

The Beginning of Computer Science in Argentina – Clementina - (1961-1966)

A Personal Experience

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I dedicate this work to the memory of Dr. Manuel Sadosky.

Abstract. 1957 marked the beginning of modern education in computing in Argentina. I was lucky enough to live this part of the history. After issuing an international bid that year, all members of a special commission from the University of Buenos Aires selected the Ferranti Mercury computer to be purchased for the University. Once installed in 1961, an Institute of Calculus¹ was created with the aim of improving the use and professional and technical applications of the machine. Almost at the same time, a new course of study was organized, the Scientific Computist². Those three events, promoted by our teacher and mentor Manuel Sadosky, set the start point of education assisted by computers in our country. The work at the Institute covered three fields: problem solving, research and teaching. Several Working Teams were organized looking to solve “real problems” in different disciplines: Mathematical Economics, Operations Research, Statistics, Linguistics, Applied Mechanics, Numerical Analysis, Electronic Engineering and Programming Systems. The architecture, structure, operation, languages and other characteristics of the machine, quite advanced for the time, determined the specific area of each of the working teams. After the military coup of 1966 disrupted several institutions, the University and several of its working teams, especially our Institute, the Institute stopped all of its operations. The Mercury computer era came to an abrupt end in our country. 90% of the members of the Institute, scientists, professors and highly trained professionals, resigned and many of them left the country taking their knowledge and expertise abroad.

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1. Introduction

In 1956, some leading personalities from several universities in Argentina began to develop the idea of becoming a part of the modern computing world. One of their first steps was the creation of a Calculus Institute in the UBA aiming to promote the development of Applied Mathematics using resources of Electronic Automatic Computing. In 1957, a public international bid was launched by a commission of the UBA, created with the purpose of providing the School of Natural and Exact Sciences with a modern computer. With that purpose a special subsidy was granted by the CONICET (National Council of Scientific and Technological Research). As for the bidding, four companies presented their proposals: IBM, Remington and Philco from USA, and Ferranti from England. After a careful study, and taking into account the technical characteristics and prices, the members of the Committee unanimously recommended the purchase of the Mercury, offered by the English company Ferranti from Manchester. It was in those days a state-of-the-art machine with excellent technical features: speed, different types of memory, and mainly because it used Autocode, a language developed for Mercury by researchers from the University of Manchester

This language was easy to learn, user friendly at that time, and fit to deal with scientific problems. The computer arrived to Buenos Aires in 1960, and the following year, during its installation at the University, a small group working in the UBA (the author included) were immediately attracted by the computer work. From the beginning we named our machine “Clementina”, because it was programmed to play the popular American melody “oh my darling Clementine”, that was easily recognized even if the machine sounded in a peculiar way. Some time later we programmed it to play opera songs and a well-known tango named La Cumparsita. 1957 to 1961 were devoted to train the first group of analysts and programmers, and also to inform to possible future users, news of the arrival of a modern computer at the University. That was one of the landmark experiences in the development of computing education in the country.

2. Installation of the Computer at the University of Buenos Aires

The installation of the Mercury was completed by the beginning of 1961. The reason for such delay was that the chosen room to place the computer, being prepared on the second floor of the new building of the School of Exact and Natural Sciences, was not yet ready and did not suit the required [2] strict Ferranti specifications. The members of the staff appointed to work with our Mercury were to be trained in Manchester, at the Ferranti plant. This was one of the factors that favoured the choice for the Mercury computer. Actually, that training began in

Buenos Aires; our teacher was Cicely Popplewell, who had been one of Alan Turing's assistants. Ernesto Garcia Camarero, a Spanish mathematician engaged by the University for the training of future computer users, also participated in the formation of the analysts and programmers of the Institute.

3. The Calculus Institute and its Working Teams

The Institute of Calculus was created by the University at the end of 1962 with the aim of doing research, working with the machine, learning, teaching and using it with different purposes. Additionally, a new course of studies, called Computer Scientist, was developed. Both projects were promoted by our mentor, teacher and leader Manuel Sadosky, who has also been instrumental in the decisions and actions that led to the era of Scientific Computing in Argentina. One of the tasks of the Institute was to tackle "real problems", and thus two lines of work were defined: on one hand, the Institute received and attended problems to be processed and solved, such as those requested by researchers and professors from the different UBA Schools or other national institutions that needed its services. On the other hand, different specialized Working Teams were created to analyse and develop different subjects [8].

3.1 Mathematical economics

That group was the largest one and was a multi-disciplinary team. Members included economists, sociologists, statisticians and professionals from other disciplines.

It was directed by Oscar Varsavsky, and composed by Arturo O'Connell, an important Argentine economist, Jorge Sabato, who became later Minister of Education of Argentina, Victor Yohai, a well known statistician, among others. This team produced two economical models Meic-0 and Meic-1, developing a new technique that used the computer to process statistical data provided by Argentine sources.

3.2 Operation research

This group started to work on a problem of great national relevance: the study of the rivers of the Andes ridge, using numerical models [9]. The project was proposed by a national institution, the Federal Council of Investments (CFI) and the Latin-American CEPAL. An automatic "rolling mill" for the company Siderca, and a human diet for CONADE (The National Council for Development) were also performed. That team was directed by Oscar Varsavsky and Julián Aráoz, with the

advice of renowned engineers and teachers from universities, like Roque Carranza, who was a professor in the Department of Mathematics, and became later a Minister and President of the CONADE. The work of this group turned to be one of the first examples in the world of the use of numerical experimental methods in complex dynamical systems. This same group led by Julián Aráoz performed the first computer works on Pert, Linear Programming and Critical Path Analysis [1].

3.3 Statistics

One of the main objectives of the Institute was to promote the study and Statistics applications, undeveloped in the country at that time. The Statistics team led by Sigfrido Mazza worked in two areas: on one hand, special studies were undertaken about the problems concerning the work of important national institutions like the National Institute for Agricultural Technology (INTA), the National Petroleum Company (YPF), the National Telephone Company, and the National Health Institute, among others. The group also had the responsibility of designing the sample and evaluating the errors of the compiled material of the 1960 Population Census. On the other hand, part of this team centred its activities on permanent collaboration with INTA and published a paper about “The use of Mercury Ferranti computer in the analysis of experimental data”, to inform users all over the country on how to normalize the compilation of statistical agricultural material [7].

3.4 Applied mechanics

Mario Gradowczyk led this area with the collaboration of a team mainly composed by engineers like Jaime Schujman and others. That group had two lines of work: solid mechanics and fluid mechanics. Regarding the first one (solid mechanics) they developed and divided their work in 3 different areas: computer calculation of structures, theory of shells and numerical calculation of elasticity problems. Concerning the second one (fluid mechanics), they studied the erosion and transport of ground material in canals and natural ditches and in the not stationary problems in piping [6].

3.5 Numerical analysis

This team was created under the direction of Pedro Zadunaisky, a well known scientist in Planetary Mechanics, with the participation of Victor Pereyra, Enrique Ruspini and others. A team of Numerical Analysis was created, which I was part of. This team had the objective to work in problems of convergence in the numerical solution of differential equations regarding the calculus of planetary orbits, especially the one of the Halley Comet, to which Zadunaisky devoted a great part of

his life, spending also some time at the Smithsonian Institute. An asteroid was baptised with his name, as an appreciation for his work ([10] and [11]).

3.6 Computational linguistics

This was a section directed by the engineer Eugenia Fisher, and composed among others by Victoria Bajar, who developed an important career in Mexican universities. The main objective of that team was the automatic translation especially from Russian to Spanish and vice versa, and the Spanish Language Structure in collaboration with the cathedra of Philology of the School of Philosophy and Literature of the UBA, and other institutions. They had a communications area in which Juan Carlos Angio performed different works for ENTEL (the National Telecommunication Company).

3.7 Electronic engineering

This was a very particular team directed by Jonas Paiuk who was trained in Manchester and became the chief of Maintenance of Mercury, and Oscar Matiussi followed in the direction of the team. Their main task was to ensure the proper functioning of the computer, something they accomplished with exceptional efficacy. They also undertook Research and Development tasks to improve the equipment, mainly its input and output, i.e. the construction of a converter from punched cards to punched ribbon, installation of new magnetic drums, a line printer and also an analogical to digital converter whose destination was the analysis of neurological data required by a research group at the Buenos Aires Children Hospital.

3.8 Programming systems team

This team was established under the direction of Wilfred Duran. Its main achievement was the creation of a new language the *Compilador del Instituto de Cálculo* (COMIC - Compiler of the Calculus Institute). See the details of this project in Section 4.3.6.

4. Working at the Institute of Calculus

4.1 Fields of work

Work in the Institute, covered three fields:

1) Solving problems on demand by scientists and professors of the different UBA Schools, other universities of the country or from abroad, and public and private institutions.

2) Application of the computer to research in the different fields the scientists of the Institute or University worked in.

3) Teaching how to program and use the computer and the languages that it allowed, a task every one of us took part in. Some of us also lectured on different subjects in careers related to computing or to the Institute, especially those enrolled in the new career of Scientific Computist.

4.2 Work at the institute

First, the team was quite small, only 7 or 8 people including, Manuel Sadosky and Rebeca Guber, a mathematician and excellent organizer, also a public relations person, who was Chief of Services during the entire life of the institution, and managed the Institute's every day operation, problems, services and financial concerns. By the time Mercury arrived and the operations began, I had the luck to have in hand a real problem of Physics that, Mercury solved as soon as it was installed. In one of her first mornings in Buenos Aires, Cicely Popplewell gave me a private lesson in which I got instructed on the programming needs of a problem to which I had devoted several months of Nestler Rule calculation without reaching the solution. That afternoon, the problem got solved.

Like my colleagues, I also helped in solving problems that were the everyday worries of different researchers of some universities of the country and other national institutions, like the Departments of Physics, Meteorology, Chemistry, Industries, and others from our UBA Schools, like the School of Engineering of the UBA, the National Universities of La Plata, Cordoba, Rosario, San Juan, the Institute of Physics of Bariloche, the University of Cuyo, and even some Universities of abroad. They were all related to the Institute, as well as the University of Montevideo in Uruguay, University of Chile, and an Institute of Mathematics from Dublin, Ireland.

National institutions like the National Commission of Atomic Energy (CNEA), the Meteorological National Service, the National Company of Communications and others, among some outstanding private companies like Shell, Ducilo, Mellor Goodwin and so on, asked help from the Institute.

4.3 Working with Mercury

Work with Mercury was defined by its resources and its characteristics, structure and operational capabilities, as well as by the languages, routines, stored libraries and facilities that it offered

Characteristics of Mercury: Clementina was an improved version of the Mercury developed in 1955 at Manchester University. It was defined in the Manchester Manual [4] as a Scientific Electronic Digital Computer of Stored Program, Large Size and High Speed, which meant:

Digital computer: Discrete representation, essentially counting arithmetic, direct descendant of the abacus and of counting with hand fingers. Besides counting, it also had to perform functions that were not arithmetic such as: storing, retrieving data or instructions from memory, using intermediate results or organizational tasks. Those functions constituted the “red tape functions”.

Stored program computer: To be run, the program and data had to be completely stored in the machines memory and the instructions were executed one by one.

Large size computer: The Mercury could operate at its normal speed only if it had instructions, operators and data stored beforehand in the memory. Therefore, it needed a great space of memory. It also needed space to store the intermediate results, otherwise it could lose speed.

High speed computer: Additions and subtractions, took 180 microseconds each and multiplication 300 microseconds. At that time, that was high speed indeed.

Scientific computer: Mercury was considered a scientific computer unlike data processing or general-purpose machines, because it could perform large and complex numerical calculus of nuclear physics or aeronautic engineering, carry out a numerical integration of complicated functions of more than one variable, play chess, or prove theorems of symmetry logic. Nevertheless, it could also perform the daily routine of book keeping of a bank.

4.3.1 Some features

Mercury was a first generation computer because it worked on valves. Its programming language was Autocode, which was user friendly and that was one of the main factors in favour of this language at the time. It was not necessary to know either the machine language or the structure or details of the “real machine”, but the programming language and the running of the “ideal machine”, that could understand the instructions.

4.3.2 Operation

The machine’s operation had concepts that were developed much further, 10 or 15 years, in other computers. For example, the pagination system was in Mercury by software and gave birth to the idea of pagination by hardware. Mercury was state-of-the-art for the time. Consider: the facility of pagination, selection of rounding or truncate to improve results, the use of sub indexes, cycles with negative steps and more, none of them used by other computers on that time. The machine had a

physical structure conceived for scientific tasks, so its capacity of calculus and processing speed was not too bad. Only input and output operations were very slow.

4.3.3 Languages

By the time it was received, Mercury operated three languages

- 1 - *Absolute* or machine language.
- 2 - *PIG2*, a symbolic language that was an Assembler.
- 3 - *Autocode*, a higher level language which was a Compiler, developed by A. Brooker from the University of Manchester and improved in 1957 for the Ferranti Mercury. This was the language used, until COMIC came along.[4] and [5].

Example of a Routine that calculates x^5 , and stores it in register of address 832, programmed in Pig2 and in Autocode. This example shows the difference between both languages and how Autocode simplified and shortened programs.

Pig2

| | |
|------------------------------|---|
| 173 [B] ← 4 | Put the value 4 in counter or register B |
| 174 [A] ← C [700] | Put x contained in register 700 into the accumulator |
| 175 [A] ← C [A] x C [700] | Put x.x in the accumulator |
| 176 [B] ← [B] - 1 | Subtract 1 from the counter or register B |
| 177 If C [B] ≠ 0 [IAR] ← 175 | Conditional jump to 175 (IAR, Instruction Address Register) |
| 178 C [A] → [832] | Put x^5 in register with address 832. |

Autocode

| | |
|---------------|---|
| Z = x | Put x in Z |
| I = 4 | Put 4 in counter I |
| 7) Z = Z . x | Multiply content of Z by x |
| I = I - 1 | Subtract 1 from counter |
| Jump 7, I ≠ 1 | Conditional Jump depending on value of counter. |

4.3.4 Basic functions

The machine contained a set of basic functions and each step of the programming would be the use of one of them. Mercury could not perform more than one operation at the same time, and they were the three basic arithmetical operations: addition, subtraction, and multiplication. Division was not a basic function: the quotient of a pair of numbers consisted in executing a sequence of the three basic operations: a succession of subtractions, combined with the counting of the quantity

of subtractions. In spite of the fact that multiplication was included in the basic operations, a repeated and counted addition could be enough, but being a scientific computer, Mercury had a set of electronic functions, one of which was the multiplication; in that way it took less than half the time than the iterated addition.

4.3.5 Input and output

A photoelectrical reader that read the punched paper ribbon made input, and the program ran instruction by instruction, only one at a time. The output after processing was produced by a paper ribbon perforator and teletype.

4.3.6 COMIC (Compiler of the Calculus Institute)

When the nature of the problems that were analyzed, studied and solved in the Institute became more complex, it became necessary to think of researching in order to create new languages to obtain the maximum potentiality from our equipment.

As it was said above, the team of *Programming Systems* under the direction of Wilfred Duran created the COMIC acronym for Compiler of the Calculus Institute. [5]. It was published in May 1966 and from the first moment it proved suitable for dealing with some of the Institute programming problems. The language was mainly created to satisfy the needs of the Mathematical Economics team directed by Oscar Varsavsky. The requirements of the Economical Models programs exceeded the Autocode capacity. With Comic, the variable identifiers got more length, and the language became more “user friendly”. It also had additional operations to manage matrixes and vectors. The use of COMIC had also the purpose that it fulfilled perfectly, of making easier the use of the machine to programmers from different institutions and different disciplines, without them having to be familiar either with the internal structure of the computer or with the machine language. COMIC was constantly improved by adding new capabilities to it. Among those improvements were routines prepared by the students of the Career of Scientific Computist as part of their curriculum. For instance: Cristina Zoltan, one of the first Scientific Computists graduated, later an important authority and professor of the Simon Bolivar University in Venezuela, designed a routine for the use of the Graphic devise that was purchased by the Institute at that time.

5. My Training Abroad

In 1961, the International Computation Centre with headquarters in Rome offered two fellowships to the UBA. Argentina was a member of the ICC and Dr. Sadosky the Argentine representative.

I received one of the scholarships. The second was not used because at the time nobody filled the required qualifications.

The fellowship consisted of a six-month stay at the Computer Unit of the University of London, the English equivalent of the Argentine Institute of Calculus and another six months at the Centre of Nuclear Studies of Saclay in France, which had an Arithmetic Electronic section. Both institutions had a Ferranti Mercury machine in their equipment.

5.1 Stay at the London University Computer Unit

The issues I worked on in the Unit, whose one and only computer was Mercury, were:

5.1.1 Programming techniques

In the Unit, I became acquainted with a very powerful new method of calculating the eigenvalues of a general matrix, the Francis method, which I studied, programmed and wrote the specifications of, under the guidance of the Unit staff. The program that calculated the eigenvalues of a general matrix up to the order 15×15 was successfully applied.

The second problem, a library routine in which I was working in, was also finished and became the third library routine for the Mercury in the Unit. Thanks to the fact that the London Unit operated as an “open store”, i.e. that the persons that knew how to operate it were allowed to use the machine, I could personally carry out all the tests, something that gave me a good background to operate our Mercury back in Buenos Aires.

5.1.2 Lectures and seminars

During my stay in London, a week duration meeting took place in order to analyse and discuss the CHLF 3 compiler, which was a new Input Routine. That seminar was very instructive; it gave me an insight of the structure and characteristics of a compiler. The Routine was finished and put to use at the Unit in April 1962.

I also attended lectures in Numerical Analysis and a course in Matrix Calculus, by Professor Wilkinson. Professor Crank developed the second course in Numerical Analysis and the subject was: Numerical Methods for the solution of Partial Differential Equations allowing me some insights into new unpublished works.

Other English computer centres, such as the computing laboratory of Manchester University and the University of Cambridge were visited with the same purpose of analysing their organizational structure and computer work as I did in the London Unit

5.2 Stay at the Nuclear Studies Centre in Saclay, France

In Saclay, the Nuclear City of France, there was an “Arithmetical Electronic Service” where I spent the second part of my fellowship.

5.2.1 Programming and technical work

The machines in Saclay were: the IBM’s 1401, 1620, 704 and 7090 and one Ferranti Mercury. The work system was “closed store”, so I could never visit the Computing Centre, nor run my programs in any of their computers.

In view of the equipment they had, a short period of my stay in Saclay was devoted to learn and practice FORTRAN, the high-level language that had been in use in the computing world since 1959 and was useful to programme the IBM machines in use in the Centre.

The subject in Numerical Analysis that the Senior Analyst of the Mathematical staff, (with whom I was assigned to work), suggested, was the study and adjustment of a method in Approximation of Functions.

This part of the fellowship was completed at the Blaise Pascal Institute, where the Francis method for solving matrix eigenvalues subject that I worked in during my stay in the London Unit, was translated by me into FORTRAN, tested and later used by the Institute.

5.2.2 Courses

Two complete courses in Numerical Analysis were attended to during that second part of my fellowship. They took place in the Henry Poincare Institute, and they were:

a) Approximation methods to solve Partial Differential Equations of the elliptic type, lectured by Jacques Louis Lions, a famous French researcher.

b) Matrix Calculus, taught by Jean Louis Rigal- (With the purpose of making possible the use of CHLF in our Institut’s Mercury, a new version, “version B”, of the CHLF routine was written and with some adjustments performed by members of the staff of our Institute, and put to use in our Mercury)

6. End of Clementina’s Era

Political changes in our countries always bring important changes in authorities, in educational institutions and in the Universities.

A political event also marked the end of Clementina, but The Mercury computers continued operating in other places of the world. Our Mercury was

beginning to be dismantled shortly after the Institute of Calculus had an important change of staff following the military coup [3].

7. Epilogue

In 1966, a military coup and the brutal invasion by the army of some institutions, one of which was the School of Natural and Exact Sciences and our Institute of Calculus, where students and professors were beaten and injured, had disastrous effects.

In our Institute, the 90% of the scientists, professors and staff resigned and took on relevant positions in the country and abroad, working in private and state institutions. Whole teams of great scientific importance emigrated and went to enrich other communities. Most of them left the country and took with them their knowledge and expertise. Those groups were successful in the country and abroad in everything they undertook.

Our mentor, *Manuel Sadosky*, was exiled, first in Venezuela and afterwards in Barcelona, Spain. In Barcelona he took part in the creation of a Science Museum for Children.

In Venezuela a group of scientist from our Institute filled important positions at the Simon Bolivar University and the Central University of Venezuela; where they had successful careers.

Manuel Sadosky, was invited later in Uruguay, where he repeated the experience of the Institute of Calculus, joined the “Universidad de la Republica” of Uruguay and obtained an “Honoris Causa” title in Montevideo.

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