Evolution of Computing in Spanish-Speaking Countries

- A Panel Presentation

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Abstract. Two decades ago, people used computers as an information resource for many fields. These fields include library information, climatic information, medicine, transportation schedules, banking, and other areas. The use of international networks at that time enabled people to communicate globally in a rapid and accurate fashion not only to experts, but to the public also. In regions such as South and Central America, however, the uses of information resources were not as widespread as they were in developed countries. Indeed, estimates showed that Latin America contained two percent of the world's informatics equipment. At that time, computers appeared in commercial and governmental agencies as well as universities that used global networks such as the internet, BITNET, FidoNet, and other similar networks.

In the mid-1980s, of course, the world wide web was only a dream and the individual use of computers was almost non-existent. The emergence of web-based technology in the 1990s caused a worldwide transformation in the use of computers and their applications, particularly in Latin America. Their natural associations with Spain and Portugal and their strong desire to be at the forefront of informatics changes, Latin American countries developed a new resurgence – a small renaissance – thrusting many of these countries into a modern technical society with accelerated growth and educational promise.

This panel attempts to emphasize the progress of computing in representative Spanish-speaking countries and to celebrate the computing achievements made there. The distinguished panelists will bring forward ways in which computing had emerged and the way the computing evolution affected computing education in the regions. The summaries of their dialogue follow.

Julián Arturo Aráoz Durand

Some South America Experiences: I will comment the evolution of the informatics curricula in some countries of Latin America, as I saw it. I participated

Please use the following format when citing this chapter:

Impagliazzo, J., Aráoz, J., Barán, B., Contreras, J., Sanjuan, A.P., Puigjaner, R., 2006, in IFIP International Federation for Information Processing, Volume 215, History of Computing and Education 2 (HCE2), ed. J. Impagliazzo, (Boston: Springer), pp. 49–57.

in curricula design, from 1965, in Argentina, Venezuela, Uruguay, Nicaragua, and Cuba directly and in forum discussions for Latin-America computing education at UNESCO and CLEI. My focus is on undergraduate studies.

Since 1962, the University of Buenos Aires (UBA) offered the "Computador Científico" program. The curriculum I studied had much mathematics and several courses about computer use. We had several courses of analysis, algebra, and geometry; from applied mathematics: probability, statistics, numerical calculus, and operations research; from computer use: programming, data processing, simulation, and computer seminar. Our professors were either mathematician or engineers working for computers companies like IBM or NCR for the computer courses, which meant that they had a very narrow knowledge of the emerging computer science.

In December 1964, three of us became graduate students. While studying, we were working as programmers and analysts; hence, we were the first people that had a broad view of the area. Our first task was to design and propose a new and more extended pensum than the one we had at UBA. However, neither the Science Faculty nor the Engineering Faculty accepted our proposition. Nevertheless, this pensum was used as a basis for the one used in 1967 at Central University of Venezuela to create the first degree in computer science. Here we incorporate a solid mathematical background more suitable for computer science, including finite math with logic, structured and linear algebra, and graphs among others and more theoretical and structured computer science.

We always kept these principles over the years and used this philosophy at Central University of Venezuela: 1967 and 1974; Simon Bolivar University, Caracas: 1976; University of Guyana, Venezuela: 1983; Latin American School of Computer Science ESLAI, Buenos Aires: 1985; among others.

As time went by, more changes were due to computer science development, like the new areas that appeared in the 1970s such as software engineering, analysis of algorithms, and networks. The schema was based upon solid mathematics that was adequate for an informatics emphasis in basic computer theory, specialization areas, and graduate projects. The core we propose was logic and algebraic structures required for the programming courses, which were independent of programming languages. The emphasis was on algorithm analysis and data structures. Advanced courses included subjects as operating systems, comparative study of programming Languages, data bases, and networks; a software engineering design workshop (as in architecture) and limited time final projects were also part of the curriculum. I believe that this paradigm is still valid for an informatics curricula design today.

Benjamín Barán

Evolution of Computing in Latin America: From the 1970s to Our Days: There was a substantial worldwide excitement in the computer field in the early

1970s but few organized regional activities had been done in Latin America, mainly because only a few universities offered specific careers in computer science or engineering. The first visionaries had realized that a regional organization was needed to develop the Latin American region exploiting the opportunities that computer meant for the well-being of its people. Thus, the Catholic University of Valparaiso – Chile organized the first Latin-American Panel in Informatics in January of 1974 based on two previous experiences organizing smaller Chilean panels by professors Amillara Morales and Aldo Migliaro in 1972 and 1973.

The success of the first Latin-American Panel encouraged the organization of an annual Latin-American Panel with computer exposition, known at that time as *Panel/Expodata* where researchers, professors, and professionals of South America met to present their work and to discuss how to develop the computer field in the region. By 1979, the number of universities and research centers interested in computers had increased considerably to more than one hundred. It was clear that the region needed a formal Latin American organization and a Latin-America Center on Informatics Studies - CLEI (*Centro Latinoamericano de Estudios en Informática*) was established during *Panel/Expodata 1979* in Caracas – Venezuela, with Colombian Victor Yockteng as its president and Chilean Aldo Migliaro as its first Executive Secretary.

The 1980s was the decade of computer consolidation in Latin America. Most Latin America traditional universities incorporated computer programs and research centers began to publish their work. The number of institutions interested in a regional collaboration through institutions as CLEI increased rapidly given the availability of personal computers (PCs) at several companies and most universities and research centers. The Latin America Conference was organized every year in a different country to encourage computer utilization in the whole region, with increasing success in Chile, Venezuela, Uruguay, Brazil, Argentina, Peru, and Colombia.

In the 1990s, the interest in computers continued and internet became the main phenomena of the field, facilitating interaction between LA professionals and the realization of workshops, conferences as well as research projects and networks. By that time, most LA universities had computer programs and research began to be significant, especially in Brazil (with almost 50% of LA scientific publications), Mexico, Chile, Argentina, and Venezuela. The Latin-America Conference became larger with an average presence of around one thousand computer professionals and students of several countries around the world, including a remarkable participation of Europe and the United States of America.

The new millennium found a promising Latin-America computer field with hundreds of LA researchers around the world, CLEI as a consolidated LA center with an itinerant LA conference visiting most countries of the region, a large amount of universities interested in informatics and investing in computer resources, at least, at a level the economy permits. Several LA countries have begun to export software

and systems and the figures for the field had begun to become considerable in several LA economies.

The future seems very hopeful with a larger number of young students interested in computers as well as increasing postgraduate's opportunities in master and doctorate programs. Research networks sprout constantly, especially with Europe and the U.S. companies requiring an even larger number of specialized computer professionals. Software assembly and exportation is already a reality that may help improve the quality of life in the LA region.

José Lino Contreras V

Perspectives from Chile: Since late 1950s, computing at universities has played an important role in the development of the computer and informatics society in Chile. With precarious data processing centers at the beginning and modern computer sciences and informatics academic departments later, computing at Chilean universities has always played an outstanding role in the building of the computing society in Chile.

During the 1950s and 1960s, the Chilean Economic Development Agency, CORFO, promoted the creation of some intensive technology based enterprises such as the national telecommunication company, ENTEL, the Chile's national television company, TVN, and EMCO, a computing services company aimed to promote and develop the use of computers at the public sector. CORFO also provided research and technical support to industry, all of what demanded for better-qualified professionals in the computing area. By introducing computers in the late 1950s, EMCO was one of the main driving forces that promoted computers use in Chili.

Some state owned universities, such as Universidad de Chile and Universidad Tecnica del Estado, also worked close to EMCO in computing, from the beginning. One of the most relevant projects of EMCO was Synco, also known as Sybersyn, a National Information System aimed to integrate information coming from more than 700 state companies placed along the country. Started in 1970, Sybersyn was a project conceived and led by Staford Beer, one of the fathers of cybernetics, who based the conception of the project on his "viable system model" as the central paradigm. The idea was to implement an online, integrated information system allowing real time data to flow from the ongoing activities of the state companies, to a central office, where decision makers would have the relevant information needed to make decisions about production and economic activities. This was one of the most advanced cybernetic projects at the time and produced a big influence in some prestigious people such as Fernando Flores (The Coordinator) and Raúl Espejo. The project ended with the military coup in 1973 and practically disappeared from the Chilean memory.

Later on, under the military regime, the Chilean internal revenue system and the central intelligence agency developed some of the most advanced computerized

information systems in the world. From the university side, advances in computing research took place during the 1970s and the 1980s and new Computer and Information Systems careers were created. During the 1970s, computer programming and System Analysis were careers offered at some universities. Later on, at the beginning of the 1980s, Civil Informatics Engineers and Computing Civil Engineers (twelve-month engineer curricula) were offered by universities starting a very rich educational offering on computing. Nowadays, being the Chilean society one of the most IT developed societies of Latin America, more than thirty universities offer computing and informatics engineer careers with ten or more semesters. The university computing educational activities and research have been continuously shaping the modern computing society in Chile.

Ana Pont Sanjuan

The Effect of the Computing Evolution upon Computing Education: This presentation focuses on the evolution of computers during the past thirty years and how this fact has affected the contents and the methodology used in computer curricula at the universities in Spain. Despite the majority of aspects we can point out that are common and general in all the countries, we will give details about the Spanish universities curricula.

The evolution of computing has supplied more powerful and friendly computers and environments but also much more complex and much more difficult to teach. This has affected the computer and network architecture courses as well as the programming languages used, causing big problems to the teaching staff and interesting controversies not only about the contents that must be included in the curricula, but also about the time needed to teach them and the appropriate methodology. We present a short summary of these problems and discussions and illustrate with examples their effect in the evolution of teaching computing in our universities.

Computer Architecture Courses: When teaching topics in computer organization and architecture, we find more complex and powerful processors and devices each year (or sometimes each half a year). Since the working principles of a CPU are an important part of the basis of a computer organization course, the teaching staff is continuously dealing with the problem simplicity versus highly topical, when choosing a processor example to illustrate their classes. This fact also affects the choice of the assembly language selected for this purpose.

Twenty-five years ago, an important discussion among the teaching staff in the Spanish universities was the choice of using the Intel 8085/8088 microprocessors (or the Motorola family) as example of CPU or a processor like the PDP-8 or 11. The defenders of the first option argued that this family of microprocessors was widely used in low cost computers and systems and, consequently easily found in real life. In addition, the lab equipment based on these microprocessors was (at that moment) cheaper than systems based on PDP processors. On the other hand, the defenders of

the PDP family argued that the internal architecture and assembly language of these processors were easier to understand and use by the students than the Intel family of microprocessors.

This controversy continued in the Spanish universities during many years creating two currents of opinion that have been maintained up until few years ago. However, in the last years the argument of reality versus simplicity has grown stronger and has added new elements to take into account when designing computer curricula. This fact affects even more strongly the design of lab sessions because in those cases the choice is more complex. On the one hand, we must decide between simpler and theoretical systems or real systems with all their powerful, possibilities and complexity and, on the other simplified simulators for educational purposes or current commercial tools

Currently an important number of Spanish universities have chosen the use of MIPS RX000 family processors for teaching examples in computer curricula. This family of RISC processors can easily illustrate how a simple CPU works taking the R2000 as processor basis. Important improvements in the architecture like pipelining, superscalar issues, or cache hierarchy can be easily added in this basic processor and be illustrated with more powerful members of the family, as for example the R10000 microprocessor. This trend is also supported by the existence of free access educational simulators that permit the design lab sessions to deal with assembly language programs, I/O systems, and cache memories. Obviously, there are still defenders of the use of real systems that do not share this extended option.

Programming Courses: Similar circumstances appear when dealing with teaching programming. We can summarize a simplified vision of the problem in the selection of the programming language to teach. In this case, the evolution of the computers has led to (a) the constant emergence of new and specific programming languages, (b) the evolution of programming models, from a structured programming to a more specific models like the declarative programming, passing through an object oriented model, and (c) the need of exploiting the improvements of the processor architecture, like the use of threads of parallelism.

According to these facts, the most common programming languages selected in the Spanish universities from their beginnings until now have been: Fortran, Pascal/Turbo Pascal, C, C++, and Java. During many years, the universities in Spain also reflected the controversy between the use of Pascal or C for teaching purposes like happened in the majority of universities around the world. In these polemical decisions, the pressure of the student's point of view has not been negligible. They always would like to learn the most recent and widely used language, as for instance Visual Basic, without considering any other educational reason.

When teaching programming the selection of the most appropriate language must be made according the following facts. (1) The capability of evolving from a simple models to a more complex ones, being useful in the first programming

courses and in more specifics ones. (2) The learning ability for offering solid basis that permit the students quickly learn the new and different languages that they will find in his/her professional life. Currently, in the Spanish universities we can find two well-defined groups according to the language/model chosen C or JAVA.

New Concepts and Dilemmas: With the computer evolution, new concepts appear or increase the leading role in computer curricula. Networks and computer communications, operating systems or databases are, currently, important subjects for our students. Web related concepts from its infrastructure, site design and maintenance, multimedia services and applications are the most recent examples.

However, each year we find more concepts, applications, services, and methodologies to teach, increasing the workload of the teaching staff and of our students. Since the available time (number of credits) for the courses is still the same or even less than at the beginning of the computer science, teachers must make the difficult decision of skipping a part of the subject when giving a course. However, what shall one select? Generally, new concepts derive from previous ones. Some of us can give in temptation of skipping the basic concepts. However, this can negatively affect the learning process making it more difficult for our students to understand or adapt to new concepts that will appear during their professional life. The question of fundamentals versus applications or functionalities still lures.

Conclusions: In this presentation, we have given some examples of how computer evolution has affected the design of computer curricula, conditioning the examples used, the lab courses offered, and the methodology employed. Many questions about designing the best curricula and which is the most appropriate methodology to explain concepts that are continuously changing or appearing are still open and will remain open during many years because the evolution of computers and technology still continue.

Ramon Puigjaner

From Early Times to Recent Times of Computers and Computer Education in Spain: Computers arrived to Spain in the late fifties and early sixties, mainly introduced by IBM and big companies. At university level, just the Universidad Complutense de Madrid had an automatic computation speciality with some courses on the basic computer architecture and on programming, common to the curricula in mathematics and physics. The industrial engineering schools had a course on computers that mainly explained the basic von Neumann architecture and the Fortran language. Historic machines of that time were an IBM 1620 at the Industrial Engineering School of Barcelona and an IBM 7090 in the computer centre of the Universidad Complutense de Madrid.

In the mid 1960s, IBM introduced the IBM 360 series and Bull merged with the computer division of GE introduced the GE400 series. In the late 1960s, the

UNIVAC appeared in the Spanish market quite strongly with the 1100 and 9000 series.

In March 1969, the Ministry of Education created the Instituto de Informatica, a strange organization, without any contact with the university and provided a strange curriculum where the students earned a different title after each one of the five years of studies. This Institute created a delegation in Donostia in 1971 and in 1972, the Universitat Autònoma de Barcelona created a Department of Informatics in its Faculty of Sciences. This Faculty was obliged to follow the same curriculum of the Instituto de Informática.

In 1974, the Spanish Ministry of Education considered that Informatics should be included in the university studies. A commission was created to study how to pass the Instituto de Informática to the university. Several universities fought with this commission to get the computer studies. Finally, by the end of 1975, it was decided that three Faculties of Informatics had to be created: Barcelona (in the Universitat Politècnica de Catalunya), Donostia (in the Euskal Herriko Unibertsitatea) and Madrid (in the Universidad Politécnica de Madrid), and that the previous institutions giving informatics studies had to stop to teach informatics. This was true in Madrid and Donostia because the Instituto de Informática and its delegation were incorporated at the corresponding universities and their denomination had changed. In Barcelona, the situation was more complicated because it was necessary to pass studies from one university to another (unbelievable in Spain at that time). Finally, both universities kept their studies. The new Faculties started to work in October 1977 with a five-year curriculum that, for the first time in Spain, was different for each university. In addition, in the Faculty of Barcelona the classical curriculum structure of courses per academic year was broken and the curriculum was organized by courses with their corresponding pre-requisites in such a way that the student was able to organize his/her own curriculum choosing courses among those offered by the Faculty but respecting some compulsory courses.

Around 1980, a new three-year study in informatics was created that started in Madrid and Valencia. Since then the number of universities that created studies in informatics has been growing and currently there are more than eighty.

Two important changes have occurred since that time. (1) The general revision of the official titles started in the late 1980s and finished in the early 1990s that transformed the "License in Informatics" into the "Engineer in Informatics". The three-year curriculum transformed into two three years leading to the "Technical Engineer in System Informatics" and the "Technical Engineer in Management Informatics" (literal translation), also known as the "Technical Engineer in Computer Systems" and the "Technical Engineer in Information Systems" (free translation). (2) In 1995, they initiated periodical meetings of the people responsible in each university of teaching informatics. This assembly has had and is having a

strong influence in the current changes introduced in Spain that reflects the European Higher Education Space.

From the marketing and technological viewpoints, the main changes experienced as found in many other countries in the world, are as follows. (a) The introduction of mini- and micro-computers in the late 1970s started the changes in the computer market. (b) The introduction of personal computers by mid eighties, with the decreasing importance of the mainframes and the increasing importance of distributed computing, and the transformation of computers from specific use by qualified people to a wide use element able to be bought at supermarkets. (c) The spread use of communication networks in mid nineties and the popular use of Internet as usual communication mean.

What will the future be?

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