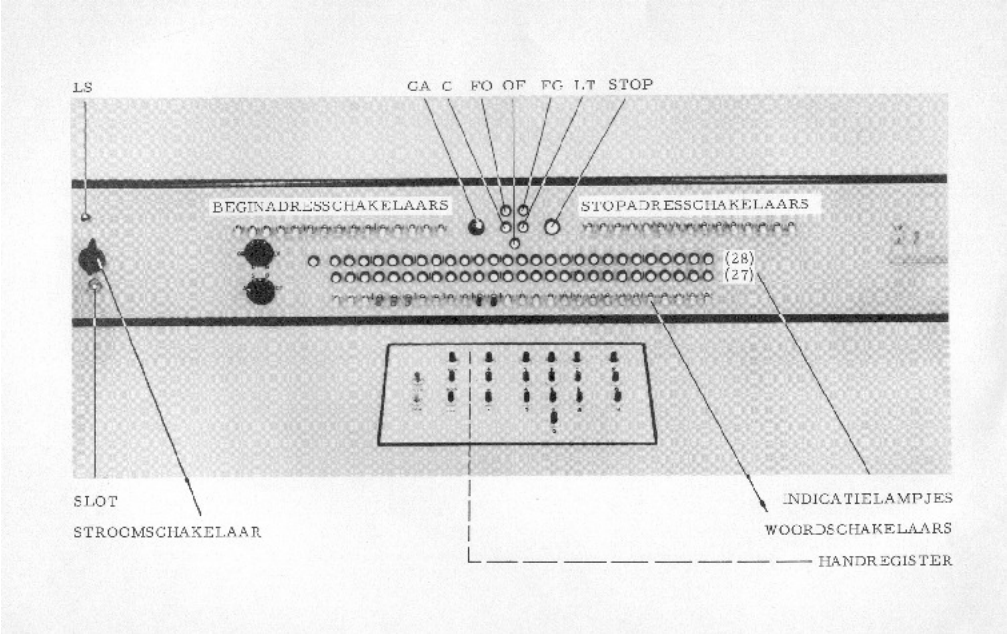

Figure 3: Overview of the X-1 console.
(Source: https://kmt.hku.nl/~hans/pdf_files/x1console.pdf)

given away for free with an X-1 installation? Of should customers order and pay for them? Scholten even suggested writing some simple interrupt programs to give away for free, and then to tell the customer they could pay for an extended version. His proposal was rejected.[46] Software was included with the X-1.

3.2 Electrologica takes off

While the construction team worked hard to realize the X-1 prototype, Nillmij cultivated Electrologica's commercial activities. When Engelfriet and Van Wijngaarden founded Electrologica, they expected to build an X-1 for Nillmij, and likely another one for Mathematical Center. Nillmij sought potential customers among other life insurance companies, but they were reluctant. They hesitated to make themselves dependant on their competitor by ordering an X-1.[47]

Despite moderate expectations, Electrologica had caught public attention. Even before the X-1 prototype was completed for testing in early 1958, no less than nine orders for the X-1 were brought in.[48] (See Table 1) Furthermore, as anticipated, the Mathematical Center also ordered their X-1 computer[49], bringing the total number of pre-orders to ten. The first X-1, the prototype, was installed at Nillmij later in 1958.

A Dortmund connection lead to an entry on the German market. Six out of the nine early orders came in from Germany. Hans Konrad Schuff of the Dortmund consultancy firm, Mathematische Beratungs- und Programmierungsdienst in Dortmund, a subsidiary of Hoesch, showed more than an incidental interest. His programming services would easily follow the sales of Electrologica's computers

[46]"Notulen van de vergadering gehouden op woensdag 1 oktober 1958 ten kantore van de Nillmij te 's-Gravenhage', 1. 'Oud Archief AEGON. Afd. Documentatie nr. 171', X.008.13.053.7 G

[47]Alberts and De Beer, 'Interview met A.W. Dek'

[48]N.V. Electrologica, 'Jaarverslag 1957' in: 'Nota aan H.H. Gedelegeerde Commissarissen van "Ned. Nillmij" en "Arnhem", 13 november 1958', 1. 'AEGON:165', X.003.3:657.372

[49]"Notulen van de 22e Curatorenvergaderingvan het Mathematisch Centrum op donderdag 13 maart 1958 te 14.30 uur in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam', 16. 'RAHN, SMC', inv. nr. 4

and he even suggested to position himself as the Dutch firm's sales representative.[50] Electrologica recognized the importance of the German market. Schuff's order of an X-1 was not taken lightly. Failure or delay might jeopardise the opportunity to reach German customers. The second copy of the X-1, built immediately following the Nillmij prototype, was swiftly completed and delivered in 1959 to Schuff's Mathematische Beratungs- und Programmierungsdienst. Electrologica did not even take the time to fully test the machine.[51] At the same time, rather than relying on a sales representative, Electrologica opened a branch in Dortmund to serve the German market.[52]

Putting the bets on the German market was successful and at the same time absorbed all energy. The result was a backlog of orders. To deal with this unexpected situation Electrologica in the Spring of 1958 installed a freeze of orders until 1960. Electrologica sought to focus on scaling up production and building the already ordered X-1 computers.[53]

When Electrologica was founded, Mathematical Center had agreed to construct all computers for Electrologica as long as Electrologica's turnover was under fl 2,500,000.[54] To fulfill this agreement given the demand for the X-1, the Mathematical Center doubled the size of the computer construction group to a 60 employees in 1958.[55]. The rapid growth of the computer construction group caused problems for Mathematical Center. Not only did it lack the physical space to shelter such a large group, producing computers at an industrial scale did not align with the goals of a mathematical research institute. At the same time, because of its success, Electrologica wanted to present itself to the outside world more independently from the Mathematical Center.[56] Electrologica and Mathematical Center decided to advance the transfer of the computer construction activities to Electrologica. Through intervention of the municipality of Amsterdam, Electrologica was able rent a factory space in the suburb of Duivendrecht. On November 1st, 1958, the first 22 employees, and with them most of the actual computer construction activities moved from Mathematical Center to the new location. Research related to computer construction stayed at Mathematical Center until January 1st, 1959, when the other 38 employees moved out to the Electrologica factory.[57]

All in all, Electrologica built 36 X-1 computers (See Table 1), including the prototype for Nillmij and a test machine for use in the factory. Of those 34 external orders, 18 came from 12 German customers. Out of the other 16 orders, two went to Electrologica's own computer service center. Fokker and the Utrecht University did not actually order an X-1, but temporarily got one in 1963 until Electrologica could deliver the computers they did order, the X-8. The success of the X-1 in Germany was even more pronounced than already appeared at first sight.

[50] Alberts and De Beer, 'Interview met A.W. Dek'

[51] "Notulen van de vergadering gehouden op Donderdag 16 April 1959 ten kantore van de Nillmij te 's-Gravenhage', 1. 'AEGON:171', X.008.13.053.7 G

[52] De Wit, 'Wat niet te verzekeren valt: Electrologica als casus uit de opbouw van een Nederlandse computerindustrie (1956–1967)', 274; N.V. Electrologica, 'Jaarverslag 1960' ('s-Gravenhage), 5. 'AEGON:165', X.003.055.5

[53] 'Notulen van de 22e Curatorenvergadering van het Mathematisch Centrum op donderdag 13 maart 1958 te 14.30 uur in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam'. 'RAHN, SMC', inv. nr. 4; 'Notulen van de 23e Curatorenvergadering van het Mathematisch Centrum op donderdag 26 juni 1958 te 10.00 uur in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam'. 'RAHN, SMC', inv. nr. 4

[54] 'Overeenkomst tussen Electrologica en Stichting Mathematisch Centrum, 25 juni 1956'. 'RAHN, SMC', inv. nr. 52

[55] 'Jaarverslag Mathematisch Centrum' (1956), 4–5; ibid., 6–7; 'Jaarverslag Mathematisch Centrum' (1957), 5–6; 'Jaarverslag Mathematisch Centrum' (1958), 43–45

[56] "Notulen van de 23e Curatorenvergadering van het Mathematisch Centrum op donderdag 26 juni 1958 te 10.00 uur in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam', 8. 'RAHN, SMC', inv. nr. 4

[57] 'Notulen van de 22e Curatorenvergadering van het Mathematisch Centrum op donderdag 13 maart 1958 te 14.30 uur in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam'. 'RAHN, SMC', inv. nr. 4; 'Notulen van de 23e Curatorenvergadering van het Mathematisch Centrum op donderdag 26 juni 1958 te 10.00 uur in het gebouw van het Mathematisch Centrum, 2e Boerhaavestraat 49 te Amsterdam', 8. 'RAHN, SMC', inv. nr. 4'Jaarverslag Mathematisch Centrum', 43–45

#	Customer	O-year	CC	I	A	I-year	R
X-1-1	Nillmij	1956	NL	V	A	1958	
X-1-2	Mathematische Beratungs- und Programmierungsdienst	1957	DE	S	S	1959	X, lease
X-1-3	(Nieuwe) Eerste Nederlandse	1957	NL	V	A	1960	
X-1-4	CBS	1957	NL	M	A	1960	X, bought in 1961
X-1-5	Hoesch AG (1)	1957	DE	I	A	1960	X
X-1-6	Mathematisch Centrum	1958	NL	C	S	1960	
X-1-7	Mannesman AG (1)	1957	DE	I	B	1960	X
X-1-8	Hoesch AG (2)	1957	DE	I	A	1960	X
X-1-9	Ruhrkohle Treuhand GmbH (1)	1957	DE	I	?	1960	
X-1-10	Interatom AG	1957	DE	I	S	1960	X
X-1-11	Nederlands Scheepsbouwkundig Proefstation	1960	NL	S	S	1961	
X-1-12	Universiteit Kiel	1960	DE	U	S	1961	
X-1-13	Rijksuniversiteit Leiden	1960	NL	U	S	1962	X
X-1-14	Algemene Kunstzijde Unie NV	1960	NL	I	S	1962	X
X-1-15	Rheinelbe Bergbau	1960	DE	I	S	1961	X
X-1-16	Hoesch AG (3)	1960	DE	I	A	1963	X
X-1-17	TH Braunschweig	1960	DE	U	S	1962	
X-1-18	Nationaal Luchtvaartlaboratorium	1960	NL	S	S	1962	
X-1-19	Amstleven/Hollandsche Sociëteit	1961	NL	V	A	1963	
X-1-20	Reactor Centrum Nederland	1961	NL	S	S	1962	X
X-1-21	Rekencentrum Electrologica (1)	1961	NL	C	B	1963	
X-1-22	Algemeen Rekencentrum Amsterdam NV	1962	NL	C	A	1964	X
X-1-23	Margarine Union GmbH (1)	1962	DE	I	A	1963	X
X-1-24	Werkspoor NV	1962	NL	I	?	1963	X
X-1-25	Hoesch AG (4)	1962	DE	I	A	—[3]	
X-1-26	Universiteit Saarbrücken	1962	DE	U	S	1964	
X-1-27	Ruhrkohle Treuhand GmbH (2)	1962	DE	I	?	—[3]	
X-1-28	Tchibo	1963	DE	I	A	1965	X
X-1-29	Rijksuniversiteit Utrecht [1]	—	NL	U	S	1963	
X-1-30	Fokker [1]	—	NL	I	S	1963	
X-1-31	Coöperatieve vereniging U.A.	1963	NL	I	?	1965	X
X-1-32	Margarine Union GmbH (2)	1963	DE	I	A	1964	X
X-1-33	Industrie Companie Kleinewefers GmbH	1963	DE	I	S	1964	X
X-1-34	Rekencentrum Electrologica (2)	1964	NL	C	B	1965	
X-1-35	Mannesman AG (2)	1964	DE	I	B	1965	X
	Electrologica[2]		NL	I	T		

: Serial number of the X-1 computer
O-year : Order year
CC : Customer country code
I : Main industry in which the customer operated: I(ndustry), N (insurance company) O(nderzoeksinstelling), C(omputer service center), U(niversity), S(oftware consultancy) of M(iscellaneous).
A : Main application type: A(dministration), S(cientific computing) or B(oth). The computer for the Electrologica factory was used for T(esting) purposes
I-year : Installation year
R : Rental. Unclear where lease constructions fit in

[1] : Until their X-8 was delivered
[2] : Only for testing purposes in their factory
[3] : Order withdrawn in 1963

sources : Annual reports Electrologica 1956, 1960, 1961, 1962, 1963, 1964, 1965, 'Periodieke rapportering 5 April 1966'

Table 1: Electrologica X-1 computers

Year	*Number*	*Bull*	*EL*	*IBM*	*STC*	*S*	*M*
1952							
1953	1					1	
1954	3					2	1
1955	4					2	2
1956	5					3	2
1957	7			2		3	2
1958	11		1	2	4	2	2
1959	25	5	2	10	5	1	2
1960	34	7	4	11	8	1	3
1960	76	7	8	45	8	2	6
1961	117	19	11	64	8	2	13
1963	227	25	17	130	9	2	44

At the top this table lists the number of installed and working computers in the Netherlands between 1952 and 1960 per year, divided by manufacturer: Bull, Electrologica (EL), IBM, Standard Telephones and Cables (STC), self-built (S) en miscellaneous (M).
At the bottom, this table lists the number of installed and ordered computers between 1960 and 1963. The data about the number of orders in 1960 is an estimation.

Sources: 'Informatie van de leveranciers', *Informatie* 2 (mei 1959), 7–8; 'Informatie van de leveranciers', *Informatie* 3 (juli 1959), 11; 'Informatie van de leveranciers', *Informatie* 5 (december 1959), 8–9; 'Informatie van de leveranciers', *Informatie* 8 (juli 1960), 16; 'Overzicht van in Nederland per 1 oktober 1961 geplaatste en in bestelling zijnde computers', *Informatie* 17 (december 1961), 16; 'Computers in de Benelux', *Informatie* 30 (januari 1964), 2–3. Zie verder de gegevens in mijn rapport over *Electrologica* en *Computergebruik bij de PTT*

Table 2: The number of installed computers in the Netherlands (1950 – 1960) and the number of installed and ordered computers (1960 – 1963).

In the Netherlands, a varied set of customers purchased an X-1. Next to Nillmij, three other insurance companies chose Electrologica, and used the X-1 for administrative applications in the insurance field. The Centraal Bureau voor de Statistiek (National Statistics Agency), used its X-1 for data-intensive statistical calculations. Electrologica also provided computing services to customers. In 1961, it still ran service jobs on the X-1 at Nillmij. Due to the success of the service, the situation became untenable, and Electrologica decided to order a separate X-1 for the service.[58] A year later, Electrologica both founded its own computing service center, Electrologica Rekencentrum, and took a 40% share in a further computing center, the Algemeen Rekencentrum Amsterdam.[59] The first, Electrologica Rekencentrum, was so successful, that it installed another X-1 in 1964 to meet the demand.[60] Overall, more than half of Electrologica's Dutch customers ordered the X-1 for administrative applications. The other customers, including universities, research institutes, and some industries, used their X-1 for scientific computing.

Electrologica viewed in isolation may have appeared a flourishing enterprise, seen in the context of the Dutch market for computers its situation was precarious. At the end of the 1950s, the Electrologica X-1 was a medium-sized computer at a reasonable price. In 1960, out of 34 computers in the Netherlands (See Table 2), 21 were used for administrative applications. Electrologica came in third with three computers, after IBM (11) and Bull (7). IBM and Bull were large, well-known manufacturers of office machinery. Larger companies seeking to automate their already mechanized administrations, would first look at these

[58] N.V. Electrologica, 'Jaarverslag 1961' ('s-Gravenhage), 2. 'AEGON:165', X.003.055.5
[59] N.V. Electrologica, 'Jaarverslag 1962' ('s-Gravenhage), 2. 'AEGON:165', X.003.055.5
[60] N.V. Electrologica, 'Jaarverslag 1964' ('s-Gravenhage), 2. 'AEGON:165', X.003.055.5

trusted suppliers of office machines for their first computer. Even when the X-1 was a modern computer compared to the supply IBM and Bull had on offer, Electrologica had trouble entering that market. When IBM offered its own medium-sized computer, in late 1959, it soon dominated the administrative market in the Netherlands. Electrologica had to up its game.

3.3 Electrologica's connection to peripherals

Electrologica's default punched tape reader, tape puncher, and typewriter, or the optional Bull punched card machines would not suffice to convince costumers in the administrative field to choose Electrologica. Customers asked for other peripherals, like a fast line printer, magnetic tape units, drum memory, and disc memory. Electrologica was eager to serve its customers. Most requests to connect new peripherals would come in after the X-1 had already been ordered. But even if requests had been done in advance, usually the X-1 installation was delivered and installed before the connections to the extra peripherals were prepared and made available.

Electrologica was keen to develop peripherals in-house rather than purchase them from other manufacturers. Not unusual was the situation that Electrologica actually delivered a peripheral built on purpose, delivering the single prototype to the customer. Development took years, delivery was late, and after installation, the connection between X-1 and the peripherals was not without issues.

Four developments of peripherals characterized Electrologica's efforts in this direction:

Punched card machinery Developed for Nillmij, the X-1 could work together with the Bull reproducing punched card machine, type P.R.D. To cement the relationship between Electrologica and Bull devices, the two companies entered serious negotiations about selling and servicing each other's products. However, Electrologica feared that close cooperation with Bull would hamper ambitions to build a successor to the X-1.[61] While slowing down talks with Bull, Electrologica also looked into starting negotiations with other manufacturers, and even considered developing punched card machines in-house themselves.[62] In July 1959, Bull and Electrologica agreed that Bull would deliver punched card machines to Electrologica without any further obligations. More so, Bull retained the right to refuse to deliver its machines might it harm its commercial interests. Electrologica on its part could connect punched card machines from other manufacturers to the X-1 as well in regions and markets where Bull was not active. Although Electrologica continued talks with other manufactures, the agreement, however noncommittal, did put an end to Electrologica's interest in their products.[63]

Paradoxically, Electrologica did hang on to the prospect of developing a card puncher and a fast punched card reader in-house. When other research and development activities took precedence in 1959, plans for the card puncher were shelved. Work on the fast punched card reader was continued for two more years, until the looming obsolescence of punched card technology forced to stop this as well.[64]

[61] "Notulen van de vergadering gehouden op donderdag 17 juli 1958 ten kantore van de Nillmij te 's-Gravenhage'. 'AEGON:171', X.008.13.053.7 G; 'Notulen van de vergadering gehouden op donderdag 10 juli 1958 op het Mathematisch Centrum te Amsterdam'. 'AEGON:171', X.008.13.053.7 G

[62] "Notulen van de vergadering gehouden op vrijdag 4 april 1958 ten huize van drs. B.J. Loopstra'. 'AEGON:171', X.008.13.053.7 G; 'Notulen van de vergadering gehouden op dinsdag 9 september 1958 ten kantore van de Nillmij te 's-Gravenhage', 1. 'AEGON:171', X.008.13.053.7 G

[63] "Notulen van de vergadering gehouden op Maandag 6 Juli 1959 ten kantore van de Nillmij te 's-Gravenhage'.'AEGON:171', X.008.13.053.7 G

[64] "Notulen van de vergadering gehouden op 1 december 1959 bij de Nillmij', 1. 'AEGON:171', X.008.13.053.7 G; 'Notulen E.L.-vergadering d.d. 18 oktober 1961', 1. 'AEGON:171', X.008.13.053.7 G

High-speed printer In 1957, funded by Nillmij, the computer construction group had started developing a high-speed printer. A year on, the development seemed to be going well.[65] Unfortunately, in 1959, the printer was far from ready, but the demand for it from X-1 customers had increased. Electrologica had to choose between speeding up the development of the printer, or purchasing one from another manufacturer and connect that to the X-1 instead.[66] Electrologica's technical director looked into it, and the Xeronic high speed printer was added to the Electrologica assortment. All the same, the in-house development was continued as well, because the high-speed printer was subject of Electrologica's negotiations with potential customer Atlas.[67]

It hoped to finish its own high-speed printer by May 1960 and offer that to clients at fl 301,000.[68] May 1960 came too early. Scaling down ambitions, Electrologica decided to focus on developing an off-line version only. "Off-line" implied that the printer no longer would be connected to the X-1. Instead, the printer was to be controlled through an external medium, like punched tape or magnetic tape. The latter option was the more modern and for that reason preferred.[69] In late 1962, Electrologica delivered its first high-speed printer, its prototype, to a customer. The delivery signaled the immediate end to the development of high-speed printers at Electrologica.[70]

Magnetic tape units The most severe problems Electrologica encountered in its efforts to connect magnetic tape units to the X-1 at the biggest customer, Hoesch AG in Germany. In 1960, it was forced to postpone the planned delivery date to March 1962.[71] The magnetic tape unit project got a bad reputation in Electrologica circles, and served as a warning of how not to develop the successor to the X-1.[72] Eventually, it took over three years to deliver the first two tape units. Even then performance was unsatisfactory.[73] The next year, in 1964, Electrologica continued to struggle with the tape units. It failed to fulfill some of the further orders for tape units. The lack of new orders for the X-1 was attributed to the failure to connect tape units in time.[74]

Fast punched tape reader Amidst all these stories of struggle and failure, one story of triumph stood out, the EL-1000 high-speed punched tape reader. The EL-1000 could read 1,000 symbols per second.[75] Starting 1961, Electrologica delivered the EL-1000 as part of the basic machine instead of the Creed tape reader it had used before.[76] Given the success of the EL-1000, Electrologica's board of directors considered marketing the EL-1000 to third parties.[77] Interest in distributing the EL-1000 abroad came

[65]N.V. Electrologica, 'Jaarverslag 1957' in: 'Nota aan H.H. Gedelegeerde Commissarissen van "Ned. Nillmij" en "Arnhem" 13 november 1958' ('s-Gravenhage). 'AEGON:165', X.003.3:657.372; 'Notulen van de vergadering gehouden op Vrijdag 28 maart 1958 ten huize van Prof. Dr. Ir. A. van Wijngaarden', 1. 'AEGON:171', X.008.13.053.7 G

[66]'Notulen van de vergadering gehouden op Maandag 9 maart 1959 ten kantore van de Nillmij te 's-Gravenhage', 1. 'AEGON:171', X.008.13.053.7 G

[67]'Notulen van de vergadering gehouden op 19 juni 1959 ten kantore van de Nillmij te 's-Gravenhage', 1. 'AEGON:171', X.008.13.053.7 G

[68]'Notulen van de vergadering gehouden op dinsdag 22 oktober 1959 ten kantore van de Nillmij te 's-Gravenhage', 1. 'AEGON:171', X.008.13.053.7 G

[69]'Notulen E.L.-vergadering d.d. 26-7-1960', 1. 'AEGON:171', X.008.13.053.7 G

[70]'Notulen E.L.-vergadering d.d. 18 oktober 1961', 1. 'AEGON:171', X.008.13.053.7 G; N.V. Electrologica, 'Jaarverslag 1962' ('s-Gravenhage), 2. 'AEGON:165', X.003.055.5

[71]'Notulen van de vergadering gehouden op maandag 28 maart 1960 ten kantore van de Nillmij te 's-Gravenhage'. 'AEGON:171', X.008.13.053.7 G

[72]'Verdere toekomstige mogelijkheden' (23 mei 1961), 2. 'AEGON:171', X.008.13.053.7 G

[73]N.V. Electrologica, 'Jaarverslag 1963' ('s-Gravenhage), 3. 'AEGON:165', X.003.055.5

[74]N.V. Electrologica, 'Jaarverslag 1964' ('s-Gravenhage), 3. 'AEGON:165', X.003.055.5

[75]N.V. Electrologica, *Programmering EL X8* (Den Haag: Electrologica 1966), 9.3

[76]N.V. Electrologica, 'Jaarverslag 1961' ('s-Gravenhage), 2. 'AEGON:165', X.003.055.5

[77]'Notulen E.L.-vergadering d.d. 3 april 1962', 1. 'AEGON:171', X.008.13.053.7 G

from various parties, including parties from the USA, Canada, and Australia.[78]

Electrologica was unable to carry out the multitude of research and development projects on connecting peripherals and in-house design of machinery. Increasingly the development of a successor to the X-1 was urgent. The limited capacity for research and development was under growing stress. In spite of ambitions, Electrologica simply could not keep up with other manufacturers. It lacked the expertise, the experience, and the financial means to compete.

3.4 Delivering software

Alongside a growing concern for peripherals, software became a serious issue in Electrologica's business. As described in Section 3.1, the X-1 came with basic programs installed in its "dead" memory: Dijkstra's communication program, some input and output subroutines and programs, and programs controlling the interrupt mechanism. However, to effectively use the X-1, users needed more code. Most administrative applications were unique projects, whereas in scientific computing many similar problems were solved using a set of standard numerical algorithms.

Software for scientific computing Halfway 1958, Mathematical Center agreed with Electrologica to offer an extensive subroutine library for the X-1. It would write such programs for its own use anyway, and did not mind sharing it with other X-1 customers on a basis of reciprocity.[79] The Center did not expect great gain from this reciprocity. In 1959, it started programming the library and published it as the series MCP.[80]

As a service to its customers with scientific computing problems, Electrologica hired a number of programmers and seconded them to Mathematical Center to work under leadership of Dijkstra.[81] Not all customers were satisfied with this programming service. According to Fokker, Mathematical Center limited the assistance to providing the subroutine library.[82]

In the late 1950s, programming languages became a vibrant area of research in which Mathematical Center aspired to assume an active role. The Computation Department joined the international effort to define an algorithmic language, ALGOL.[83] Upon publication of the ALGOL 60 report[84] in early 1960, Edsger Dijkstra and Jaap Zonneveld took up the task to write a compiler for ALGOL 60 on the X-1. In just six months, from their visit to Copenhagen where they invited Algol-report editor Peter Naur and his team to come to Amsterdam and see the results in half a year, they finished the compiler. They were the first in the world to develop an almost complete ALGOL 60 compiler. Electrologica, proudly announced: 'The Algol compiler has arrived, and programmed for the X-1'.[85]. In under two years, the share of ALGOL 60 programs that ran on the X-1 of Mathematical Center grew from 20% to 70%.[86] Alongside the subroutine library written in machine code, Mathematical Center also published a program library in ALGOL 60.

[78] 'Verkoop/vertegenwoordiging voor de EL-1000 in de V.S. en Canada' ('s-Gravenhage, 7 juni 1963). 'AEGON:171', X.008.13.053.7 G; 'Notulen EL-vergadering d.d. 9.7.1963'. 'AEGON:171', X.008.13.053.7 G

[79] 'Notulen van de vergadering gehouden op donderdag 18 september 1958 op het Mathematisch Centrum te Amsterdam', 2. 'AEGON:171', X.008.13.053.7 G

[80] 'Jaarverslag Mathematisch Centrum' (1959), 38, 45

[81] 'Notulen van de vergadering gehouden op donderdag 18 september 1958 op het Mathematisch Centrum te Amsterdam', 2. 'AEGON:171', X.008.13.053.7 G; 'Notulen van de vergadering gehouden op dinsdag 10 juni ten kantore van de Nillmij te 's-Gravenhage', 1. 'AEGON:171', X.008.13.053.7 G

[82] 'Notulen E.L.-vergadering d.d. 22 september 1961', 2. 'AEGON:171', X.008.13.053.7 G

[83] For more information about this ALGOL effort, see HT de Beer, 'The history of the ALGOL effort', Master's thesis, Technische Universiteit Eindhoven (2006), (URL:https://heerdebeer.org/ALGOL)

[84] J. W. Backus et al., 'Report on the algorithmic language ALGOL 60', *Commun. ACM* 3:5 (1960), 299–314

[85] 'Notulen van Electrologica-vergadering dd. 10-9-1960', 2. 'AEGON:171', X.008.13.053.7 G

[86] 'Jaarverslag Mathematisch Centrum' (1962), 64

Unsurprisingly, other scientific computing customers were also interested in the ALGOL 60 compiler for the X-1.[87] Mathematical Center was happy to share the work, but porting the compiler was far from straightforward. Different X-1 systems were not one-to-one compatible. The first X-1 to which it was tried to convey the ALGOL 60 compiler was the computer of the Scheepsbouwkundig Proefstation in Wageningen. Once this transfer succeeded, porting to other X-1 installations would become easier.[88] Soon, early 1961, Mathematical Center announced that its ALGOL 60 compiler was available for the X-1; Electrologica would bear the costs of porting the compiler for their customers.[89]

As was wont in the field of scientific computing, customers and users of the X-1 shared their knowledge, experience, and programs. More so, some of the customers founded user associations dedicated to the Electrologica X-1 in the Netherlands, Düsseldorf, and Braunschweig.[90]

Software for administrative applications While the Mathematical Center's numerical subroutine library would serve Electrologica's scientific computing customers, Nillmij knew that this library would not be very useful for the administrative customers.[91] Nillmij created an administrative programming group, which it placed as a subdivision under Electrologica's sales department at Nillmij. If there was a starting point for a software department of Electrologica it was this subdivision stationed in The Hague. Except, the work was not called software. The first task for this new programming group was to develop interrupt programs for the Bull reproducing punched card machine for the prototype of Nillmij. In late 1959, it was decided that the group write a library of subroutines and programs for administrative applications. This library would be set up similar to the MCP series with numerical subroutines developed at Mathematical Center. [92] Furthermore, this programming group would be available for consultancy to help Electrologica's customers with their automation projects.

Electrologica realized that software was becoming more and more important for the customers. Customers wanted more ready-made programs, such as programs to support their programmers in writing programs and control peripherals. It was such programs for programming that first came to be called software. For example, when in 1962 the Centraal Bureau voor de Statistiek eyed for the installation of magnetic tape units, it wanted to know whether Electrologica would include with the hardware the service of delivering or help to compose programs for sorting, aggregating, and conversion.[93] From 1960 on, also in the field of administrative applications the demand grew for programming languages. And indeed in the USA higher level programming languages such as COBOL were designed for the administrative domain. Electrologica, on this side of the ocean, needed more time than anticipated to fulfill the promises for administrative software. On top of that, at the start of the 1960s the board of Electrologica realized they needed to develop a successor to the X-1, which also would entail a growing need for software.

[87]'Notulen van Electrologica-vergadering dd. 10-9-1960', 2. 'AEGON:171', X.008.13.053.7 G

[88]'Notulen E.L. vergadering d.d. 14 maart 1961', 2. 'AEGON:171', X.008.13.053.7 G

[89]'Notulen E.L.-vergadering d.d. 29 maart 1961-', 1. 'AEGON:171', X.008.13.053.7 G

[90]'Notulen E.L.-vergadering dd. 21 oktober 1960', 1. 'AEGON:171', X.008.13.053.7 G

[91]'Notulen van de vergadering gehouden op dinsdag 10 juni ten kantore van de Nillmij te 's-Gravenhage', 1. 'AEGON:171', X.008.13.053.7 G; 'Notulen van de vergadering gehouden op donderdag 18 september 1958 op het Mathematisch Centrum te Amsterdam', 2. 'AEGON:171', X.008.13.053.7 G

[92]'Subroutine-bibliotheek van de X 1 gebruiken', *Programmeermededeling* 12 (1 december 1959). 'Oud Archief AEGON. Afd. Documentatie nr. 254', X.046.1:658.564

[93]'Brief van Prof. Dr. Ph. J. Idenburg, directeur-generaal van de statistiek, aan Prof. Dr. J. Engelfriet, directeur Nillmij, over X-1-installatie, 27 juni 1962'. 'AEGON:171', X.008.13.053.7 G

4 Seeking a successor: X-0 and X-2, or the X-8

4.1 Ambitious successors to the X-1

From the outset, Electrologica knew it had to build a successor to the X-1. By the end of 1959, the company was not sure what machine to build. Would it envisage a large computer, or, like the X-1, go for a medium-sized system at about fl 1,500,000? And Engelfriet wished to preserve the option of building smaller machines dedicated to administrative applications. One year before, in 1958, the board had even discussed building a decimal machine with lots of peripherals for the purpose.[94] But later, in 1960, Van Wijngaarden issued a warning that the X-1 was about to lose its attraction even for scientific computing.[95] Decisions about a successor to the X-1, an X-2, would bear no further delay.

Soon, the technical director of Electrologica reported that it would be impossible to sufficiently speed up the memory of the X-1, say by 20 times. Elementary arithmetical operations in under 10 μs should be feasible. The board lamented that, particularly for administrative applications, Electrologica still did not know exactly what was wanted.[96] During 1961, two concepts were presented, a large and fast computer for scientific applications, the X-2, and a smaller administrative machine, the X-0:

- For the X-2, the research and development department reported that by using newer and faster transistors, the speed of the X-2 could be increased 30-fold compared to the X-1. Using even faster transistors made little sense, since increasing the speed of the memory access accordingly was beyond their powers.

  The advent of programming languages had an impact on the design of the X-2. Designers contemplated the idea of adding special machine instructions to facilitate ALGOL 60 compilers. On the downside, they noted that such dedicated instructions might not be very useful for other programming languages. And the X-2 should certainly be capable to run many different programming languages, so they thought. To resolve this issue, they looked into introducing some sort of microprogramming. That would allow them to create a variable instruction set.

  Besides the peripherals for which connections had already been construed to the X-1, they would like to add a large random-access memory, like a drum or disk memory. Magnetic tape units, punched card machines, and printers appeared on their wish list as well. Finally, the designers dreamt of time-sharing features.[97]

- The X-0 was envisaged as a totally different machine. Not a successor of the X-1, as such, but an improved version of the X-1 dedicated to administrative applications. By using functional bits in the instruction set, this X-0 was thought to be easy to program. Floating point arithmetic should be a built-in feature. Customers should be given the option to connect the X-0 to very large memory units. For the ease of input and output, the designers had in mind to offer a choice of character-reading devices, telecommunication devices, punched card machines, and magnetic tape units.[98]

Aiming at computer speeds as envisioned for the X-2, implied speculations on the use of new and unfamiliar components. The result was a high degree of uncertainty whether the X-2 project was achievable in the short term. Therefore, halfway 1961, Electrologica decided to first focus on developing the X-0. The board was convinced that in six months, enough progress would have been made to

[94] 'Notulen van de vergadering gehouden op woensdag 1 oktober 1958 ten kantore van de Nillmij te 's-Gravenhage', 2. 'AEGON:171', X.008.13.053.7 G

[95] 'Notulen E.L.-vergadering d.d. 26-7-1960', 2. 'AEGON:171', X.008.13.053.7 G

[96] 'Notulen E.L. vergadering d.d. 29 november 1960, gehouden in de fabriek', 2. 'AEGON:171', X.008.13.053.7 G

[97] 'Beschouwingen betreffende toekomstige machines' (19 mei 1961). 'AEGON:171', X.008.13.053.7 G

[98] 'Verdere toekomstige mogelijkheden' (23 mei 1961). 'AEGON:171', X.008.13.053.7 G

officially announce an X-0. An initial price was estimated just below that of the X-1, assuming that margins on the X-0 would be large enough to lower the price later.[99]

By the end of 1961, the concept of the X-0 was taking shape. It would consist of a basic machine, with punched card I/O, and two magnetic tape units, extendable to four units. A fast printer and a large random access memory were optional. For programming the X-0, Electrologica wanted a fully interpretative system. The use of functional bits allowed microprogramming the instructions, i.e. before delivery in the "dead" memory. The instruction set was thus easily adaptable to various programming languages, and could in particular be set to facilitate the construction of a COBOL compiler, by that time the typical choice for administrative applications. Although the memory and logic of the machine would be much faster than that of the X-1, the interpretative nature of the X-0 system would result in a machine of similar speed as the X-1.[100]

Meanwhile, research and development for the X-1 in a number of projects and dreams, was ongoing. Too little experience and expertise was available to turn the advanced ideas for an X-0 into a practical design.[101] While six months before Electrologica had moved its focus to the X-0, in early 1962, it turned its sails again and decided to continue the work on the X-2 as well, and tried to accommodate the customers for a scientific computer. The board held that developing an X-2 might go a lot faster than creating a completely new design for the X-0. X-2 was intended to be similar to the X-1, be it equipped with with floating-point arithmetic in hardware rather than in software.[102]

Delays pushed the prospected price of an X-0 system. To be profitable annual sales had to reach 25 machines per year, which in turn demanded a considerable expansion of the company's sales team. A cheaper X-0 would compromise the design. By consequence the introduction of the X-0 had to be postponed. Electrologica had been working on the X-0 for too long, particularly in the face of what was happening outside.[103] If the X-0 was to target the market for smaller customers, IBM's 1400 series presented an insurmountable competition. The X-0 might even turn out to be more expensive. It was time for Electrologica to rethink, but the board of directors had no idea how. Loopstra, the technical director, exclaimed 'it would be better if the commercial department would formulate what exactly should be built.' [104]

Facing the decision to put the development of the X-0 on hold, Engelfriet, Dek and Schmidt returned to the idea of upgrading the X-1. They would extend the X-1 with more peripherals, like a drum memory, a disc memory, fast magnetic tape units, a fast tape puncher.[105] But the X-1 was not suitable to connect so many extra peripherals. What could be done was to speed up the X-1 by about 8 times, and to connect a limited number of peripherals. Varying versions of the X-1 could be sold, each version with a different, but limited set of peripherals. Electrologica's board liked this idea because it could be realized at relatively low cost.[106]

The X-0 on hold and the X-2 stalled put Electrologica in an untenable position in the market. It had to shelve its dreams of an administrative machine and to appease its customers in the field of scientific computing, and act swiftly at that.

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[99]'Notulen E.L.-vergadering d.d. 26 juni 1961', 2. 'AEGON:171', X.008.13.053.7 G

[100]'Notulen E.L.-vergadering d.d. 22 december 1961', 2. 'AEGON:171', X.008.13.053.7 G

[101]'Notulen E.L.-vergadering d.d. 22 december 1961', 2. 'AEGON:171', X.008.13.053.7 G

[102]'Notulen E.L.-vergadering d.d. 3 april 1962', 1. 'AEGON:171', X.008.13.053.7 G

[103]'Notulen E.L.-vergadering d.d. 3 mei 1962'. 'AEGON:171', X.008.13.053.7 G

[104]'Notulen E.L.-vergadering d.d. 19 oktober 1962'.'AEGON:171', X.008.13.053.7 G

[105]'Enkele conclusies en overwegingen besproken door Prof. Engelfriet, Hr. Dek en Hr. Schmidt op 27 oktober 1962'. 'AEGON:171', X.008.13.053.7 G

[106]'Notulen E.L.-vergadering d.d. 29 oktober 1962', 1. 'AEGON:171', X.008.13.053.7 G

Figure 4: Cover of an Electrologica X-8 brochure from the mid-1960s. The text reads: 'Electronic calculation and administration machine'.
(Source: 'Rijksarchief in Noord-Holland, Archief van de Stichting Mathematisch Centrum (RAHN, SMC), 1946–1980', inv. nr. 50.)

4.2 A realistic successor to the X-1, the X-8

Utrecht University was the first to lose its patience. Waiting for an X-2, it had received a very good offer from Electrologica's English competitor Elliot. Elliot was to deliver an Elliot 503 computer with 8,000 words of memory at a price below fl 800,000. It promised that, in case of delay, Utrecht University would get an Elliot 803 computer free-of-charge, until the moment of delivery.

For fear of losing its first customer for the X-2, Electrologica immediately made Utrecht University a counter-offer: '*Our proposal*: To build for Utrecht a computer with exactly the same code as the X-1 (hereafter called X-1-prime), with a speed-up of 1:8, both with respect to the memory and operations. Not included [in this speed-up], of course, input and output devices. The machine will contain 16,000 words [of memory] and have floating-point arithmetic built-in. Furthermore: punched tape reader, typewriter, and tape puncher.'[107] The offer came with a discount, and an X-1 for rent until the completion of the X-1-prime.[108] Within a month, Electrologica renamed "X-1-prime" to "X-8".

Utrecht University was the first customer to order an X-8. Mathematical Center followed soon after. To keep Utrecht University happy with the choice for the X-8, Electrologica sped up production by building the X-8 prototype and the first copy of the series production. The prototype was to be installed at Mathematical Center given its experience in working with computers of unfinished appearance.[109]

Electrologica intended to accommodate customers for whom the X-1 was getting outdated, and who

[107]'Electronisch Rekencentrum der Rijksuniversiteit Utrecht' (1 november 1962), 1. 'AEGON:171', X.008.13.053.7 G
[108]'Electronisch Rekencentrum der Rijksuniversiteit Utrecht' (1 november 1962), 1. 'AEGON:171', X.008.13.053.7 G
[109]'Notulen E.L.-vergadering d.d. 10 december 1962'. 'AEGON:171', X.008.13.053.7 G

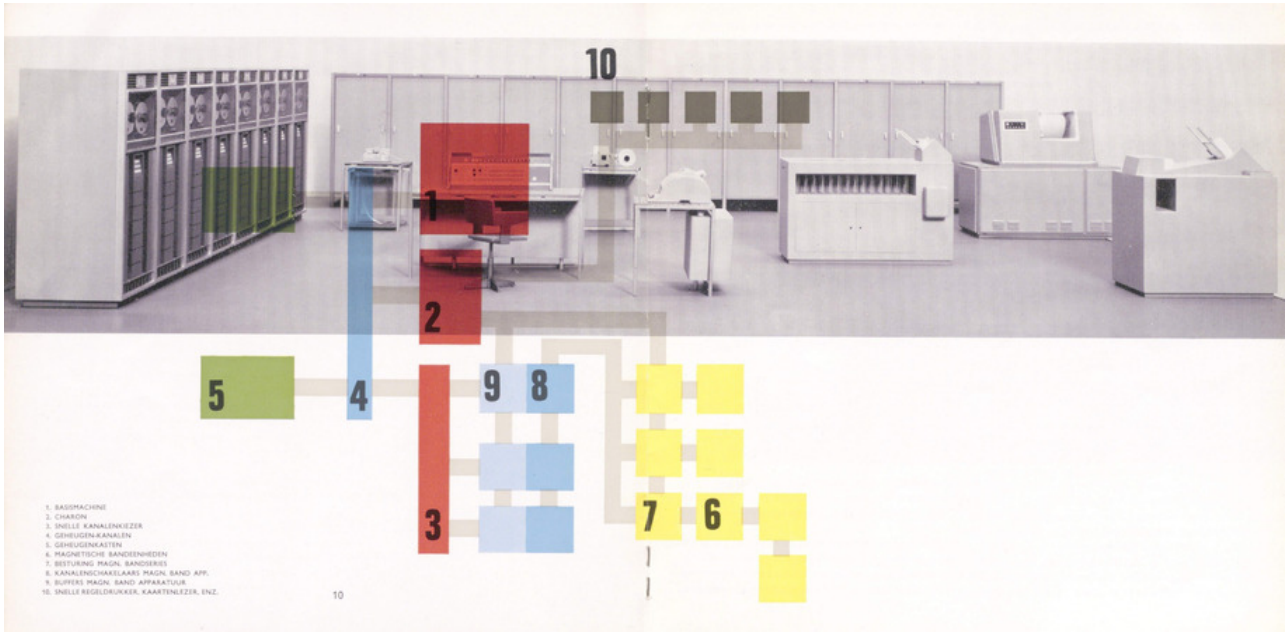

Figure 5: Schematic overview of the X-8 computer overlaid on a photo of a trade show maquette of the X-8 from an Electrologica X-8 brochure from the mid-1960s.
(Source: 'Rijksarchief in Noord-Holland, Archief van de Stichting Mathematisch Centrum (RAHN, SMC), 1946–1980', inv. nr. 50.)

could not wait for an X-2 either. Development and delivery of the X-8 got priority over the lingering desire for an X-2 and X-0. The X-8 clearly aimed at scientific computation. Even so, Electrologica would not give up the wish to build an administrative machine, and envisioned that the X-8 would be an attractive option for administrative work by connecting all sorts of peripherals to it.[110]

The X-8 system consisted of a central unit: the basic machine with memory. The minimal configuration had a core memory of 16,384 words that could be upgraded to 262,144 words of 27 bits plus a parity bit. For the X-1, Electrologica had built the core memory in-house. Now, for the X-8, memory was purchased from an external manufacturer. A novelty in the X-8 set up was the central device to control input and output, called CHARON, "Centraal Hulporgaan Autonome Regeling Overdracht Nevenapparatuur". Per type of I/O device, multiple peripherals could be connected and use the memory of the X-8 independently from the central processing unit.[111]

The peripherals available at the outset were a teleprinter, a clock, an EL-1000 fast punched tape reader, a tape puncher, a printer, a drum memory, magnetic tape units, and also a magnetic disc storage. At a later stage, customers could connect a period clock, telecommunication devices, punched card machines, an optical reader, a magnetic character reader, and a multi-channel selector, a photo-printer, Plessy memory, and even an X-1 computer.[112] Thus, at stage two, Electrologica meant to satisfy administrative customers as well.

Despite efforts to make the X-8 suitable for administrative applications, the listing of X-8 computers in operation leaves little doubt (Cf. Table 3). The Electrologica X-8 found its customers in the field of scientific computation exclusively. The X-8 was, by far, not the best machine on the market for scientific computation. By delaying the development of the X-2 to develop the X-8, Electrologica alienated some

[110] 'Notulen EL-vergadering gehouden op donderdag 29 november 1962 ten kantore van de Nillmij te 's-Gravenhage', 2. 'AEGON:171', X.008.13.053.7 G

[111] Electrologica, 'Electrologica ELX-series. General Description', (URL:https://kmt.hku.nl/~hans/pdf_files/electrologica-engl.pdf), 6

[112] 'Verslag EL-vergadering d.d. 30 mei 1963'. 'AEGON:171', X.008.13.053.7 G

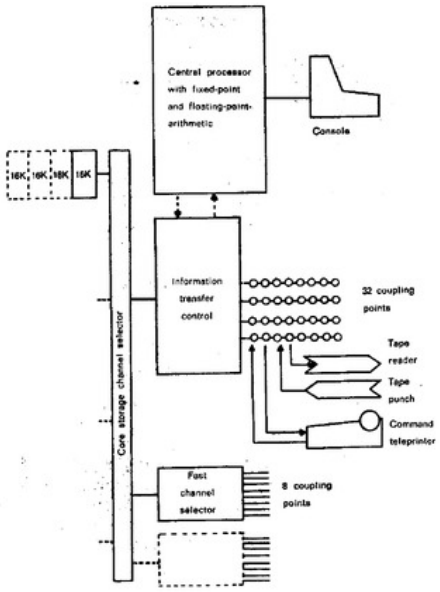

Figure 6: Schema of the Electrologica X-8 computer system.(Source: 'Electrologica ELX-series. General Description', p. 14)

#	Customer	Year	CC	I
X-8-1	Mathematisch Centrum	1963	NL	C
X-8-2	Rijksuniversiteit Utrecht	1963	NL	U
X-8-3	Fokker	1963	NL	I
X-8-4	Technische Hogeschool Eindhoven	1963	NL	U
X-8-5	Electrologica	1963	NL	I
X-8-6	Reactor Centrum Nederland	1963	NL	R
X-8-7	Interatom	1963	DE	I
X-8-8	Universiteit Kiel	1963	DE	U
X-8-9	Universiteit Karlsruhe	1963	DE	U
X-8-10	Universiteit Würzburg	1963	DE	U
X-8-11	PTT (Dr. Neherlaboratorium)	1964	NL	R
X-8-12	Hoesch AG	1964	DE	I
X-8-13	Grande Dixence (stuwdam)	1964	CH	H
X-8-14	IKO	1965	NL	R
X-8-15	KNMI	1965	NL	R
X-8-16	Philips (NatLab)	1965	NL	I
X-8-??	Gelsenkirchener Bergwerke AG (1)	1966	DE	I
X-8-??	Gelsenkirchener Bergwerke AG (2)	1966	DE	I
X-8-??	Philips (HIG Electronische Componenten)	1966	NL	I
X-8-??	Centrale Melkcontrole Dienst Utrecht	1966	NL	I

: Serial number of the X-8 computer
Year : Order year
CC : Customer country code
I : Main industry in which the customer operated: I(ndustry), R(esearch), C(omputer service center), U(niversity) or H(ydroelectric power station)

Sources : Annual reports Electrologica 1963, 1964, 1965 and 'periodieke rapportering', 2 maart 1966. Also: Philips, 'Philips Data Systems 1959 – 1969' (jaar unknown).

Table 3: Ordered Electrologica X-8 computers

customers who were interested in the larger X-2, but not in the X-8. Even the Mathematical Center saw the X-8 mostly as a temporary and intermediate solution until the X-2 could be delivered.[113] Worse, compared to computers from competitors, the design of the X-2 at that stage was not all that advanced. Electrologica hoped that delaying the X-2 could be an advantage. It might create the opportunity to come up with something even more powerful later.[114]

After an initial enthusiasm for the X-8, ten sold in 1963, interest waned. Sales dropped quickly, to three orders in 1964 and 1965, and another four in 1966. Electrologica blamed the lack of X-8's success to the growing competition from abroad,[115] in particular IBM. On April 7th, 1964, IBM announced the "third generation" of computers, IBM System/360. Announced as a family of computers, IBM System/360 offered a range of machines of increasing power, supposedly compatible, software for one machine in the range was to be portable to any of the other models. IBM had the position in the market to authoritatively define a new, "third", generation of computers. Electrologica did not compare. The X-1 was no longer interesting for the market and the X-8 had been introduced too late.

4.3 Users get involved: The Z8 software committee

A failure from a commercial point of view, the X-8 did satisfy the small circle of its customers. These involved themselves as an active user group, turning the use of the X-8 into a better experience. In particular, they stepped up to write software for scientific computing for the X-8. Their contributions allowed Electrologica's programmers to focus on system software and administrative software.

In the summer of 1963, professor Weise from the University of Kiel asked Electrologica if his department could be commissioned to write a Fortran compiler for the X-8. He expected to order an X-8 later that year.[116] In June of that year, Electrologica held a meeting with a team at Utrecht University, to discuss their ambition to develop a simple assembler, or auto-code, for the X-1 they had on rent. During the meeting, parties came to the conclusion that it would be more prudent the for Utrecht University team to write an assembler for the X-8 instead.[117] Electrologica called this assembly language for the X-8, "ELAN", short for "Electrologica LANguage".[118] Other customers also expressed interest to develop such an auto-code,[119] and Electrologica expected that various customers would develop compilers and other software for the X-8 anyway. To coordinate these efforts, and to avoid duplication, Electrologica created the committee "Z8" and sought the participation of the best and brightest of Dutch computer science. Z8 would pronounce "zacht", which is Dutch for soft, as in software. Electrologica intended Aad van Wijngaarden to chair the committee, and wanted Willem van der Poel on board, known for his Stantec ZEBRA computer and for "functional bits" in defining instructions, as well as Edsger Dijkstra, who had been called to a chair at the Eindhoven University of Technology in 1962.[120]

Most Dutch research institutes and universities that ordered an X-8 participated in the Z8 committee. If considered a user group, the committee gathered the very elite users. Each of the institutes took on a specific task:

- Mathematical Center wrote an ALGOL 60 compiler, just as it had done for the X-1.
- Dr. Neher laboratory of the Dutch PTT wrote a tracer program and ELAN assembler.
- Utrecht University also wrote an ELAN assembler.

[113] 'Notulen E.L.-vergadering d.d. 10 december 1962', 1. 'AEGON:171', X.008.13.053.7 G
[114] 'Notulen E.L.-vergadering d.d. 10 december 1962', 1. 'AEGON:171', X.008.13.053.7 G
[115] N.V. Electrologica 'Jaarverslag 1964' ('s-Gravenhage). 'AEGON:171', X.008.13.053.7 G
[116] 'Notulen EL-vergadering d.d. 14-6-1963', 2. 'AEGON:171', X.008.13.053.7 G
[117] 'Verslag bespreking "Autocode" X1 dd. 20 juni 1963'. 'AEGON:171', X.008.13.053.7 G
[118] For more information about ELAN, see Electrologica, *Programmering EL X8*
[119] Notulen EL-vergadering d.d. 9.7.1963'. 'AEGON:171', X.008.13.053.7 G
[120] Notulen EL-vergadering d.d. 3-9-1963'. 'AEGON:171', X.008.13.053.7 G

- Eindhoven University of Technology, under leadership of Dijkstra, wrote the famous THE-multiprogramming operating system[121] with its own ALGOL 60 compiler.
- University of Kiel wrote a FORTRAN compiler.

The Z8 committee and its members covered the software for the X-8 for scientific computing. That left Electrologica with much software to write. In particular, the company had to develop the basic software controlling the input and output. Electrologica greatly improved the connectivity to the X-8 compared to the X-1. Instead of controlling all peripherals by the main computer, it introduced a separate component, CHARON. The Electrologica programming department wrote the software to control the interaction between CHARON and X-8. The same group was responsible for all software for administrative applications, and would write some of the software for scientific computing.

The task was a gigantic. Electrologica estimated that its programming department would need to write about 130,000 lines of code for the X-8, taking about 130 man-year.[122] The department grew, both in terms of number of programmers and budget, but Electrologica was not up for the task. It failed to complete a COBOL compiler, which was estimated to take tens of thousands of instructions and many man-years of effort.[123] More so, the programmers found that they would have to extend the X-8 instruction set to write a correct implementation of COBOL.[124] As an alternative, they tried to write a COBOL compiler in ALGOL 60. That project failed as well. Without the software, the X-8 was just not a suitable computer for administrative applications. And none of the customers tried to use it in that field.

5 The ELX series marked the end

After making profit in the early 1960s, Electrologica suffered major losses in 1963 and 1964. A reversal of that trend seemed unlikely.[125] In an almost desperate attempt to compete with IBM's System/360 in the Dutch market, Electrologica countered with its own "family" of increasingly more powerful but compatible computers. In 1964, Electrologica announced two different ranges of computers, the X-2, X-4, and X-8 series, and the X-3, X-5, and X-8 series.[126] The ELX series computers targeted small and medium-sized companies. The X-2 and X-3 were the starter machines of both series. Customers wanting more power or more capacity, could upgrade to the next machine in the series, the X-4 or X-5. The top of both series was the X-8. Electrologica explained: 'These EL systems can grow as the company grows, since their flexibility is practically unlimited. With the smallest model one may lay the foundations for the largest installation.'[127]

With the even ELX series, Electrologica tried to revive the dream of developing computers for administrative applications. For scientific computing, it recommended the odd-numbered series because these computers had built-in floating-point arithmetic. As a result, the odd series consisted of more expansive machines with respect to registers, machine code operations, and index registers. Other than

[121] E.W. Dijsktra, 'The structure of the 'THE'-multiprogramming system', *Communications of the ACM* 11:5 (1968), (URL:https://www.cs.utexas.edu/users/EWD/ewd01xx/EWD196.PDF), 341–346

[122] Notulen EL-vergadering 20-4-1966', 2. 'AEGON:171', X.008.13.053.7 G

[123] 'Communicatiebijeenkomst medewerkers HA Verkoop en Bedrijfadviezen en HA Programma Research' (28-5-1965). 'AEGON:171', X.008.13.053.7 G

[124] 'Notulen EL-vergadering 19-8-1965', 1. 'AEGON:171', X.008.13.053.7 G

[125] De Wit, 'Wat niet te verzekeren valt: Electrologica als casus uit de opbouw van een Nederlandse computerindustrie (1956–1967)', 277

[126] N.V. Electrologica, 'Jaarverslag 1964' ('s-Gravenhage). 'AEGON:171', X.008.13.053.7 G

[127] N.V. Electrologica, *Electrologica EL elektronische informatieverwerkende systemen ELX3, ELX5* ('s-Gravenhage: N.V. Electrologica 1965), 5

Figure 7: Cover of an Electrologica brochure for the even ELX series with subtitle 'Electronic administration machines', from the mid-1960s.
(Source: 'Rijksarchief in Noord-Holland, Archief van de Stichting Mathematisch Centrum (RAHN, SMC), 1946–1980', inv. nr. 52.)

that, the two series were the same. [128] Because the X-8 also had built-in floating-point arithmetic, the computers in the odd series resembled the X-8 more than those computers in the even-numbered series. By implication computers in the odd series were more compatible with the X-8. Thus programs written for the X-3 could be run on the X-5 and X-8, or vice versa, provided enough memory in the smaller computers. [129]

The only difference between the starter computers and the middle computers in the series was the number of possible connected peripherals. The smallest machines could not work together with a magnetic drum, magnetic disc, or fast magnetic tape units because the system missed the fast channel selector. Each system in the series could connect to a fast punched tape reader, a tape puncher, line printer, teleprinter, magnetic tape units, punched card machines, plotter, telecommunication devices, measuring devices, and a clock.[130]

The minimum configuration of an ELX series computer system consisted of a basic machine with a core memory of 4,069 words of 28 bits including a parity bit. Customers could extend that memory to 32,768 words. All computers could be programmed with ELAN; an ELAN assembler was part of the standard software. Furthermore, Electrologica would deliver testing programs, sorting programs, tabulating programs, communications programs, a programming library, and more. For the X-3 and X-5, customers could also run FORTRAN and ALGOL compilers. Finally, the X-4 and X-5 would support multiprogramming.[131]

As early as August 1965, Electrologica decided to give up the even-numbered series, and focus on the X-3 and X-5 series. Cutting one of the two series, the company hoped to gain enough time to develop software and documentation. The X-3 would be on offer for the price of an X-2.[132] Although, no X-3 or X-5 machines were ordered, Electrologica did receive four orders for an X-2 computer, and a single order for the X-4 (See Table 4). It is unclear if these X-2 and X-4 computers were actually X-2 and X-4 machines, or that these customers got a rebranded X-3 or an X-5 machine instead.

Time failed Electrologica to turn the ELX series into a success. Two years after the announcement of the two ELX series, Electrologica was sold to Philips Computer Industry. Almost invisibly, the first Dutch computer industry came to an end.

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[128] N.V. Electrologica, *Electrologica EL elektronische informatieverwerkende systemen ELX2, ELX3, ELX4, ELX5* ('s-Gravenhage: N.V. Electrologica 1965), 1,2

[129] Electrologica, *Electrologica EL elektronische informatieverwerkende systemen ELX3, ELX5*, 9

[130] Electrologica, *Electrologica EL elektronische informatieverwerkende systemen ELX2, ELX3, ELX4, ELX5*, 1,2; Electrologica, *Electrologica EL elektronische informatieverwerkende systemen ELX3, ELX5*, 9

[131] Electrologica, *Electrologica EL elektronische informatieverwerkende systemen ELX2, ELX3, ELX4, ELX5*, 5

[132] 'Notulen EL-vergadering 19-8-1965', 2. 'AEGON:171', X.008.13.053.7 G; 'Notulen EL-vergadering 26-8-1965', 1. 'AEGON:171', X.008.13.053.7 G

#	Customer	Year	CC	I
X-2-1	Willem Smit Transformatoren[1]	1964	NL	I
X-2-2	Verenigde Touwfabrieken	1965	NL	I
X-2-3	Intromart	1965	NL	R
X-2-4	Belgische Spoorwegen	1965	BE	T
X-4-1	C.M.C.D.	1965	??	I
X-4-?[2]	Willem Smit Transformatoren	1966	NL	I
X-4-?[2]	Steenkolenhandelsvereniging NV	1966	NL	I

: Serial number of the X-2/4 system
Year : Order year
CC : Customer country code
I : Main industry in which the customer operated: I(ndustry), R(esearch), T(ransport).

[1] : Unclear if this was an X-2 or an X-3. The annual report of 1964 notes that Willem Smit Transformatoren ordered an X-3. However, in all other sources it is put under X-2.
[2] : Unclear if these two computers were actually ordered. And if they were, it is unclear if they were X-2 or X-4 machines.

Sources : Annual reports Electrologica 1964, 1965, 'Periodieke rapportering 2 maart 1966', and Philips, 'Philips Data Systems 1959 – 1969' (year unknown).

Table 4: Orders for the Electrologica X-2, X-3, X-4 en X-5 computers

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