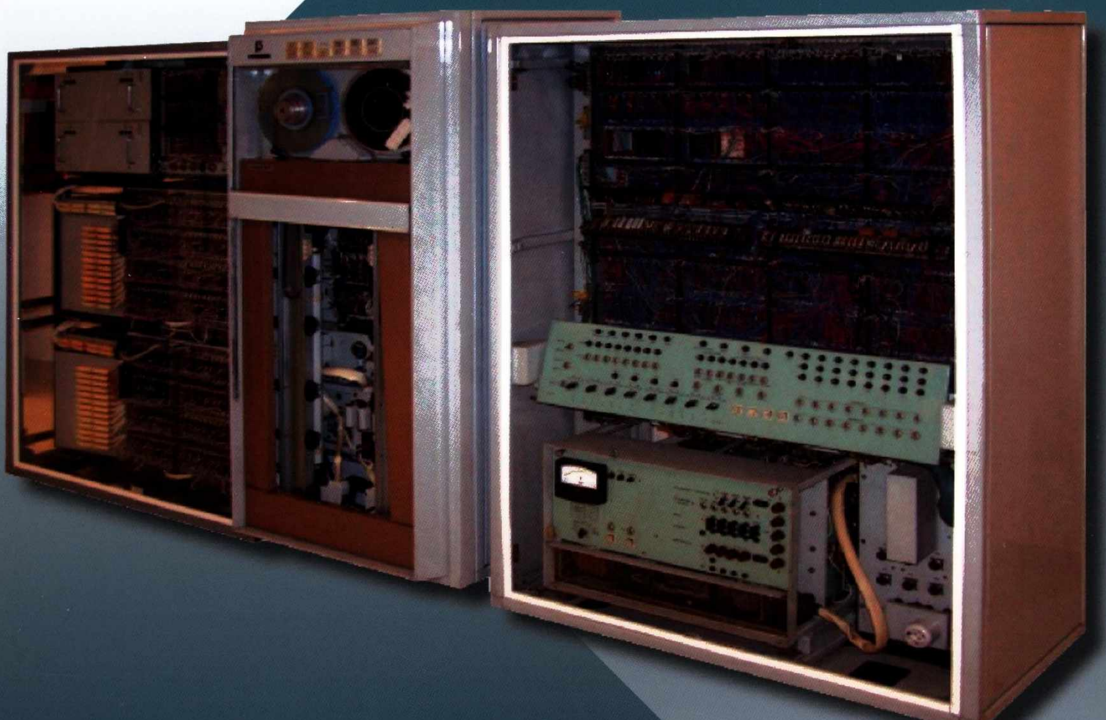
Plamen Nedkov, Balint Domolki & Giulio Occhini (Editors)

IT STAR

History of Computing



IT STAR Series

History of Computing

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Plamen Nedkov, Balint Domolki & Giulio Occhini (Editors)

History of Computing

Proceedings of the **8th IT STAR Workshop**
on History of Computing

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1. Introduction

1.1. Introduction and Executive Summary

At the invitation of the John von Neumann Computer Society of Hungary, IT STAR confirmed during its Business meeting in May 2013 its intention to convene the 8th IT STAR Workshop on History of Computing in September 2014 in Szeged, Hungary.

The Museum on Computer History and the permanent exhibition it features on "The Past of the Future" were the primary reasons for selecting Szeged as venue.

A. The Organizers

NJSZT – the John von Neumann Computer Society, is an independent professional society engaged to assist in

- Disseminating practical applications and results of IT, helping to solve current problems
- Conserving and increasing the prestige, the standards and the ethics of the profession
- Informing computer specialists about the development of theory, about useful practical results and experiences made by users
- Pronouncing the views and representing the professional interests of the computer community
- Spreading the culture of computing, providing regular further education for computer professionals
- A wide-ranging participation in the international professional exchange of experience and information to IT professionals.

IT STAR as a regional information technology association of 15 leading national computer societies in Central, Eastern and Southern Europe has the mission to augment the activities of its members by providing a forum for debate within a regional and international context. It organizes conferences, publications and projects related to education, research, development and applications within the IS agenda, and disseminates information and results internationally.

Following the decision to convene the 8th IT STAR WS in Szeged, a Program and Organizing Committee was set with co-Chairs – Balint Domolki, Honorary President of NJSZT and its representative to IT STAR, and Istvan Alfoldi, Managing director of NJSZT and local OC Chair, and Plamen Nedkov, IT STAR Chief Executive and Moderator of the WS on History of Computing.

An Editorial Board for the post-conference proceedings was established with Messrs Nedkov, Domolki and Occhini (AICA CEO) as editors.

B. Mission, program and participants

The 8th IT STAR Workshop focused on computer and informatics related developments in Central, Eastern and Southern Europe - projects, processes, interactions and results - within a period of four decades beginning in the 50s of last century.

National and regional programs and processes leading to the construction of the first computers and their applications came to the forefront. The social impact of this activity was examined with emphasis on research, education and economics. The computer pioneers – constructors, policy makers and managers – were spotlighted, with recollections of their achievement and their motivation as role models to current and future generations.

Computing History museums in the region and their role and approach in documenting and preserving IT History, so as to help understand the technological processes and the driving forces of innovation, were discussed.

The program allowed a debate in three distinct areas:

- The broader scene of early computing in Central, Eastern and Southern Europe
- National ICT developments
- Museums of computer history and their role

Twelve presentations were delivered during four consecutive sessions, with speakers from Bulgaria, Croatia, Czech Republic, Finland, Hungary, Italy, Poland, Romania, Russia and Spain.

The conference proceedings are video recorded and available on DVD.

C. Executive Summary of Presentations

C.1. The Broader Scene

Blagovest Sendov in his keynote on Eastern European cooperation in the 60s talked about the influence of the International Federation for Information Processing (IFIP), established in 1960 within the framework of UNESCO, on developments and cooperation of the academies of sciences in the computing field. He provided specific examples with the establishment of the Commission for Scientific Problems in Computing in 1962 and the establishment of the Group for Automatic Programming of Middle-Class Machines, which produced an algorithmic language named ALGAMS.

Vladimir Kitov's presentation was on the first computers and the evolution of cybernetics in the Soviet Union. Work on the first computers "MESM" and "M - 1" started in 1949. The first computer produced in industrial series was created in 1953. The first computer centers were established in the 50s. Cybernetics in the USSR, after the initial period during which it was considered "bourgeois pseudo-science" took its rightful place as one of the major sciences. University courses on computers and programming were organized, and during the second part of the 1950s there were projects proposing to extend the use of computers from scientific calculation tasks to tasks related to the Soviet economy and military.

Petri Paju offered an overview of IBM's business in Central and Eastern Europe from pre-WW II times to the collapse of the Soviet Union in 1991. Light was shed on new information about this little known western computer business in Central and Eastern Europe - when and how IBM entered Central Europe, and how it managed, despite the difficulties of the cold war, to increase its business.

C.2. National Developments

Bulgaria – *Kiril Boyanov* reported that use of mechanical calculating machines dates back to 1937 and the first electronic computers were imported at the beginning of the 1960s. The first Bulgarian computer "Vitosha" and the organization of R&D and educational activities were described. The cooperation within the Council for Mutual Economic Assistance in electronics and computing had given a significant push to the creation of a solid research and production base in Bulgaria. The country developed and produced mid-class computer systems, hard disc and magnetic tapes, I/O devices for tele-working and data processing, computer systems, mini and personal computers. The presentation offered a comprehensive overview of the production parameters of computer-related equipment for the period 1971-1990

Czechoslovakia – *Alena Šolcová* traced the first ideas of computer construction starting in the 1935 when Antonin Svoboda and Vladimir Vand began work at the Skoda Works. In 1947, a sophisticated semi-automatic punch card computer was designed by Svoboda, who was also running a course on "Mathematical Machines" at the Czech Technical University in Prague. During the period 1950-1956 the first fully automatic digital computer in Eastern Europe – SAPO was designed and constructed, followed by the automatic digital computer EPOS 1.

Hungary – *Balint Domolki* traced computing developments based on the history of five organizations:

- The first computer in Hungary was built in the late 50s from Soviet documentation in an academic group preceding the Computer and Automation Institute of the HAS (SZTAKI).
- Market oriented application development started in the mid 60s at INFELOR, later forming the Computer Application Company (SZAMALK).
- A PDP-compatible family of minicomputers was developed and manufactured at the computer department of the Central Research Institute of Physics (KFKI).
- For the co-ordination of the Hungarian activities in the Unified System of Computers (ES EVM) the Computer Research Institute (SZKI) was created, later becoming an important R&D center for hardware, software and applications.
- Manufacturing of computing equipment, mainly under French license was done in the VIDEOTON Computer Factory, with considerable export of (mini)computers and peripherals to neighboring countries.

Italy – *Corrado Bonfanti* offered a concise account of the origin, course and aftermath of four far-reaching initiatives in Italy at almost the same time, in a few months encompassing 1954 and 1955. The Polytechnic of Milano and INAC (an Institute of the National Research Council located in Rome), urged by the need of hard computations, embraced the "buy" approach by purchasing an American CRC 102-A at Milano and a British Ferranti Mark I* at Rome. The University of Pisa and the Olivetti multinational company, preferred the "make" approach and launched two projects that succeeded in setting-up a computer entirely designed and built in Italy: the CEP at Pisa (a single powerful scientific machine) and the Olivetti ELEA 9000 (a business-oriented and fully transistorized computer). These efforts complemented each other, and several kinds of collaborations arose since the beginning. Computing centers in Milan and Rome, together with Pisa's and Olivetti's laboratories, have become the incubators for the first generation of Italian informaticians.

Poland – *Marek Holynski* reported that the beginning of computing in Poland dates back to December 1948 with the organization of the first seminar on electronic calculating machines organized by Prof. Kuratowski, Director of the Institute of Mathematics at the Polish Academy of Sciences. As a result, a research team was set up. The first working machine (Differential Equations Analyzer) was completed in 1953, followed by the Electronic Machine for Automatic Calculations in 1955. In 1957 an independent Mathematical Apparatuses Division (ZAM) was established at the Academy and in 1958 the first Polish electronic digital machine named XYZ was launched, followed by the improved and suitable for mass production ZAM-2 in 1960. The ZAM division was transformed in 1962 into the Institute of Mathematical Machines. In the late 60s various other centers were established.

Romania – on the backdrop on international developments, *Vasile Baltac* presented the first Romanian computers - CIFA-1 (1957) in Bucharest, MECIPT-1 (1961) in Timisoara, DACICC-1 (1962) in Cluj-Napoca, and the role of Academician Grigore C. Moisil, as a mentor to all teams. The first generation computers were followed by a series of second generation transistorized computers CET-500 (Victor Toma-1963), MECIPT-2 (Lowenfeld, Kaufman, Baltac – 1963), DACICC-200 (Muntean, Farkas, Bocu -1964). In 1965-1966, a powerful R&D institute for computers was established to respond to the needs for a computer industry. A license from CII-France for the production of IRIS-50 led to the birth of the computer industry in the 1970s. A joint venture with Control Date Corporation – USA, was set up in Bucharest, manufacturing modern peripherals. The software industry emerged. Romania's attitude to the Ryad computer series and the Mini EVM project within the East European cooperation was recalled. The presentation reviewed the link between political decisions and computer industry development and traced the roots of the present IT development in the past. A case of professional restoration (MECIPT-1) was presented.

Yugoslavia – *Marijan Frković* provided an outline of development in the former Yugoslavia primarily through the prism of the history of computing in Croatia and Slovenia The history could be roughly divided into three periods: before 1965, 1965 to 1975, and after 1975. Before 1965 the deployment of computers was limited to purchase of computers and their use mostly in universities. After 1965, computers have been imported also for commercial purposes, training centers have been established, and the first faculties of computing and informatics have been found. In the seventies the country had developed an ambition to produce its own computers. The start was license production of computer peripherals in Croatia and Serbia and after that also license production of computers. This effort culminated with "eigen"-production of minicomputers in Slovenia. Parallel to hardware production also a noticeable development of software could be registered, starting with general usage application software. After 1975, the achievement of Suad Alagić related to his DBMS concept was probably one of the world's best at the time.

C.3. Museums of Computer History

Ana Pont Sanjuán presented how a group of teachers of the Universitat Politècnica de València (UPV) has included the visit to the Museum of Computer History as an additional activity of the Computer Organization subject with the main objective of increasing the student motivation and spreading the history of computers among young people. The Museum of Computer History of the UPV is an official museum recognized by the government of the autonomous region of

Valencia, and can be an interesting tool to help educational challenge. The presentation explained the organization of this experience, traced the links between museum collections and the topics of the studied subjects, and showed evaluation concerning the satisfaction level of students and the degree of achievement of the set objectives.

Istvan Alfoldi traced the efforts in setting up a collection of computer related artifacts in the Szeged Exhibit. Since the mid-seventies, an intensive collection was organized to preserve used equipment of computing centers in Hungary. The work of a handful of volunteers, mainly from the University of Szeged, has been helped by the expertise and financial support of the John von Neumann Computer Society, resulting in one of the largest collections in Europe of computing equipment. Full configurations and equipment in operating condition are available. A carefully selected part of this large collection is exhibited in the newly built Szent-Gyorgyi Albert Agora in downtown Szeged, under the motto "The Past of the Future", providing an overview of the history of computing from the abacus to the internet, also including valuable relics from the life of John von Neumann. The Ladybird of Szeged has been chosen as the symbol of the exhibition.

D. Conference Documentation

Slide presentations and other conference documentation are available at the 8th IT STAR WS website – www.starbus.org/ws8. Further recommended literature is available at the IT STAR Newsletter website – http://nl.starbus.org, and specifically in the 2014 NL issues – Vol. 12, nos. 1 and 2, as follows:

Vol. 12. No. 1, Spring 2014 pp.6-13	
Vitosha, the 1st Bulgarian Computer	*Kiril Boyanov*
Antonin Svoboda and the 1st Czechoslovak Computer	*Julius Stuller*
The Short History of M-3, the 1st Hungarian Electronic Digital Tube Computer	*Győző Kovács*
MECIPT 1 – The 1st University Project and the 2nd Computing Machine of Romania	*Vasile Baltac*
ELEA, the 1st Italian Computer	*Giulio Occhini*
The 1st Lithuanian Accounting Machine	*Gintautas Grigas*
Poland's First Computers – How It Started	*Stanisław Jaskólski*
CER-10 – The First Digital Electronic Computer in Serbia	*Dusan Hristovic*
Vol. 12. No.2, Summer 2014 pp.3-8	
Development and Use of the First Three Soviet Computers	*Vladimir Kitov*
Datatron 205 comes to Vienna	*Walter Grafendorfer*
First Real Computers in Slovenia	*Franci Pivec*

Plamen Nedkov
Chief Executive and Conference Moderator
IT STAR

PROGRAM

8th IT STAR Workshop on History of Computing
Friday, 19 September 2014
Albert Szent-Gyorgyi Agora, Szeged, Kalvaria sgt. 23, Hungary

09.00
Welcome on behalf of the John v. Neumann Computer Society - *István Alföldi, Managing Director*
Welcome on behalf of the Hungarian National Council for Telecommunication and Informatics - *Albert Biro, Chairman of the Advisory Board*

Opening and Setting the Scene
Plamen Nedkov, Conference Moderator
Keynote: **60s and Early 70s – Eastern European Cooperation in Computing**
Blagovest Sendov, Keynote Speaker

09.30 – 10:30
Soviet Union: **First Computers and Evolution of Cybernetics**
Vladimir Kitov
Yugoslavia: **History of Computing in the West Balkan Countries**
Marijan Frković, Niko Schlamberger & Franci Pivec

10.30 Coffee break

11:00 – 13:00
The Museum of Computer History - Teaching Support for Computer Organization Subjects
Ana Pont Sanjuán, Antonio Robles Martínez, Xavier Molero Prieto, Milagros Martínez Díaz
History and Highlights of a Computer Museum
István Alföldi, Mihály Bohus, Dániel Muszka, Gábor Miltényi

[*Guided tour, Szeged Museum*]

13.00 Lunch break

14.00 – 14.30
IBM and Eastern Europe
Petri Paju

14. 30 – 16.00
Bulgaria: **History of Computing in Bulgaria**
Kiril Boyanov
Italy: **The Early Approach to the Computer Era**
Corrado Bonfanti
Czechoslovakia: **History of Computing in the Czech and Slovak Republics**
Alena Šolcová

16.00 Coffee break

16.30 – 18.30
Poland: **Early Computing in Poland**
Marek Holynski
Romania: **History of Computing in Romania**
Vasile Baltac, Horia Gligor
Hungary: **Computing in Hungary – Through the History of Five Institutions**
Balint Domolki

18.30 Conference Wrap-up

1.3. Moderator, Speakers and co-Authors

Plamen Nedkov (*Moderator*) is Chief Executive of IT STAR and Steering Committee member of CEN's WS on ICT Skills. He was Head of Department at the Bulgarian Academy of Sciences, Executive Director of IFIP and elected member of UNESCO's NGO Liaison Committee.

Blagovest Sendov (*Keynote Speaker*) was Rector of Sofia University, President of the Bulgarian Academy of Sciences, President of the International Association of Universities (IAU) and the International Federation for Information Processing (IFIP). He was Chairman of the Bulgarian Parliament and Bulgarian Ambassador to Japan.

István Alföldi is Managing Director of the John von Neumann Computer Society (NJSZT). He was the editor of the book "The Past of the Future" and has significantly contributed to enhancing the prestige of NJSZT. He is a member of the Quality Assurance Committee of ECDL Foundation since its beginning.

Vasile Baltac is a computer pioneer and has made significant contributions to the development of the computer industry in Romania. He served as President of CEPIS and is currently President of ATIC, the Romanian ICT Association member of IT STAR, CEO of the SoftNet Group and university professor of information systems.

Mihály Bohus is a senior lecturer of networking at University of Szeged. The topic of his university doctoral thesis was the protocol specification and testing. He is responsible for the programs of computer history Collection and Exhibition of ITMA foundation.

Corrado Bonfanti was involved in technical and managerial assignments in computer-related industries and taught history of informatics and computing instruments at several Italian universities. He is a frequent conference speaker and authored over thirty papers.

Kiril Boyanov is Member of the Bulgarian Academy of Sciences and Bulgarian representative to IT STAR. He has provided leadership within the Bulgarian ICT industry and in ICT R&D, notably as Director of the Institute of Parallel Processing at BAS.

Milagros Martínez Díaz is Associate Professor of Computer Architecture at the Universitat Politècnica de València (UPV), Spain. She has taught several courses on computer organization and structure and her current research interest includes web and internet architecture.

Balint Domolki participated in the building of the first electronic computer in Hungary, held several leading positions in the software industry and represented Hungary in various IFIP bodies. He is Honorary Chairman of the John von Neumann Computer Society and its representative to IT STAR.

Marijan Frković is President of the Croatian IT Association and National ECDL coordinator. He held leading informatics-related positions in a large industrial company and served as Director of the Center for Informatics of the Croatian Chamber of Commerce.

Horia Gligor is Head of the Institute for Computer Technology - Timisoara Branch. He is also vice president of ATIC – Association for the Information Technology and Communications of Romania and head of IDG Group Banat Area. He managed the project of MECIPT-1 restoration and set-up of a Computer Branch of the Banat Museum.

Marek Holynski is Director of the Institute of Mathematical Machines in Warsaw and Vice-President of the Polish Information Processing Society.

Vladimir Kitov is Professor of Applied Mathematics at the Plekhanov Russian University of Economics. He is author of 70 publications, including 3 monographs on real-time systems and computer networks and a textbook on System Programming.

Antonio Robles Martínez is full Professor of Computer Architecture at the Universitat Politècnica de València (UPV), Spain. He has taught several courses on computer organization and architecture. His current research interest includes high-performance interconnection networks and scalable cache coherence protocols.

Gábor Miltényi is Deputy Chief Executive of John von Neumann Computer Society (NJSZT) and Program Manager of the Past of the Future – Exhibition on the History of Information Technology. As such, he has contributed to the maintaining the prestige of NJSZT.

Dániel Muszka is technical director of Laboratory of Cybernetics founded by professor Kalmar at the University of Szeged. He designed the Ladybird robot of the 50s. His research work was vehicle cybernetics and he is university doctor. His main dream is the making of a computer museum, the idea of Gyozo Kovacs in the 70s.

Petri Paju is a Postdoctoral Researcher at the University of Turku, Finland, in the department of Cultural History. His doctoral dissertation in 2008 concerned information technology and nationalism in the 1950s Finland. Recently he has studied IBM's European history in the post-war period.

Franci Pivec is Chairperson of the Chapter of History of the Slovenian Society INFORMATIKA and a former Vice President of the Society.

Xavier Molero Prieto is Associate Professor of Computer Architecture at the Universitat Politècnica de València (UPV), Spain. He has taught several courses on computer organization and performance modeling and evaluation. Currently he is Director of the Museum of Computer History at the UPV.

Ana Pont Sanjuán is full Professor of Computer Architecture at the Universitat Politècnica de València (UPV), Spain. Her current research interest includes web and internet architecture. Currently she is the Spanish representative to IFIP's Technical Committee 6.

Niko Schlamberger is President of the Slovenian Society INFORMATIKA. He has served the International ICT Community in various functions including as IT STAR Coordinator, IFIP Vice-President and CEPIS President.

Alena Šolcová is Associate Professor at the Department of Applied Mathematics of the Faculty of Information Technology, Czech Technical University in Prague, the Czech Republic.

2. The Broader Scene

2.1. Eastern European Cooperation in Computing – 60s and early 70s

Blagovest Sendov

During the socialist period in Eastern Europe, the official representative of the scientific community of each socialist country was its Academy of Sciences. The international scientific cooperation was organized and managed by the Academies.

The **Commission for Scientific Problems in Computing (KHBBT)** was established in October 1962, in Warsaw, Poland, during the First Meeting of all Academies of Sciences of the socialist countries. In the translation of the name of the commission, the words "Вычислительной Техники" stand for "computing".

One of the ideas of the founders of KHBBT was to use the contacts with the West, through IFIP, for helping the development of computer science in the East. In these days, an approved by the government membership in an international organization gave freedom for travel abroad of the scientists to attend activities of this organization.

The Polish Academy of Sciences was elected as coordinator of KHBBT.

In 1960, following the idea of Isaac Auerbach, the International Federation for Information Processing (IFIP) was founded in the framework of UNESCO. The socialist countries became members of IFIP through their Academies of Sciences. Because of this, the structure of the scientific cooperation between the socialist countries in computing followed the model of IFIP.

The founding members of KHBBT were:

Acad. Lubomir Iliev, Bulgaria, Prof. Matthias Arato, Hungary, Prof. Joachim Lehman, East Germany, Prof. Zdzislav Pawlak, Poland, Prof. Stefan Berty, Romania, Acad. Anatol Dorodnicyn, USSR and Prof. Vladimir Knichal, Czechoslovakia.

As in IFIP, KHBBT established Technical Committees and Working Groups. The proposal for the establishment of the first working group of KHBBT, named GAMS (ΓAMC), was made during a meeting, which took place 7-12 October 1963 in Sofia. The idea came from Antoni Mazurkiewicz (Poland). The name ΓAMC stands for "Group for Automatic Programming of Middle-class Machines." GAMS worked very hard and produced an algorithmic language, called ALGAMS.

It is interesting to note the letter of Acad. A. Dorodnicyn, dated March 1965, to the meeting of GAMS in Berlin.

"... I point out on the differences existing between ALGAMS and SUBSET-ALGOL. These differences are not principal and its removal is considered very important for USSR. The removal of these differences must make ALGAMS an expansion of SUBSET-ALGOL. ..."

This letter shows exactly the influence of the West on the East in computing.

During the 4th working meeting of GAMS, Berlin (DDR) 22-27 March 1965, the recommendation of Acad. A. A. Dorodnicin was realized and approved. The protocol was signed by: Bl. Sendov (*Bulgarian Academy of Sciences*), Balint Domolki, Tamas Bakos (*Hungarian Academy of Sciences*), Reinhold Kreter, Roland Strobel, Friedrich Grund, Immo Kerner (*DDR Academy of Sciences*), Josef Maronski, Antoni Mazurkieweicz, Ludwik Czaja (*Polish Academy of Sciences*), Dragos Vaida (*Romanian Academy of Sciences*), Eduard Ljubimski, Vladimir Kurochkin (*USSR Academy of Sciences*) and Evzen Kindler (*CSSR Academy of Sciences*).

4th working meeting of GAMS, Berlin (DDR) 22-27, March 1965

Bulgarian Academy of Sciences:	Blagovest Sendov
Hungarian Academy of Sciences:	Balint Domolki, Tamas Bakos
DDR Academy of Sciences:	Reinhold Kreter, Roland Strobel, Friedrich Grund, Immo Kerner
Polish Academy of Sciences:	Josef Maronski, Antoni Mazurkieweicz, Ludwik Czaja
Romanian Academy of Sciences:	Dragos Vaida
USSR Academy of Sciences:	Eduard Ljubimski, Vladimir Kurochkin
CSSR Academy of Sciences:	Evzen Kindler

SUBSET ALGOL – subset ALGAMS

During the 4th working meeting of GAMS, the recommendation of Acad. A. A. Dorodnicin was accepted. In this meeting, several other technical problems were discussed and adopted. Every delegation reserved a specific problem to be studied and reported during the next working meeting of GAMS

TEKMO - Technical Committee for Mathematical Support

- In 1969, following the decision of KHBBT, the "Технический Комитет по Математическому Обеъпечению (TEKMO)" - Technical Committee for Mathematical Support, was established.

In the framework of TEKMO, several seminars were organized. Examples of TEKMO seminars:

- Construction of translators for high level programming languages, in USSR, 1971. Org. committee: A. P. Ersov, V. M. Kurochkin, E. E. Lubimski.
- Methods for creating specialized languages ad their realization, in DDR, 1971. Org. committee: N. Lehmann, S. S. Lavrov

Cooperation and responsibility in the framework of KHBBT in 1970

- Numerical methods – USSR AS
- Automatic programming and algorithmic languages - Polish AS
- Automata theory and theory of information - Romanian AS
- Theory of the logical structures of the calculating machines and projects for systems – DDR AS
- Mathematical linguistic - Hungarian AS
- Mathematical modeling – Bulgarian AS
- Using mathematical methods and computers in the problems of economics – Czechoslovak AS

Letter of Prof. Dr. Jdislav Pavlak, 24.08.1972

- As responsible for KHBBT, Prof. J. Pavlak evaluated its activity and concluded: "... The existing practice of attaching the responsibility for coordinating the cooperation in specific scientific fields to different Academies is formal and not effective."

Prof. J. Pavlak proposed to give responsibility the working groups such as TEKMO.

End of the first decade of scientific cooperation

The second decade of the cooperation between the socialistic countries in the field of information processing was dominated by economics, not by science. The leading role was taken by СЭВ "Совет Экономической Взаимопомощи" (Council for Mutual Economic Assistance).

2.2. First Computers and Evolution of Cybernetics in the Soviet Union

Vladimir Kitov

Part I.

1.1. The First Soviet computers "MESM", "M-1" and "Strela"

The first official step in USSR's computer industry was patent number 10475 for the invention of an "Automatic digital computer" registered on December 4, 1948 by the prominent Soviet scientists Isaak Bruk and Bashir Rameev. It was the USSR's first officially registered invention in the field of electronic digital computers. In parallel, another computer pioneer, Sergey Lebedev, also pondered the architecture of his computer.

Creating the first Soviet computers "MESM" and "M-1" began in 1949 by teams led by Sergei Lebedev in Kiev and Isaac Bruk in Moscow. The two computers were created in academic laboratories and were completed at the same time at the end of 1951.

Since the end of 1948, Lebedev in Kiev started working on the MESM computer. During the next two years under his leadership the principles of "MESM" were developed, its individual modules and implementation of their union as a holistic computer. It included about six thousand vacuum tubes and used hexadecimal binary system with a fixed point. The memory device was made on trigger cells using a magnetic drum. In its three-address commands system basic operations were addition, subtraction, multiplication, division, shift, comparison with sign, and comparison of the absolute value. MESM's speed was about 50 operations per second. Initial data input used either punch cards or dialing codes on the plug-in switch. Output of data was performed using electromechanical printer. The computer used a room of 60 square meters, power consumption - 25 kW. On December 25, 1951 MESM was approved by the Commission of the Academy of Sciences of the USSR and was recommended for practical use.

Fig.1. Computer MESM

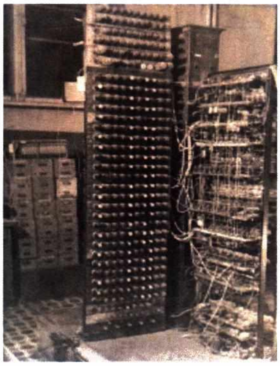


Fig.2. Computer M-1

Bruk's computer "M -1" had several thousand semiconductor devices and only 730 vacuum tubes. This significantly reduced the size of the computer, which occupied a room as small as 15 square meters. It used two-address command system, electronic memory electrostatic tubes memory on a magnetic drum, wide-screen TTY output and transmitter for their input from a punched tape; Number of bits – 24; Internal memory on the tubes of electrostatic and magnetic drum - 256 25-digit numbers. Its performance was 20 transactions per second. Operations: addition, subtraction, multiplication, division, and a number of auxiliary operations. Power consumption - 8 kW.

During the first two years of computer "M-1" operation it was used to calculate operation mode of electrical networks in Moscow, heating of ballistic missiles during the motion in the atmosphere, and for a number of projects of the Institute of Atomic Energy.

Fig.3. Isaak Bruk (1902-1974)

Fig.4. Sergey Lebedev (1902-1974)

Fig.5. Bashir Rameev (1918-1994)

In the early 1950s the Committee for Computers headed by Keldysh was established. A few months later two computer projects were presented to this committee: Lebedev's project of creating computer BESM and Bazilevskiy and Rameev's project of creating computer "Strela". In a competition between these two projects Keldysh supported "Strela". Computer "Strela" became the first Soviet serial computer and Keldysh in 1961 became President of the USSR Academy of Sciences [6]. Less than two years after the creation of MESM and M -1 the Soviet industry produced and began to use computer "Strela". Seven copies of computer "Strela" were made. Unlike their predecessors, which operated in the same scientific institutes where they had been created, computer "Strela" was a serial one. It was used in the seven major state organizations of the USSR.

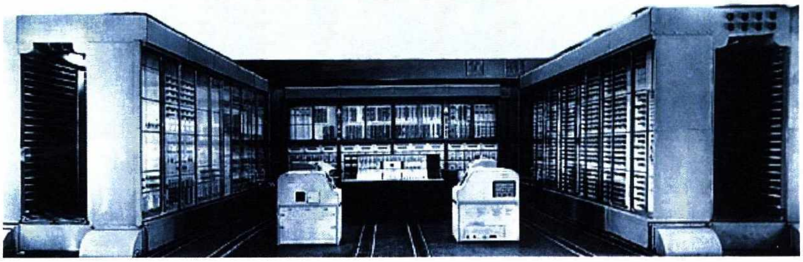


Fig.6. Computer „Strela"

Computer "Strela" had a performance of 2000 operations per second. In the random access memory (RAM) it had 43 cathode-ray tubes - one tube for each digit. It operated numbers with floating point, which corresponded to almost 10 -11 -bit decimal numbers. External hard drive had two units with tape width of 125 mm and length up to 100 m. Data on the tape housed in groups of zones. In the last modification the computer had a magnetic drum storage with capacity of 4096 words, having a speed of 6000 rev./min. The computer used about 6,000 vacuum tubes and tens of thousands semiconductors. It used a computer room area over 400 square meters. Total power consumption - 150 kW: the computer itself consumed 75 kW; 25 kW - for the ventilation unit and 50 kW - for the refrigeration unit. It is worth to mention that computer "Strela" implemented many modern ideas. In particular, it had co-processors for fast execution of short programs.

1.2. Seven most important organizations of the USSR, where the first serial computers "Strela" were established

The seven organizations of the USSR, where the first Soviet serial computer "Strela" was installedare the Institute of Applied Mathematics (IAM), Computing Center №1 of the Ministry of Defense (CC №1), Research Institute "Almaz", Computing Center of the USSR Academy of Sciences, Research Computing Center of Moscow State University, the Nuclear Center "Arzamas-16" and the Nuclear Center "Chelyabinsk-70."

1.2.1. Institute of Applied Mathematics

At the end of 1953 the first computer "Strela" was delivered to the institute founded and directed by Mstislav Keldysh. Later, this institute became known as the Institute of Applied Mathematics (IAM). In the Soviet Union, the IAM was the main center for nuclear calculations. It was one of the world's leading centers of computational mathematics. In the USSR, computational mathematics using computers became a link to Soviet nuclear and missile projects.

Fig.7. Mstislav Keldysh (1911-1978) - Founder and Director, Institute of Applied Mathematics

Until 1954, a huge amount of computations for the Federal Nuclear Center "Arzamas-16" was carried out in large groups of employees (teams) on electromechanical machines "Mercedes" and "Rheinmetall". These teams followed one another, passing each other special notebooks with a lot of numbers. It was a real "factory of accounts". This factory operated effectively until the commissioning of the computer "Strela". The setting up of computer "Strela" began in Keldysh's Institute in 1954.

Specific results from the use of this computer were the carrying-out on 22 November 1955 at the Semipalatinsk test site of the explosion of new type of nuclear weapons. These nuclear weapons were created on the basis of previously developed mathematical models of physical nuclear processes.

Then, the great physicist Andrei Sakharov in his scientific report on the hydrogen bomb wrote about the important role of mathematical calculations in his project. On that date these calculations were carried out under the leadership of Mstislav Keldysh and Andrei Tikhonov.

In the mid-1950s, M.V. Keldysh, M.A. Lavrentiev and S.L. Sobolev wrote a letter to the leaders of the Communist Party with the suggestion to create in the USSR a certain number of computers to solve problems related to the development nuclear weapons.

1.2.2. Computing Center №1 of the Ministry of Defense of the USSR

Another installation of computer "Strela" was in Computing Center № 1 of the Ministry of Defense of the USSR (CC №1) created in 1954 by Second World War veteran engineer-colonel Anatoly Kitov [5]. Computer "Strela" in the CC №1 was the first computer installed in the organization of the Soviet Ministry of Defense. In the 1950s, the Computing Center №1 of the Ministry of Defense carried out a lot of different activities: it calculated orbits of artificial satellites and interplanetary space stations; developed new types of specialized computers; conducted extensive work on mathematical modeling of various combat situations, calculations were carried out for the General Staff and the various departments of the Ministry of Defense (intelligence, logistics, ground troops, artillery and others); it created software and hardware for missile defense systems and processed information from radar stations, etc. During the1950s, CC №1 solved a large number of military problems of national importance. Several hundred highly qualified scientists and engineers worked in its various departments. CC №1 of the Ministry of Defense was the most powerful computing center in the USSR and one of the most powerful computer centers in the world. CC №1 executed many important projects for Soviet defense and space programs including creation of one of the most powerful computers "M-100" (1958, one hundred thousand operations per second),the launching of the first artificial satellite in 1956 and Yury Gagarin's flight in 1961.

Fig.8. Anatoly Kitov (1920-2005) - Founder and Scientific Director, Computing Center №1 of the Ministry of Defense

1.2.3. Research Institute "Almaz"

Another computer "Strela" in the first half of the 50s was installed in a secret research institute called "Almaz". It was created in the late 1940s at a Special Office № 1 of Ministry of Armaments, its core competence was the development of air defense missile systems (ADMS). Over the years, this top-secret research institute has successfully completed a major cycle of works on the development of missile defense. For many years, the director and chief designer of a number of ADMS was Alexander Raspletin - founder of the national school of anti-aircraft missile systems.

Fig.9. Alexander Raspletin (1908-1967) - Director and Chief Designer of ADMS

During the 50s and 60s, A.A. Raspletin provided scientific and technical guidance on development and modernization of air defense missile systems S-25, S-75, S-125, and S-200 as well, and on creating a space defense system.

Fig.10. Secret Research Institute „Almaz"

1.2.4. Computing Center of the Academy of Sciences of the USSR (CC AS).

Computer "Strela" was installed in the Computing Center of the Academy of Sciences of the USSR (CC AS), which was founded in 1955 by Anatoly Dorodnitsyn. Literally within a few years after its founding, CC AS became the country's leading institute in the field of computational methods, mathematical modeling, mathematical and computer software, as well as in a variety of applications, primarily in the area of military applications, such as aviation, shipbuilding, ballistic calculations and etc. The main lines of its research was computational hydro aerodynamics, computational mathematics and mathematical physics; design automation; space dynamics; development of computer software systems, etc. Still popular worldwide is the Journal of Computational Mathematics and Mathematical Physics, published since 1960 under the auspices of this Computing Center.

Fig.11. Anatol Dorodnitsyn (1910-1994) - founder and director of the Computing Center of the Academy of Sciences of the USSR

1.2.5. Scientific Research Computing Center of the Moscow State Lomonosov University (SRCC MSU)

Scientific Research Computing Center of the Moscow State Lomonosov University (SRCC MSU) was founded in 1955. It was the first computer center in the educational institutions and one of the first in the country. In December 1956, SRCC MSU got computer "Strela". During nearly 25 years scientific director of SRCC MSU had been an outstanding mathematician Andrei Tikhonov, the head of Moscow's State Lomonosov University department of computational mathematics. It was the golden age of computer science in this University. In addition to scientific and educational purposes, "Strela" in SRCC MSU was used to solve important for the country secret tasks.

Fig.12. Andrey Tikhonov (1906-1993) - founder and scientific director of the SRCC MSU

Andrei Tikhonov is well-known as the author of one of the world's most famous books on mathematics "Equations of mathematical physics" (co-authored by Alexander Samarsky).

1.2.6. Soviet nuclear program

The higher Soviet leadership paid great importance to the Soviet nuclear program. The Soviet government decided to start work on the atomic bomb in February 1943. The deputy of Stalin, L.P. Beria, and the famous physicist I.V. Kurchatov, were appointed as leaders of the Soviet atomic project. Information coming from the USA and other countries on intelligence channels, facilitated and accelerated work of Soviet scientists. The first top-secret Soviet Federal Nuclear center "Arzamas-16" was created in 1946 for the atomic project. Initially, the necessary calculations for nuclear projects were carried out on adding machines. In the first half of 1950s these calculations were performed on computer "Strela" in IAM (Director Keldysh). The first Soviet atomic and hydrogen bombs were developed in the nuclear center "Arzamas-16", where prominent physicists of the 20th century Julius Hariton and Andrei Sakharov worked. At the end of 1956 computer "Strela" was installed in "Arzamas-16". Currently, 24 000 employees work in the nuclear center "Arzamas-16". In 2011 a modern supercomputer was installed there - to date, the most powerful supercomputer in Russia.

The last seventh computer "Strela" was installed in 1957 in the nuclear center "Chelyabinsk-70". It was organized in 1955 as the second Federal Nuclear center after "Arzamas-16 ". Nuclear center "Chelyabinsk-70" is located on the eastern foothills of the Middle Urals, midway between the cities of Yekaterinburg and Chelyabinsk. In the Nuclear Center "Chelyabinsk-70" there were created the majority of peak nuclear weapons, most of them have no analogues in the world. There was created the world's smallest nuclear charge for artillery shells of 152 mm. Since the beginning, the Nuclear Center "Chelyabinsk-70" had a strong team of theoretical physicists, specialists on mathematical modeling and computer programming. Its scientists obtained unique scientific results in the field of nuclear physics processes through their computer simulations.

The first Soviet serial computer "Strela" played a prominent role in strengthening the military might of the USSR. The years 1950-1960 were the period of cold war.. The Soviet priority in using computers in the USSR was to provide calculations and solving various problems of mathematical modeling for the nuclear program, missile and space programs and military command.

1.3. Difficult fate of cybernetics in the USSR

1.3.1. Initial resistance to cybernetics in the USSR

Published in the USA in 1948, the book by Norbert Wiener "Cybernetics or Control and Communication in the Animal and the Machine" was available in the Soviet Union only in secret libraries because its author expressed ideas that did not correspond to the official communist doctrines advocated in Soviet society. "Seditious" ideas could not become the property of Soviet citizens and, therefore, the place of his book was well defined - the secret library accessed by a limited number of people. In Soviet science, along with genetics and a number of other sciences, cybernetics was a typical victim of the Stalinist regime. In the Soviet Union, during the life of Joseph Stalin, selected anti-cybernetics publications such as "Mark III, calculator", "Computer Science - Science obscurantist", "Cybernetics or longing for mechanical soldiers" appeared. The apotheosis of the attack on the cybernetics was the article "To whom cybernetics serves?» in the ideological journal of the Communist Party of the USSR, «Problems of Philosophy» (1953). This article has been placed in a section of the magazine «The criticism of bourgeois ideology.» Author of this lampoon cowardly hid himself under the pseudonym «Materialist». Set of labels for cybernetics (empty shell, pseudoscience, ideological weapon of imperialist reaction, causing the lackeys of imperialism, etc.), as if meant for granted that no representative of the Soviet science cannot deal with such a vile, according to the author, science.

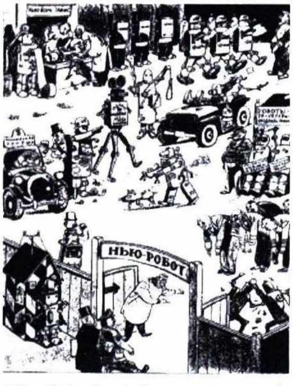


Fig.16. Article against cybernetics: "Cybernetics means longing for mechanical soldiers"

The official attitude of the state toward cybernetics in 1954 clearly reflected the fourth edition of the short encyclopedia, in which was told: "instigators of a new world war used cybernetics for their dirty deeds ... practical for the development of new methods of mass murder - electronic, telemechanical, automatic weapons, design and production of which has become a major branch of military industry in the capitalist countries. Cybernetics is thus not only an ideological weapon of imperialist reaction, but also a means of implementing its aggressive military plans". Everywhere in the Soviet ideological publications, to cybernetics such labels were "stuck" as "pseudo-science", "whore of imperialism", "Maid of the capitalist world" and so on.

Anatoly Kitov had to have an enviable scientific foresight to appreciate the depth and usefulness of the new science just after reading Wiener's book «CYBERNETICS» (which was marked "Top Secret" and needed a special permit to access). In addition, it was necessary to have an enviable courage in Stalin's years to write, contrary to the official doctrine, the first in the USSR positive article "The main features of cybernetics". As co-authors of this fundamental article Kitov invited professor Alexey Lyapunov and academician Sergey Sobolev.

In recognizing cybernetics in the USSR as a science a great role was of a small group of courageous military scientists, who only a few years before had taken part in the Second World War. If there were no active position by Anatoly Kitov and Alexei Lyapunov the ideological concepts, protected by the conservative philosophy of the communists, would have prevented for many years the introduction of computer methods of cybernetics and its applications to management and economics.

Since the spring of 1953, Kitov and Lyapunov during a period of one and half years have organized a series of lectures in several major public institutions, famous research centers and universities. In the two years that have passed since the publication of the article there were serious changes and Stalinist methods of management science were already very unpopular. Finally, in 1955, as a result of successful lectures made by Kitov, Lyapunov with their several associates, the Ideological Department of the CPSU Central Committee gave permission to publish the article "The main features of cybernetics" written by Kitov. This paper was signed by academician Sobolev, Kitov and Lyapunov and was published in the journal "Problems of Philosophy" in August 1955. It was known that articles, which appeared in the journal "Problems of Philosophy" (the main ideological journal of the CPSU), expressed the official view of the Communist authorities.

The publication of the article "The main features of cybernetics" became a solid point in the struggle for cybernetics. The struggle for the recognition of this science was successful and a small group of scientists defending cybernetics had won.

1.3.2. After the victory of cybernetics in the USSR in 1955

In the second half of the 1950s and the 1960s there was a real cyber-boom in the Soviet Union. National Research Institutes of Cybernetics were organized in different republics of the USSR (Ukraine, Georgia, Estonia, Uzbekistan, etc). Appropriate departments, laboratories, chairs in universities were established. Scientific councils, departments, scientific journals, etc. appeared, in the names of which was the word "cybernetics" in various combinations (technical, mathematical, theoretical, agricultural, economic, chemical, and even legal). Hundreds of thousands of scientists, engineers, technicians and teachers have been involved in this area. It was assumed that cybernetics formulates universal laws of the analysis and synthesis of complex systems of diverse physical nature and will play a crucial role in modern scientific and technological progress. It was stressed that the concept of information in the new science was just as important as the concept of energy in physics. Scientists actively reviewed technical sciences and mathematical methods from the new point of view and found new applications.

If we look at the United States - homeland of cybernetics at that time, we would see a dramatically different picture: No special faculties or giant cybernetics institutions created. There were also a lot of people dealing with applications in various fields of cybernetics, but they were fewer than in the Soviet Union, and they were evenly distributed in engineering, computer and mathematical faculties of universities. Books on cybernetics and the term "cybernetics" in the United States were much less popular than in the USSR, where the same communist propaganda once again created an overlap.

1.4. The first courses on computers and informatics in three Soviet universities

In 1951, in the Soviet Union three courses on computer and programming had been organized.

Sergei Lebedev delivered lectures on computers to the students of Moscow's Power Engineering Institute (*MEI in Russian*). For the course, Lebedev came once a from Kiev to Moscow. MEI was the first university in the Soviet Union where the Chair on Computer science was created.

Anatoly Kitov made series of lectures on computers and programming in Moscow in the Artillery Engineering Academy for cannon and missile officers.

Bashir Rameev lectured on computers for the students of the Moscow Engineering Physics Institute (*MEPHI in Russian*).

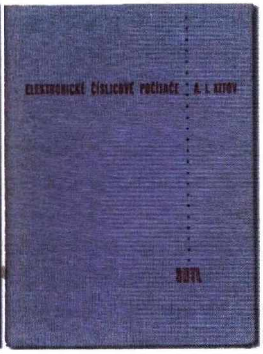
1.5. The first Soviet books on programming, computers and applications and their significant role in several foreign countries

Until 1956, only a few Soviet and Western publications on separate aspects of computers were published in the Soviet Union. Among them, there were two pioneer publications: ***"Solving mathematical problems in automatic digital computers"*** (L.Lyusternik, V.Abramov, V.Shestakov, M.Shura-Bura, 1952) and ***"Computer Applications"*** (A.Kitov, 1953).

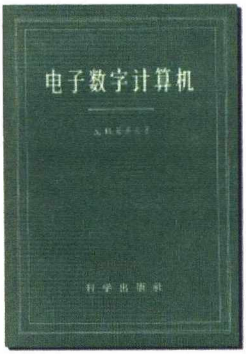
1956. A.Kitov **"Electronic digital computers"** - the first Soviet publicly available book on programming, computers and their applications. Publishing house "Sovietskoe radio."

In 1958 University of Michigan professor John Carr, in his book „Lectures on Programming" wrote that at present the most complete presentation of the manual and automatic programming for computers (with detailed examples and analysis) is given in Kitov's book. Some sections of this book are translated into English and may be obtained from the American Association of Computers.

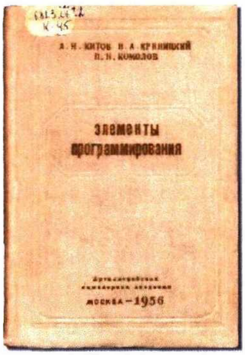
Publications in Poland and Czechoslovakia of the book „Electronic digital computers"



Publication in China of the book „Electronic digital computers"

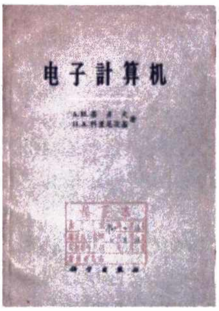


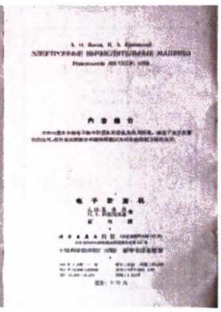
1956. A.Kitov, N.Krinitsky, P.Komolov – *"**The Elements of Programming**"* The book "



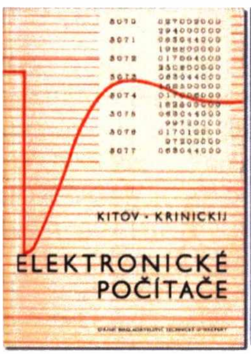
1958. A.Kitov and N.Krinitsky - *"Electronic computers"*.

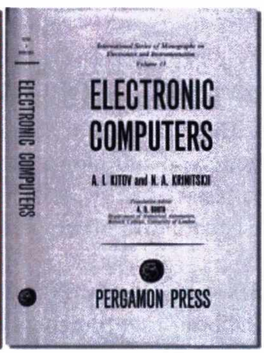
A.Kitov and N.Krinitsky - *"Electronic computers"*, published in China



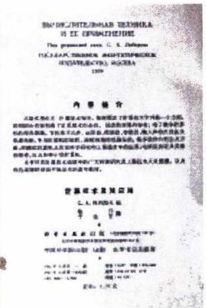


A.Kitov and N.Krinitsky - *"Electronic computers"*, in Czechoslovakia and in the West.



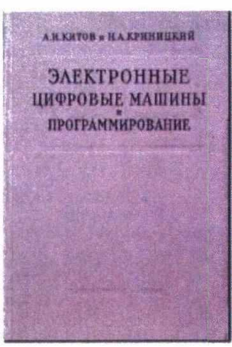


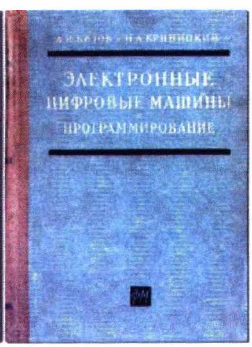
1959. Collection of articles ***"Computer techniques and its applications"***
Editor Sergey Lebedev. Publication in China in 1962



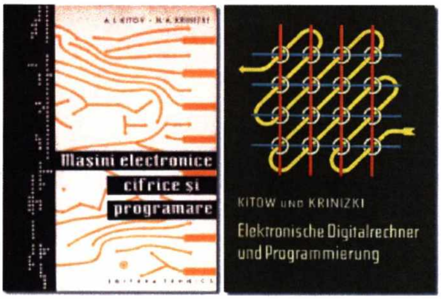
A.Kitov and N.Krinitsky, and S.Lebedev were published abroad in the famous series of books ***"International Series of Monographs on Electronics and Instrumentation"***.

1959. A.Kitov and N.Krinitsky ***"Electronic digital computers and programming"***





This was the first Soviet official tutorial textbook (computer encyclopedia, about 600 pages). The total circulation of this computer encyclopedia is about 100 000 books. The second edition was in 1961. Two generations of computer specialists in the USSR and several foreign countries were trained with this textbook.



Part II.
Several key moments of Soviet informatics

2.1. About computers after MESM, M-1 and "Strela"

Isaak Bruk, Sergey Lebedev and Bashir Rameev played prominent roles at all stages of the Soviet computers history. In the history of science Lebedev, Bruk and Rameev entered as the creators of the three first Soviet computers M-1, MESM and "Strela" as well as three families of computers created under their leadership in subsequent years.

2.1.1. Lebedev's scientific school after MESM

After creating MESM Sergey Lebedev moved from Kiev to Moscow. Under Lebedev's leadership in Moscow there was created computer BESM (1953), which served as a prototype for the first computers in China (maybe in Asia as well). At that time it was the most powerful computer in the USSR and in Europe. About this computer Lebedev reported at the International Conference in Darmstadt in October 1956. It was fastest computer in Europe. But this BESM was inferior in speed and memory capacity to the American computer IBM 701.

At the same time of the 1950s the computers BESM-2 and M-20 were created under his leadership. In 1959 computer M-20 was put into production. Compared with previously created computers BESM the performance of M-20 was 4 times higher.

Fig.17. Computer BESM-2

In 1964, Lebedev created the computer BESM-4 - one of the first Soviet universal computers of the second generation.

The top of Lebedev's computer line was the creation of second-generation mainframe computer BESM-6. At that time it was the most powerful computer in the Soviet Union and one of the most powerful computers in the world with performance equal to 1 million operations per second. Since 1967 for about 15 years BESM-6 was installed in many Soviet scientific centers.

Lebedev's computers M-20, BESM-3M, BESM-4, BESM-6 and others became very famous in the Soviet Union.

Fig.18. Computer BESM-6 and its main developers with Lebedev

2.1.2. Bruk's scientific school after M-1

In addition to M-1 under the leadership of Isaak Bruk a series of computers was created. Computer M-2 was developed in 1952. M-2 has been used for the calculations of the Institute of Atomic Energy, the design bureau led by Sergey Korolev and other scientific institutions. In the mid-1950s, M-2 has been improved by introducing the device memory on ferrite cores. In 1955-1956 Bruk created the concept of small computers based on experience in the creation of M-1 and M-2. After a while the computer M-3 was created, which operated 30-bit binary numbers with fixed point, had two-address instruction format, the memory capacity of 2048 numbers on a magnetic drum, and had an initial average capacity of 30 operations per second.

Fig. 19. Computer M-4

In 1957, Bruk began to work on the creation of computer M-4 for processing data received from the radar. This computer had shared internal memory and program ROM and constants used special processors for input-output. M-4 was one of the first computers that were made on the basis of more advanced components - semiconductor transistors. Soon, Bruk developed a multiprogramming, multi-terminal computer M-5, which could work with several programs. Its performance was 50 thousand operations per second.

2.1.3. Rameev's computer school after computer "Strela"

After computer "Strela" Bashir Rameev created the family of computers "Ural". This family included the famous in the USSR computers Ural-1, 2, 3,4, 11, 14, and 16.

The application field of this family of computers "Ural" was solving of abroad range of mathematical and engineering computations in computing centers of scientific research institutes, design bureaus and industrial enterprises.

Computer Ural-1

Completion of design: 1955. Basic organization in charge of the computer project and design: Special Design Bureau - 245 under the USSR Ministry of Instrumentation and Automation Means (MIAM). Final preparations and bringing to serial production was performed by SDB-245's affiliate in the town of Penza. Serial production was from 1956 till 1961 and number of produced computers: 183 pieces.

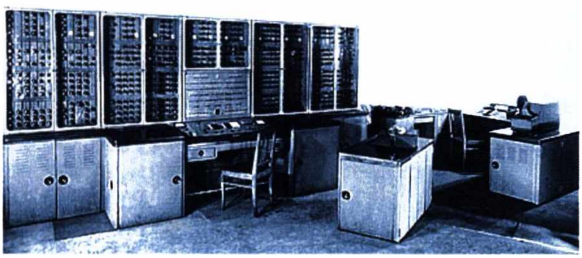


Fig. 20. Computer Ural-1

Computer Ural-2

Organization in charge of project and design: Penza Scientific Research Institute of Controlling Computers. Beginning and finishing of serial production: 1959 and 1964. 139 computers were produced.

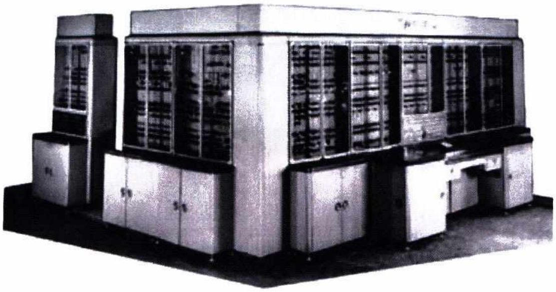


Fig. 21. Computer Ural-2

Computer URAL-3

Design of URAL-3 had been performed as further development of **URAL-2**. Computer URAL-2 was modified in two directions: Additional devices (including input-output devices) were incorporated into its structure. Perforated tape devices were replaced with perforated card ones. The numeric printer was replaced with alphanumeric one with lines of 128 places. Increased capacity and reliability of external memory units. New magnetic tape memory devices greatly increased volume of stored information. Beginning and finishing of the serial production: 1964. 22 computers were produced.

Computer URAL-4

Beginning and finishing of the serial production: 1962 and 1964. 30 computers were produced. Computer URAL-4 design was developed by numerous modifications of the basic **URAL-2** model, which were conducted in two principal directions:

- Expanded set and increased number of additional input-output devices. Punched tape devices were replaced with punched card ones, numerical printer replaced with alphanumeric one with lines of 128 places.
- Increased capacity of external memory storages and their reliability.

Computer URAL-11

Computer URAL-11 was the first one of a new line, which also included URAL-14 and URAL-16. Computers of the URAL line had unified basic design, manufacturing technologies and components. All three models had the same input\output and storage devices, implemented the same input\output alphabet and the same codes on punched cards, magnetic tapes and internal computer codes. 123 computers were produced. Beginning and finishing of the serial production: 1965 and 1975.

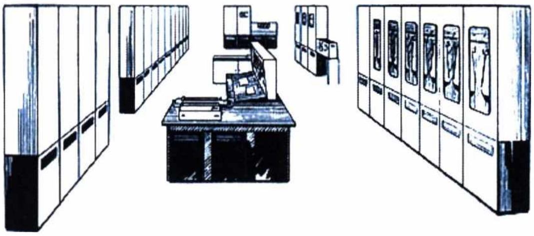


Fig. 22. Computer Ural-11

Computer URAL-14

Completion of design and beginning of serial production: 1965. Finishing of serial production: 1974. Number of produced computers: 201 pieces.

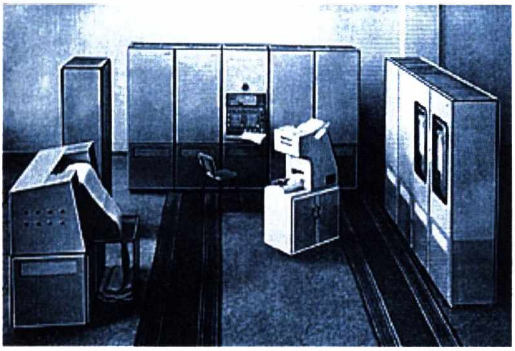


Fig. 23. Computer Ural-14

Computer URAL-16

Beginning and finishing of serial production: 1969. URAL-16 was the senior model of the URAL computer line. Same as the other computers of the family, URAL-16 was produced on unified component and technology basis of URAL-10. That was the USSR first experience in designing not a single computer but an extended line of compatible computing machines and appliances. Their technical unity was the focus of the designers' attention. Most of their technical, structural and designing solutions were undoubtedly progressive and promising ones. However, only one piece of URAL-16 was produced and put into operation.

2.1.4. Computers Minsk-22 and Minsk-32

During 10 years, from 1959 till 1969, several types of general-purpose computers had been developed in Byelorussia. The Minsk computers appeared when the BESM computers, seven Strela computers and the first M-20 machines had been operating for several years in Moscow, small universal Ural-1 machines were being assembled in Penza, the development of the semiconductor Razdan computer was close to its completion in Yerevan and the first prototype of the Dnieper semiconductor computer was being adjusted at the Kiev Institute of Cybernetics of the Ukrainian Academy of Sciences.

Computer «Minsk-22» and computer «Minsk-32» were one of the most mass Soviet computers for the time of second part of 1960s and first years of 1970s. These computers were produced in Minsk and had the greatest use in the USSR. They were designed to solve the economic problems, problems of statistics and planning, production management, information retrieval.

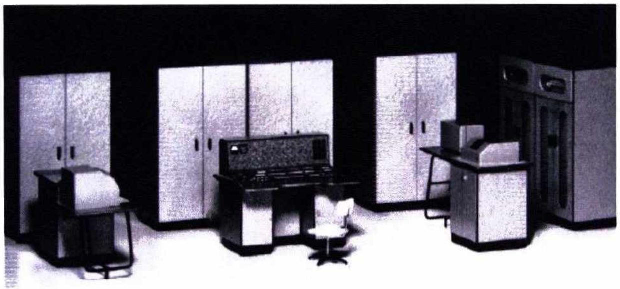


Fig. 24. Computer Minsk-22 was produced in series from 1965 till 1970 -One of the most mass Soviet computers of that time

734 computers Minsk-22 and 2889 computers Minsk-32 were produced. At that time, computer "Minsk-32" was the most common in the USSR between the general-purpose computers. Minsk-32 was manufactured from 1968 to 1975. Its main designer was Victor Przyjalkowski.

Fig. 25. Soviet computer designer Victor Przyjalkowski

2.2. The first in the world project - Nationwide computer network for management and control of the economy and military forces of the USSR

The scientist who formulated in 1959 the proposals for complex automation of information processing and state administrative management on the basis of a Unified State Network of Computer Centers (USNCC, *EGSVC in Russian*) was Anatoly Kitov.

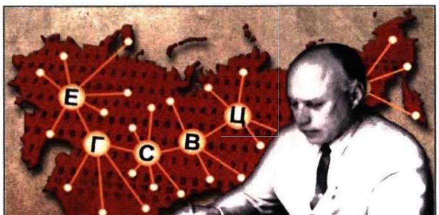


Fig.26. Anatoly Kitov and his project USNCC (EGSVC)

Since 1955, in his articles and presentations A.Kitov paid considerable attention to prospects of economic and management applications of computers which could become feasible after the full amount of economic data was collected and processed. As a necessary tool for that he proposed to create a Unified nationwide network of computers, which would collect all economic data in the country including the information of different enterprises, material supplies, data of financings, labor force data and operatively process this information for planning and management of economics of the USSR.

Particularly in 1958, in his publication "Electronic computers" Kitov offered to create such a Common state computer network for the whole country. His suggestions were particularly risky at that time as Soviet Party ideologists continued to consider applications of mathematics in economics as "the instruments of capitalist apologetics". Such indictment could have had particularly serious consequences for supporters of the use computers and mathematics in the economy.

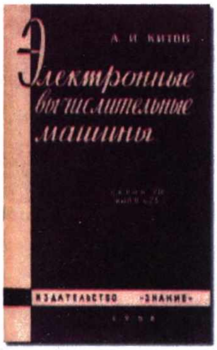


Fig.27. Publication of A.Kitov, in which he first raised the question of the establishment of Unified State Network of Computer Centers (USNCC, EGSVC- in Russian).

The proposals of Kitov, considering computer applications, were introduced in his two letters to the head of the USSR Nikita Khrushchev. Kitov sent his first letter on January 7th 1959 and received understanding in the Soviet political circles and some of the proposed by him measures were implemented. However, his main proposal – the creation of The Nationwide Computer Network for effective and timely economic management of the USSR - was not accepted. The second letter to Khrushchev was sent by Kitov in autumn 1959. His letter contained an even more radical project (named "Red Book") with double functionality - Universal computerization of the management for national economy and military forces based on The Unified Nationwide Computer Network. The creation of such network, according to Kitov, could bring management of the national economy and military forces on a qualitatively new level and liquidate outlined backlog from the USA in the use of computers (as A.Kitov wrote, «to overtake the USA without catching up with them»).

The project "Red Book" caused anger of influential Communist Party and military officials since realization of its ideas seriously limited the power of the Communist Party in the country. The project was rejected, and its author was excluded from the Communist Party (which actually meant civilian death), dismissed from the prestige job with prohibition to occupy command positions. It is indicative that Anatoly Kitov's persecution followed the campaign against writer Boris Pasternak awarded in 1958 the Nobel Prize in literature, and chronologically preceded the persecution of General Petr Grigorenko. These three campaigns revealed that Soviet communist party, wishing to preserve its political monopoly power, toughened its control over arts, science and politics.

2.3 The application of computers for the economy and the creation of automated management systems (AMS) for different levels and purposes

Isaak Bruk proposed the idea of using small computers

Isaac Bruk developed the idea of using small computers for control of industry production and technological processes. In 1957 the Institute of Electronic Control Machines (INEUM) was created for development and design of small control computers. Bruk was appointed as its director. Offers of Bruk on the use of computers in the economy met sharp objections from officials at the State Planning Ministry of the USSR (Gosplan). In 1964 Bruk was forced to resign as director of INEUM.

Twenty years of the Soviet age of automated management systems (AEMSs)

In the 1960s and 1970s, during a period of twenty years, the director of the Kiev Institute of Cybernetics Victor Glushkov was the informal leader of the department "Soviet Automated enterprise management systems (AEMSs)" (*ASU in Russian*). In this department several hundred thousands of Soviet programmers, analytics, engineers, etc. were employed. V.Glushkov applied his theory of automata to enhance construction of computers Dnepr, Promin and MIR. These computers were designed in Kiev under his leadership and produced during the 1960s and1970s.

Since 1964, Glushkov began again to promote Kitov's ideas of creating in the Soviet Union the United state network of computer centers (USNCC or EGSVC). From 1980 Glushkov continued to promote the ideas of this project under new name "OGAS". This time this ambitious project received the opposition of the Ministry of State Planning (Gosplan) and the Ministry of state statistics. In the 1980s, the official interest in this project ended.

Fig. 28. Director of Kiev Institute of Cybernetics Victor Glushkov (1923 – 1982)

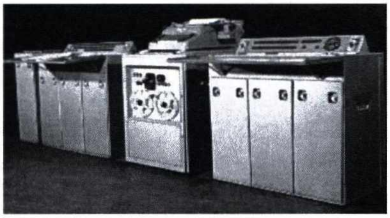


Fig. 29. Computer «Dnepr»

Fig. 30. Computer for engineering calculations Mir

Algorithmic Language for the Programming of Economical and Mathematical tasks ALGEM
ALGEM (Algorithmic Programming Language for the Economy and Mathematics) was designed for the programming of the economic, mathematical, logical and control (including the real time control of the technical systems) tasks. The creator of ALGEM was Anatoly Kitov. In particular, ALGEM was the language for the programs for processing of large (super large at that time) information arrays of complex but determined structure. The first version of ALGEM was developed in 1965.

ALGEM realization and use
In 1967 A. Kitov published the monograph «The programming of informational logical tasks» in which ALGEM was described. This language was realized in the system of computer programming ALGEM ST-3 (ST-3 □ Syntax-directed Translator, 3rd version). The system ALGEM ST-3 was realized on the basis of the second generation computer Minsk-22. ALGEM ST-3 included in Minsk-22 software had several hundred installations in the USSR and was widely used during the development of various applied systems.

ALGEM specifics
ALGEM was the procedure-oriented programming language - that is why Algol-60 was selected as a base for it. ALGEM was mainly designed for practical purposes of industrial programming, while Algol is a classical language for algorithms presenting. The practical orientation of ALGEM determined the deep modification of the basic language and the introduction of serious alterations: new block nesting mechanism, new variable types and also the special advanced instruments for the work with the values densely packed in computer memory cells. In ALGEM there is a possibility to describe the structure of variables by means of declarator shape. It points the quantity and type of symbols contained in variable value. Variables in ALGEM language may be simple and composite. Composite variable contains other variables including composite as well, and in fact it is a record type. Composite arrays are also provided in the language. All these means make it possible for ALGEM to solve specific economic and management tasks at any level (they are also attributable to the systems of real time, in particular to air defense systems). There are also compound operators in the language except blocks. It provides unlimited nesting of blocks and composite operators as well. The operators are the same as in Algol: "assignment" operator, "go to" operator, conditional jump, loop operator. Instead of procedure operator procedure-code operator was introduced.

ALGEM language was very successful product oriented toward industrial programming. It combined the best features of procedure-oriented languages (Algol-60), languages for complex data structures processing (COBOL) and list-processing languages (Lisp, IPL-V). ALGEM realized the principles of Kitov's theory "Associative programming". As a result ALGEM became one of the most popular programming languages in the USSR during the 1970s.

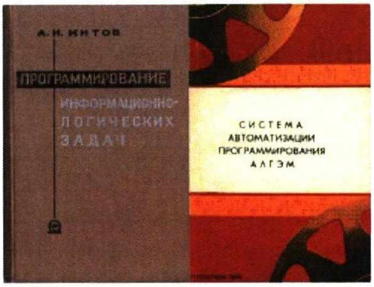


Fig. 31. The book "Programming of Information and Logical Tasks" (1967 and) and the book "Automatisation Programming System "ALGEM" (1970)

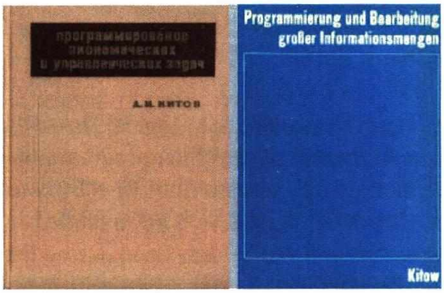


Fig. 32. The book «Programming of Economic and Management Tasks» (1971)

Several words about Soviet Medical Cybernetics

In the early 1970s A.Kitov started developing and implementing the country's first automated control system (ASU in Russian) in the non-manufacturing sector, which was a new excellent innovation. Kitov performed design of automatic management system "Health care". He formed an information model of medical branch, developed standard structure of the system, software packages for information arrays control, developed logic, structure and functional algorithms for information retrieval systems, etc. His principal monograph (1976) written about that project was named "Automation of information processing and management in health care". In 1977 publishing house "Medicine" published his other book, "Introduction to medical cybernetics", and in 1983 another on the subject titled "Medical cybernetics".

2.4. Soviet computers "ES EVM" are the clones of IBM/360 computers. The beginning of the end of Soviet computers

In late 1966, the Soviet Government decided to set up new computers ES EVM (Unified Series Computers) by copying the architecture of computers IBM-360 and borrowing system software of these American computers.

This decision was supported by the head of the Ministry for the production of computers V. Kalmykov, President of the Academy of Sciences M.Keldysh and government officials. Against this decision were most of the scientists mentioned in this article. Kitov said: «Anyone who copies, will always lag behind». However, these scientists were in the minority. Under this ambitious program to create ES EVM the bulk of state finances was allocated. This was done by reducing the funding of Lebedev's and Rameev's computer research centers, Kiev Institute of Cybernetics, and others. Many Soviet research centers and factories were reoriented. Many professionals had to retrain. In university programs, mainly architecture and software IBM / 360 and IBM / 370 computers were included. Other directions of Soviet computers began to decline due to lack of funding, customers and young professionals. Creating computers or copying computers are two completely different things. Established Soviet scientific schools building computers began to decline.

Thus, the Soviet Union began to produce ES EVMusing borrowed from IBM›s system software. In the program codings their names just replaced the letters common in Latin and Cyrillic. So the IBM multi terminal monitor CICS became the Soviet multi terminal monitor KAMA. The database management system IMS became the Soviet similar system OKA, and so on ...

ES EVM showed inflexibility of the Soviet socialist system. The absence of real incentives for work and competition.

There have been rare examples of own system software development. In particular, under the leadership of Vladimir Kitov was created an original (not IBM) multi terminal monitor OB (in Russian ОБЬ – name of a famous Russian river). Multi terminal monitor OB contained several hundred thousand assembler commands and has been used successfully on computers ES EVM in 220 industrial enterprises of the USSR (Moscow Electricity Corporation – MosEnergo, many weapon factories, and others).

Subsequent years have shown the fallacy of this chosen path of the computers **"ES EVM"** development of the Soviet government. As a result, the Soviet computer schools were destroyed. Some people believe that it was one of the most successful operations of the West against the USSR.

Common conclusion

In the 1950s due to S.A.Levedev, I.S.Bruk , B.I.Rameev, Y.Y.Bazilevskiy, A.I.Kitov, M.V.Keldysh, A.N.Tikhonov, A.A. Dorodnitsyn, M.A.Lavrentiev, A.I.Berg, S.L.Sobolev and other Soviet scientists the USSR, together with the United States of America and Great Britain, was among the first three countries in the world in the field of computer science and informatics.

At an early stage of scientific and technological progress, the USSR was able to compete with the West in the then fundamentally important technologies - nuclear weapons, nuclear energy, space and missiles. At the same time, we know that the most important scientific and technological progress in the last decades of the twentieth century occurred in the field of computerization, automation, information technology and telecommunications. Remarkable achievements in these areas were largely due to the development of electronics, the improvement of the element base, things purely technological. There has been a most important breakthrough. And in this, the Soviet Union eventually lost to the West, which played an important role in its collapse.

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2.3. IBM History Milestones in Central and Eastern Europe

Petri Paju

At present, computing historians are not so familiar with western computer business in Central and Eastern Europe during the Cold War and these countries' IT professionals' enduring contacts with developments elsewhere. This short article offers an overview of International Business Machines (IBM) Corporation's business in Central and Eastern Europe from pre-WW II times to the collapse of the Soviet Union in 1991. Because this topic is large and complex, the article focuses on IBM's most important dates and turning points without even trying to contextualize and explain these properly. Let us begin with when and how did the later king of computer trade first enter Central Europe.

The Austro-Hungarian Empire, although not known as an industrial power, was the first European country to use Herman Hollerith's punched card machinery in 1891. Moreover, the "Improved Electrical Tabulator" was produced locally in Vienna based on Hollerith's patents. The machine tabulated the Austrian census.[1] The capital Vienna was the historic center of a larger region also in punched card machines. From 1914 to 1919, Dehomag or Deutsche Hollerith MaschinenGesellschaft ran an office in Vienna that operated in the Austro-Hungarian Empire and the Balkan countries. This operation was discontinued by the demise of the empire. After the First World War, IBM (then still called C-T-R) started taking over the Hollerith business in the former Habsburg Empire and beyond.[2]

In the 1920s and 1930s, IBM entered and developed in the new countries of Central and Eastern Europe. In 1927, among the early ones in all of Europe, IBM established a subsidiary in Czechoslovakia and already in 1930 it started a punched card plant in Prague. These were the first subsidiary and the first plant in the region that was later called Eastern Europe. IBM Hungary was established in 1936. In addition to Czechoslovakia and Hungary, IBM opened national subsidiaries in Poland, Yugoslavia, Bulgaria and Romania. In the 1930s, the companies in Czechoslovakia, Poland and soon Hungary built a punched card plant.[3]

The war years brought a severe rupture to IBM's operations. Less than a year after the Second World War ended in Europe, an IBM report estimated that the outlook for the company was favorable there. Yet unlike the considerable increases in demand in many Western European countries, Eastern Europe continued in a deadlock situation, except for Czechoslovakia where business was normal and predicted as getting back in the usual ways in 1947.[4] However, the communist coup d'état in Czechoslovakia in February 1948 led IBM into difficulties in that country too.

In some countries, such as Hungary, IBM continued to operate. Regarding the Hungarian census in 1949–1950, one student of computing history wrote: "A team was assembled for the Central Statistics Office, which used [IBM, author's addition] punched-card machines to process the

1 Heide 2009, 129–131.

2 Connolly 1967, E-1, E-3.

3 Connolly 1967, passim. On similar IBM plants, see Paju 2011.

4 Report on IBM Foreign operations, March 11, 1946. World Trade Corporation/history, 1946-1964. RG 6, World Trade Corporation. Box 1. IBM Archive, Somers, New York.

census data. This team later formed the core of the coordinating authority for national electronic data processing."[5]

Then followed the 1950s: the remnants of IBM struggled in Eastern Europe while the corporation designed and built computer technology for the military and soon for business customers in the United States of America. Thomas J. Watson Jr. who led IBM into the computer age, concluded: "It was the Cold War that helped IBM make itself the king of the computer business."[6]

In Eastern Europe, the breakthrough for IBM came in 1965 when IBM World Trade Corporation set up the "Austria Control Centre" in Vienna, Austria. Its mission was to develop IBM business in the Eastern bloc. Thus, this IBM's special office was able to start business beyond the Iron Curtain and to compete with other western manufacturers who had already been able to sell some computers to socialist customers.

Already in late 1965, the US Commerce department in a show in Budapest, Hungary exhibited an IBM 1440 machine, a low-cost system for smaller businesses. "Then an IBM team was sent to a Czech trade show in June 1966 with a 1410 computer (much to the discomfiture of British exhibitors)."[7] Hungary for instance purchased its very first IBM computer in 1967; the small-sized System/360 Model 20.[8]

The Control Centre was renamed IBM Regional Office Europe Central and East (ROECE). IBM ROECE hired a multinational staff for its transnational operations in the so-called Iron Curtain countries. Many of these experts were assignees from other IBM subsidiaries. ROECE had its headquarters in Vienna and operations in Yugoslavia, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and later Albania. The business in these countries was not free but heavily regulated. Nevertheless, it could happen and genuine IBM-sold computers were delivered. According to an internal IBM magazine, it was one of the most multinational operations in IBM, with an unusually high percentage of foreign assignees. The ROECE reported back to the IBM's World Trade headquarters in New York and European headquarters in Paris.[9]

Separately, in principle at least, IBM's sales to the USSR started officially in 1971 when IBM World Trade Corporation, in practice IBM ROECE with help from IBM Finland, took part in a large computer and office products exhibition in Leningrad.[10]

By early 1976, after ten years in operation, ROECE had sold or rented (over) 300 IBM systems. IBM had delivered half of these, mainly small and medium-sized systems, to Yugoslavia, which was not part of Comecon or subject to embargo regulations.[11] Meanwhile, since the decision in

5 Szentgyörgyi 1999, 50.
6 Watson &Petre 1990, 230.
7 Foy 1975, 163.
8 Connolly 1967, E-46.
9 "PioneerihenkeäROECE:ssa." (Pioneering spirit in ROECE, in Finnish.) *IBM Uutiset*, vol. 6, 7/1971, 6–7. (Kirj. ilm. toimittajaKatriKettunen.) *IBM Uutiset* was the personnel magazine of IBM Finland.
10"Systemotechnica -71:llä alkoi myyntimme Nl:oon." (Our sales in the USSR began with the Systemotechnica -71 (exhibit), in Finnish.) *IBM Uutiset*, vol. 6, 7/1971, 8–10. (Author was probably the editor KatriKettunen.)
11"IBM ROECE lieferte 300 Rechner in den Ostblock. Eastward ho, Computer." Computerwoche, Ausgabe 8/1976, 20.02.1976.

approximately 1968, the Soviet Union had led the building of the socialist camp's own version of the IBM System 360 mainframes called the Unified System computers. These modified copies of IBM and other computers were both produced and delivered in the Eastern European countries, making their mix of IBM influenced hardware and software unique in the global scale.[12]

Although the early 1980s were again difficult times for IBM because of the increasing embargo control against the Eastern bloc countries, the IBM Personal Computer that was launched in the US in 1981 soon found its way to Eastern Europe. For instance, a Hungarian PC called Proper 16 and based on reverse engineering of the original IBM PC came out in 1982. Already in the late 1980s, these Hungarian PCs were made from parts manufactured in the Far East.[13]

After the regime change in 1989–1990, IBM invested early on in Central and East European countries, re-established many national companies, created new plants and transferred work from its Western European subsidiaries to the East, especially in the corporation's major reorganization in the 1990s. Today, in addition to their important present operations, the IBM companies in the former Eastern bloc have interesting and indeed unique histories that have only been touched upon here.

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12 SeeCortada 2012, 255–258.
13 Képes&Álló 2013, 175, 177.

3. National Developments

3.1. History of Bulgarian Computing

Kiril Boyanov

The history of Bulgarian Computing starts in the mid 1930s when Bulgaria imports "Powers" punching-card machines for statistical purposes. The first IBM punch-card machines are hired for the needs of the railways, mining, insurance, and statistics in 1937. During those years, Bulgaria starts importing various mechanical and electromechanical machines and devices for accounting, to be used in different organizations and enterprises. Most of these machines were widely used until the 1960s. During the 1950s, the banking institutions and clerical departments of various organizations use punching-card and electromechanical machines not only for accounting but also for solving banking and insurance tasks.

In the 1950s, Bulgarian scientists were acquainted with the major tendencies in cybernetics, and the abilities of the computers at that time. Bulgaria imported the French computer "Gamma 10" in 1962, and the Bulgarian company "Balkankar" acquired IBM 1460 in 1963. The establishment of the first Computing Center at the Institute of Mathematics at the Bulgarian Academy of Sciences (BAS) in the spring of 1961 marks the birth of the Bulgarian electronic computing. In the center, under the leadership of Prof. L. Iliev, the first Bulgarian computer - "Vitosha" was designed, built and was fully functioning at the end of 1963. "Vitosha" is a computer with about 1500 tubes, and set of 32 instructions using index registers. Its main memory was based on magnetic drum and had 4096 words. The programming was in machine code. In the team, which designed and developed the first machine were G. Alipiev, R. Aslanyan, K. Boyanov, M. Dimitrova, D. Bogdanov, E. Kurmakov, S. Pashev, D. Rachev, Bl. Sendov, I. Stanchev, I. Yulzari.

The word size of the machine was of 40 bits and represented: fixed-point integer in two's complement representation, two one-address commands (instructions). They are represented in octal numeral system. The main blocks of the machine are: Arithmetic unit, Control unit, Main memory, Input device, Output device (fig.1). The main registers of the machines are latches, built on the double triode ECC 862. The electronic circuits are built on changeable modules (fig.2).

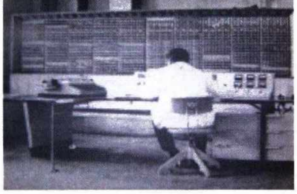

Fig. 1

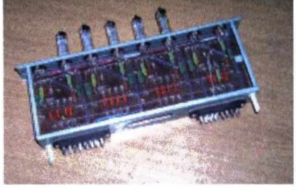

Fig.2

The construction of the machine is about 4 meters long and 2 meters high, where some 200 modules and the magnetic drum are situated. The average time for access to data is 10 ms, the recording system is two levels with return to zero. The input device is punched tape operating at a speed of 7 lines per second. The output device uses electrical typewriter with wide roller and it reaches a speed of 15 characters per second, converting the numbers from binary into decimal by a program. The cooling of the machine is mandatory. The total power consumption is 12 kW. The power supply is 220/380 volts and is stabilized by motor-generator group. The control of the machine is carried by a control panel at the front.

The Russian machine Minsk 2 was installed in the Institute of Mathematics with Computing Center (IMCC) in 1964. A team of mathematicians and engineers enhanced the software for tasks from scientific and research institutes and design organizations.

The first Bulgarian electronic calculator – ELKA was designed in 1965 at IMCC by St. Angelov, L. Antonov and P. Popov. This was a significant achievement of its time, having in mind that there were only three known devices in the world of this kind (products of "IME-84," "FRIDEN" and "ANITA"). The calculator used transistors, it had 16 bit registers with a number of advantages and improvements compared to the existing at the market at that time: square root, integer division, average numbers, fixing of decimal point with rounding up, etc. ELKA found soon a wide number of applications and became rapidly employed. Following it was the design of a series of calculators ELKA 22, ELKA 25 (with printer). The Scientific and research institute on electronic calculators (NIPKIEK) was found in 1969. The first calculators on Integrated Circuits – ELKA 42 were developed. This was the model, Bulgaria presented at the World's Fair EXPO 1970 in Osaka and this was the only calculator built using IC – at the top level at the time.

The design of ELKA 42 was with MOST IC – the UNIMOST series, developed in the Institute of microelectronics and it consisted of standard set of counters, latches, and logical elements.

The logical circuits of the calculator were realized in "logical matrixes". According to modern terminology – micro-programmed ROM. The unification improved significantly the technical and economical features of the products. The next series are ELKA 50, ELKA 55 where new Bulgarian electronic circuits are embedded with some 1000 elements in a 24 pin chip. This allowed the number of IC to be up to ten. Due to the use of structures of the type "logical matrixes", a new calculator with new design, smaller dimensions and weight was created – ELKA 40. Four bit microprocessor configuration CM-500 was developed. These were the first in the country and in the socialist block 4-bit microprocessor series. Using them, ELKA 51 was produced, where the number of MOS IC was reduced from 10 to 4.

Pocket calculators ELKA 130 and ELKA 135 were produced following an order of a Swiss company and 50 000 have been exported to Switzerland and also some quantity for Italy.

The period from 1964 when the first calculator was developed until 1974, when the last calculators using domestic IC, was a very successful one both in technological and production terms. The design and production of calculators in Bulgaria stimulated the development of many technologies in Bulgaria – for example – the printed circuits board technology.

The microelectronic was developed because it had the specific task to create and produce calculators. Since the foundation of the Plant for microelements in Botevgrad, the main user of those elements, starting with germanium transistors was the calculator production, and then followed the integrated circuits – the UNIMOS series, which had small and medium level of integration and last came the microprocessor systems for calculators and other automats.

The most original solution of the UNIMOS series was the universal base IC: counters, registers, logical blocks, etc.

The Institute of microelectronics was one of the institutes that started production of IC for calculators and reached modern IC on MOST technology. Its first director – corresponding member of BAS Yordan Kasabov, a prominent scientist and constructor left us rather early. His followers – I. Zarkov and K. Filiov did a lot for its growth.

For the period 1971-1985 Bulgaria exports calculators at a volume of more than 480 million leva, including countries in the West – for 4 million leva. In their design a number of prominent experts take part: L. Antonov, Y. Kasabov, S. Hritova, V. Chilov, D. Shishkov, I. Stanchev, V. Elenkov, Z. Aleksandrova, E. Parvanova, I. Staneva, Y. Petkov, G. Ganchev, G. Kazandjiev, E. Pandov, M. Zaharieva, G. Chakyrov, M. Medarov, I. Minchev, P. Gerginov, D. Borshukov, S. Nachev, I. Zarkov, Ch. Bogoev, D. Vateva, D. Peshin, S. Hovanesyan, etc.

In 1965, under the directions of Prof. I. Popov – Head of the State committee for scientific and technical progress, a decision of the Council of Ministers (CM) on the development of the computing and organizational technique has been prepared. Experts from IMCC - E. Karmakov, S. Srebrev, P. Popov, B. Bonchev, B. Hristova traveled to Japan. Upon their return in Bulgaria, under the leadership of I. Marangozov, they started the design of the ZIT 151 machine, following a license of the Japanese company FACOM. In the Plant for Computing Technique in Sofia, 20 machines have been produced. Following a decision of the CM № 25 from March 1st 1966, a group of experts from IMCC, working in the field of computing and software is transferred to a newly established Central Institute for Computing Technique (CICT) with 233 employees out of which 101 experts with university education and 24 research associates. In 1980 IMCC provides the fertile environment that allows CICT to have some 2700-3000 staff out of which 1/3 was research associates and experts.

At the beginning of 1967, DSO "IZOT" was established, which in a very short period of time created a base for modern industrial production of computing systems and devices. According to data from V. Nedev, for just 17 years, DSO "IZOT" provided income for Bulgaria for 11,230 billion currency leva and a profit of 6.480 billion leva, while the expenses were only 633,350 million leva. Here the proper credit should be given to the professionals, who under the leadership of Prof. Ivan Popov formed the national policy in the area of Computer science. The general directors of DSO "IZOT" that actively participated were S. Chavdarov, V. Nedev, I. Tenev, A. Shopov, as well as other economic managers: S. Markov, P. Kisyov, J. Mladenov, A. Stamenov, L. Vitanov, L. Kozlev, V. Hubchev, L. Guturanov, V. Tzarevski, P. Vachkov, M. Marinov, D. Dimov, A. Trifonov, etc. A long-term strategy with clear objectives was prepared, with specific intentions in which areas Bulgaria should produce what its specialization should be and in what directions the efforts must be aimed. The development of the first products, that were compatible with Western products started soon. For example – IBM for mainframes and DEC for mini machines.

The design and construction of the Plant for mechanical constructions in Blagoevgrad, the Plant for magnetic disks in Stara Zagora, the Plant for printed circuit boards in Ruse, the Plant for magnetic tapes in Plovdiv, the Plant for magnetic-disk packets in Pazardjik and the Plant for instruments and non-standard equipment in Shumen started in 1970.

In the DSO "IZOT" system a number of organizations worked very successfully – CICT, NIPKIEK, the foreign trade organization IZOTSERVIZ and one for the design of systems – SISTEMIZOT.

The Eastern bloc countries (COMECON) established an Intergovernmental Commission for Cooperation in the area of Computing in 1969. One of the founders and Bulgarian member of the commission was Prof. Ivan Popov. He is regarded to be the founder of the Bulgarian Computing industry. The main task of the Commission was coordination of the promotion and manufacturing of the computers within COMECON. The Commission took a decision to develop and start production of a Unified Series (US) of computers and software for them. This concept was adopted because the import of such products from the developed countries required hard currency. USSR, Bulgaria, Hungary, Poland, East Germany, Czechoslovakia were the first participants in the design and production of the products from the US. Cuba and Romania joined the Commission in 1973.

The Executive Boards of the Commission were a Coordination Center based in Moscow and the Council of the Chief Constructors. Several Councils were established - for mainframes, minicomputers, personal computers, etc. Each Council consisted of representatives from each member country - in most cases the director of a leading institute in a country. In the Council of the Chief Constructors Bulgarian representatives were: for mainframes – A. Angelov and Zh. Zhelezov, for mini-computers – S. Srebrev and V. Elenkov, for personal computers – K. Boyanov.

At the councils of the Chief Constructors have been organized councils of experts on the main computer system blocks: architecture, Input/Output devices, storage devices, channels and interfaces, software, standards and documentation, etc. In each council several experts from each country have been nominated. The councils gather on regular basis 2-3 times per year and the meetings are held mainly in Moscow in one of the buildings of NICEVT (scientific and research center on electronic and computing technique), known as "Detskij sad" (Kindergarden). The member countries have also hosted meetings on a rotating principle.

The unified series of computers (US C) was also known as "RYAD". This name meant machine family with growing performance and program/software compatibility – the software working on the models with lower performance should also work on the models with higher performance. The technological and constructive bases were unified in term of use of standard integrated circuits (IC) and common constructive parts. The main elements of the construction were standardized, unified codes and security access levels were introduced and unified connection of the devices (standard interface) was used. The adopted standardization led to favorable environment for international labor division during the design and production of the systems and the various devices. This allowed to great extend to facilitate the use and service of the products. A naming scheme for the devices of the Unified Series was adopted – code – the letters EC (for Unified Series) and four digit numbers.

The first digit of the number defines the class of the device, following the classification: 0 – nodes and components, 1 – computing systems, 2 – CPU, 3 – main memory, 4 – channels (interfaces), 5 – external storage devices and their control, 6 – input devices, 7 – output devices (print, etc), 8 – teleprocessing devices, 9 – preprocessing data devices.
The second digit carries the classification further and denotes a group of devices – for example – 50 denotes external storage, 55 – control for external storage, teleprocessing devices start with 8, 80 is the code for modem, 81 – for error protection, 84 – for multiplexors, 85 – for terminals.

The third digit concerns the parameters of the devices and those from certain group can be further subdivided according to the most important parameters. For the computing machines this number shows the models with better performance: EC1010, EC1020, EC1030, etc.

The fourth digit is used to denote the various devices in a subgroup or their modification.

As an example, let us look at the EC1020 system. Central processor (CPU) – EC 2020, console with typewriter EC 7074, punch card input device EC 6012, printing device EC 7071, magnetic tape control device – EC 5512, magnetic tape storage EC 5012, disk storage control device EC 5552, magnetic disk storage device EC 5052.

A similar system was deployed for the design and development of minicomputers, where the family was known as (CM). During time, the coding system (the digit) was modified according to the new requirements and technologies. Integral circuits were built using TTL in addition with silicon semi-conductor elements. Gradually ECL, big IC and others were introduced. The unified construction nodes were four: printed circuit board (TEZ – type element for change), cassette, frame and cabinet. The printed circuit boards were standardized and with the change of technologies, new standards were introduced. The consolidation of the boards was in cassettes.

The cassettes were mounted in frames and the lower part of the frame accommodated the power supply and the ventilation blocks. The last level – the cabinet, allowed placement of up to 3 frames. For the rest of the devices that were outside the CPU, unified constructive elements were used, according to their specific technical requirements.

The production of computing systems and devices had to be in line with the Unified system for constructor's documentation (ESKD). This system encompasses technical and organizational requirements that lead to documentation exchange between various enterprises. ESKD allowed enhancement and unification during the design and development of industrial goods, simplified the form of various documents and allowed for their automation. It was compliant with the adopted standardization documents in COMECON and was constantly improved in accordance to the introduction of new technologies. Several classification groups of standards were drafted and each one of them had the option of including 99 standards.

Bulgarian computing advanced in three main directions: mainframes, mini and personal computers, disk and magnetic tapes systems.

The mainframe machines from the Unified System (US) - EC 1020, EC 1022, EC 1035, EC 1037 were sold primarily in the Eastern block countries. The very first mainframe computer produced from this series was EC 1020. It was a result of the joint efforts of a Bulgarian team from the "Central Institute for Computing Technique" in Sofia and a team from the "Scientific Research Institute for Computing" in Minsk (НИИЭВМ). The computer was compatible with IBM 360/40. Amongst the Russian specialists were G. Lopato, V Prijalkovski, G. Smirnov, N. Maltzev, V Kachkov, R. Astzagurov, A. Fleorov, etc. On the Bulgarian side were S. Angelov, G. Alipiev, K. Boyanov, S. Srebrev, N. Sinyagina, V. Lazarov, T. Velichkov, I. Georgiev, N. Ganchev, B. Drumev, K. Batmazian, S. Namliev, P. Popov, V. Kisimov, R. Papazov, T. Kanchev, H. Turlakov, G. Hadjidimitrov, I. Dalbokov, K. Yanev, Y. Raikov, N. Sherev, G. Ganchev, G. Draganov, N. Ikonomov, Z. Zlatev, M. Ivanova, K. Kirov, I. Minev, D. Petrov, P. Daskalov, K. Stankov, A. Spasov, A. Takov, etc.

EC 1020 had micro programmed control with 142 instructions, 256 KB main memory with a cycle of 2 μsec and performance of 10 000 operations per second. It had 1 multiplex and 2 selector channels at speed of 200 KB/sec. Eight controllers for peripheral devices could be attached to each channel. The improved version of that machine - EC 1022 had performance up to 0.08 MIPS.

The capacity of the main memory was up to 512 KB. Both EC 1020 and EC 1022 were software compatible with the IBM 360 series machines. The next stage of the main frame development was the EC 1035 machine, a joint development with НИИЭВМ, from Minsk (Belorussia).

The production of this machine started in 1978 and it was capable of producing 200 thousand operations per second. The maximum volume of main memory was 1 MB, the number of channels was increased to 5, with improved throughput of 1MB/sec. An important characteristic for EC 1035 was that it used not a disk based OS (like EC 1020 and EC 1022) but OS 6.1 and operational system OS 351, which is compatible with the IBM 370 architecture.

The development of EC 1035 is an important moment in the history of the creation of mainframes as a number of new devices with bigger capacity was designed for it – disk and tape subsystems. The joint teams that developed EC 1035 overcame the significant difficulties with the transition to the new technology.

The first independent design of electronic computer in Bulgaria was of EC 1037, the production of which started in 1987 (fig.3). EC 1037 is mid class universal computer aimed at solving a wide number of technical and economical tasks and is compatible with the systems built on the IBM 370 architecture. It was alternative to the models IBM 4331 and IBM 4341. It had CPU, disks using the Winchester technology and tape device with improved characteristics. The system included character-digit printing device EC 7033 M, punched card input device EC 6019, multi-console station EC 8566, processor for video data processing EC 8371, matrix processors EC 2706 and EC 2707. The processor performance was about 2 million operations per second and the main memory varied between 2 and 16 MB. The data speed transfer reached 2 MB, while in the byte-multiplex channel it went up to 350 KB. The channel subsystem had up to 12 modified channels, each of which could work in each of the following modes: multiplex, block-multiplex, selector. A special service subsystem supported the link between the operator and the computer and additionally carried out control and diagnostic services for the processor. The diagnostic system was very well designed. Matrix processors produced in Bulgaria could have been attached to EC 1037. Using this machine, the Institute of space research in Moscow has been controlling the space station "Vega". The team that carried out the design included: V. Lazarov, D. Minev, E. Naumov, Z. Yancheva, Z. Zlatev, Y. Ivanova, K. Kirov, M. Tashev, M. Ivanova, D. Petrov, P. Popov, O. Kostadinov, P. Daskalov, S. Serbezov, T. Velichkov, N. Tashev, F. Filipov, H. Setyan, P. Kozhuharov.

Fig 3

The development of the first Bulgarian mini-computer started in 1974, using as a prototype PDP8L of the company DEC. The mini-computer was known as IZOT 310 and its word was 8 bits and time for execution of the instruction- 2-12 μsec, main memory – 64 KB and UNIBUS interface.

With a decision of the Intergovernmental Commission for Cooperation a development of series of mini-computers started - CM2, CM3, CM4, which are compatible with DEC's PDP11/34, VAX11/730, and VAX11/750.

In organizational aspect, the policy remained the same – Council of Chief Constructors on minicomputers and specialization of various countries. 16 and 32 bit mini-computers were designed. The former had a processor cycle of 0,2 – 0,4 μsec, main memory up to 124 KB, UNIBUS interface, while the later had main memory of 2 MB and UNIBUS interface.

Bulgaria has been designing the models CM 1426 (IZOT 1054 C), CM 1706 (IZOT 1055 C), CM 1504 (IZOT 1056). The team working on the series of mini-computers was: S. Srebrev, K. Boyadjiev, I. Aleksiev, P. Popov, N. Gelibolyan, A. Velichkov, G. Kukureshkov, A. Kamenov, L. Bonchev, T. Valchev, B. Simeonov, Y. Yankova, D. Micev, M. Angelova, K. Cocheva, etc.

The design and development of personal computers in Bulgaria started at the end of the 1970-ies, when in the Institute of technical cybernetics at BAS, Inko1 was presented. Its constructor was Ivan Marangozov, who, together with his team was successful in developing a working model of the famous at its time Apple computer. In the next few years, a powerful modern technical base was created, which allowed the production of these computers.

Following a reorganization of the Institute of technical cybernetics in 1978, work on the next generation personal computers, IBM compatible, started. In such way Pravetz 8 appeared (still Apple compatible), and soon after that – Pravetz 16, which was IBM XT/AT compatible. The first personal computer that was distributed in a wider scale was Pravetz 82, being in serial production since 1982. It had main memory of 48 KB and had options for graphical mode, which allowed use of color monitor.

The personal computer IZOT 1031, which has been designed in CICT, went into production in 1984. It was compatible with Atari 3. The construction was based on the Z80 microprocessor and had main memory of 64 KB. The chief constructor of this personal computer was Vladimir Chilov with a team of very capable experts.

The production of Pravetz 8 was software compatible with Apple 2E and started in 1987. It used new hardware solutions and the main hardware base was with elements of Bulgarian production. The main memory was enhanced to 1 MB.

In parallel with the perfection of the 8-bit personal computers, the teams of I. Marangozov and Vl. Chilov designed 16 bit personal computers. The production of Pravetz 16, which was build using the processors 8086 and 8088 and was software compatible with IBM PC/XT, started in 1985. Its basic configuration included 256 KB main memory, which could be enhanced to 640 KB, two floppy disk devices, each with capacity up to 500 KB, video controller and color monitor. Additional modules for main memory enhancement, for parallel interface, for hard disks had been created. The production of the improved model Pravetz 16A started in 1987. These models had been designed under the leadership of I. Marangozov and a team – G. Zhelezov, K. Dosev, N. Popov, P. Petrov, K. Koruchev, G. Georgiev, etc.

Since 1987 started the production of: Pravetz 16I, which is a laptop with embedded monitor and up to 3 floppy disk devices, Pravetz 16V – with vertical construction and reduced size, with two 5.25 inch floppy disk devices, and Pravetz 16A, which is a desktop personal computer. For those personal computers, a number of additional modules on the basis of Intel 8087 and Intel 80286 have been developed – such are the 2 MB main memory module, controllers for external storage, color video controllers with high resolution, LAN adapters, and interface adapters for the IEEE 488, RS 232 and RS 432 standards.

The cooperative "Microprocessor system" with general director Plamen Vachkov was founded in 1987. It developed in a very short period of time its base, including in it the newly created Institute of microprocessor technique in Sofia, the Plant for microprocessor system in Pravetz, the Plant for power supply devices "Analikik" in Mihailovgrad (today Montana), the Plant "Elektronika" in Gabrovo, the Plant for printed circuit boards in Pravetz, the Plant for production of instrumental equipment in Gorna Malina.

The personal computer IZOT 1036 (EC 1831) was created in CICT in 1985 and started being produced, being used mainly as intelligent terminal. The personal computers IZOT 1036 (EC 1831) and IZOT 1037 (EC 1832) were adopted for production in the factories of the newly created union "Inkoms" in Veliko Tarnovo and Silistra. These personal computers were developed by teams with leaders Hristo Turlakov and Todor Kanchev with the following experts: N. Vecev, V. Getov, A. Simeonov, O. Gorchakov, S. Machev, N. Petrov, V. Barbutov, S. Voinov, M. Simeonova, S. Stanchev, B. Filipov, N. Dabov, S. Dimitrov.

The personal computer Pravetz 286(EC 1838), based on Intel's 20286 microprocessors, was created in the Institute for microprocessor technique (director K. Boyanov) at the end of 1986 and later adopted in production. It had main memory 3 MB, address space – 16 MB, multi-layer and color graphical monitor with options for use of arithmetic coprocessor, synchronous and asynchronous communication modules, and controllers for LAN with ring and bus topology. The developing team was led by Zlatka Alexandrova and prominent experts: S. Pishtalov, I. Saraivanov, D. Lilov, Y. Visulchev, E. Aleksieva, B. Bachvarova, N. Germanova, H. Karagetliev, Sh. Koen, G. Marinov, L. Nedeva, S. Rashkova, M. Ribarska, K. Todorov, M. Treneva, I. Cankova, A. Aleksandrov.

The creation of external storage started in 1970 when the first storage device, magnetic tape – analogue of Fakom 603E was produced. On the basis of the experience gathered by the leadership of Ivan Arshinkov, in 1971, the first product of the Unified System – a magnetic tape storage device EC 5012/01 was designed. The mini-tape device IZOT 5003 was adopted in 1975. During the next couple of years, a series of storage devices on magnetic tape had been manufactured. At the end of the 1970-ies, a quality improvement of their parameters took place – phase modulation was introduced and also automatic load of the magnetic tape and a group-coded write method. Magnetic heads with hard chrome and ceramic coat were adopted. During the 1980-ies, a number of devices with dataflow mode of operation had been developed. Some modifications of magnetic tape storage devices and their parameters are given in Table 1. For the control of the devices – the appropriate controllers had been manufactured.

Table 1

Tape Drives Production				
EC 5012.03	real tape unit	96 KB/s	32 bits/mm	1972
EC 5612	real tape unit	190 KB/s	63 bits/mm	1977
EC 5026	real tape unit	492 KB/s	246 bits/mm	1985
EC 5027	real tape unit	738 kB/s	246 bits/mm	1986
EC 5028	real tape unit	1230 KB/s	246 bits/mm	1988
EC 5710	stream tape unit	160 KB/s	63 bits/mm	1987
	20 MB cartridge tape unit	90 KB/s	394 bits/mm	1988
	60 MB cartridge tape unit	55 KB/s	315 bits/mm	1989

The team that has developed the magnetic tape storage devices and the controllers for them was: I. Arshinkov, D. Dyakov, H. Momerin, T. Popov, M. Kolarov, L. Markov, M. Strahilova, I. Dimitrov, T. Topalov, M. Tarpesheva, Y. Raikov, A. Spasov, P. Manolov, H. Rashev, K. Stankov, V. Tenev, L. Fenerdjiev, etc.

The design of an external storage device with magnetic disk was carried out under the leadership of Zhivko Paskalev, having disk packages developed for it. In the next couple of years, a series of magnetic disks had been adopted for both the Unified Series of machines and the mini-machines series.

Disk devices for personal computers have been developed in 1985. Table 2 lists some of the manufactured products. In parallel, controllers, disk packages and floppy disks were created.

Table 2

Disk Drives Production				
EC 5052	7,5 MB	disk driver 14"	156 KB/s	1971
EC 5061	29 MB	disk driver 14"	312 KB/s	1973
EC 5066.01	100 MB	disk driver 14"	806 KB/s	1977
EC 5067	200 MB	disk driver 14"	806 KB/s	1977
EC 5063	317 MB	disk driver 14"	Winchester	1982
EC 5063	635 MB	disk driver 14"	Winchester	1986
CM 5508	10 MB	disk driver 5,25"	Winchester	1987
CM 5510	160 MB	disk driver 3,5"	Winchester	1990

The team that developed these products was: Zh. Paskalev, N. Botev, B. Conev, B. Hristova, B. Cenkulov, L. Yordanov, K. Mitev, L. Petrov, G. Mutafov, I. Kovachev, V. Denishev, R. Kadijska, A. Blagoeva, M. Avramova, D. Aleksandrov, D. Todorov, L. Mihov, N. Sinyagina, G. Malinovski, O. Carnorechki, etc.

In 1984, the design and development of teleprocessing systems begun. The ESTEL system had been assembled, including a machine from the Unified System, multiplexor, modems and terminal devices.

Software was also written, including base software and application programs for a wide range of problems. Different devices for computer networks had been developed: multiplexors, synchronous and asynchronous adapters, etc. Members of the team were: I. Yulzari, K. Vitanov, V. Altanov, V. Videv, A. Dochev, Z. Zlatev, R. Iliev, E. Yonchev, S. Karagyozov, A. Matrazov, P. Pavlov, M. Grueva, R. Savov, T. Kanchev, G. Hadjidimitrov, K. Yanev, E. Dimitrov, V. Markov, V. Vladova, A. Pamukchiev, P. Chernokozhev, B. Raichev, M. Petrov, S. Basmadjieva, L. Zabunov, B. Iliev, S. Krastev, I. Vladikov, V. Damyanova, etc.

The industrial organization in Bulgaria could have been viewed in hierarchical structure. The plants and enterprises belonged to 3 groups.

The plants for main components and base clients belonged to the first group; for big components for the computers, which can be sold as separate devices – to the second group, the plants for computers, end devices and complex system – to the third group. Close links with mutual dependencies and coordination existed between the plants, which led to good management and effective production. During the development of the computing industry some important production areas were neglected, mainly in the field of microelectronics and passive elements. For them, the country relied on the cooperation with various socialist countries but later it became evident that this approach did not lead to very good results. In total, in the area of computing, more than 30 plants were functioning, some of which are listed below.

The first group included:

1. **The Plant for printed circuit boards and technological devices in Russe.** It had a capacity of production of 30 000 to 50 000 square meters printed circuit boards per year. The plant had about 2500 employees.
2. **The Plant for mechanical constructions in Blagoevgrad.** It produced mechanical constructions for mainframes and mini-computers, cases for personal computers, constructions for magnetic disk and magnetic tape devices, etc. The plant was had about 1800 employees.
3. **The Plant for instrumental equipment and non-standard equipment in Shumen.** In that plant, instruments, plastic press forms, stations, matrices, and others were designed and manufactured. It had a well-developed constructor-design unit and more than 1500 workers and engineers that created more than 5000 instruments annually.
4. **The Plant for power supply devices in Harmanly.** It produced various power supply devices: traditional, high-frequency and no-transformer for mainframes and mini-computers, and also for disk and tape devices.
5. **The Plant for magnetic heads in Razlog.** The plant had 1500 employees and used to produce big quantities of magnet heads for tape and disk devices.
6. **The Plant on electronics in Gabrovo.** It produced keyboards for terminals and personal computers, digitizers, various types of plotters, etc. The plant had more than 800 employees.

The second group included:

1. **The Plant for magnetic disks (ZZU) in Stara Zagora.** This was the most advanced and modern plant in the Bulgarian machine building and electronics. It used to produce magnetic disks for the countries of the ex-socialist block. It had an export for other countries as well, and the annual export exceeded 1.2 billion rubles, which was more than 1 billion dollars at the exchange rate at the time. The plant had more than 5000 employees and had excellent for its time equipment.
2. **The Plant for magnetic tapes (ZZU) in Plovdiv.** It was the second most important in the Bulgarian electronics, where magnetic tape devices for mainframes and mini-computers were produced, and also devices for data preprocessing.
3. **The Plant for magnetic disks in Pazardjik.** It manufactured changeable packets and after the introduction of new technologies, it started producing videocassettes, floppy-disk devices and test systems. It had more than 1500 highly trained employees.
4. **The Plant for typewriters in Plovdiv.** Its yearly production reached 200 000 portative mechanical typewriters. The plant used to assemble copying machines following according to a cooperation agreement with the Rank Xerox company.

The third group included the plants for final production:

1. **The Plant for computing technique in Sofia** was one of the oldest in "IZOT". It manufactured predominantly mainframes.
2. **The "Elektronika" plant in Sofia.** It has a profile for the production of mini-computers, compatible with DEC machines, series PDP 11 and VAX 730/750. Its employees were almost 2000 and yearly turnover of 1700 million dollars.
3. **The Plant for systems and teleprocessing in Veliko Turnovo.** It manufactured products for teleprocessing, close range converters, magnetic tape devices, modems, etc. The plant had about 1500 employees.
4. **The Plant for personal computers production in Pravetz.** It united 3 plants: for printed

circuit boards, for mechanical constructions and for personal computer assembly. The later was equipped with production pipelines, fully automated with a capacity for production of 100 000 computers per year. The plant had more than 2000 employees.

During the period 1975-1989, the Bulgarian share of export of computers, computing devices and software products reached 40% of the total volume of exports within COMECON. This industry employed more than 120000 people in 9 companies (tables 3 and 4).

Table 3

CMEA Countries									
Export (mil.rubles)	Total	Bulgaria	Hungary	DDR	Cuba	Poland	Romania	USSR	Czecho-slovakia
	3174	1653	245	472	14.6	404	36	153	197
%	100%	52%	7.7%	14.9%	0.46%	12.7%	1.13%	4.81%	6.21%
Import (mil.rubles)	3174	36	28.6	223	28	80.7	67.7	2390	321
%	100%	1.14%	0.9%	7.02%	0.88%	2.54%	2.13%	75.3%	10.1%
Total turnover (mil.rubles)	6348	1689	273.6	695	42.6	484.7	103.7	2543	518
%	100%	26.6%	4.3%	10.1%	0.67%	7.63%	1.63%	40%	8.17%

Table 4

Year	**1980**	**1985**	**1988**	**1990**
Total amount of enterprises	144	165	204	206
Total personal involved (thousands)	126	148	169	181
Percent of total Bulgarian labor force	9.3%	10.6%	11.7%	13.1%
Assets (mil.USD)	1154	1935	3162	3949
Total production (mil.USD)	3861	4951	7387	5436
Percent from Bulgarian total Industrial production	9.3%	11%	14.5%	12%

The volume of export had been very big for a small country like Bulgaria and the profit from these products was very big, far more than 20-22% (for some products it exceeded 200-300%), i.e. the maximum for a market economy. One reason for this was the special position of the computer industry and electronics, as such products were still in high demand on the market of the ex-socialist countries and such demand dictated their higher prices. Another reason was the monopoly position of Bulgaria on the market because the country was able to modernize its production in a very short period of time, making it relatively efficient and the equipment in the Bulgarian plants were at world level. Almost all machines, technological pipelines, equipment were imported from the most prominent world companies from Europe, Japan and sometimes from the USA.

For some of them the existing embargo had been broken – the foreign-trade organizations managed to find a way for delivery of banned for Bulgaria goods, on higher prices, of course. As a final result – the Bulgarian factories and plants had a world and European class equipment and were lagging behind only in few areas.

In the field of technological equipment of the production of disk devices, compact discs, personal computers and many other products, our plants and enterprises were some of the best equipped in Europe and were only behind those from USA. We talk only about certain plants and factories but the rest were also on a very high technological level. This was due to the huge investment on behalf of the state and the high level of the personnel and the management staff, who were able to determine the technological process (Table 5).

Table 5

Fields of science	Total	In research and technological organizations	In Universities
Radio technique, electronics, communication technique	945	654	291
Device manufacturing, automation, telemechanics	2379	1949	430
Physics[1]	1351	839	512
PhD students	615	-	-
Total (1, 2 and 3)	4675	3442	1233

* Taken as a representative of the natural sciences, serving to a great extend the field of electronics.

The production of several devices typical for the Bulgarian export list is given in table 6.

Table 6

Name	1989	1990	till 06.1991
Minicomputers CM-ЕИМ	80	58	-
Micro calculators	32806	32346	20
Magnetic Tapes for ES ЕИМ	4776	1087	638
-„- CM ЕИМ	52861	12885	848
-„- Magnetic Drivers for ES ЕИМ	44612	85854	101103
-„- CM ЕИМ	125138	112220	5831
Magnetic Data Inscriber	5878	1798	-
Devices for Teleprocessing	57586	-	-
Disk Packets	166897	156630	16156
Diskettes	15185	6037	11241

The economy managers, factory directors and their teams and the institutes that were designing and developing the products and the technologies for their production were at a very high professional level.

Not surprisingly, after the 1990s most of the found jobs in the West are still in demand. Very often it is said that the products have been copied from Western companies. This is not exactly so. Most of the world producers, starting with Japan, have copied their initial products or parts of them. And this happened in the environment of full market economy, where copying is far easier, as each company or trade organization can buy any element, detail or component of a product, to buy the product itself and to copy it one-to-one. For the Bulgarian conditions this was impossible as the new product fell under the embargo and their components could not be purchased, and just 3-5% from the embedded details could have been Western production. So, in no way one can speak of copying and prototyping.

Our task was to create products, which had to operate in the same functional way as those, produced by Western companies. This meant that it was very difficult to make a product that completely corresponds to the Western product and its features, including its look, construction, etc. However, in regard to the main features, technical parameters, applications, use of software, it had to have a similar functioning, so it is better to say that the work was on similar functionality products or **analogues**.

Sometimes the parameters of our similar products were better than the Western goods and this was due to two factors: first – the shortcomings of the products in production were already known and our constructors had been correcting them, and second – due to the weaker competitiveness, we had in many cases more time for design and detailed tests, experiments in extreme conditions of the products – all this allowed getting better results and having products with better qualities.

Let me make a note here. The opinion that our production was of lower quality, gives more defects, fails more often, etc. was well known but was not always true and was to a great extend exaggerated. Most of the exported products, and even more – those with special purpose for the military industry, were of remarkable quality and reliability during their use. If some of the initial series had some defects, during the production cycle in few months the complaints were dropping down significantly, and even more – their exploitation lasted long after the period of time, given in the documentation. Even nowadays, some countries continue to use our devices, manufactures in the 1990-ies, which is very rare for a computing product.

In order to develop new generation computers, with parameters close to the best available computer systems in the world, a Commission for International Cooperation for the Academies of Sciences of the Eastern Block countries was established. To implement the program of the Commission, a Center for Informatics and Computing Technologies (CICT) at BAS was founded in 1985. The first director of CICT, and deputy president of the Commission, was Acad. Bl. Sendov. The research group of the Center developed and built new generation parallel computers - matrix processors, a transputer based (T414 and T800) parallel computer, and a dataflow parallel machine. Highly parallel computer architectures were the solution for satisfying computationally intensive tasks.

However, the computing power attainable through parallel processing had to be combined with the ability to reconfigure the topology of the interprocessor structure in order to provide a smoothly expansible range of facilities. The Advanced Parallel Systems (APS) combined parallel processing with a reconfigurable topology to cover a wide spectrum of applications.

The transputer was used as a basic microprocessor element for building multiprocessor structures. With its local memory, built-in floating point unit, four communication channels and its parallel programming language Occam, the Transputer was one of the most eligible microprocessors for parallel systems. The transputer architecture allowed modular design of large networks with up to thousands of processor nodes.

Using transputer technology, the APS family offered a computing environment with a network structure, easily reconfigurable according to the characteristics of the application task. The computing environment was comprised of a set of computing nodes and parallelism could be easily scaled by adding additional high performance modules.

The APS family included personal computers, workstations, mini-supercomputers and supercomputers. All models were highly parallel systems, the personal computers having from one to 16 nodes, the workstations from 16 to 96 nodes, the mini-supercomputers from 64 to 256 and supercomputers from 512 to 1024.

The form of modularity used had allowed the development of a whole range of program-compatible machines, starting from a single board system. The performance ranges from several millions to several billions of operations per seconds.

Programmable reconfiguration of the network topology was provided for all models of the APS family. The processor nodes and the host computer communicated through programmable switches.

The APS 48 was designed to be supported by existing system software for parallel computers. The following software packages could be used: the Inmos Transputer Development System, the Helios operating system, and compilers for parallel languages.

The transputer development system was used for writing and debugging of parallel programs. It worked under the control of MS DOS.

The distributed operating system Helios was multitasking and supported the execution of parallel user programs on one transputer or on a network of interconnected transputers.

FORTRAN, PASCAL, PROLOG and C compilers were available for the development system and for the operating system. Along with the standard features, these languages were supplemented with extensions for writing parallel programs.

In IMPS and CCIT, a family of transputer boards was designed and developed and they were embedded in personal computers, turning them into Parallel Computations Workstation. For example, ten-transputer enhanced computing board for a PC based workstation for parallel computations had the following technical parameters:

- 10 IMST800 20 MHz transputers giving 80 MIPS or 15 MFLOP speak performance
- Link speed at 10 or 20 Mbits/s
- PC interface – IMSC 012 link adapter
- 20 edge connectors providing 40 serial Imnos links

Cresta Marketing Company (UK) reported "And yet the Sofia Academy of Sciences has produced transputer boards, which were tested by DTI at Strathelyde University where they were certified as excellent".

New industrial corporations were created in 1987, aimed to provide the industrial base for Bulgaria's Computing industry. They were: "Information and Communication Systems" (general director L. Guturanov), "Microelectronics" (general director M. Marinov), etc. Most of the research and design activities continued to be in the "Central Institute for Computing Technique", "Institute for Microprocessor Systems", "Institute for Microelectronics", etc. The system software support was provided by various research organizations, and also by the joint Bulgarian-Soviet institute "Interprograma". Those with the most significant contribution for the establishment of that institute on the Bulgarian side were R. Angelinov and V. Spiridonov.

Several types Local Area Networks (LAN) were developed during the period 1985 – 1990 and they were for export and for the internal market. The MicroLIM was a bus topology local area based on the ES 1838, ES 1839 and IBM PC, PC/XT PC/AT compatible personal computers. The MicroLIM was an open system. Every system configuration was built on the basis of specific user requirements. The MicroLIM might had been used in office automation and CAD systems. It was designed for administrative and office work automation and is a basis for the development and building of complex local area network configurations. Data transmission rate was 10 Mb/s, the max number of stations per segment were 100, and the max coaxial cable segment length was 300 m.

The MicroSTAR communications system was built around a star topology local area network. The network comprised of two types of stations: central and peripheral. Several peripheral stations might have been connected to a single central station. The stations were based on the personal computers EC 1838, EC 1839, and compatibles: IBM PC /XT/AT.

The central station had to be equipped with MicroSTAR adapter board. The specialized software might have defined one station either as a central, or as a peripheral, or both.

The peripheral stations were connected to the central station via serial channels. The channel data transmission rate depended on the distance between the central and the peripheral stations. The team that developed the transputer systems and LAN included: A. Ananiev, B. Anachkov, V. Sabev, V. Barbutov, V. Getov, V. Filipov, E. Elicina, I. Pavlov, I. Popov, I. Radev, I. Cikandelov, K. Boyanov, K. Yanev, K. Arabadjiiski, L. Manikov, L. Zekova, M. Simeonova, M. Iliev, N. Avramov, N. Vecev, N. Vapcarov, N. Dabov, N. Petrov, O. Gorchakov, O. Chipev, P. Malinovski, P. Ruskov, P. Tomov, R. Salchev, S. Bezuhanova, S. Machev, S. Voinov, T. Kanchev, T. Kardjiev, H. Turlakov, etc.

The software for transputer systems was developed by R.Lazarov, S.Margenov, Kr.Georgiev, P. Marinov,A.Andreev, Ch.Djidjev etc. More than 1200 transputer systems were exported to Russia and APS station was used as development platform for diagnostic software for nuclear reactors.

The volume of the Bulgarian Computing production started to decrease rapidly after 1991. The total number of people, employed in this field, fell from about 120000 to 30000. With the collapse of the state controlled sector, a number of private companies were established in Bulgaria. They were engaged primary in trade, or assembling machines from imported modules.

At present, the research activities are carried out in the institutes of BAS, and Computer Science departments of the Bulgarian Technical Universities. About 80 hardware private companies are distributing and supporting machines and materials. The production in Bulgaria is limited - mainly based on assembly of computers and devices with imported printing boards and components. The existing infrastructure in Bulgaria can be used more effectively and a number of governmental programs consider options for the revival of the Bulgarian computer industry. At the same time more than 52 software companies successfully work in local and international market.

Bulgaria was one of the co-founders and amongst the first members of IFIP, which was founded in 1959. Bulgarian scientists held the posts of vice-president - Acad. L. Iliev (1974-1977), and President - Acad. Bl. Sendov (1989-1992) in this prestigious international organization.

Finally, it is worth mentioning the Bulgarian connection in the development of World computing. In 1973, a US court ruled in favor of the American citizen of Bulgarian origin John Atanasoff, in his case against Eckert and Mouchly, who were regarded until then as the pioneers of the first electronic computer - ENIAC. Atanasoff together with Cliff Berry designed the prototype of the first electronic computer ABC, using binary arithmetic, with capacity storage device, and is rightfully regarded as the “father of the modern computer”.

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3.2. First Steps in History of Computing in Czechoslovakia

Alena Šolcová

Introduction

Fig. 1 Karel Čapek

The word: „ROBOT“ is known all over the world. Its origin and birthplace is Prague, Czechia. In the year 1920 the Czech writer Karel Čapek and his brother painter Josef introduced the term "ROBOT". Karel wrote a play ***R.U.R - Rossum's Universal Robots***, in which human-beings-like robots take over the world. The robots were a source of cheap labor for the humans. The word "ROBOT" is a derivative from the Czech word "robota" meaning slave-like work.

Fig. 2 First picture of a robot

Later in 1958 Antonín Svoboda said during the 1st National Conference of Computational and Organizational Technology in Prague:

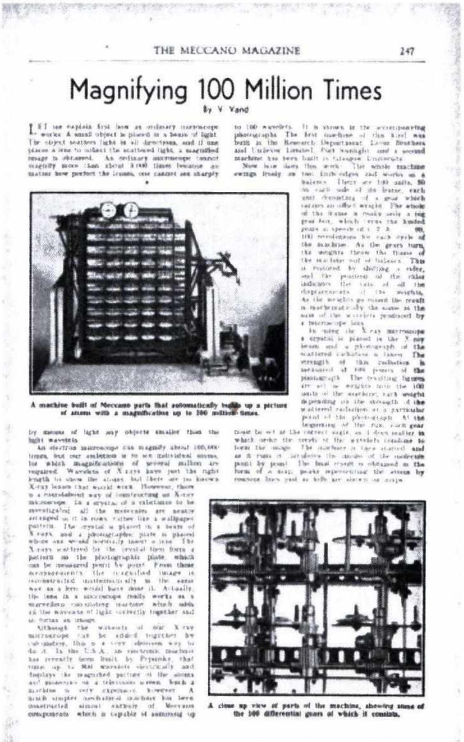
The mathematical machine couldn't be a sensational surprise for a young man. He has to know it as a common device for mining of means of subsistence.

The history of computer developments in Czechoslovakia in this contribution spans the period from a time before of World War II until recent times. The country split into two: the Czech Republic and Slovakia twenty-five years ago.

The first Ideas of Computer Construction

The first ideas of computer construction started in 1935 when Antonín Svoboda (1907- 1980) and Vladimír Vand (1911-1968) began work at the Research Department of the Skoda Works. They designed an original position locator for use by anti-aircraft artillery. It was based on the concept of the analog solution of differential equations describing dynamics of the airplane.

Both men were pioneers in computing: Antonín Svoboda in Prague and Vladimír Vand in Great Britain. In 1946 Vand's mechanical computer helped in evaluating Fourier coefficients and this invention played the important role in the study of the molecular structure and in the discovery of the structure of DNA.


THE MECCANO MAGAZINE 247

Magnifying 100 Million Times

By V. Vand

Fig. 3 Vand's paper in the Meccano Magazine, 1950

Vladimír Vand's Way to Nobel Prize Winners

In May 1939 Svoboda and Vand left Czechoslovakia for France. They became special advisors to the French Government. Their mission was to cooperate with the SAGEM Company. (La Société d'Application Générale d'Electricite et de Méchanique) and to continue their work there. Then, France had entered into war with Germany. Both men left France with many difficulties. Their adventurous days were later described in their biographies [8,9].

Vladimír Vand (1911 – 1968) landed on June 30, 1940 in Liverpool. Later he was hired by the research department of the Lever Brother and Unilever Ltd. in Port Sunlight in the county of Cheshire. He worked in the fields of crystallography, rheology and in research of the physical properties of long-chain molecules. He also started to investigate the molecular structure of organic compounds by means of a new roentgen tube.

At the end of 1946, Vand started thinking how to construct a computer since calculation of crystal structures by means of X-ray diffraction took him a lot of time. By hand he calculated only two-dimensional projections to two decimal places. One such calculation took two days. Therefore, he invented a one-purpose calculating machine for evaluating Fourier coefficients. This machine contained about one million little steel balls rolling through many guide bars.

In December 1946 Vand wrote to Prague.

„I invented a machine that makes the calculation within several days, otherwise it would take over a year. Tonda Svoboda will stand agape when I write him about that".

Vand sent its plans and photographs to Svoboda. Specialists from Utrecht, Edinburgh, and Sheffield came to see his 6 meters long mechanical computer. A brief description of his invention appeared in Nature in January 1949. The first page of [10] starts as follows:
„A large mechanical machine for calculation of X-ray crystallographic structure factors has now been completed in our laboratories and is running satisfactorily. ..."

Next progress of this development is described in [8, 9].

In 1950 Vand delivered a lecture on computers at a conference in London. Two computers based on Vand's ideas were exhibited there. The construction of the first was initiated by Sir Lawrence Bragg, the head of the famous Cavendish Laboratory in Cambridge, and with his father Nobel Prize winner in 1915. The second was constructed at the University of Cardiff. At the closing conference, Sir Lawrence Bragg showed how their computer worked and expressed his compliments to Vand.

Vand was invited to Cavendish Laboratory at Cambridge University to present a lecture there on new computational methods for finding structures of complicated molecules. He started cooperation with William Cochran and Francis Crick, later Nobel Prize winner. Their collaboration is illustrated by a letter in Francis Crick's archive and by the paper [1].

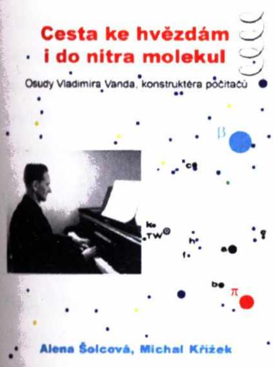


Fig. 4 Vladimír Vand playing piano [9]

Vladimír Vand continued as professor of crystallography as one of pioneers of computer technology and numerical methods [9].

Antonín Svoboda (1907 – 1980) and SAPO (Automatic Computer)
Svoboda´s Lectures at CTU in Prague

In 1947 Antonín Svoboda designed a sophisticated semi-automatic punch card computer and began to teach a course on "Mathematical Machines" at the Czech Technical University in Prague.

In 1947 A. Svoboda published a comprehensive monograph on "*Computing Mechanisms and Linkages*", MIT Cambridge Mass., Radiation Laboratory Series. It was one of the first textbooks on computers. In its Preface he explains his collaboration with Vladimír Vand as follows:

„The impulse to the development of the methods presented in this volume for mathematical design of linkage computers grew out of a collaboration of the author with his friend, Dr. Vladimír Vand. That collaboration was begun in France in 1940, and was brought to a premature end by the progress of the war. Though these ideas and methods have largely been developed by the author since that time, he wishes to emphasize that credit for the initiation of the work is shared by Dr. Vand."

In 1950-1956 he designed and supervised the construction of the first fully automatic digital computer in Eastern Europe SAPO. In 1957-1963 he designed and supervised the construction of automatic digital computer EPOS 1, in 1963-1964 worked on EPOS 2, an advanced version of EPOS 1. Then Svoboda escaped from Czechoslovakia to USA.

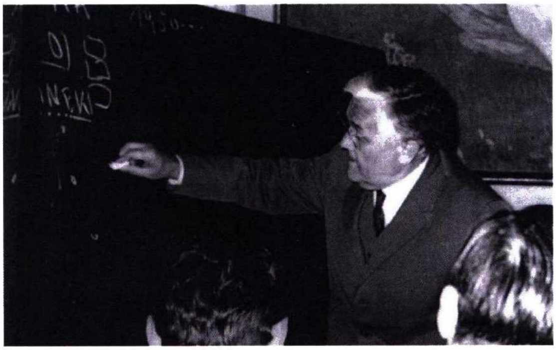


Fig. 5 Antonín Svoboda explains basic ideas to his students

In 1958 Antonín Svoboda expressed an important philosophical idea during the *1st National Conference of Computational and Organizational Technology* in Prague:

The mathematical machine couldn't be a sensational surprise for young man. He has to know it as a common device for mining of means of subsistence.

SAPO - the Automatic Computer

The **SAPO** (short for **SA**močinný **PO**čítač – the Automatic Computer) was the first Czechoslovak computer. It was designed and constructed in 1950 – 1956. It operated in the years 1957-1960 in the **Research Institute for Mathematical Machines** - *Výzkumný ústav matematických strojů* (VÚMS), part of the Czechoslovak Academy of Sciences in Prague. It was the first fully automatic digital computer in Eastern Europe. Another similar computer was used for the driving system of the project Apollo. Head of team Antonín Svoboda had great experience from building electromechanical computers in the USA, where he worked at MIT during WWII until 1946.

The computer was the first fault-tolerant computer. It had three parallel arithmetic units and they decided on the correct result by voting, an example of triple modular redundancy (if all three results were different, the operation was repeated).

It was electromechanical design with 7,000 relays and 400 vacuum tubes, and a magnetic drum memory with capacity of 1024 32-bit words. Each instruction had 5 operands (addresses) - 2 for arithmetic operands, one for result and addresses of next instruction in case of positive and negative result. It operated in binary floating point numbers.
In February 1960, a spark from one of the relays fired the greasing oil, and the computer burnt down. Although the damage was relatively small, only 2% of the computer, the government decided to dismantle the computer rather than to repair it, because usage of the main logic element–relay was not perspective. This was an unfortunate decision since no part of this early highly original computer was preserved for historic purposes [3].

In early 1950s **Antonín Svoboda** started to build the **Department of Mathematical Machines** in the Central Mathematical Institute. One of the main tasks of this department (later transformed in the Institute of Mathematical Machines of the Czechoslovak Academy of Sciences in 1955) included the design and construction of the **first original Czechoslovak automatic computer SAPO**. Despite many difficulties that the team of Mr. Svoboda had to deal with during the SAPO development, they succeeded in designing the equipment with many top quality parameters, e.g. being the first in the world to use the so-called **fault-tolerant principle**.

Obstacles of SAPO

One of the greatest obstacles slowing down the SAPO development was a lack of adequate components, which the Czechoslovak electro-technical industry was not able to produce, neither in the required quality or quantity. In the 1950s, **the relay construction elements of SAPO were outdated** as regards computer technology and they were used as a substitute for non-available electron tubes, unlike the USA or Western Europe, where in the 1950s electron-tube computers fully dominated the field.

EPOS – the Calculating Machine

The second step of development of computers in Czechoslovakia was EPOS: EPOS means **E**lektronický **PO**čítací **S**troj (the Electronic Computer or the Calculating Machine). The automatic digital computer EPOS 1 (1957-1963) was based on electron tubes. In 1963-1964, the team of A. Svoboda decided to replace electron tubes by transistors. The advanced transistorized version of EPOS 1 was called EPOS 2. The design of EPOS turned out to be highly innovative. In 1960 the computer EPOS 1 worked in decimal arithmetic, in code with automatic repair of one mistake (the length of word - 12 digits). It gave 30 000 operations per sec and capacity of the ferrite memory was 40 000 words. It was the first computer ever built, in which a residual-classes representation of decimal numbers was employed. This representation, together with a high-speed algorithm for divisions, made the arithmetic unit extremely powerful. The specialty of the computer was the hardware equipment for sharing time among five independent programs.

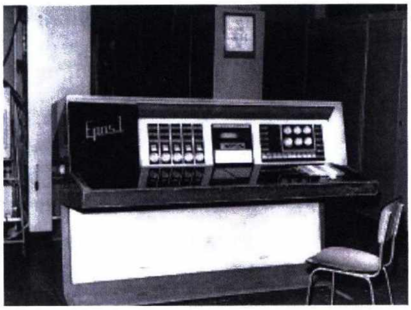


Fig. 6 The EPOS 1

The Research Institute for Mathematical Machines (VÚMS), was of the highest standard and its staff managed to design original computing equipment (e.g. **EPOS 1**) that often had the same parameters as top computers produced in capitalist countries.

Fig. 7 EPOS 2

Emigration of Svoboda's Team

In 1964, Svoboda escaped from the Czechoslovakia to USA. with 80 young colleagues and their families!

„We don't need similar people here!", the president of Czechoslovakia, Antonín Novotný, answered students during their discussion.

ELIŠKA – the computer of Allan Línek

Vladimír Vand left behind at the Škoda Works in Czechoslovakia his basic experimental equipment: a Weissenberg-Bohm goniometer and Debye-Scherrer camera. The famous Allan Línek from his student's years worked and experimented here. He suggested, in cooperation with people from the Laboratory of Mathematical Machines, two mathematical machines for automation of his calculation of crystallographic structures.

Fig. 8 Allan Línek (1925 – 1984)

Fig. 9 Computer Eliška

Computer ELIŠKA (Czech name for young girl Elizabeth) was used some years. Allan Línek created the name for the computer from the first letters E – Eniac, LI – Línek, ŠKA – Škarda. This relay computer for special calculations in crystallography was realized sooner than SAPO 1. Today it is functional and it is possible to see it in the collection of the National Technical Museum in Prague. Allan Línek suggested to reconstruct the Weissenberg-Böhm goniometr and it was exhibited with model structure of vinan ethylen-di-amin at the World Exhibition in Brussels in 1958. The work in computation and crystallography of Allan Línek was accepted with international respect.

Machine Production and Automation (ZPA)

In the early 1960s, failure to produce computers designed by VÚMS resulted in the following situation: in Czechoslovakia at the beginning of 1964 there were in operation **only 25 small automatic computers** of foreign production that were far from meeting the requirements of the national economy. The low number of automatic computers sharply contrasted with a great attention paid to computer technology by the Czechoslovak government and the Central Committee of the Czechoslovak Communist Party in mid-sixties.

In 1965, the consortium of **Závody přístrojů a automatizace - ZPA ("Machines production and automation")** was created, becoming the new production base for the Czechoslovak computer technology. In the ZPA the serial production of the first Czechoslovak computer MSP 2A was launched in 1966. Yet, the MSP 2A production was almost four years behind the original schedule and it was for these reasons that e.g. the EPOS 1 computer never became a part of serial production.

Fig. 10 MSP 2A

Computers or Tractors?

In 1960 and 1965 **the government published 14 resolutions on the issue** and another 3 resolutions covered the field partially. However, none of the 17 resolutions were consistently complied with, which resulted in Czechoslovakia seriously lagging behind in the field of computer technology as a whole. The policy for the production of digital computers adopted by the government- Resolution no. 935/61 (VHJ ZJŠ Brno, Aritma Praha) - was not complied with by the Ministry of General Engineering, since the Brno production facility **did not focus that much on the production of computers, but rather on the production of tractors**. As a result, no production facility for mathematical machines was constructed before 1965. In 1964 the government responded to the lack of digital computers withResolution no. 335/64 that catered for the needs of the Czechoslovak economy for mathematical machines by **importing them from abroad**.

URAL and MINSK

The director of the Institute of Theoretical Informatics and Automatization of the Academy Science and secretary of the Academy of Science in Prague, Jaroslav Kožešník, organized cooperation with Russian computer scientists. The first computer URAL I worked in the Českomalínská Street in the part of Prague–Dejvice. The other copy of Ural I spent about an year packed in boxes in the monastery Emauzy. First, there was no suitable room for the computer and then the visa for the Russian engineers – experts necessary for official revision before the onset of operations, had expired. The computer was never used for numerical calculations.

Then, there was a quick change for URAL II and MINSK. The next copy of URAL worked in the building of Academy from 1960 in Horská Street and this computer was used for solving scientific problems, for instance for researchers in the roentgen structure analysis.

Models Ural I to Ural II based on vacuum tubes (valves), with the hardware being able to perform 12,000 floating-point calculations per second. One word consisted of 40 bits and was able to contain either one numeric value or two instructions. Ferrite core was used as operative memory.

It was able to perform mathematical tasks at computer centers, industrial facilities and research facilities. The device occupied approximately 90-100 square meters of space. The computer ran on three-phase electric power and had a three-phase magnetic voltage stabilizer with 30kVA capacity.

The main units of the system were: keyboard, controlling-reading unit, input punched tape, output punched tape, printer, magnetic tape memory, ferrite memory, ALU (arithmetical logical unit), CPU (central processing unit), and power supply.

MINSK

Then, the computers Minsk were used in Czechoslovakia. The Minsk family of computers was developed and produced in the Belorussian SSR from 1959 to 1975. The most advanced model was Minsk-32, developed in 1968. It supported COBOL, FORTRAN and **ALGAMS** (a version of ALGOL). This and earlier versions also used a machine-oriented language called *AKI* (*AvtoKod* - i.e., "Engineer's Autocode"). It stood somewhere between the native assembly language *SSK (Sistema Simvolicheskogo Kodirovaniya*, or "System of symbolic coding") and higher-level languages, like FORTRAN.

Unified Systems in the Development of Computing

In the second half of the 1960s the Czechoslovak computer technology started to be **more and more closely linked to other countries of the Council for Mutual Economic Assistance**. The production of integrated-circuit computers that were becoming dominant computing devices in capitalist countries, turned out to be too technologically demanding and well beyond the capacity of individual socialist countries. Therefore, in 1969 the international agreement was signed on the **Unified System of Electronic Computers (USEC)**, with Czechoslovakia as one of its founding countries. The accession to the Single System program meant the end of Czechoslovak independent activities in the computer technology development, which started in 1950 and had its peak between 1958 and 1968.

The Czechoslovak participation in the **Unified System international program between 1968 and 1990** represents a rather different chapter of the Czechoslovak history of computer technology. Its analysis remains a challenge for further historical research of this - so far rather neglected - chapter of the Czechoslovak science and technology history.

EC – clone of IBM 360

ES EVM (ЕС ЭВМ, Единая система электронных вычислительн машин, meaning "Unified System of Electronic Computers") was a series of clones of IBM's System/360 and System/370 mainframes, released in more countries under the initiative of the Soviet Union starting in the 1960s.

Fig. 11 EC 1021

Production continued until 1998. The total number of ES EVM mainframes produced was more than 15,000. In the period from 1986 to 1997, a series of PC-compatible desktop computers, called ПЭВМ ЕС ЭВМ (Personal Computers of ES EVM series), was also produced; the newer versions of these computers are still produced under a different name on a very limited scale in Minsk. These computers were used in Czechoslovakia.

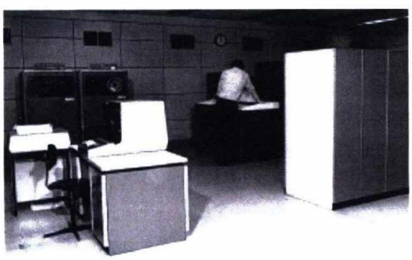


Fig. 12 EC1025.

Computers for schools!

The first of computers projected for the Czech schools were IQ 150 and IQ 151.

Fig. 13 First version IQ-151

Notice circle keys typical for this computer and the key RESET, which was not divided from the other keys. We do not know, how many programs were missed due to the position of the RESET key.

The first ideas are connected with the Czech Technical University in Prague in 1982. In 1984 the government decided to produce computers for schools. In 1985, ZPA Nový Bor in North Bohemia, started with IQ-150. It is an older model of IQ-151 with blue design and without any graphics or a graphics module. Only about 50 copies of IQ 150 were made there. This computer was based on the microprocessor *Tesla MHB 8080A* and the usual chips of series Intel 8080 (*8255A, 8259,* etc.), similarly as in our friendly countries.

Fig. 14: 8-bit microcomputer IQ-150 with added TV and a tape recorder. This computer was made in blue color, in comparison with its successor IQ-151 in orange color.

Next step in this development:

The IQ-151 was a school microcomputer made by ZPA Novy Bor. The case was from cast iron in orange design. Standard language was a clone of Basic. It has five expansion slots for modules. According to these, the most common ones were:

- VIDEO [display],
- BASIC [interpreter],
- BASIC G [graphic Basic interpreter],
- GRAFIK [256 x 512 graphics],
- STAPER [printer],
- MINIGRAF [plotter]

Fig. 15 One view on the back side of computer IQ-151 with three installed modules.

Besides common modules, there are some more unusual ones:

- AMOS: „Autonomous Microcomputer Operating System" – Project of students at Faculty of Mathematics and Physics, Charles University, Prague
- MIKROS: MIKROS was a CP/M clone developed in East Germany for IQ 151.
- Pascal.

Usually, every computer had its own cassette player attached to it (slightly modified TESLA tape-deck - even after years these tape-decks are valuable for Hi-Fi people, because their quality was quite high) at school classes with IQ151s. The teacher was able to load programs from his player to all computers IQ151 in the class and he was able to do this remotely from any IQ151 in the class as well. So he was able to explain something to the students on the students' computer and control his own (teacher's) computer and its tape-deck from the student's place. The computers were connected using 5-pin round gramophone connectors. Some output devices more: CONSUL 2112 or 2113 (typewriters), and SESTYK (telex machine). MINIGRAF was type of 0507, manufactured by Aritma. The tape-deck mostly used was probably TESLA M710A. The main supplier of software for IQ-151 was the Komenium Company.

The computer produced lots of heat. People say that they put a coffee cup on it to keep their drink warm. The users had great problems with hardware. Very often half of the computers in school classes were out of order. The keyboard was of a membrane type, so after a certain time of the usage the membrane was almost unusable.

Fig. 16 Computer IQ 151 – A model from 1986

The fourth step: IQ – 151G – the second version of this computer from 1987 played also a role as an expensive toy for heads of factories. The production was closed in 1990.

SAPI 1

We could briefly remember the computer SAPI 1 from Tesla Eltos, Prague: The first version of the SAPI-1 had only 2k ROM (EPROM) and 2k RAM. A later version called SAPI-1Z was an enhanced version with 64-row display. Processors used were 8080 and (later, for use with CP/M) Z-80. ROMs - usually was used only for BIOS. As a monitor, black and white TV (with Video-IN added) was used Tesla Merkur. The TV is placed just on the computer case.

Next computers for schools – PMD 85 or Didactic from Slovakia

PMD 85 – 8-bit personal computer

Fig. 17 PMD 85

The **PMD 85** was an 8-bit personal computer produced from 1985 by the companies Tesla Piešťany and Bratislava in Slovakia. They were deployed *en masse* in schools throughout Slovakia, while the IQ 151 performed a similar role in the Czech part of the country. This computer was produced locally due to a lack of foreign currency, with which to buy systems from the West. After the Velvet Revolution in 1989, production of the PMD 85 was stopped. PMD 85 was not competitive in quality or features compared to foreign PCs available at that time. Users used a ROM module with the BASIC programming language as a standard part of the computer, but there were more ROM modules containing Pascal, LOGO, etc.

Variants of PMD 85

The **PMD 85, first version**, produced by Tesla Piešťany (the author was Roman Kiss), was originally in a white-colored case and later in some other colors. It was more of a prototype and is quite rare today.

The **PMD 85, second version**, produced by Tesla Bratislava, was known as "the" PMD 85, and sometimes labeled as PMD 85-1. It was made with a dark gray case, and was famous for its keyboards with extremely tough keys. Alphanumeric keys were evaluated at the moment of a key release.

The **PMD 85-2** introduced some improvements in BASIC, some in input routines (for instance, key auto-repeat), a much more ergonomic keyboard (but much less mechanically reliable) and also terminal mode. Some of the changes caused it to be not completely backward compatible.

The **PMD 85-2A** used 64 Kib chips instead of 16 Kib, leading to less overheating of the memory chips, resulting in more memory available for BASIC, but was otherwise compatible with PMD 85-2.

The **PMD 85-3** added color TV output. Character encoding included all Czech and Slovak characters, and a Cyrillic version was also produced. System monitor was enlarged to 8 KiB and included routines for communication with PMD 32 floppy disk assembly, a ROM integrity test and also "PMD 85 compatibility mode" by relocation.

The **PMD 85-2** was an inspiration for the **MAŤO personal computer**, also sold as a self-assembly kit in 1989. It had different hardware and very limited compatibility with PMD; its BASIC, memory structure and I/O were almost, but not completely, the same but tape format was different. It was intended as a home computer, but never really caught on.

Sinclair computers

Sinclair – was a dream for many people in all Czechoslovakia. It was together a toy for children and for parents, too, and also the important instrument for experiments, education purposes, etc.

Many young people used **Sinclairs (mainly ZX Spectrum), Commodore, Atari**, etc., in the second half of the eighties. The history of Sinclair Computer started in 1980 with ZX80. In 1982 ZX81 personal computer was shipped in over 30 countries, between them Czechoslovakia. During the same year Sinclair Research introduced ZX Spectrum. It is as starting instrument to computing for many young people in the eighties in many countries, not only in Czechoslovakia.

Didaktik

Fig. 18 Didaktik M

The **Didaktik** was a series of home computers based on the Intel 8080 and Zilog Z80 processors produced in former Czechoslovakia. The variants were: Didaktik Alfa, Didaktik Beta, Didaktik Gama, Didaktik M, and Didaktik Kompakt.

Didaktik Alfa

Didaktik Alfa was produced in 1986, as a "more professional" clone of PMD 85. It featured 2.048 MHz Intel 8080 CPU, 48 KiB RAM, 8 KiB ROM with built-in BASIC, good keyboard (compared with PMD 85), monitor video output (but not TV output) with 288×256 resolution, 4 colors. Despite some changes in ROM, it was mostly compatible with PMD 85. Didaktik Alfa 1 was a clone of PMD 85-1, Didaktik Alfa 2 of PMD 85-2.

Didaktik Beta

Didaktik Beta was a slightly improved version of the previous Didaktik Alfa, having almost identical hardware. While Didaktik Alfa and Beta were mostly deployed in schools (to replace older PMD 85 computers), there was another production line, meant as home computers. These were Sinclair ZX Spectrum 48K clones.

Didaktik Gama

Fig. 19 Didaktik Gama

Didaktik Gama was the first clone of the ZX Spectrum with one speciality: 80 KiB RAM divided into two switched 32 KiB memory banks and 16 KiB of slower RAM containing graphical data for video output, while the size of ROM was 16 KiB. This computer had become an unreachable dream for many children and adults in former socialist Czechoslovakia as the computer was considerably expensive and seldom available to buy. It is said there were waiting lists several years long. The design of the computer was very simple — just a gray or black box the size of A5 with flat plastic keyboard and connectors mounted on the rear side. All games developed for the ZX Spectrum 48K were generally compatible with this computer. There is no need to say that it established massive and flourishing black market with these games countrywide, as they were officially unavailable behind the "iron curtain". An audiocassette was used as the data store, and a TV served as the monitor.

Didaktik Gama was produced in three variants: the first, Gama '87, fixed some bugs in the original ZX Spectrum ROM, thus breaking compatibility in some percentage of applications (it means: games), and introduced its own bugs effectively inhibiting the use of the second 32 KiB memory bank from BASIC. Gama '88 fixed the original ZX Spectrum bugs in a more compatible way and fixed the memory-switching bug. The last and the best model was Gama '89 which fixed some more bugs. Production of Didaktik Gama computers ceased in 1992.

Didaktik M

Fig. 20 Home computer - Didaktik M

The next version, the Didaktik M introduced in 1990, was more advanced in design and reliability. The machine resembled more of a professional home computer with arrow keys separated from the rest of the keyboard and a more ergonomic shape of the case. Inside there was only 64 KiB of total memory (16 KiB ROM and 48 KiB RAM), which was a disappointment in comparison to the

Gama. The computer was considerably redesigned. A custom circuit from the Russian company Angstrem was used instead of the original ULA as a result the screen had a square aspect ratio instead of a rectangle 4:3. In addition the whole RAM was realized by one set of 64 KiB chips from which only 48 KiB were used and there was no difference between the fast and slow memory with the video content. There were two separated connectors for joysticks and one connector for additional interfaces, such as a printer interface. Unlike the previous version of Didaktik, these connectors were a typical "socialistic solution" compatible with nothing that was then available in Czechoslovakia. Thus, users were forced to develop and produce various and sometimes funny homemade interfaces to satisfy their needs. Data storing and monitor type was the same as in the case of the Gama.

Two floppy disk drives were developed and released later to offer the possibility of fast saving/ loading of various programs.

5.25" floppy disk drive called D40 was introduced in 1992 and featured a "Snapshot" (button that allowed to store current content of the memory (memory image) on diskette. It was also possible later to load the memory image and continue playing the game (or whatever was stored) from the respective state. 3.5" floppy disk drive called D80 was also introduced later in 1992, at the same time as Didaktik Kompakt was released.

Didaktik Kompakt

The Didaktik Kompakt from 1992 was essentially a Didaktik M with built-in floppy 3.5", 720 KiB drive and parallel printer port. These computers were famous for their simplicity allowing people with little technical ability to produce various hardware add-ons such as FDD controllers, AD/DA converters or software (such as Desktop — unique WYSIWYG word processor with functions like proportional text, pictures in text support, block functions, multi-font support etc.). Both versions of these computers had been produced in Skalica, Slovakia. Didaktik's glory went out with the price fall of 16-bit computers, such as the Atari and Amiga, around the middle 90s until it was finally steam-rolled by the PC soon after. The production of Didaktik computers stopped in 1994.

Later, the Didaktik Alfa and Beta were produced as more reliable clones.

Conclusion

„There is no reason any one would want a computer in their home." Today it is very difficult to understand this idea of the sixties.

We would like to show in this brief treatise that there were many creative people in Czechoslovakia, who worked under difficult conditions and continued in the development of computers as successors of Antonín Svoboda, Vladimír Vand, and Allan Línek. Their contribution helped the general progress of computing.

Acknowledgments: The author expresses many thanks to Dr. Věra Suchánková for our fruitful discussion on the work in a group of "Uralists" - people that joined their lives with computers URAL I and URAL II, and my thanks also belongs to Dr Jakub Šolc for his general support..

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3.3. Computing in Hungary – Through the History of Five Institutions

Balint Domolki

In the first three decades of the history of computing - i.e. by the end of the 80s – Hungary lived under a political system, in which the state had a dominating role in society and economy. It is no surprise that computing life was also shaped to a large extent by five state-owned institutions with leading positions in different areas of this new discipline. These were:

- The *Computer and Automation Institute of the HAS (SZTAKI*[1]*)*, where the first computer in Hungary was built in the late 50s from Soviet documentation;
- The *Computer Application and Service Company (SZAMALK)*, created from several organizations playing a pioneering role in the market oriented development of computer applications as well as in supporting services, first of all computer education and training;
- The *Central Research Institute of Physics (KFKI)*, where a PDP-compatible family of minicomputers was developed and manufactured with many applications in Hungary and abroad;
- The *Computer Research and Innovation Center (SZKI)*, being established originally for the co-ordination of the Hungarian activities in the Unified System of Computers (ES EVM) and later becoming an important R&D center for hardware, software and applications;
- The *VIDEOTON Computer Factory*, manufacturing (mini)computers and peripherals - mainly under French license - with considerable export to the neighboring countries.

These institutions had a considerable impact on the whole scene of computer related activities in Hungary, and it would be appropriate to describe the early history of computing in Hungary by telling the individual stories of these five institutions. That is what we aim to do in this paper.

1. The first computer in Hungary

The story of modern computing in Hungary starts … in a prison! In late 1953 a group of inmates working in the engineering bureau at the Budapest Central Prison - having a fairly good access to Western professional literature (sometimes better than their colleagues "outside") - got acquainted with the advances of computing in the West and formulated a proposal to the Hungarian Academy of Sciences (HAS) to design and build a computer. The prison management sent the letter to the appropriate department of the Academy, from where they received a polite negative answer. It might be, however, an interesting coincidence that a few months later, in February 1954, a small research group on electronic computers was established in the Research Institute for Measuring Techniques of the HAS. Moreover, when *Rezso Tarjan*, one of the authors of the letter mentioned above, came out of prison in 1955, he became the head of this group. After some preparatory work, in early 1956 the Academy decided on the necessity of purchasing an electronic computer and creating around it the Research Group for Cybernetics (KKCs). Then, the politics stepped in: the government agreed to the establishment of the new institution only if its director was a political nominee, *Sandor Varga*. So Tarjan became deputy director and KKCs started to work in September 1956, with placing an order for an Ural-1 computer. Political events in the autumn of 1956 interrupted these activities and in early 1957 the Soviet foreign trade company withdrew

1 The acronymes are abbreviations of the Hungarian name of the institutions

from the Ural contract. In this situation, director Varga, - who during World War II worked as an engineer in the Soviet military industry - made use of his contacts and arranged to receive through the channels of academic cooperation the documentation of a recently developed Soviet computer, the M-3.

In order to fully understand the situation a small detour has to be made to the early history of Soviet computing:
One of the first Russian scientists who recognized the significance of electronic computers was *Isaac Bruk*, member-correspondent of the Soviet Academy, who as early as in 1948 – together with a young colleague[2] – received a patent for a digital computer with a common bus and prepared a detailed proposal for building a computer. The M-1 computer was built in 1951, followed by the more powerful M-2 in 1952, serving most of the academic computing needs for several years. In parallel, another computer was also developed, intended for smaller research organizations. This was the M-3, completed in 1956. However, due to some bureaucratic difficulties ("the M-3 was actually a self-initiated project independent of any state plans"[3]), it was not admitted to mass production, only a few experimental copies were manufactured and its documentation was spread through informal channels. In this way versions of M-3 were built – apart from Hungary – also in Estonia and China. Moreover, in Yerevan M-3 served as a starting point for the development of the Razdan family. Later, in 1959 mass production of M-3 started in the newly built computer factory in Minsk. (The history of the M series continued with sophisticated special purpose process control computers, intended mainly for military applications. So, the Bruk group disappeared from the open scene of Soviet computing.)

That was the story of M-3. One can say that it was born as an "illegitimate child of a very respectable family".

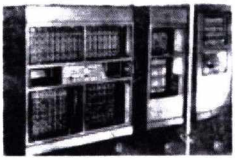
The documentation of this M-3 computer arrived in late 1957 to Budapest. A small group of freshly graduated engineers and mathematicians received the task to put together the computer and make it operational. It was not an easy task, since none of us had seen a computer before and in the documentation everything was described in much detail, but it did not say anything on how the electronic impulses running around different places of the circuits will result in the execution of instructions, from which the programs were composed. In other words – as we would say it now – we had to extract the architecture of the computer (its "principles of operation") from a purely technical documentation. More difficulties were caused by the inherent unreliability of electronic tube devices, resulting in a rather low "main time between failures". Nevertheless, we succeeded: the official launch of M-3 was in January 1959, one more year was, however, needed to reach a more or less stabile operating condition.

So KKCs had a computer with about 1000 electronic tubes, a memory of 1024 words on a magnetic drum (1 word= 31 bits), with an average speed of 30 operations per second.

2 His name was Bashir Rameev, who became later Chief Constructor of the Ural family of computers and in 1969 he advocated to build the Unified System on a license from ICL (UK) for the - IBM 360 compatible - System 4 series. This proposal was rejected, resulting in the (illegal) cloning of IBM hardware and software and in resigning of Rameev from his leading position in Unified System. See in more details in B.N. Malinovsky: Pioneers of Soviet Computing. pp.107-134 http://www.sigcis.org/files/SIGCISMC2010_001.pdf

3 See p.73 of the same book.

(Later a ferrite memory was introduced increasing the speed to about 1000 op/sec.)[4]



Nevertheless, this first computer attracted many application ideas from different areas:

- Scientific-technical calculations, being performed "by hand" or mechanical desktop calculators could be speeded up on the M-3 (e.g. static calculations, optical lenses etc.);
- Mathematical methods started to gain acceptance in economic sciences, requiring a large number of calculations. E.g. experiments with the "balance of intersectoral relations" method (known also as "input-output tables") were performed at the Central Planning Office, requiring the inversion of a 40*40 matrix. (As one of the first "real" applications to be run on M-3, it was a rather difficult task, considering that 40*40=1600>1024!)
- Application ideas started to come from different branches of science (e.g. linguistics, medicine etc.)

In 1965, M-3 was transferred to Szeged, where it served educational purposes until 1968. In the meantime, KKCs was renamed to *Computing Center of HAS (SzK)* and continued to perform its pioneering activities in solving various application problems as well as popularizing computing with courses, textbooks, lectures, etc. In 1965 an Ural-2 computer was installed, followed by a CDC-3300 in 1970.

In 1972 the Academy decided to merge SzK with its other computing-related institution, the *Automation Research Institute* (*AKI*, established in 1964). The profiles of the two institutes complemented each other well: more software at SzK and more hardware as well as industry experience at AKI. In this way the ***Computer and Automation Institute of HAS*** **(SzTAKI)** was created, becoming the leading research and development center of the Hungarian computing field with significant results in a wide range of disciplines like process control, computer aided design and manufacturing, production informatics, operational research, computer vision, networking, etc.

4 See also in Gyozo Kovacs: The Short History of M-3, the First Hungarian Electronic Digital Tube Computer IT STAR Newsletter Vol. 6, no.4, Winter 2008/09

2. Computer applications

Apart from these mentioned above, an important source of application ideas for the new computer(s) has come from the processing of (business) data. Here, Hungary has had a long tradition of using punched card (Holerith) equipment for data processing. IBM established a subsidiary as early as in 1936 and IBM Hungary Inc. existed continuously without interruption during World War II and also in the years of cold war as a US-owned company serving Hungarian customers with punched card machines and their support. A nationwide census of the population was performed in 1950 on IBM equipment.

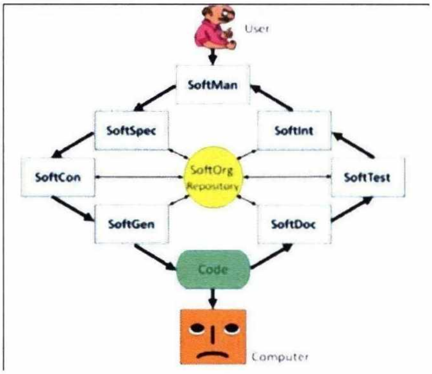
The *Central Statistical Office (KSH)* was charged with the overall responsibility of supervising the application of punched card machines in the country and gradually it was extended to the application of computers for data processing and later to the whole spectrum of computer applications.

In the centralized political system each organization belonged to one of the ministries (or similar high level offices). Therefore, the data processing tasks emerging from punched card applications were usually solved - with more or less success - by the institutions for "accounting and system analysis" of the given ministry, which became gradually centers for computer applications coming from the given area of the national economy. This proved to be not a very efficient solution, since computer knowledge at that time was rather rare, so these specialized institutions could not have enough knowledgeable people in computing.

In this situation the KSH decided in 1965 - making use of its nationwide supervisory role about computer applications - to establish an organization with a "free license" to solve problems in any areas, belonging usually to the ministerial institutions mentioned above. (At that time, this was considered a "revolutionary" move, a step towards the "market economy", in accordance with the economic reforms coming in 1968). The new organization started to work as *"Information Processing Laboratory"* of the KSH, later being reorganized as a company under the name of *INFELOR*, becoming soon – what would be called nowadays – a successful "software house", having a good concentration of computer experts in departments as hardware and software engineering, operational research, data processing, (macro)econometrics, etc. In 1975 it was renamed *Computer Research Institute (SZÁMKI)*.

A few examples of software projects successfully performed then:

- Development of basic software for the Hungarian designed EMG 830 computer
- Data processing and production control (ERP-like) systems for large factories (e.g. Chinoin, Ikarus)
- Industrial process control systems (e.g. Paks, together with KFKI)
- Integrated software development support system (together with SZKI), becoming a product exported under the name of SOFTORG
- Large registers for public administration (e.g. population)
- Operational research algorithms and applications (together with SZTAKI)



In the meantime, the Central Statistical Office has established a whole empire of institutions serving various aspects of the application of computers. For the education and training of computer specialists a large organization called *SZÁMOK* was established in 1969, receiving a substantial grant from UNDP and becoming a leading educational center, also for the neighboring countries. Companies for support and maintenance of computers and also computer-related publishing were also established, as well as a nationwide network of regional computing centers, performing data processing tasks for local enterprises (*SZÜV*).

In 1982 KSH decided to merge most of these organizations into the giant ***Computer Application and Support Company (SZÁMALK)***, becoming one of the leading institutions of the Hungarian computing scene.

3. Minicomputer family development

The ***Central Research Institute for Physics (KFKI)*** was established in 1950 to perform high-level scientific research in many areas of the physical sciences, including an experimental nuclear reactor. Capturing and processing of the results of the physical experiments required a large number of – sometimes rather sophisticated - measuring equipments. For their production a strong Electronics Department was created in KFKI. In mid-60s they started to realize the international trends of using computers for measurement automation. Since availability of a wide-range of application programs was considered important, they decided to produce computers compatible with members of the leading family of minicomputers, the PDP family of Digital Equipment Co. Development of these devices at KFKI was performed by a combination of "reverse engineering" and original design, taking into consideration the component base available at that time in Hungary. As the centralized system of the planned economy at that time did not permit production of computers (especially not in a research institute of the Academy of Sciences), they dcided to call these devices Stored Program Analyzers, abbreviated in Hungarian to TPA[5]. It was soon realized, that the TPA machines could be used not only for measurement automation at KFKI, but also for a wide range of tasks everywhere. So, the mass production of minicomputers was started at KFKI (causing some conflicts with the research institute status of that institution).

5 The name of the PDP machines, Programmable Data Processor, was the result of similar considerations: as in the early 60s the word „computer" was associated with very expensive equipments of gigantic sizes, Digital Co. did not want to use this word for their smaller machines. The term „minicomputer" became accepted much later only.

The members of the minicomputer family, together with the number of units produced is summarized in the table below[6]:

years	compatibility	type: -	production
1966-80	PDP-8	TPA-1001 TPA –i TPA-L/**	~800
1970-75	**original !** -	TPA-70, TPA-70/25	~100
1976-87	PDP-11	TPA-1140, -1148 TPA-11/428, -440 TPA-11/110, -170	~500
1983-89	VAX-11	TPA-11/540 TPA-11/58* TPA-11/510,-520, 530,-535	~150

The TPA 11/440 computer

Configurations of TPA minicomputers were used in many different branches of the Hungarian economy and a fairly large number was exported to the neighboring countries. Main application areas did include:

- Measurement and control systems in oil and energy industries, nuclear power station (Paks),
- Laboratory automation systems in research institutes,
- Production and process control systems in various enterprises.

6 Source: J. Lukacs: From Punched Tape to Informatics – The TPA Story (In Hungarian), KFKI, 2003
A short summary of the story of TPA computers in English can be found at http://hampage.hu/tpa/e_index.html

4. Unified System participation

In 1968 the Eastern Bloc countries, on the initiative of USSR decided on the joint development of a series of computers, being compatible with the IBM 360 family of computers, making use of its fairly large, widely available software supply. In developing the *Unified System* of computers, copying[7] of the different models of the 360 (and later 370) series was divided between the participating countries. The role of Hungary was to produce the smallest model of the series and succeeded to be in a special position by convincing the partners, that the smallest model should play a specific role in the configurations, being satellite computers, terminal concentrators, etc. around the larger machines. Therefore the smallest model could not be compatible with the rest of the series and Hungary developed the R-10 (and later R-12) under license from the MITRA-15 minicomputer[8] of the French *Compagnie internationale pour l'informatique (CII)*. Besides, several peripheral devices (displays, printers, disk memories, etc.) of different Hungarian manufacturers were included into the Unified System effort.

In each of the countries participating in the Unified System, an institute was appointed for coordinating the efforts related to the cooperation. In Hungary, the *Computer Coordination Institute (SzKI)* was established in 1969 for this purpose with the tasks of

- Participating in the various technical organs of the cooperation
- Adapting Hungarian products to Unified System standards (and get them accepted)
- Developing some of the products (R-10, R-12, R-15).

These activities were performed by SzKI to the satisfaction of all interested parties, the management of SzKI, however, recognized that in order to be a successful institution, some own research and development activities should also be included into the portfolio of the institute. Therefore, SZKI started to perform significant R&D tasks not directly connected to the Unified System coordination. A few examples are:

- Development of network based application systems (railways, banking etc.)
- Software products distributed in international markets (*MProlog, Qualigraph, Recognita*)
- Creation of innovative image processing methods with applications in many fields
- Operating the most advanced Siemens computers (allowed by the embargo, or beyond...!)
- Starting the organized software export activities (paying for Siemens equipment with work)
- Development and distribution of the first Hungarian made PC family (**Proper-8, -16**)

Proper 16

Later, such activities became dominant in the profile of the institute, so in the mid 80s the name of the institute was changed to **Computer Research Institute and Innovation Center** (keeping the SzKI acronym).

7 See also the footnote 2. on page 81.

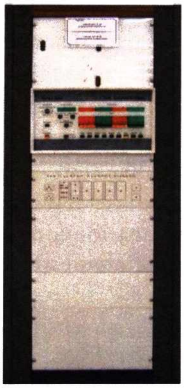
8 Later this situation was changed and R-15 was developed from the prototype of IBM 370/115-125. It has undergone the acceptance procedure of the Unified System, but did not go into mass production

5. Computer manufacturing

VIDEOTON was established in 1938 as a small factory producing ammunition for hunting weapons. In the early 50s it started to produce items of household electronics (radio and later TV sets) and also military telecom equipment. This latter might have been one of the reasons why, with a rather unexpected decision of the government, VIDEOOTON was appointed to be the home of the Hungarian computer industry, becoming the recipient of the licenses bought from France to manufacture minicomputers, partly as the smallest member of the Unified System series (see above).

Starting the computer profile "from scratch" VIDEOTON established a *Computer Factory* in Szekesfehervar (a provincial town 70 km from Budapest) and took over a research institute of electronics in Budapest, becoming the *VIDEOTON Development Institute (VIFI)*.

The first computer produced at VIDEOTON was the Hungarian version of the CII 10010 minicomputer, appearing under the name of VT1010B in 1971. Although it did not satisfy the Unified System standards, it proved to be a great success, both in Hungary and in the neighboring countries. Apart from its applications as a general purpose or as a process control computer, it was used also as a satellite machine. E.g. its linkage to a MINSK-32 computer realized the first "front-end" connection in the Eastern Bloc countries. The next step was the adoption of the license of the French Mitra-15 computer and its production under the name VT1010. This was already done in accordance with the Unified System standards and – with the contribution of SZKI – the official acceptance procedures were performed and R-10 (EC-1010) became the smallest member of the Unified System. This was followed by an improved version (R-12), also based on the MITRA-15 license.



The R-10 computer

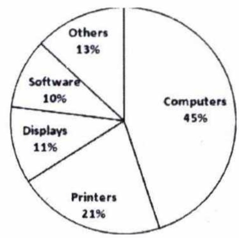
Meanwhile in France the *Societe Europeene de Mini-Informatique et de Systenes (SEMS)* was taking over the minicomputer profile of CII. They started the development of the "S" series and in the framework of cooperation the engineers of VIFI heavily participated in its development. As a result, the models Mitra-115 and Mitra-225 appeared in the mid 70s, produced in Hungary as VT-60 and VT-600, accepted in the Unified System as R-11 and R-10M respectively. An interesting episode was the development of the VT-1005 computer, realizing an original, stack-based architecture in a computer smaller than the 1010, for specific applications. A few prototypes were produced and experimental applications were developed, but it did not reach mass production.

In the second half of the 70s a new action emerged in the cooperation of the Eastern Bloc countries: the System of Small Computers (CM), compatible with the computers of the Digital Equipment Corporation (PDP and VAX). In Hungary it was coordinated by VIDEOTON, which had the task to produce the model CM-52. This was developed on the basis of Mitra-225, but in order to be accepted in the CM series, a unique technical solution was applied: CM-52 had a "bi-processor" architecture and it could work in two modes: in the "S" mode it realized the instruction set of the "S" series, while in the "M" mode it was PDP-11 compatible. VIFI engineers with success realized this rather difficult technical task and CM-52 was accepted in the CM series. Mass production, however, did not happen.

In the 80s the Unix –based VT-32, VT-320 and VT-3200 models were produced with success.

Apart from computers, VIDEOTON manufactured several peripheral devices as well:

- The production of terminal displays was a real success, with more than 90 000 units sold in several countries, especially in the USSR (in the Russian professional slang for "terminal" sometimes they said ""“видеотон"). The most popular model was the VT-340, followed by more sophisticated models like the VT.52000 and VT-47000 series as well as the microprocessor controlled VT-56000.
- The line printers VT-2400, -2500 and -2300 were produced under license for Data Products. A matrix printer (VT-21400) was also manufactured. The VT-LP laser printer was accepted in CM under the code CM-6314 was the first laser printer produced in the Eastern Bloc.
- Optical discs also were produced on magneto-optical principle, with 640MB capacity.
- The personal computers VT-110, VT-160 as well as the TV-computer proved to be not a success on the market, mainly due to the high competition from smaller companies, being able to more cost-effective production.



The distribution of computer related revenues of VIDEOTON is shown in the following chart:

This is the story of the five institutions dominating the computer field in Hungary in the late eighties.[9] While competing with each other in many areas, they formed a loose cooperation called *Computing Research and Development Association (SzKFT)*, performing also a few projects of common interest.[10]

9 More details about the situation of the computer field in the late 80s can be found in the booklets Computing in Hungary, published by NJSZT in 1987 and 1989 (see http://web.itf.njszt.hu/wp-content/uploads/2014/09/CinH_87.pdf and http://web.itf.njszt.hu/wp-content/uploads/2014/09/computing_1989.pdf resp.

10 Such a project was the development of a compiler for the programming language Ada, intended by the US Department of Defense as standard language for their applications. For obvious reasons programming tools for this language were not available behind the Iron Curtain, where our compiler was the most serious attempt to make this language available to users. By the end of the 80s it was „almost ready", due to the political changes, however, its development became obsolete.

6. Three outstanding personalities

There were several outstanding personalities, whose activities were not directly connected with these institutions. Three of them are mentioned below:

Laszlo KOZMA (1902-1983)
In the late thirties he was working on the development of telephone exchanges at a subsidiary of Bell Laboratories in Antwerp (Belgium). He had several patents there on computing devices based on electromechanical relays. Back in Hungary after World War II he became a leading personality in the Hungarian electrical industry until his arrest for fictive political reasons. In the prison, he was one of the authors of the letter mentioned above. Later, he became a respected professor at the Budapest Technical University, where in 1955 he built the MESZ-1 relay-based computer for education purposes.

Laszlo KALMAR (1905-1976)
Being a well-respected researcher in the area of mathematical logic and set theory, he was the first among Hungarian mathematicians to realize the significance of electronic computers and fought for the recognition of computer science as a separate discipline. He also made a lot of efforts to find application possibilities of computers in different areas of science and industry and organized computing courses (with degrees) at Szeged University as early as in the late 50s. He developed a Logic Machine, evaluating logical expressions without active elements and outlined principles of operations of a Formula Based Computer. Some of his ideas have been realized in the MIR computer family in Kiev.

In 1996 the IEEE Computer Society recognized the achievements of Kozma and Kalmar with its prestigious Pioneer Award.

Arpad KLATSMANYI (1923-2007)
Established development of digital equipments in the Electronic Measurement Factory. After several desktop calculators (Hunor), in 1966-68 he developed a medium sized computer family with completely original, modular architecture and software system (EMG-830)[11]. This might have been suitable for being the basis of an independent Hungarian computer industry, after manufacturing 15 configurations, however, computer development was stopped at EMG in 1970 for industry-political reasons.

11 For a short description of the EMG-830 in English see http://ajovomultja.hu/emg-830-computer/?l=en_US

7. Present situation of the five institutions

The political changes in 1989-90 had a considerable impact also on the Hungarian computing field, by removing the embargo restrictions, privatizing many state-owned institutions, entering multinationals to the Hungarian market, etc. The following short account is on what happened with our five institutions in the past twenty-five years:

- *Computer and Automation Institute (SZTAKI)* continued all the time being in the forefront of computer oriented research and development in Hungary. The Institute has wide external relationships and since 1994 is a full member of ERCIM (European Research Consortium of Informatics and Mathematics) and also a Center of Excellence of the European Union. Its name has changed recently to "*Institute for Computer Science and Control of the Hungarian Academy of Sciences*", keeping the „MTA SZTAKI" acronym. (The celebration of the 50th anniversary of SZTAKI will take place on September 23-24, 2014 at the Hungarian Academy of Sciences).
- *Computer Application and Service Company (SZAMALK)* was privatized in the early nineties. Many parts of its profile have gradually disappeared, since in the new economic climate application development and some of the services could be more efficiently performed by smaller companies (sometimes "spinned-off" from SZAMALK). The only profile being intact and developing with success is education, where SZAMALK is holding a leading position in Hungarian adult education, operating the *Dennis Gabor Technical College* and many product oriented courses for hardware and software manufacturers.
- The story of the *Central Research Institute for Physics* started with an interesting episode: in 1989 the Digital Equipment Corp. established a joint venture with KFKI and SZAMALK, employing part of the persons who earlier in KFKI were dealing with the development and application of PDP compatible computers (Later Digital Hungary bought out both Hungarian partners). This started the split of the computer-oriented departments of KFKI:

  - The "business part", those dealing with the minicomputer development and applications created a management-owned private company, keeping the name KFKI Inc. In the nineties it became one of the leading Hungarian system houses, operating as a holding of several companies with different profiles. In 2006 the whole KFKI Group was bought out by Hungarian Telekom and its parts have been integrated into *T-Systems Hungary Inc.*
  - From the "academic part", the researchers in computer science joined SZTAKI in 1997, while the Computing Center continued to serve in the researchers in physics in different parts of KFKI (having undergone also a lot of organizational changes). Their recent success story is winning a tender of CERN for establishing a Tier-0 data center for the real time processing of physical experiments at CERN (e.g. the Large Hadron Collider). For this purpose the *CERN-WIGNER Data Center* was built in 2013 on the territory of KFKI, being now one of the most powerful data centers in Europe.

- The *Computer Research and Innovation Center (SZKI)* has dissolved completely in the early 90s. Some of its spin-off companies survived, e.g.
  - o *IQSOFT* became a successful software house in the 90s, dealing with application development and distributing advanced software products like Oracle, BEA etc. until joining the KFKI Group (see above) in 2002;
  - o *Recognita* started as a joint venture to sell its unique optical character recognition (OCR) product worldwide. After a series of acquisitions, it was bought by *Nuance Communications Inc.*, the market leader in intelligent human-computer interfaces, and a considerable part of research and development activities of Nuance is performed now in Budapest.
- At *VIDEOTON* all computer related activities were stopped in 1990. Being privatized in 1991 it was reorganized into VIDEOTON Holding with a completely new profile: to provide infrastructure and services for companies manufacturing electronic products. (e.g. IBM produced a considerable part of its data storage equipments at some time in Szekesfehervar). At present Videoton is considered the 5th largest Electronic Manufacturing Services (EMS) provider in Europe and the 28th worldwide.

8. And much more....

The story of the five leading institutions and three outstanding personalities provides a fairly good overview of the first three decades of the history of computing in Hungary. However, this cannot cover the whole picture. A few important issues are outlined below:

- Government policies

Starting from the mid-sixties, development of computing in Hungary was considered by the government as an important priority area, being supported by nationwide government programs, providing coordination and ample state financing:

- o The aim of the *Central Development Program for Computers (SZKFP)* was to promote the development of computing expertise in Hungary, including subprograms for supporting basic research, education, and training and application of computers to a wide range of tasks. The most important measure of SZKFP, however, was the creation of a computer industry in Hungary (see e.g. the VIDEOTON story above)
- o In early 80s the government decided to focus "on computer applications with an aim of increasing their effectiveness in socioeconomic processes, and providing favorable conditions for their extensive introduction into society." Thus, in 1985 SZKFP was transformed into the *Central Economy Development Program for Electronization (EGP)* to help encourage the nationwide introduction of electronic devices[12]

All these efforts were managed by the *National Committee for Technology Development (OMFB)*, an organization at ministerial level, maintaining a coherent, long-term technology policy not only for the computer field, but also for other perspective areas.

12 See in more detail in Zsuzsa Szentgyörgyi: A Short History of Computing in Hungary, Annals of the History of Computing. Vol. 21. No.3. 1999.

One of the most far-reaching actions of OMFB was that as early as in 1986, together with the Academy, it started the *Information Infrastructure Development (IIF)* program to create a computer network for researchers (academic institutions, universities, even individuals). Since networking equipment was at that time still at rather strict COCOM restriction, many of the hardware and software tools had to be developed in Hungary (mostly in SZTAKI). As a result, Hungarian researchers had the possibility to gain "hands on" experience in networking (and to establish connections with foreign colleagues), so they were well prepared for the "internet age", coming to Hungary a decade later.

- Hungarian Software

May be as compensation for the relatively less advanced hardware development and manufacturing situation (due to many reasons not to be outlined here), always high emphasis was given to the area of software development in Hungary. At the beginning it was mainly devoted to solving individual application tasks, but for making the further steps towards a software industry, several factors had to be considered:

  - o As a positive factor, the good human resource preconditions can be mentioned, appearing in a fairly good educational system with high emphasis (at that time!) on mathematics and natural sciences, as well as the overall respect of Hungarian mathematical traditions;
  - o As a negative factor, market limitations did appear, due to the size of the domestic market and in relation to the Eastern countries the so-called "Sofia Concept" requiring the free-of-charge exchange of "research results" (and software for a long time was considered belonging to that category).

As a result, Hungarian software activities were driven towards the Western markets with considerable success with some "niche products" (e.g. *Recognita, ArchiCad, NavNGo*) as well as with the wide practice of, exporting the work of Hungarian programmers worldwide appearing in many forms ranging from individual hiring to "manpower leasing", or to outsourcing development projects to be performed in Hungary.

This has created a fairly good reputation around Hungarian software abilities, which is in our days is being manifested in the success of quite a few Hungarian startups (e.g. *Prezi, Ustream, Tresorit, Gravity* etc.).

- Civil organizations

Civil society has always played an important role in the Hungarian computing scene. Apart from the *John von Neumann Computer Society (NJSZT)*, being the host of our conference (and shortly described on p. 7 of the Introduction), several similar organizations exist also for "neighboring" areas as

- The *Scientific Association for Infocommunications (HTE)*,
- The *János Bolyai Mathematical Society (BJMT)*,
- The *Scientific Society of Measurement, Automation and Informatics (MATE)*
- The *ICT Association of Hungary (IVSZ)*,

as well as "umbrella" organizations, like

- The *Federation of Technical and Scientific Societies (MTESZ)*, being very active in the past, and
- The *IEEE Hungary Section (IEEE HS)*, established in 1987.

The overall aim of these organizations is to help the development of the information society with their specific methods, like spreading scientific-technical information, organizing national and international conferences, competitions, voluntary work etc. Goals and forms of activities may vary, e.g., BJMT organized a conference on Automata Theory in 1956, being the first computing-related scientific event in Hungary, and in the seventies the NJSZT was in the forefront of the popular "microcomputing" movement, organizing youth groups, publishing the "MicroMagazin" journal, broadcasting a Basic course on TV, etc.

An important task of the civil society is the preservation of past values. One of the professional communities of NJSZT, the IT History Forum (iTF), is organizing memorial meetings about past events and building a comprehensive IT History Data Archive, providing an organized collection of data about Persons, Institutions, Products, Papers and Conferences relevant to the history of Information Technologies. The collection is published on the website http://itf.njszt.hu.

And, last but not least, NJSZT has organized and operates the IT History Exhibition[13], serving as the venue of our conference.

13 See the paper of Alföldi et al. in the present proceedings

3.4. Italy's Early Approach to the Computer Era – Thinking Back to Olivetti's Gamble

Corrado Bonfanti

1. Seminal initiatives

Until 1954, only a handful of Italian mathematicians and engineers had the privilege of some insight and hands-on acquaintance with stored-program electronic computers, on the occasion of study missions at the most renowned pioneering installations in the United Kingdom and especially in the United States. At the same time, no one of such technological marvels was still available throughout the country.

Two different approaches – "buy" or "make" – were viable to fill the gap, and both were actually pursued.[1]

<u>The "buy" approach:</u>

- The Polytechnic of Milan acquired in the USA a CRC 102-A computer to equip the just then set up *Centro di Calcoli Numerici*. The machine was running by Oct 1954 and the center officially opened some months later.
- The *Consiglio Nazionale delle Ricerche* (CNR) bought in England a Ferranti Mark I* for the *Istituto Nazionale per le Applicazioni del Calcolo* (INAC). The FINAC machine (a contraction of "Ferranti INAC") arrived in Rome in November 1954 and completed the acceptance test in June 1955.

<u>The "make" approach:</u>

- The University of Pisa established its *Centro Studi Calcolatrici Elettroniche* (CSCE) with the aim of designing and building the *Calcolatrice Elettronica Pisana* (CEP) scientific computer. CSCE activities started in March 1955.
- The internationally renowned firm Olivetti decided to enter the then emerging computer industry. Its *Laboratorio Ricerche Elettroniche* (LRE) was then established at Barbaricìna – a suburb of Pisa – in order to design and prototype the ELEA commercial mainframe. R&D activities began during the middle of 1955.[2]

The already mentioned simultaneity of the four initiatives – a circumstance that did not imply any underlying overall strategy – clearly indicates that the urgency to enter the computer era was widely perceived throughout the country. As a very fruitful consequence, the efforts went through distinct approaches, which complemented each other avoiding competitive or conflicting situations: although resting on mutually independent scopes and resources, several kinds of collaboration were set up since the beginning. As a matter of fact, computing centers in Milan and

1 Note on bibliography. Italian literature sharing the subject of this paper is very extensive and we shall quote only some title, concerning specific passages of the narration. Selected primary sources are quoted whenever appropriate. As far as international literature is concerned, let mention [1] and the more recent [2].

2 Some translation can help. *Centro di Calcoli Numerici*: Numerical Computation Center. / *Consiglio Nazionale delle Ricerche*: National Research Council. / *Istituto Nazionale per le Applicazioni del Calcolo*: National Institute for Applied Calculus. / *Centro Studi Calcolatrici Elettroniche*: Study Centre for Electronic Computers. / *Laboratorio Ricerche Elettroniche*: Electronic Research Laboratory.

Rome, together with CSCE and Olivetti laboratories, became the incubators for the first generation of Italian informaticians.[3]

The Polytechnic of Milan and INAC at Rome embraced **the "buy" approach** in order to have a quickly available up-to-date and powerful tool to afford computing problems whose solution was massively required, arising from the most varied needs of industry, engineering, physics, economy and mathematics itself; such was, after all, the institutional mission they had to fulfill day-by-day.

Worthy of mention is that both acquisitions were almost entirely supported by ERP funds.[4] An even more important common trait of the two initiatives appears when appreciating what "to buy a computer" really meant in 1954-55: far from being a ready-to-use product, the computer required in-house hardware maintenance and upgrades, often implying design and construction of original supplementary hardware features. Moreover, the machines were shipped "nude", i.e. lacking of any software aid. Software development thus became the most impelling and demanding concern: service and utility programs (the forerunners of Operating Systems); algorithms for vectors and arrays handling; libraries of subroutines for recurring problems like mathematical functions calculation. Until users themselves built up their own loaders/interpreters and assembler-like symbolic languages, software had to be coded in machine language.

All these hardware and software tasks and duties visibly reduced the often over-estimated distance between buying and making. As a further consequence, such in house activities – that concerned in the first moment the particular machine owned by the user – soon evolved into a generalized approach to almost every branch of computer science.

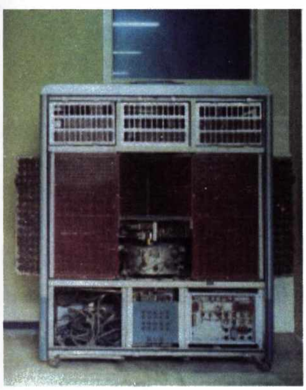


Fig. 1 – CRC 102-A. (1954) Drum memory is placed in central position. (Preserved at the Polytechnic of Milan)

3 Let's at least mention other seminal initiatives.
The Institute of Cybernetics at Napoli, founded by the theoretical physicist Eduardo Caianiello, mainly concerned with artificial and human neural networks from the Artificial Intelligence point of view. [3]
Dda (Digital Differential Analyzer, i.e. analog or hybrid non-von Neumann computers) installed at universities of Napoli, Bologna and Torino and the research that arose around them. [4]
A small but effective enough electronic computer built at the University of Padova by Francesco Piva and others, expressly designed for teaching/training purposes. [5]

4 ERP: European Recovery Program, better known as "Marshall Plan". Apart from its political meaning within the cold war climate, ERP was highly effective in redeeming Western Europe from the disasters of the war.

Fig. 2 – Finac / Ferranti Mark I *. (1965)

According to **the "make" approach**, ultimate tangible goals lasted instead several years even if the intermediate phases were full of scientific, technological and educational achievements.

The University of Pisa did not exhibit any traditional concern with scientific computing and the CSCE-CEP project originated from rather fortuitous (as well as fortunate!) circumstances: a consortium of local governments had made available quite wealthy funds in order to foster some substantial scientific undertaking in the Tuscany region. Upon an authoritative suggestion by Enrico Fermi (the 1939 Nobel laureate for physics), the construction of a powerful electronic computer was chosen, and the *ad hoc* CSCE center was committed to manage such an unprecedented undertaking. An interim prototype (*Macchina Ridotta*: Reduced Machine) was ready as early as 1957 and – despite obvious restrictions – its usage revealed to be quite fruitful. Official opening of the CEP lasted instead until November 1961, even if it was running well before on a rather uncertain provisional ground.[5]

Olivetti's LRE (see forthcoming paragraphs) was able to complete in 1957 two prototypes based on vacuum tube technology. The final product was a fully transistorized mainframe: the ELEA 9003. The first machine was delivered to a customer in 1959.

Such accomplishments deserve appreciation because – as far as technological and theoretical indigenous know-how were concerned – projects started from almost *tabula rasa*.

To give some example of this, it is widely known that American and English computer projects massively recruited former military Radar engineers, notably acquainted with non-linear (i.e. "pulse" or "digital") electronics, the basic technology of computer circuitry.[6] Italy lacked instead almost completely of such already skilled personnel, due to the blindness of military staff who,

5 Let us argue that the official opening could have been intentionally delayed because the formal statement of the completion of the CEP – i.e. of the institutional scope of CSCE – implied the dramatic vanishing of the entire structure of the Centre, included the whole staff. The delay then allowed a providential intervention by the National Research Council, who granted to CSCE the status of permanent research institute under the name IEI (*Istituto di Elaborazione dell'Informazione*: Institute for Information Handling).

6 To be reminded that "linear" electronics originated from the invention of the triode vacuum tube (Lee De Forest, 1907). Its main concern was the undistorted (i.e. "linear") amplification of continuous electric signals; it was then the core technology for radio communications.

along the war, denied resources to Radar development: only a handful of single scholars was then familiar with digital electronics.[7] For the same reason, domestic industries did not receive any stimulus to produce components needed by the "new" electronics, namely special quality vacuum and cathode-ray tubes.

A further cultural drawback could be found in the lack of knowledge about the relatively recent results in theory of computability and mathematical or symbolic logic: revolutionary findings by Gödel, Church, Turing, Post, Carnap and others began to affect Italian academy only in the post-war years and lasted even more to be appreciated as founding principles of theoretical computer science.[8] This was but a consequence of a long lasting supremacy of the neo-idealistic culture that caused, among other, decline and fall of the Giuseppe Peano's school, that flourished and gained international reputation at the outset of twentieth century.[9]

Since a detailed survey about every one of the above mentioned seminal initiatives exceeds the limits of this paper, we now restrict to what happened at Olivetti.

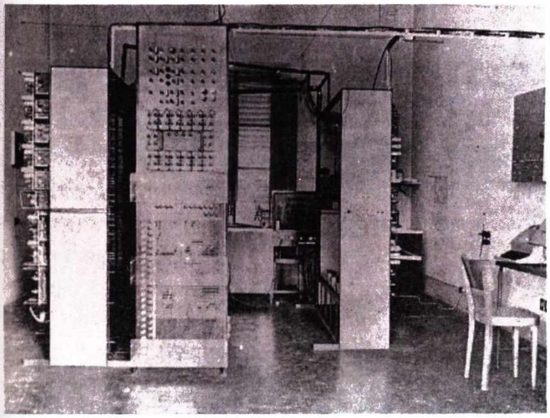


Fig. 3 – CSCE "Reduced Machine". (1957)

7 It was only in the highly specialized domain of particle physics that an expertise arose on the ground of Bruno Rossi's innovative experiments on cosmic rays. [6] During the Thirties – before migrating to America escaping the fascist racial laws – he invented very fast electronic circuits that are the equivalent to the now-days logical gates. A great expert of such techniques was Marcello Conversi, whose contribution to the CEP project we shall mention hereafter.

8 A single but outstanding exception was Corrado Böhm, whose brilliant career in the logic of computation began with his 1952 doctoral dissertation given at the Polytechnic of Zürich – with E. Stiefel and P. Bernays as rapporteurs – concerning the first compiler ever written in its own language. [7] He immigrated to Switzerland to escape fascist racial laws and went back to Italy (1953) as an INAC researcher. During the formative years in Switzerland he became familiar with IBM and Bull punch-card equipment and, most of all, with Konrad Zuse's Z4 relay computer and its *Plankcalkül* programming language. On the occasion, let mention the celebrated 1966 Böhm-Jacpini theorem [8] that assured a theoretical groundwork for the "GoTo-less crusade" by Edsger Dijkstra and subsequent Structured Programming methodologies.

9 Along the first half of twentieth century, Benedetto Croce has been the undisputed champion of neo-idealistic philosophy, according to which, roughly speaking, conceptual and hard sciences – from mathematics to technology – were to be confined in the realm of instrumental activities, useful to mankind but deprived of cultural dignity; an approach that deeply biased public opinion and every degree of education. Croce particularly fought against the mathematization of logic: logic, on his mind, had to be an hunting preserve for qualitative philosophical speculation [9].

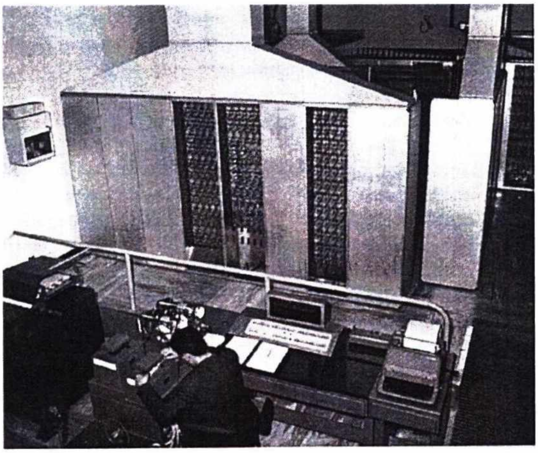


Fig. 4 – CEP computer (1960); partial view (Preserved – not depicted here – at the Museo degli strumenti di calcolo in Pisa.

2. Computers at Olivetti

2.1 Preludes

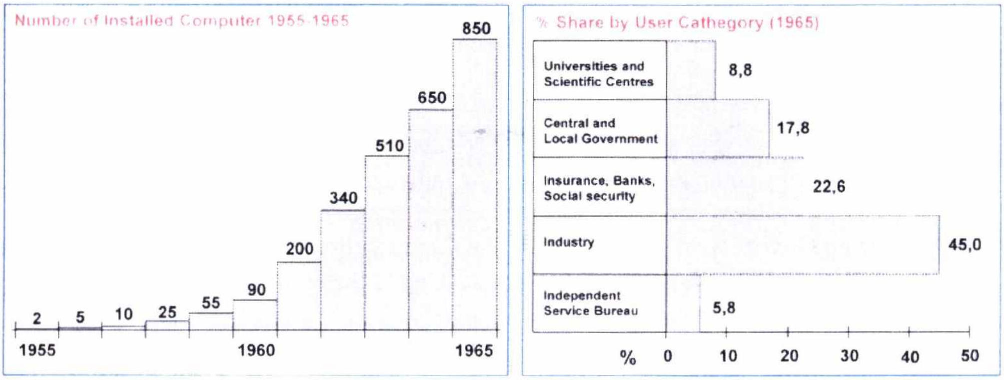
The firm Olivetti was established in 1908 by Camillo Olivetti who set up a typewriter factory in Ivrea, a town near Torino. Along three decades the business grew at a steady rate on domestic and foreign markets until Adriano, the eldest son of the founder, succeeded in 1938 when he was thirty-seven. Inspired by the lesson of his father, he gradually developed his own peculiar management style, that combined the restless care for business with the strong believe in the social responsibility of an industry; an attitude that led to many-sided benefits towards workers and employees, their families and the surrounding community. Trade unions often accused Adriano of subtly hidden paternalism aimed to better submit the workers; on the opposite side, the quite conservative Manufacturers' Confederation (*Confindustria*) treated him as a dangerous revolutionary utopist and someone arrived to boycott Olivetti's products. Being an exquisitely learned personality, he fostered over the years a sort of cultural circle – taking-in architects, sociologists, psychologists and artists – strictly tied to various practical activities of the firm.[10] Under his clever and resolute leadership, Ivrea's enterprise undertook a substantial upwards jump that became particularly fruitful during the post-war years, making Olivetti a multinational holding and a leader in the worldwide market of office equipment. New plants were built in Italy and abroad (Spain, Germany, UK, Mexico, Brazil, Argentina). An efficient worldwide commercial network was established. Mechanical calculators and accounting machines flanked traditional typewriters as flag-product. New products were developed like teletypes, office steel furniture, precision machine tools.

The establishment of the already mentioned electronic laboratory (LRE) was anything but an abrupt decision: it was instead the first move of a strategy that Adriano Olivetti matured over the post-war years. Electronics – on his mind – never represented a departure from the traditional and successful business of office equipment: his long-sighting vision conceived in fact the electronic computer

10 Ref. [10]

– better to say, the electronic data-processor – as the core of the "office of the future".[11] In other words, he clearly felt that the "computer by the scientists for the scientists" was to be superseded by the "data-processor by the industry for the market". Looking in retrospect, the soundness of such an early intuition is proved by the trend actually observed in Italy over the period 1955-1965. The histograms testify the explosion of the market in terms of quantity as well as the decline of the scientific segment: from almost 100 % in 1955 to a poor 9 % ten years later.[12]

COMPUTER SPREAD THROUGHOUT ITALY



Replacement of punched-card data processing with electronic computing significantly contributed – not only in Italy – to speed up the growth in number of computer installations.

Let's also point out that the accompanying growth of computer-concerned people fostered in 1961 the birth of AICA – the Association of the Italian Informaticians – which immediately associated to the international federation IFIP and has nowadays the privilege to be a Member Society of IT STAR.

During the same post-war period, other facts occurred that deserve mention even if – at the moment – they didn't affect the research issues that the ELEA project carried on at LRE. Their long-term consequence shall appear at later stages of the story.

- Olivetti-Bull. It was a fifty-fifty venture, established in 1949 in order to market in Italy the punch-card equipment produced by the French *Compagnie des Machines Bull*, the principal outsider of IBM in Europe. Olivetti-Bull did not significantly contribute to Olivetti's technological know-how but allowed its personnel to acquaint with punched-card data processing – the immediate forerunner of electronic computing – and, most of all, to fight against IBM's aggressive commercial policy.[13] Later on, Bull products evolved into early small sized electronic computers:

11 It seems likely that Adriano's vision could be influenced to some extent by the early (about 1950) commercially available and business-oriented computers built by Eckert and Mauchly Computer Company in the USA (soon acquired by Remington Rand to form its UNIVAC Division) and by Lyons Industries in England (the LEO, meaningfully christened Lyons Electronic Office).

12 Histograms are based on data taken from [11]. IBM, over the years, consolidated a position of market leader but its activities in Italy overcame a merely commercial organization: factories of small-sized computers and applied research centres were established as well. IBM-Italy's employees were over ten thousand in 1970.

13 The engineer and former commander of the Navy Ottorino Beltrami was the director of Olivetti-Bull, while the very young Elserino Piol emerged as the technical and sales-supporting driving person, thus beginning a brilliant and long lasting career inside Olivetti. A detailed history of Olivetti-Bull is given in [12].

the Gamma3 and the Gamma3-Et (*Extension Tambour*, i.e. upgraded with a magnetic drum memory) that met only poor acceptance in Italy.

- New Canaan. In 1952 an Electronic Laboratory was set-up at New Canaan (Connecticut). The laboratory acted as a sort of hunting preserve of Dino Olivetti, Adriano's youngest brother. According to current literature, headquarters at Ivrea ever considered the laboratory as a mere observatory over the USA state-of-the-art. Things went partially different, mainly due to the skilled technical directorship by Michele (later changed into Mike) Cànepa.[14] The laboratory worked in fact on several electronic products and an Olivetti-GBM (General Bookkeeping Machine) was mentioned in a 1955 survey of computers commercially available in the USA.[15] GBM was a small machine with 112 vacuum tubes, 450 crystal diodes and magnetic drum storage. The laboratory specialized on magnetic drums, that apparently became the sole marketable product but with almost negligible results, even if two drums arrived in Italy to fit out the CEP scientific computer. As seen from the Italian motherhouse, New Canaan laboratory – away from any business concern – appeared only a source of expenditure and was then shut on 1961.[16] Dino Olivetti went back to Italy while Cànepa, after a brief and rather disappointing stay at the Olivetti LRE, definitely migrated to the United States.[17]

2.2 The Barbaricìna Guys

Adriano Olivetti was perfectly conscious that a strong scientific and technological groundwork was the prerequisite to afford the computer market with an original and competitive product. He therefore welcomed and fostered the opportunity of joining the still then starting initiative of the University of Pisa – the already mentioned CSCE – aimed to set up the CEP scientific computer. After a period of friendly collaboration, the University and Olivetti signed a formal agreement: CSCE offered free access to invention and patents that could arise in the course of the project, while Olivetti assured – until completion of the project – an yearly financial contribution and, most important, free assignment of skilled scientists from his own staff. The CEP project then started under the directorship of the physicist Macello Conversi and on the ground of a learned survey on the world-wide state of the art – prepared by Alfonso Caracciolo – together with an overall project plan bringing a reliable estimate of duration, manpower and expenditure – prepared by Mario Tchou, of Olivetti, who acted as interim technical director.

Tchou deserves special consideration because – until his untimely death – he represented the driving force of Olivetti's activities in the domain of electronics.

Adriano Olivetti – who ever had the ability to immediately perceive and evaluate people's personality – met him during a trip to the United States, when he was a thirty years old professor

14 Cànepa formerly served as an advisor in tight contact with Adriano Olivetti and spent an year at Harvard University taking part at the development of H. H. Aiken's Mark IV computer.

15 Ref. [13].

16 A further witness of such unfriendly relationships can be grasped from the fact that, according to a 1959 announcement of the ELEA 9003 computer – Ref. [14] – the machine had to be equipped with an auxiliary mass storage of up to three magnetic drums – possibly supplied by New Canaan – but this feature was in fact never implemented.

17 The author came recently across a proposal, dated January 1962, that Cànepa submitted to the management for a devised "201-P General Purpose Data Processing System". The proposal – a substantial document whose concluding chapter ("Evaluation of manufacturing costs") was symptomatically left void – simply fell into oblivion.

at Columbia University, and was touched by his human and professional traits.[18] Within a few months, in 1954, Tchou was hired by Adriano who charged him with the twofold responsibility to contribute at CSCE's early activities and to set up the Olivetti laboratory for research on electronics (LRE). According to Adriano's intuition, Tchou emerged as an excellent manager as well as a resolute but friendly leader of the LRE team, a small group of young engineers and physicists carefully selected by himself.

Even if CSCE's and Olivetti's initiatives shared the courageous "make" approach, we owe to point out some intrinsic difference between them. First of all, before the advent of the general-purpose computers, the architecture of a scientific machine markedly departed from that of a business-oriented one. As a further difference, whilst the CEP was intended as a one-of-a-kind machine to be used in a single laboratory-like location, the Olivetti computer was conceived as an industrial product; it had therefore to fulfill specific needs of mass production as well as easiness of maintenance, ergonomics and aesthetic appeal. Last but not least, the CEP project was carried on in the style of an "open" contribution to the advancement of science, thus originating a flush of papers detailing scientific and technical achievements; Olivetti's policy – according to common practice in industrial research – privileged instead confidentiality so that articles and reports – anyway of more or less promotional scope – appeared only in the latest phase of the project.

In early 1956, after a short period of hospitality at the University of Pisa, LRE moved to a pleasant ancient villa at Barbaricìna, a suburb of Pisa, and the crew became currently known as the "Barbaricìna guys". With the exception of Giorgio Sacerdoti and Matin Friedman, LRE members almost lacked of previous specific knowledge.[19] When Tchou selected them, he mostly appreciated in fact their intellectual potentialities, so that they only needed a brief and intense training to plenty master the fundamentals of the new science. While Sacerdoti knowledgeably assisted him in defining the overall design of the machine, Tchou committed to each member of the staff the care of a specific functional subsystem and regular meetings were held to check the interfaces. Tchou was highly confident about the professional self-control of the members of the laboratory and avoided a rigid regulation of working time; with fair weather, for instance, lunch time was occasion for a relaxing jaunt at the nearby beach, to be recovered working at night.[20]

It seemed almost incredible that at the end of 1957, in advance over the schedule, Tchou and his guys – whose number grew up to thirty – completed the first vacuum tube prototype that took the name *Macchina Zero* (Zero Machine). A second vacuum tube machine immediately followed and it was only at this point that Adriano Olivetti openly confirmed electronics as a new concern of his company and allowed further investments to enable the heavily demanding industrial and commercial gamble.

It was not enough because Tchou insisted that Olivetti had to afford the market with a cutting edge product; full solid-state (i.e. transistor) technology was then mandatory. Saving only the logical

18 Mario Tchou was born in Roma in 1924 and ever lived there; his father was in fact a diplomatic officer at the Chinese embassy. When the war ceased he went to the USA, becoming bachelor in electrical engineering (1947), master of science in physics (1949) and associate professor of electrical engineering at Columbia University (1952).

19 Sacerdoti came from Rome, where he led the engineering staff of the FINAC computer. Friedman, a Canadian engineer, previously worked with Ferranti Industries at Manchester.

20 Ref. [15].

and functional design, circuitry had to be completely redefined; a quite demanding task that LRE quickly accomplished so that, in autumn 1959, the production plant was able to deliver the ELEA 9003, one of the earliest – possibly the first at all – commercially available solid-state computer in the world. Other notable features were: magnetic core memory expansible from 20,000 up to 160,000 characters in modules of 20.000;[21] variable length memory fields; interrupt signals that allowed the simultaneous execution of three programs; up to twenty magnetic tape units; last but not least, an ergonomic and pleasant appearance designed by the architect Ettore Sottsass.

Fig. 5 – Roberto Olivetti, left, and Mario Tchou (about 1958)

Fig. 6 – Adriano Olivetti (1958). In the background - Olivetti's buildings at Ivrea.

Fig. 7–The first group of "Barbaricìna Guys"(1956). Standing, from left: G. Calogero, F. Filippazzi, M. Tchou, R. Galletti, P. Grossi, S. Sibani, G. Sacerdoti. Kneeling, from left: L. Borriello, S. Fubini, O. Guarracino, G. Raffo. On that occasion, M. Friedman was away.

21 A character was coded into a "Byte" of six bit plus one for parity check. Filippazzi invented a method that halved the bit-selection circuitry and the invention was patented by Olivetti and licensed to Plessey in England.

	CRC 102A (1954)	FINAC Ferranti Mark I* (1954)	CEP (1960)	Olivetti ELEA 9003 (1959)
Addressable memory element	Word (42 bit)	Word (20 bit)	Word (36 bit)	Character (6+1 bit)
RAM technology	Magnetic drum	Williams (Cathode ray) tubes	Magnetic cores	Magnetic cores
RAM Capacity	1,024 Words	832 Words	4,096 Words	20 up to 160 KChar
Mass Memory Devices	Magnetic tape	Magnetic drum	Magnetic drum Magnetic tape	Magnetic tape
Mass Memory Capacity	117 KWords/Tape	32 KWords/Tape	32 KWords (Drum) 1,536 KWords/Tape	13,000 KChar/ Tape
Additions per second (approx.)	100	1,000	6,700	5,000
Active Components Technology	Vacuum tubes Germanium diodes	Vacuum tubes Germanium diodes	Vacuum tubes Germanium diodes (Transistors for Tape Control Unit)	Transistors Germanium diodes
Instruction Set	25	30	128	91
I/O Devices	Tape punch/reader Teletype	Tape punch/reader Teletype	Tape punch/reader Teletype	Tape punch/ reader Teletype Card punch/ reader Fast printer
Power Consumption (kW)	20	35	25	4.5
Number of Manufactured Machines	20 (by CRC-Computer Research Corporation and NCR-National Cash Registers)	9 (by Ferranti Ltd.)	1	35

Table 1. Selected characteristics of the mentioned computers. Data are taken from Ref. [1], with adjustments by the author.

2.3. Maturity and Crisis

The computer factory was established at Borgolombardo, near Milan, where the research group of LRE also moved. Production activities together with setting up of a commercial organization – including hardware and software customer assistance – became the most demanding and finance-draining concern of Olivetti. It soon appeared that the computer business could benefit of the commercial experience already matured by Olivetti-Bull, also because punched-card and electronic data processing shared the same category of customers. Olivetti then acquired 99% of Olivetti-Bull and merged it into the DEO (*Divisione Elettronica Olivetti*: Olivetti Electronics Division) together with computer factory and sales department, a highly structured organization with a work force of about two thousand peoples.[22] The exciting times of Barbaricìna were over, but intensive research on new products continued under Tchou's directorship, willingly flanked by Roberto Olivetti to whom his father Adriano, since the beginning, committed a special care of the electronic branch. The most valuable achievement was the mid-range ELEA 6001 computer that had a micro-programmed architecture: it was delivered since 1961 and became a nearly standard equipment for Italian university computing centers. In order to improve sales of this successful product, Piol insisted to slightly modify the machine into the ELEA 6001-C model, better suited for business applications.

Tchou, however, distinctly perceived that the new initiatives in electronics could fall in isolation or – even worse – in contrast with the firmly settled and profitable Olivetti's business of mechanical devices. He then caught every opportunity to show how electronics could be beneficial even outside the specialized realm of computer. The UME, for instance, (*Unità Moltiplicatrice Elettronica*: Electronic Multiplying Unit) allowed a successful upgrade of the Audit electromechanical accounting machines. A number of electronic off-line "converters" was set up in order to transfer onto magnetic tape the data originated on paper tape by the same Audit, possibly in far-away locations; the same for data available on punched cards (and, vice versa, from magnetic tape to cards) thus allowing data exchange between computer and punched-card processors.

When considering the activities that LRE carried on in the domain of software, some weaknesses appear in retrospect, especially in comparison with the experiences we have discussed in the introductory paragraph.

Along the early phases of the ELEA project, attention was almost exclusively focused on hardware while the critical role of software began to be appreciated only upon completion of the Zero Machine. The care of software was committed to a small – and perhaps under-sized – group led by the mathematician Mauro Pacelli, who privileged the theoretical study of high-level programming languages – the so-called "logic programming" – leaving almost unattended the domain of application software; an approach that compelled the sales department to fulfill almost at random the software requirements issued by customers.

A few examples: the lack of a software supervisor left to the application programmer the exceedingly delicate handling of concurrent programs, so that multiprogramming – a distinguished feature of ELEA 9003 – rested almost unused. Later on, the LRE "logic programming" team defined an original Algol-like language, named Palgo, and built a compiler for the ELEA 6001. But it happened that the 6001 users – almost all of them were scientific institutes – urgently asked for a

22 DEO was headed by Ottorino Beltrami, and Elserino Piol became the marketing manager.

Fortran compiler and it was the customer care department, not the LRE, to fulfill in a hurry such a request.[23]
According to Beltrami,[24] thirty five ELEA 9003 and sixty four 6001 were delivered, that represented about 20-30% share of the domestic market; a result that could appear rather satisfactory, also because the Italian government never supported Olivetti with the benefits – like preference in procurements, protectionism, assignment of strategic projects – that were common practice abroad in order to strengthen the "national champions" of computer industry.[25] Moreover, DEO's cash flow heavily suffered IBM's practice of renting instead of selling computers. But the most serious drawback appears when considering that the domestic market was far to reach the critical width that the computer business required in order to get a profitable return on investment; after all, it was the time of IBM 1401, the first computer to sell over 10,000 worldwide.[26] On the other hand, the powerful multinational structure of Olivetti was strictly bound to the traditional mechanical products and was then unable to engage the extraneous and completely different business of computer. Roberto Olivetti and Tchou sought to escape national confinement but their effort to gather abroad some industrial and/or commercial partner revealed fruitless.[27]

We owe also mention that Adriano, in 1959, audaciously embarked in taking control of Underwood, an American industry based on mechanical products (typewriters and desk calculators) that fairly matched Olivetti's business.[28] It was the key to enter the huge and wealthy market of the States and the acquisition of a prestigious American company by an Italian one caused sensation at the stock exchange. On the occasion, the long-lived Underwood brand changed into Olivetti-Underwood and an American subsidiary – the Olivetti Corporation of America – was set up. The successful strategic move really strengthened Olivetti's leadership on the international market but the business soon revealed less advantageous than expected: not only the stock acquisition price was overestimated but Underwood's works at Hartford (Connecticut) appeared obsolete at the point to require heavy investments for restructuring. Due to Olivetti's poor financial capacity, investments implied loans from banks and the growth of indebtedness became a critical concern.

Such was the overall picture when Adriano Olivetti, on February 1960, suddenly died by heart attack; the firm was completely unprepared to face such a disaster and the members of Olivetti family – the majority shareholders – decided to commit management to some extraneous personality. The electronics at Olivetti had lost its authoritative tutelary deity and the supporters of the mechanical tradition, who prevailed at any level of the hierarchy, felt free to spread rumors against LRE and

23 It should be reminded that high-level computer languages were then in their magmatic infancy, far from later standard definition by *super partes* authorities. It seems likely that Pacelli refused Fortran in order not to appear as an IBM-follower. Moreover, Algol represented the leading edge of the state of the art and was ennobled by its academic and mostly European origin.

24 Ref. [16].

25 The notion of "national champion" is borrowed from Chandler's essay [17].

26 Because of the confinement within national borders, ELEA computers remained almost unknown abroad. This also accounts for the usual lack of consideration by foreign historians.

27 Similar attempts by Beltrami and Dino Olivetti had the same negative outcome. As a matter of fact – as far as computer industry is concerned – European countries repeatedly exhibited their inability to cooperate and the venture of Unidata is paradigmatic. Unidata was established in 1972 as a transnational joint venture between CII (France), Siemens (West Germany) and Philips (Nederland). Its mission consisted in a strong reaction against the supremacy of the Americans – namely the IBM – but reciprocal jealousy and mistrust of the partners caused its vanishing within a couple of years.

28 Ref. [18].

DEO that they measured only on the base of poor financial performance.

It was not enough: on November 1961, even Mario Tchou – aged only thirty seven – perished in a car crash, thus leaving Roberto Olivetti the sole defender of electronics.[29]

The final scene matured between 1963 and 1964 when the economy entered a worldwide recessive cycle that affected also the market of office equipment. Moreover, the cost of Underwood's acquisition still represented an heavy weight. Olivetti's finance definitely exhausted and the president Bruno Visentini – a distinguished economist – in order to avoid catastrophic bankruptcy, urged for an "intervention group" of private banks and industries. The group acquired control of the stock – thus reducing to almost nothing the share owned by the Olivetti family – and guaranteed against default but firmly stated the dismissal of the Electronic Division as a preliminary condition. It was argued that investments required to successfully run the computer market overwhelmed the capabilities of every Italian industry. Letting aside the excellence in technology, electronics represented after all only a tiny fraction of Olivetti's overall business that included about thirty affiliate companies, twenty factories and fifty five thousand employees.

Just in that moment, General Electric was seeking for opportunities in order to widen its computer business in Europe; Olivetti's DEO in Italy and Bull in France – that was facing too a financial crisis – appeared the most viable chances and GE took advantage of both. Between 1964 and 1965 DEO was then sold to the Americans.[30] This marked not only the defeat of an admirable adventure, but also the ultimate subduedness of Italy in the domain of big computers. It is interesting enough that the government lacked at all appreciating the damage of losing such a unique and strategic asset. In France the delivery of Bull to foreign hands was felt instead as a wound to the national pride, at the point that president Charles De Gaulle reacted launching the celebrated *Plan calcul*.[31]

Fig. 8 – Olivetti ELEA 9003 (1959). (Preserved and functioning – not depicted here – at the Istituto Tecnico "Enrico Fermi", Bibbiena (Arezzo))

29 He was elected among the top managers but almost deprived of autonomous initiative. Beltrami – the Deo managing director – and Sacerdoti – who succeeded to Tchou as responsible of the research laboratory – loyally assisted him but they were both in an even worse position.

30 To be precise, the Oge (Olivetti-General Electric) company was established (75% GE and 25% Olivetti); it became Geisi (General Electric Information Systems Italy) when GE acquired 100%. Later on (1970) Honeyell replaced General Electric and Geisi became Hisi (Honeywell Information Systems Italy).

31 Ref. [19], [20].

Fig. 9 – Olivetti ELEA 6001 (1961). (Preserved – not depicted here – at the Museo degli strumenti di calcolo; Pisa)

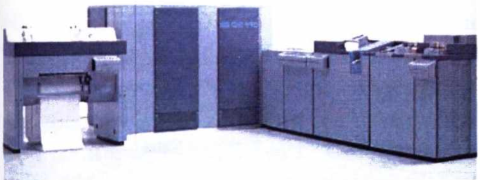


Fig. 10 – General Electric GE 115. (1965)

2.4 Heritage

Let us conclude with some selected "flashes" in order to show that the story we have dealt with didn't simply come to an end with the disappearance of the *Divisione Elettronica Olivetti.*

- Olivetti's withdrawal from "big" electronics still now keeps attracting attention of Italian historians; they unanimously complain that unfortunate happening.[32] From another point of view, it has been remarked that the LRE-DEO experience was not scratched out by General Electric but simply merged into a multinational enterprise with new criteria to handle the business.[33] As a matter of fact – and even if some discontinuity occurred like in the case of the ELEA 9004 project to be dealt hereafter – the Italian managers, human resources, factory and research laboratory were kept almost untouched, and even increased, by General Electric. Assuming this point of view, the story of ELEA 4001 is meaningful enough. This medium-sized computer was launched by Olivetti in 1964 and represented the most valuable and ready-to-market asset that DEO brought as a dowry; with a minimum reshaping in order to fit the GE series of computers, ELEA 4001 was marketed as GE 115 and sold over 4,000, being particularly successful in the United States. It was the first time that a computer entirely designed and manufactured in Italy massively reached foreign markets; according to previous discussion, Olivetti could have hardly achieved such a remarkable result.

32 Ref. [21], [22], [23], [24].

33 To give but an example, "product planning" methodology was introduced by the Americans and represented a novelty for the Italian management culture. Ref. [25].

Over the years, many other "Italian" computers went through the world under the General Electric – and later Honeywell – brand that left hidden their being "designed and manufactured in Italy"; among them, in the early 70s, the Level 2 model of the Honeywell Series 60, that was even licensed to the Japanese Hitachi.

- FINAC – the Ferranti computer that the INAC institute bought in 1954 – revealed to be an exceptionally long-lived machine: switch off occurred on June 1967. However, its obsolescence became clear much earlier. INAC resumed then the idea of setting up an original computer and its director Aldo Ghizzetti, in 1961, addressed then a proposal to Olivetti that promptly assured a quite robust collaboration.

A joint project was then agreed, according to which hardware set up was an Olivetti's concern: the outcome of the project had to be a prototype owned by INAC – called CINAC (a contraction of "Computer Inac") – while Olivetti had to assume the prototype as the ground for an innovative industrial product – the devised ELEA 9004 series. The outstanding feature of CINAC/ELEA 9004 consisted in its being a "stack" machine with zero-address instructions, the same architecture that inspired the almost contemporary Burroughs B 5500 computer.[34]

Construction of the machine started at Olivetti factory in early 1963 and CINAC was delivered in February 1966, but the seemingly successful outcome of the project is misleading. When the DEO was sold to General Electric, the devised ELEA 9004 series was abandoned because it mismatched the product policy of the Americans; GE didn't discontinue collaboration but reduced resources to the minimum.[35] INAC, on its own, faced the problem of transferring on the new machine the huge amount of Finac-bound software accumulated over the years. The hypothesis of coding it anew was unfeasible, so that they went to a tradeoff: a sort of hardware emulator of FINAC on the CINAC was set up in a hurry. At the same time, due to the lack of resources, the development of software specifically designed for CINAC never went to a satisfactory outcome. As a result, the innovative capabilities of CINAC were left hidden and almost unused.

- While the crisis of Electronic Division culminated with its selling to GE, a gratifying surprise matured thanks to Pier Giorgio Perotto, an engineer who worked at Olivetti LRE since 1957. Perotto's personality resulted incompatible with the GE representatives so that – together with his two assistants – he didn't quit Olivetti. In fair agreement with Roberto Olivetti and working with extremely poor resources, he was able to work out a small desktop electronic computer; not a toy but instead a professional tool at any rate, programmable by means of an essential but effective language. It was the revolutionary Olivetti Programma 101 (P 101 or "P one-o-one" for short) that, in an epoch dominated by the hardly accessible mainframes, brought computing power on everyone's desk.

When exhibited in New York at the 1965 Bema Show, the success was astonishing - almost obscuring Olivetti's mechanical products. Over the years, 44,000 machines were shipped throughout the world, many of them in the United States, with the Olivetti-Underwood brand; the NASA space

34 Ref. [26], [27].

35 Interesting details about the almost unexplored story of CINAC/ELEA 9004 are given in Ref. [28].

agency was among the first customers and bought sixty.[36]
Within Olivetti, the success of P 101 shocked the supporters of the mechanical technology; little by little they accepted the new course towards the so-called "light" electronics.37 Worthwhile mentioning that the P 101 incorporated an I/O original feature that used removable and reusable magnetic floppy-cards as the medium for storing programs and data. Hewlett-Packard cloned that feature in his HP 9100 model and paid to Olivetti a royalty of about one million dollar.

- At the end of the Fifties, the massive import of solid-state components concerned not only Olivetti but also other industries, namely for consumer electronics, giving the opportunity to set up an autonomous production in Italy. Tchou and Roberto convinced Olivetti to catch the opportunity; the SGS company (*Società Generale Semiconduttori*) was then established and production started under Fairchild Semiconductor license. SGS revealed a far-seeing initiative that grew over the years independently from Olivetti's ups and downs; still now-days it is well alive with the new name ST-Microelectronics in partnership with the Thompson French industry.

Worth mentioning is that the Italian scientist Federico Faggin began his career at SGS. He was then hired by Fairchild and later on joined Intel, where, in 1971, together with Ted (Marcian) Hoff and Stanley Mazor, he built the first microprocessor – the celebrated Intel 4004 – i.e. the whole computer on a single silicon chip.[38]

Fig. 11 Pier Giorgio Perotto (1991)

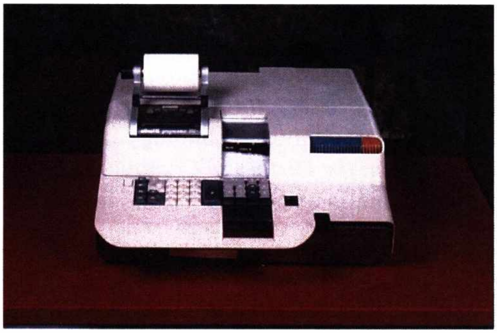


Fig. 12 – Olivetti Programma 101. (1965)

36 Ref. [29]. A key factor of the P 101 success was that, quite differently from huge computer systems, it could be sold piece by piece (at the price of 3,200 $) like it happened with mechanical typewriters and calculators. Moreover, it was extremely easy to use and to maintain (due to its modular structure, maintenance simply implied the replacement of the faulty module).

37 Typical "light" products were video and printing remote terminals and other peripheral equipment. Later on, electronics arrived to affect the same traditional office machines: the Auditronic 770 accounting machine (1969), the Logos 250 calculator (1970) and the ET 101 (1978) represented the first electronic products of their category.

38 Ref. [30].

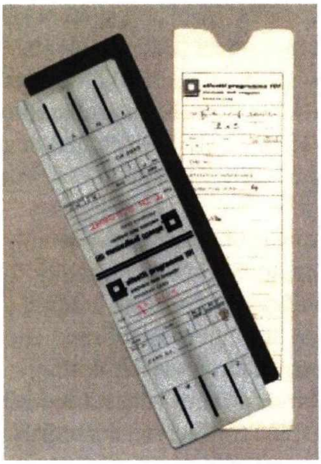


Fig. 13 – Floppy card for P 101; the black reverse is the magnetic-sensitive side. (7x25 cm)

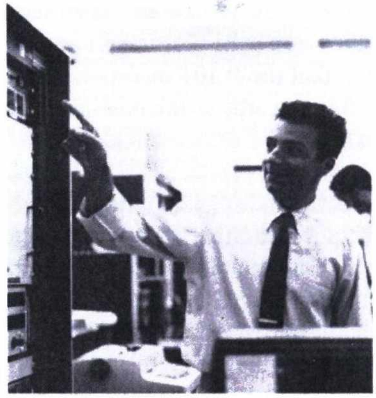


Fig. 14 – Federico Faggin at Intel. (1969)

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3.5. **What is a Mathematical Machine?** - A Brief History of Early Computing in Poland

Marek Holynski

On December 23, 1948 the weather in Warsaw was particularly bad. Wet snow continued to fall as the inhabitants of the ruined city desperately tried to salvage what they could of their holidays with a meager meal for their family.

Only a small group of people seemed untroubled by the worries of the upcoming celebrations. These were attendees of a seminar on electronic calculating machines, listening to a talk given by Prof. Kazimierz Kuratowski.

Kazimierz Kuratowski

Kuratowski was a renowned topologist and director of the Institute of Mathematics in the Polish Academy of Sciences. He had just returned from a lecture in the United States, where he was shown ENIAC, the first electronic general-purpose computer, dubbed in the press as "the giant brain". His excitement about the newly built machine gave the listeners great motivation to pursue a similar project and led to the immediate formation of a research team.

Thus, the new research team, later officially named the Mathematical Apparatuses Group, began building their own computer, despite having access to very limited resources. The researchers, who were barely surviving on the food parcels from post-WWII international relief agencies and wore leaky boots, did not have access to the proper equipment, parts, or even premises to pursue their endeavors. Moreover, the new American advancements in relevant fields were not often shared with the public, much less other countries, due to their applications in the military. Even those that were released did not often reach Poland, as a result of the Iron Curtain.

Analog or Digital?

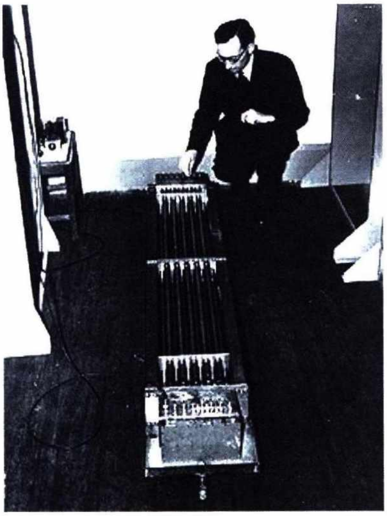
The Mathematical Apparatuses Group was provided three rooms at the Institute and for quite a while their work remained only on paper. Their first attempts to deal with real devices did not bring the significant results. For each damaged module they repaired, another one was breaking down, and the process would repeat itself.

Finally, in 1953 they were able to get something working: an analog machine built with 400 vacuum tubes, which was called the Differential Equations Analyzer. It was able to solve complex differential equations with very high accuracy and was used for a number of practical applications, including the design of turbines and aircrafts.

Differential Equations Analyzer

The next project was completed in 1955. The Electronic Machine for Automatic Calculations was able to perform 2000 additions or subtractions, 450 multiplications and 230 divisions per second, using an analog technology that operated on 1000 vacuum tubes. The solution, which allowed for the "fast" memory of this machine relied on a number of glass tubes filled with mercury, which often times were not sealed properly, resulting in a health hazard.

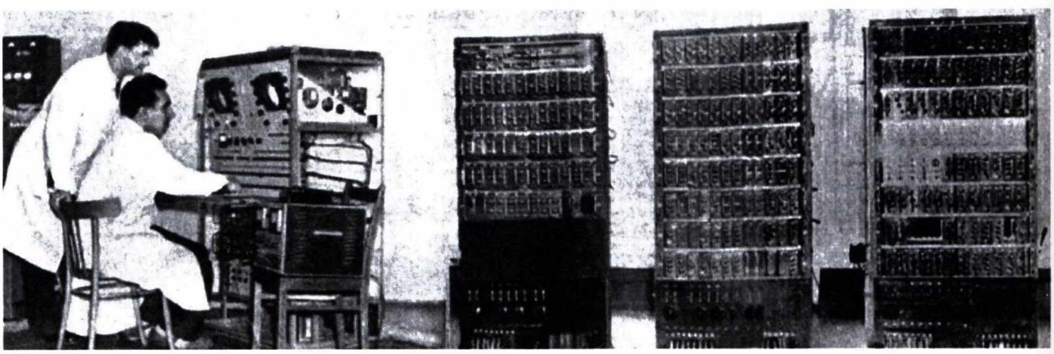
According to an anecdote passed from one generation of computer scientists to the next, one of the team members was reminded of a commonly used item made of latex that had the perfect dimensions for sealing the glass tubes. While the saleswomen at the pharmacy were not particularly surprised when he requested one hundred pieces, they were taken aback by the request to invoice these highly personal items to the Polish Academy of Sciences.



Mercury memory of the Electronic Machine for Automatic Calculations

From ABC to XYZ

In order to consolidate the existing research and design efforts, the Polish Academy of Sciences established the independent Mathematical Apparatuses Division (Zakład Aparatów Matematycznych – ZAM) in 1957. It was there that, in autumn of 1958, the first Polish electronic digital machine was launched with the name **XYZ**.

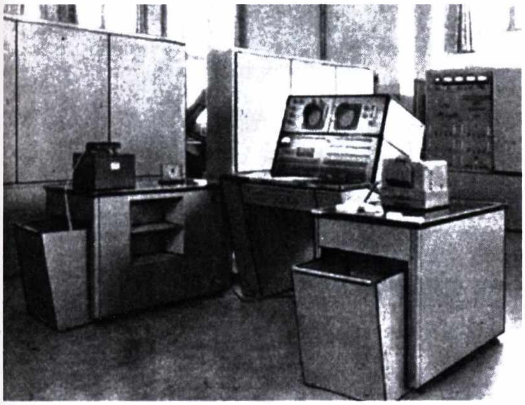


XYZ digital computer

It used 400 tubes and 2000 diodes, flip-flops on one triode, had drum memory and punched cards for input and output. It could perform up to 1000 arithmetic operations per second and had an internal binary language with symbolic addressing. The head of the team, Prof. Leon Lukaszewicz, when asked by journalists why the machine was named XYZ, would answer: "Well, the version we started with was called ABC".

Leon Lukaszewicz

At that time, commercial applications for such an efficient machine had just begun to emerge. In 1960 the first unit of ZAM-2 was built. It improved on the previous versions by including 600 kb of memory, teletype, a paper tape reader, and being suitable for mass production.



ZAM-2

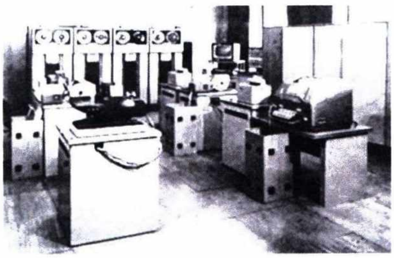
The Mathematical Apparatuses Division, which by 1962 was operating out of its own building, began its transformation into the **Institute of Mathematical Machines** (Instytut Maszyn Matematycznych – IMM). In order to maintain the tradition, the Institute exists to this day under the old name, despite the burden of facing continuous inquiries (especially from younger generations) about what mathematical machines really are.

The word "computer" was only allowed to appear in the Polish language fairly late -- in the mid 70s. Before, it was routinely replaced by the censors' office with the phrase "electronic calculating machine", a compulsory copy from the Russian term for computers.

Instytut Maszyn Matematycznych

The end of pioneering

The new Institute continued ZAM's series with ZAM-3 and ZAM-21 (launched in 1965). The last of them, ZAM-41, was not far from the contemporary notion of a computer - it performed 30,000 fixed-point operations per second, was equipped with a tape memory, line printer and other peripherals. Its production started in 1966. IMM later became responsible for building mainframes R-30 and R-32, the Polish contribution to the "Unified System of Electronic Computers" released in the Comecon countries and ZAM line had to be dropped.



ZAM-41

With the advent of minicomputers, IMM became a strong center for designing and manufacturing such systems like Momik 8b, Mera, K-202, and Mazovia, as well as various peripheral devices. In the late 60s, however, numerous other research centers became involved in constructing, producing and using computers for different applications ultimately ending the pioneering era of Polish research in computing.

Mera-400

K-202

3.6. Some Key Aspects in the History of Computing in Romania

Vasile Baltac, Horia Gligor

First World Computers

The glory of being the first computer is disputed by ZUSE 3, built by Conrad Zuse in 1941 [1], a relay based computing equipment, and ABC built by John Atanasoff and Clifford Berry at Iowa University in 1942 [2], a non-programmable device. During the war years in complete secrecy COLLOSSUS was built in UK for the need of war decryption work. Only recently information was declassified on COLOSSUS and it shows that COLOSSUS Mark 1 was a programmable machine, but not yet a Turing complete machine [3]. Most authors consider ENIAC announced in 1946, built by John Mauchly and J. Presper Eckert of the University of Pennsylvania for the US Army, as the first truly general purpose computer[4].

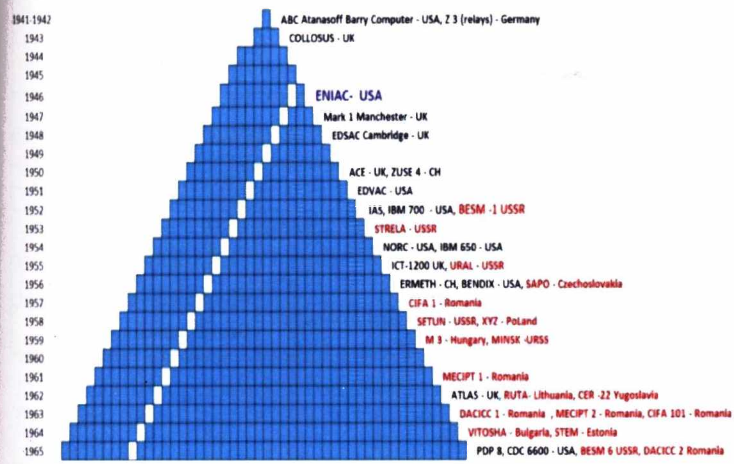


Figure 1 First World Computers

First computers in Eastern Europe

The 50s and 60s

Not very long after the first computers were launched in the USA and Western Europe, research started in USSR and Eastern Europe to build computers. The first one seems to be BESM-1, completed in 1952 at the Academy of Sciences of USSR in Moscow. Some sources mention an earlier smaller variant MESM-1 [5] built 1948-1951 in the same place. BESM-1 was a fully programmable computer [6], used for scientific calculations, automatic translation, etc. It consisted of 5000 electronic tubes, paper tape input, magnetic drum and band memories, photographic printer, etc. The next machines were also built in the USSR: STRELA and URAL in 1953 and 1955. First computers outside USSR were SAPO built in Czechoslovakia in 1956 and CIFA-1 built in Romania in 1957. They were followed by SETUN in USSR and XYZ in Poland in 1958 and M-3 in Hungary and MINSK in USSR in 1959. MECIPT-1 was put into operation in Romania in 1961, followed by RUTA Lithuania and CER -22 in Yugoslavia. First generation computers were still launched in 1963 in Romania (DACICC 1 and CIFA 101) and in 1964 in Bulgaria (VITOSHA) and Estonia (STEM). But the years 1963-1965 marked the advent of the second generation transistorized machines MECIPT 2 in 1963 in Romania, BESM -6 in USSR and DACICC 2 in Romania in 1965.

Table 1 Chronology of Eastern Europe (including USSR) Early Computers

Year	Computer name	Country	Place	Computer Generation	Biblio-graphy
1952	BESM 1	USSR	Academy of Sciences, Moscow	Electronic tubes	[5]
1953	STRELA	USSR	Special Design Bureau 245, Moscow	Electronic tubes	[7]
1955	URAL	USSR	Scientific Research Institute of the Ministry of Machine and Measuring Instruments Industries	Electronic tubes	[8]
1956	SAPO	Czechoslovakia	Academy of Sciences, Prague	Electronic tubes + relays	[9]
1957	CIFA 1	Romania	Institute of Atomic Physics, Bucharest	Electronic tubes	[10]
1958	XYZ	Poland	Academy of Sciences, Warsaw	Electronic tubes	[11]
1958	SETUN	USSR	Moscow University	Electronic tubes	[8]
1959	M 3	Hungary	Academy of Sciences, Budapest	Electronic tubes	[12]
1961	MECIPT 1	Romania	Polytechnic University of Timisoara	Electronic tubes	[10]
1962	RUTA	Lithuania (USSR)	Special Design Bureau Vilnius	Electronic tubes & semiconductors	[15]
1962	CER 10	Yugoslavia	Mihailo Pupin Institute Belgrade	Electronic tubes & semiconductors	[16]
1962	CIFA 101	Romania	Institute of Atomic Physics, Bucharest	Electronic tubes	[10]
1963	DACICC 1	Romania	Institute of computing, Cluj-Napoca	Electronic tubes	[10]
1963	MECIPT 2	Romania	Polytechnic University of Timisoara	Semiconductors	[10]
1964	VITOSHA	Bulgaria	Academy of Sciences, Sofia	Electronic tubes	[14]
1964	CET 500	Romania	Institute of Atomic Physics, Bucharest	Semiconductors	
1965	STEM	Estonia	Institute of Cybernetics, Tallinn	Electronic tubes & semiconductors	[15]
1965	BESM 6	USSR	Institute of Precision Mechanics and Computer Engineering, Moscow	Semiconductors	[5]

The technology divide

The chronology drawn in Table 1 according to various sources shows a serious lag behind the USA and Western Europe. This was due not only to inherent problems of the centralized planned economies characteristic to the period in USSR and Eastern Europe, but to ideological problems. The computers were considered a part of cybernetics, and cybernetics was considered in the fifties a "capitalist pseudoscience" [13]. In the 1950s, Romania was heavily influenced by the Soviet political dominance. The Philosophical Dictionary published in 1953 in Moscow described cybernetics as a "reactionary bourgeois science directed against the working class." [10]. The situation changed in 1955 when a classified report stated that "As a result of irresponsible allegations by incompetent journalists, the word "cybernetics" became odious and cybernetic literature was banned, even for specialists, and this has undoubtedly damaged the development of information theory, electronic calculating machines, and systems of automatic control"[13].

However, Soviet, Eastern European and Romanian scientists promoted computers and cybernetics, in academic, university, industrial and high school circles and research on computers flourished despite technological difficulties.

It is to be said that during the first generation of computers the research was able to keep the technology divide limited to several years. The electronic tubes and the passive circuitry were produced in the USSR and Eastern Europe, complexity of computer architecture was not big and programming was simple. With the development of integrated circuitry and LSI, on one hand, and complex operating systems on the other, the divide started to grow during the 60s to 80s.

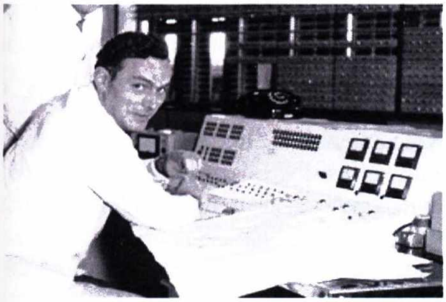


Figure 2 Victor Toma and CIFA-1

Romanian computers

First and second generation

CIFA

The first Romanian computer was built at the Institute of Atomic Physics (IFA) in Bucharest starting 1954 and put into operation in April 1957. CIFA-1 had 1500 electronic tubes, a magnetic drum memory of 512 31-bit words, paper tape input, typewriter output and was able to process data at 50 operations per second. Its creator was Victor Toma (1922-2008) (figure 2), researcher at IFA, who continued building new versions of the first generation CIFA (CIFA 2 to CIFA 4) and the second generation CET-500 released in 1964. During 1962-1964 within an agreement of the Romanian and Bulgarian academies of sciences, Victor Toma contributed to the creation of VITOSHA, the first Bulgarian computer [17].

His contribution to computer development was recognized by both academies. The Romanian Academy elected him Honorary Member in 1993 and the Bulgarian Academy elected him also Honorary Member in 2008.

In the same institute, another team led by Armand Segal (1929-2010) built CIFA-101 launched in 1962, a first generation computer with serial processing of data leading to a much simplified hardware.

MECIPT

At the Polytechnic Institute (now Politehnica University) of Timisoara a team led by Wilhelm Lowenfeld (1922-2004) and Iosif Kaufmann(1921-) started in 1957 the project MECIPT-1. In 1960-1961 Vasile Baltac (1940-) joined the team being in charge with the design of the diode decoder matrix and memory optimization [10]. The computer was put in operation in 1961 (figure 3) and had over 2000 electronic tubes, tens of thousands of passive components, 30 bit words, magnetic drum memory of 1024 words, paper tape input, electric typewriter output, machine code programming. The speed was 50 operations per second, increased to 70 operations per second through interleaving algorithm by Vasile Baltac. MECIPT 1 introduced the concept of microprogramming, based on a paper sent by Prof. Sir M. V. Wilkes, FRS of Cambridge University, father of micro-programming[10].

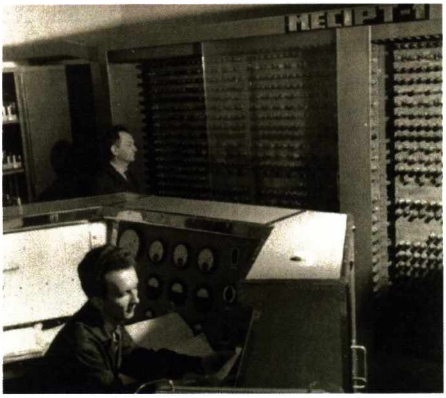


Figure 3 Wilhelm Lowenfeld and Vasile Baltac (at the console) and MECIPT-1 in 1962

As MECIPT was built in a university, the first courses on computer engineering were started at Timisoara Polytechnic Institute in 1963 and the first graduates in computer engineering finished their studies in 1966.

The next computer was MECIPT 2, fully transistorized and with a ferrite core memory. Both computers were fully utilized for scientific and technical computing. A first automatic translation from English into Romanian was performed with MECIPT in 1963.

Pupitrul de comanda al calculatorul DACICC 1, in timpul primelor exercitii efectuate de cercetatorii clujeni

MECIPT was the place were intense technical cooperation took place, both domestic and internationally. Based on plans delivered by the MECIPT team, a Romanian Army team built CENA, the first military computer in Romania.
The magnetic drums for MECIPT 1 and 2 were acquired from the Hungarian colleagues from the Academy of Sciences of Budapest who built them within M-3 project [18].

DACICC

At the Institute for Computing of the Academy from Cluj-Napoca a computer called DACICC 1 was finished in 1963, by a team led by Emil Muntean and Gheorghe Farkas. The computer was based on electronic tubes, but used several transistors. Next computer was the second generation fully transistorized DACICC 200 delivered in 1968 with a nucleus of operating system [19]

Romanian Computer Pioneers

The development of early computers would not have been possible without help from prominent scientists of the period engaged in promoting computer science and despite official repudiation of cybernetics. One such personality was academician Grigore C. Moisil (1906-1973), mathematician, founder of a school of polyvalent logic. He gave great support to all teams building computers in Bucharest, Timisoara and Cluj-Napoca, sent students to summer sessions, brought scientists from the USSR and Eastern countries to IFA and MECIPT. Recognizing his role, IEEE Computer Society awarded him post-mortem in 1996 the Computer Pioneer Award. In Cluj-Napoca a great mentor of those who created DACICC was Academician Tiberiu Popoviciu (1906-1975), founder of a school of applied automatic calculus.

Figure 4 Romanian Computer Pioneers awarded National Orders 25 February 2003

The gallery of Romanian computer pioneers, people who were engaged in developing first and second generation computers, includes Victor Toma, Armand Segal (CIFA - Bucharest), Wilhelm Lowenfeld, Iosif Kaufmann, Vasile Baltac (MECIPT- Timisoara), Emil Muntean, Gheorghe Farkas, Mircea Bocu (DACICC –Cluj-Napoca).

In 2003 the Presidency of Romania recognized their contribution and awarded them national orders. A rare photo shows all of them who were alive in 2003 and could participate at the ceremony (Figure 4).

National and International Cooperation

The cooperation among teams of CIFA, MECIPT and DACICC took place by participation in scientific conferences and exchange of published papers. Academician Moisil did a great job promoting exchanges of visits among teams. Due to this normal environment the early Romanian computers had different approaches and they did not have common parts.

There was a quite active international cooperation. Victor Toma and Wilhelm Lowenfeld paid visits to sites in the USSR. At MECIPT an active cooperation was established with the Cybernetics Research Group of the Hungarian Academy of Sciences who built the M-3 computer based on documentation of Soviet M-3 computer [20]. The cooperation included the delivery of magnetic drum memories used by MECIPT-1 and 2. On that occasion Vasile Baltac, Gyozo Kovacs and Balint Domolki met for the first time in Budapest in 1962.

At MECIPT, Iosif Kaufmann wrote a letter to Prof. M. V. Wilkes, FRS father of microprogramming and creator of EDSAC, the first British computer. As a result prints of his published papers were sent to Timisoara, inspiring the design. Later on, Prof. Wilkes agreed to accept in his Mathematical Laboratory at the University of Cambridge, England, the young researcher Vasile Baltac, who was able to step up on a different level of computing. After many years Prof. Sir Wilkes remembered those years in an e-mail to Vasile Baltac (figure 5).

Vasile, It gave me very great pleasure to receive your letter. {..}.

Meeting you when you spent a year in Cambridge in 1966-67 was a great experience for me. I had never met anyone before from such a different background who absorbed, as readily and as rapidly as you did, information that we were able to offer you.
By the time you left, you were a fully experienced user of the Cambridge Multiple Access System with a knowledge of its internal working. ... I am glad that I was able to help you in the early part of your career.

I am now 94 years old and not as active as I was. However, I still read my email and respond to it. I shall always be glad to hear from you.

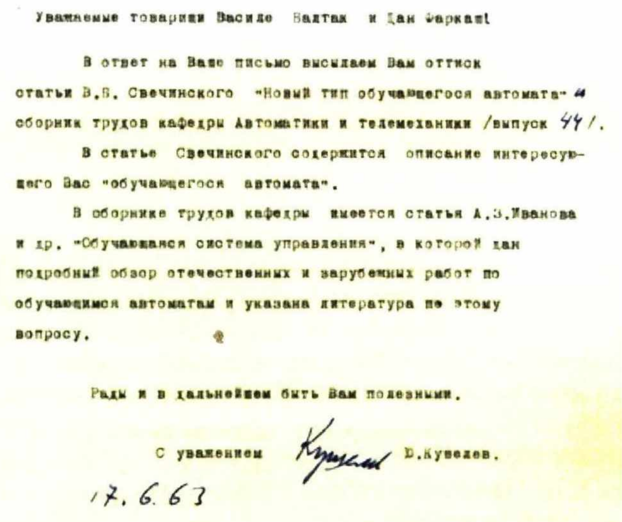
With very kind regards and best wishes... Maurice Wilkes

12 July 2007

Figure 5 Letter of Prof. Sir M. V. Wilkes, FRS to Vasile Baltac (2007)

Other international cooperation at MECIPT included exchanges with laboratories from the USSR. Wilhelm Lowenfeld paid a visit to Leningrad (now Sankt Petersburg) and Soviet professors accompanied by Grigore C. Moisil visited Timisoara.

In fact, the teams that built the first Romanian computers of the first and second generation were engaged in more than building computers: research in computer applications, language translation, mathematical algorithms, computer aided design, etc. flourished. New areas were explored such as self-learning automata. Vasile Baltac and Dan Farcas exchanged papers on this subject in 1963 with Professor Kusheliov from Moscow Energy University who sent them a paper on the subject (see Figure 6).



Уважаемые товарищи Василе Балтак и Дан Фаркаш!

В ответ на Ваше письмо высылаем Вам оттиск статьи В.В. Свечинского "Новый тип обучающегося автомата" и сборник трудов кафедры Автоматики и телемеханики /выпуск 44/.

В статье Свечинского содержится описание интересующего Вас "обучающегося автомата".

В сборнике трудов кафедры имеется статья А.З.Иванова и др. "Обучающаяся система управления", в которой дан подробный обзор отечественных и зарубежных работ по обучающимся автоматам и указана литература по этому вопросу.

Рады и в дальнейшем быть Вам полезными.

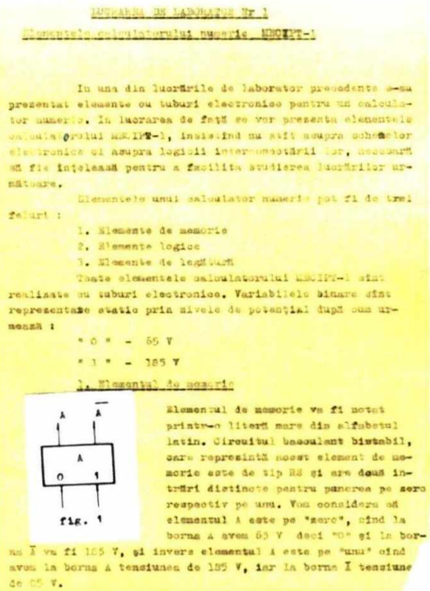
С уважением D.Кушелев.

17.6.63

Figure 6 Letter of Prof. Kusheliov to Vasile Baltac and Dan Farcas (1963)

Computer education

Romania had a tradition in university training in electronic and electrical engineering, mathematics, economics. The first Romanian computers brought the new science into the curricula of several universities. The first generation of computer engineers graduated in 1966 from the Polytechnic University of Timisoara. Professor Alexandru Rogojan (1914-1984) was the initiator of these new university diploma courses in close cooperation with the MECIPT team. Computer courseware based on MECIPT (1964) is illustrated in Figures 7 and 8. Early graduates in computer science or engineering appeared in 1967–1968 from universities in Bucharest (the Polytechnic University, Bucharest University's Faculty of Mathematics, the Academy of Economic Sciences) and in Cluj-Napoca (the University of Cluj-Napoca).



Elementele calculatorului numeric MECIPT-1

In una din lucrările de laborator precedente s-au prezentat elemente cu tuburi electronice pentru un calculator numeric. In lucrarea de față se vor prezenta elementele calculatorului MECIPT-1, insistînd nu atît asupra schemelor electronice ci asupra logicii interconectării lor, necesară să fie înțeleasă pentru a facilita studierea lucrărilor următoare.

Elementele unui calculator numeric pot fi de trei feluri :

1. Elemente de memorie
2. Elemente logice
3. Elemente de legătură

Toate elementele calculatorului MECIPT-1 sînt realizate cu tuburi electronice. Variabilele binare sînt reprezentate static prin nivele de potențial după cum urmează :

"0" - 65 V

"1" - 185 V

1. Elementul de memorie

Elementul de memorie va fi notat printr-o literă mare din alfabetul latin. Circuitul basculant bistabil, care reprezintă acest element de memorie este de tip RS și are două intrări distincte pentru punerea pe zero respectiv pe unu. Vom considera că elementul A este pe "zero", cînd la borna A avem 65 V deci "0" și la borna Ā va fi 185 V, și invers elementul A este pe "unu" cînd avem la borna A tensiunea de 185 V, iar la borna Ā tensiune de 65 V.

Figure 7 Computer course-ware based on MECIPT

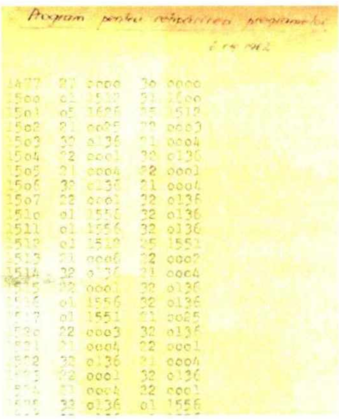


Figure 8 Program for MECIPT-1 written in machine code (1962)

Computer Industry in Romania 1968-1990

Despite the great research efforts, the gap between the own computers and Western computers already mass manufactured started to be alarmingly big, both as time lag and technological capability to industrial manufacturing [8] [10].

In 1967, the government of Romania decided to promote the industrial development of computers. A Governmental Committee for Computers and Data Processing was formed in 1967 led by a vice prime-minister, having as the first permanent secretary Prof. Mihai Draganescu (1929-2010). A national plan to introduce computers in the economy was announced. A modern infrastructure of a computer industry was formed. All research teams of the country were merged in 1968 in a computer R&D institute in Bucharest - ITC, with branches in Timisoara and Cluj-Napoca. Victor Toma was appointed as the first scientific director. Manufacturing plants were set up: Computer Plant FCE, Peripheral Plant FEPER together with a service company IIRUC. An Institute of Informatics was also set up in 1970 with the aim at promoting the introduction of computers in the Romanian economy [10]. Missions were sent to USA, UK, France, Italy, Netherlands and Japan to assess the best solution for data processing equipment for Romania. The approach was to build a national computer industry able to mass produce data processing equipment for the domestic needs and also for export.

The final decision was to buy a license for a third generation computer from France, a license for accounting machines from Frieden–Netherlands, a license for calculating machines and to continue search for peripheral equipment licenses (disk drives, magnetic tape memories, printers, etc). While the Romanian computers were performant, they were developed in research laboratories and there was no experience for industrial production.

IRIS-50 License

The transfer of technology to Eastern countries was then regulated in the Western world - an organization known as COCOM approved any transaction that may affect the West. All major companies in the US, UK, Japan and other countries mentioned that they would export to Romania complete computers, but no subassemblies, parts and technology to manufacture them.

The only country that agreed to offer a manufacturing license was France, led then by General de Gaulle. France was out of the military structure of NATO and upset by the decision of the US Administration to block the delivery of a supercomputer CDC 6600 to France. It had launched its own program to build computers, the famous *Plan Calcul*. A new company was formed: CII – *Compagnie Internationale pour L'Informatique*, the production of a new third generation computer IRIS-50 has started, other companies were engaged in manufacturing integrated circuits (*Thompson CSF*) and peripherals (*Sperac*).

In May 1968 *General de Gaulle*, then President of France, paid a state visit to Romania. As a result it was agreed not only to deliver to Romania the plans of IRIS-50, a third generation computer, but to deliver subassemblies, components, technology and, what was decisive, to deliver also an integrated circuit components plant and a printed circuit board plant [21]. This was a very serious leap forward for the Romanian electronic industry.

A first big national debate started at that time. A group, mostly industrialists, supported the license from France and the creation of an industry. Another group, mostly economists, was in favor of importing IBM computers. At the end, the crisis was settled by Ceausescu, in power since 1965, in favor of an industry.

While in principle agreeing with the creation of a computer industry, Victor Toma was against

IRIS-50 license, his wish being the industrial reproduction of his CIFA computers, obviously not a solution for the country. He resigned in 1969 and in his place was appointed the then young Vasile Baltac.

FELIX computer family

IRIS-50 was renamed in Romania to FELIX C-256. The ancient name of the present Romania when it was a Roman province was *Dacia Felix*. So in the 1960s the name *Dacia* was given to Romanian cars produced under a license from Renault[1] and *Felix* to Romanian computers. C-256 was related to capacity of internal memory that was at IRIS 50 of 256 Kilobytes. The operating system was SIRIS 2. The production of Felix C-256 started in 1970. FELIX computers were not IBM compatible, as IRIS-50 was a computer based on the structure of a computer called *Sigma 7*, manufactured by a US company SDS.

ITC promoted the concept: buy a license and further develop it by your own R&D. This meant that independently from CII, the institute started immediately to develop the license as a computer family. First new member was a smaller member called C-32. For this model a new operating system was developed including file manager and assembler. Next was a bigger member C-512/1024, also with a new operating system fully developed in the country HELIOS. The upward compatibility for application programs was assured.

The production of C-32 started in 1972 and of FELIX C-512 in 1975. Altogether, 650 FELIX mainframes compatible IRIS were produced in the period 1970-1990. Most of these computers were installed in Romania, but 11 were exported to P. R. China. The number of FELIX C-256 computers identical with IRIS-50 produced was most probably 160 [22]. Additional 15 pieces of a mainframe called FELIX 5000 developed in the country with an advanced hardware technology and the new operating system HELIOS were produced in the period 1988-1990.

Initially, IRIS computers were delivered with French *Sperac* disk drives, *Ampex* core memories, Ampex tape memories, *Control Data* printers. Sperac drives proved to be unreliable and were replaced by Control Data drives.

The search for manufacturing licenses for peripherals was launched in 1970-1973. The main result was cooperation with *Control Data Corporation – CDC*, but also with *Ampex* and other US companies.

Due to COCOM regulations the technology for core memory existent in IRIS-50 was not received, complete blocks have been imported. The technology was developed by domestic R&D at *ITC Timisoara Branch* and produced later at the newly set *Timisoara Electronic Memory Factory*-FMECTC.

RCD peripherals

Control Data Corporation - CDC agreed to cooperate on peripheral equipment manufacturing.

1 Now a successful Renault trade mark

During the negotiations it was concluded that the necessary technology transfer approval would be easier if CDC keeps a participation in the project. Then, a joint venture company Rom Control Data – RCD was set up in 1973, the Romanian partner keeping 55% of the shares. RCD initially produced disk drives, tape transports, drum printers, matrix printers, plotters, etc.

RCD was an elite member of the Romanian computer industry with high quality products. Romanian computer exports were favored configuring computers with RCD peripherals, more reliable than the peripherals made in other Eastern countries.

CDC expected also a direct export of peripherals to the big P. R. China market, never achieved mainly by currency transfer problems.

Minicomputers

Following the world trend, two minicomputer families were developed in Romania: INDEPENDENT and CORAL. The first minicomputer INDEPENDENT I-100 created by ITC was launched in 1977 on the occasion of centenary of Romania's independence as a state (1877-1977). The name is related with this event.

This time, after a second national debate, the compatibility with a world recognized minicomputer was chosen and INDEPENDENT -100 was made compatible with DEC PDP-11/34. The INDEPENDENT I-100 model was followed in 1979 by the more powerful I-102F.

The CORAL family was launched a few years later in 1979 by FCE with a different technology with more Western components, fully compatible with the INDEPENDENT family and using the same operation systems.
Both INDEPENDENT and CORAL families were configured with Rom Control Data peripherals and they were quite competitive, being exported in many countries: Czechoslovakia, East Germany, P. R. China, Middle East countries, etc. An estimated 4500 minicomputers of INDEPENDENT and CORAL families were produced.

Microcomputers, PCs

Beginning 1974-1975 microcomputers and later PCs started to be produced in Bucharest and Timisoara. They followed the world pattern being built around INTEL microprocessors. Statistics do not exist, but only FCE produced 52.000 pieces of M-8 to M-216.

Operating systems and application software

The first generation computers CIFA-1, MECIPT-1, DACICC-1 and CIFA 101 were programmed in machine code (figure 7) and were not compatible with each other. The second generation had rudiments of operating systems and assemblers.

FELIX family was initialy using licensed operating system SIRIS -2, upgraded to SIRIS -3.

Beginning 1970 in ITC a software engineering concept was introduced with separate teams for development, testing, validation. The operating systems were developed in Bucharest, compilers in Cluj-Napoca and assemblers in Timisoara.

DOS-C32 and DOS C-64 operating systems were developed for junior members of FELIX family C-32 and C-64.

A new original operating system for FELIX larger mainframes HELIOS was developed, probably the first major operation system fully developed in Eastern Europe.

Two operating systems for minicomputers AMS and MINOS were developed in ITC based on their DEC PDP and VAX models RSX and VMS.

ES EVM

Not only Romania but all Eastern countries started programs to build computers on an industrial base. In 1968 the Soviet Union had the initiative to create a unified series of mainframes called ES EVM (Edinaya Sistema Electronnykh Vytchislitel'nykh Mashin – Unified series of Electronic Computing Machines). The decision taken was to make computers compatible with IBM 360 series, of course without the approval of IBM. But so did Western companies such as Amdahl, Siemens and Hitachi [23]. The main reason was not to replicate the high cost of software development. The models were called Ryad (Series).

Romania's participation was insignificant as FELIX computers were not compatible with IBM 360. Romanian experts were present mainly in application software task groups. Participants to the meetings in 1968-1969 were not able to understand the Romanian delegation's obvious reservation on any technical decisions, as details about IRIS-50 deal were not yet released. Romania already had the decision not to manufacture Ryad computers.

SM EVM

A similar organization was created to produce minicomputers. The name was SM EVM (Systema Malyh Electronnykh Vytchislitel'nykh Mashin - System of Mini Computers). The multi-national decision was to make them compatible with DEC PDP-11 and VAX.

This time, Romania was quite active in this organization, the PDP compatible minicomputers INDEPENDENT I-100 and I-102F, being internationally commissioned and as a result exported to many Eastern countries, except the USSR.

The Intergovernmental Commission on Cooperation in the field of the Computer technology (MPK po VT)

An international organization was created in the 1970s to promote cooperation in the field of computer technology. Its name was MPK po VT (Mejpravytelnaya Comisya po Vytschyslitelynoi Technike - *The Intergovernmental Commission on Cooperation in the field of the Computer*

technology). All COMECON countries and Cuba were members.
Its structure included:

- Council of Chief Designers for ES EVM
- Council of Chief Designers for SM EVM
- Council for Applications
- Economic Council
- Council for service and Maintenance

Technical decisions were taken in the councils. As said, Romania was not very interested in ES EVM (Ryad) computers, its range FELIX being not compatible with IBM. However, the participation in SM EVM was important with INDEPENDENT range very popular in Eastern Europe.

The economic decisions were taken mostly by the Soviet Union and were politically based. Bulgaria was the great winner, being designated the main manufacturer of disk drives exported in large quantities to the USSR at prices much higher than world prices (For example, a 7 MB disk drive was sold for 25.000 rubles, while in USA was 5.000 USD). Using higher prices than world prices was a more general practice in COMECON, but computer related products were at the highest prices possible. As the USSR exported to Comecon countries raw materials at prices closer to world prices, buying computers and computer equipment at huge prices became a political tool. Due to Romania's independent political position in COMECON and Warsaw Pact, exports of Romania to the USSR were under strict embargo.

Coordination Center

For the day-to-day coordination of activities a Coordination Center was set up in Moscow with representatives from all country members.
The commission ceased its activity in 1990, but not all its members left officially. It seems that the coordination center still exists under its old name [24], but it is not clear what it represents.

Computer Industry post 1989

The transition to market economy has completely changed the industry. The transition was quick as it had deep roots in the past. The existence of first and second generation of computers developed in Romania accelerated the creation in 1968-1970 of a computer industry, as Romania had a base of several hundreds of high-level specialists.

The 1980s marked an autarchy that damaged the computer industry, all western imports being forbidden by Ceausescu's decision. However, the presence in SM EVM preserved the links and the industry had still grown at a pace superior to other industries.

Most important, in 1989 as a result of the existence of a computer industry and networks of computing centers, Romania had more than 100,000 trained IT people.

Now Romania is a major player in IT and, despite specific brain drain, the country had in 2013 more than 1,4 Billion Euros exports of software and IT services [29], all major IT multinationals being present in the country.

Computer History

ATIC Events

ATIC – IT&C Association of Romania is one of active promoters of computer history in various forms. By cooperation with IEEE the international award Computer Pioneer was given to Grigore C. Moisil. Several conferences were organized in cooperation with the Romanian Academy [26,27]. ATIC awards were given on several occasions to computer pioneers. One such award was given in cooperation with CEPIS to computer pioneer Gyozo Kovacs from Hungary (figure 9).

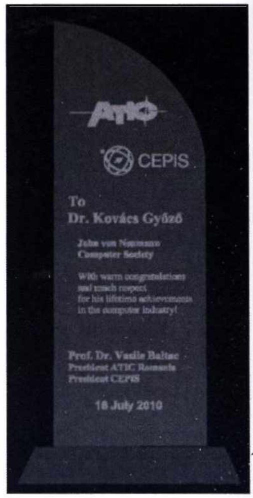


Figure 9 ATIC/CEPIS recognition of Gyozo Kovacs

MECIPT 50 Years

A special celebration was organized in 2011 marking 50 years of MECIPT-1. That included a dedicated conference, marking with a commemorative plaque the building where MECIPT was built and a meeting of veterans (figure 10) and a book [27].

Figure 10 Participants to MECPT 50 years celebration in Timisoara 2011

On this occasion the Banat Museum finished the restoration of some parts of MECIPT 1 and 2 and opened a Computer History branch in Timisoara.

Restoration of MECIPT by Banat Museum

Special work has been done at the Museum of Banat by a team led by Maria Mitzu, expert in metal – ceramics restoration, in cooperation with ATIC represented by Horia Gligor [28]. The time deteriorated the computer components. The command board, two logical circuits with electronic tubes and the memory of magnetic roll have been restored and preserved. The restoration continues.

Figure 11 MECIPT-1 Control desk and drum memory restored on 50 years anniversary

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Appendix

MECIPT 1 RESTORATION AND CONSERVATION

Author: Expert in metal – ceramics restoration: Mîţu Maria, Museum of Banat, Timisoara

In 1961 MECIPT 1 started to be used, the first computer realized by The Politechnic Institute of Timişoara. The time passing and the rough conditions deteriorated the computer components (photo 1). The command board, two logical circuits with electronic tubes and the memory of magnetic roll have been restored and preserved.

It was necessary to execute some physical and chemical operations in order to recondition all these objects. The command board was the first piece that needed to be restored.

The commission formed of Dr. Ciubotaru Dan Leopold, the manager of the Museum of Banat, Timişoara, Dr. Eng. Horia Gligor, from The Politechnic University of Timişoara, prof. Dudaş Vasile, the History Section chief, drd. Dan Octavian Paul, The Zonal Laboratory chief and Mîţu Maria, expert in metal - ceramics restoration, decided to restore the computer components. According to this, a material report needed for the command board restoration was prepared.

The Command Desk

The first step is the photography before the restoration (photo 2), followed by dust removal and disassembling of the deteriorated plates. The degreasing was made with organic solvents (acetones). The removal of the oxide deposit from the metal frames was made physically and chemically. We used a round wire brush installed on a little electric engine (dental mill), an easy bath on H3 PO4 (phosphoric acid) 20% solution with inhibitor, followed by successive brushings under water flush and neutralization with distilled water to neutral ph. Then followed a free draining, at room's temperature. On the deteriorated melamine panels we completed the losses with the same material. For mobility, there were mounted 4 wheels, followed by the chromatic integration of the metal body and panels (photo 3) and the installing of all components.

On March 25 of 2011 we celebrated 50 years since the MECIPT – 1 was put into service and this Command Desk was exposed aton the entrance lobby of the Polytechnic University Rectorate. Today, MECIPT – 1 can be found in the exhibition rooms of the Museum of Banat, Timişoara.

The restoration process did not finish with the Command Desk restoration, it continued and developed the interest of several persons, especially Dr. Eng. Horia Gligor. We continued with the restoration of the two logical circuits with electronic tubes and the computer's memory, a process that was finished inon October.

Computer Memory restoration and conservation

Taking photos of the computer memory was the first step before the restoration. This step was followed by dust removal and degreasing. I must mention that this component was less deteriorated than the others. The removal of the oxide deposit from the metal frames was physically made, by using the round wire brush. The next step was chromatic integration – using acrylic dyestuff, followed by spraying with silicone oil for conservation.

The two Logical Circuits with electronic tubes - restoration and conservation

These pieces were more deteriorated because of the bad storage conditions.
First of all, the electronic tubes were disassembled; this was followed by the same phases as above, the circuits having significant oxide deposit, which was completely removed by using a more resistant round wire brush, with a higher yield. The next step was chromatic integration, followed by conservation – using silicone oil – and taking pictures in the final phase of the process (photo 4)

Photo 1

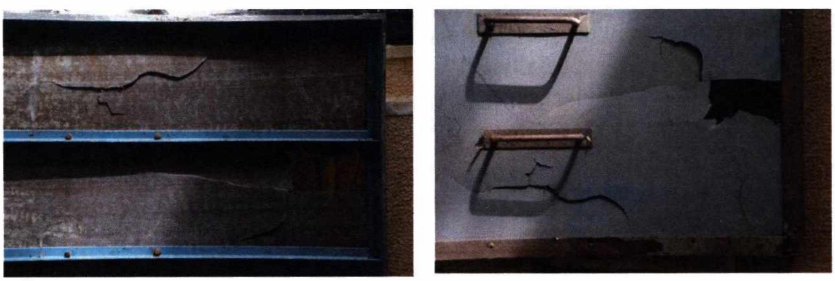

Photo 2

Photo 3

Photo 4

3.7. A Contribution to the History of Computing and Informatics in West Balkans Countries

Marijan Frković, Niko Schlamberger, Franci Pivec

Summary

The history of computing and informatics in the area, which is now known as West Balkans Countries has not been systematically and methodically considered so far. There are a few books that are more or less memoirs and therefore provide a rather narrow and specific view. The ambition of this paper is not to offer a comprehensive overview of the beginnings of deployment of computers in former Yugoslavia but rather to serve as a seminal paper for those that would like to explore the issue in depth. In particular, the paper covers deployment of first computers in Slovenia and Croatia and the influence the process has had on development of related business, profession, and science.

Introduction

The paper deals with history of computing and informatics in the countries now referred to as West Balkans. However, actually it is about the said history in the countries that have come to existence as successors of the federal republics of ex-Socialist Federative Republic of Yugoslavia. The denomination WBC is therefore somewhat misleading as the paper does not take into account the history of computing and informatics in Albania, which is definitely one of WBC too. Also, it is not complete as it does not deal with the respective history in Bosnia and Herzegovina, Kosovo, Montenegro, Macedonia, and Serbia. Separate contributions have appeared in IT STAR Newsletters (Vol. 6, No. 4, 2008, and Vol. 12, No. 1, 2014). The former provides the story of the first installed computer Zuse 23 in Slovenia, and the latter the story of development of the first Serbian made electronic computer CER-10. As far as we know, apart from Croatia, Slovenia and Serbia in the rest of the former Socialist Federative Republic of Yugoslavia neither computers nor peripherals were produced. Also the introduction of computers there was rather slow and conservative, which is understandable as the three mentioned republics of Yugoslavia were most economically advanced. Nevertheless we must not ignore achievements in applied computing and informatics that have come about in the period after 1975. In 1980s a notable achievement can be recorded, namely Suad Alagić from Bosnia and Herzegovina has developed at that time a most, if not even the most advanced concept of a data base management system. The reason that he has not lived to see the recognition it deserved is probably the same as that for a relatively short-lived success of Triglav/ Trident computer, described further in this paper.

The history of computing in WBC can be roughly divided into three periods: before 1965s, 1965s to 1975s, and after 1975s. The division is arbitrary and reflects authors' perception and experience but can be argued. Before 1965 the deployment of computers was limited to purchase of computers and their use mostly in university. After 1965 computers have been imported also for commercial purposes, training centers have been established, and first faculties of computing and informatics have been founded. In the seventies the country has developed an ambition to produce its own computers. The start was license production of computer peripherals in Croatia and Serbia and after that also license production of computers. This effort culminated with "eigen"-production of minicomputers in Slovenia. Parallel to hardware production also a noticeable development of software can be registered, starting with general usage application software. After 1975 the achievement of Suad Alagić must not be overlooked as his database management concept was probably the world best at the time.

In former Yugoslavia there were no political barriers to import state of the art computer equipment from the West, which significantly influenced faster development of information systems and professional trainings of computer programmers. In that period, the trainings were done abroad and later in the school centers of equipment distributors in Yugoslavia.

Open market and the possibility of buying equipment in the West had a negative influence on the development of computing because users were buying computers mainly from abroad.

A. Brief History of Computing and Informatics in Croatia

Before 1965

In Croatia, the development and manufacture of computers started in 1948 when Tvornica racunskih strojeva Zagreb (TRS, eng: Computing machinery factory Zagreb) was set up, the first of its kind in Croatia. At the beginning, the factory produced mechanical computers.

From 1948 to 1973 there were not any other computer manufacturers in Croatia.

Initiator and the one who built the first digital computer in Croatia was a Croatian scientist, a doyen of computer science in Croatia and worldwide, Professor Branko Soucek, PhD. He developed and in 1959, together with the team from the Institute "Rudjer Boskovic", carried out a project called "256-channel analyzer, memory, logics and programs", which marked the beginning of computer science development in Croatia.

With regard to the achievements in technology then, Professor Soucek's computer was state-of-the-art: logic gates were based on vacuum tubes, the memory used magnetic cores, and the programs were performed at the speed of unbelievable million cycles per second, which was incredible at that time. The whole device was placed in a closet 2m high, and the cathode tube was used as an output unit to display the data.

After the first fully functional prototype, at the beginning of 1960s, the Institute "Rudjer Boskovic", together with a group of enthusiasts who were involved in Professor Soucek's project, made a series of these computers that were used at the Institute as well as in other institutions.

Apart from practical purpose at the Institute, Professor Soucek's project aroused interest of scientific communities worldwide, so many scientists from all over the world visited the Institute to copy Professor Soucek's computer.

One of the persons to visit the Institute was Mr. Willy Higinbotham, the director of BNL (Brookheaven National Laboratory) from the US, the biggest institute for scientific research in the world, which meant that the work of Professor Soucek, i.e. the beginning of computer science in Croatia, was recognized globally.

When we look at the importance of Professor Soucek's project today, we should remember some facts related to the world trends in computer science from that period: in 1956, Japanese company Fuji developed a computer for calculation of optical systems production with 1700 vacuum tubes; in 1957, the first FORTAN compiler was developed and in 1958 the first prototypes of integrated electronic circuits were developed. In 1959, Japanese company NEC produced the first commercial computer based on transistors (opt: transistorized computer), while the first commercial mini-computers were developed at the beginning of 1960s (DEC PDP-1 in 1960 and DEC-PDP-8 in 1965).

In Croatia, the usage of computers and the development of information systems started in that period, and it was based mainly on imported equipment. Due to high price, only large organizations could afford to buy computers. Although the equipment had limited capacity, highly trained staff could develop complete applications, thus compensating for limited capacities.

From 1965 to 1975

At the beginning, TRS produced, like most of other producers worldwide, mechanical computers only. During 1968 in Croatia, the first electronic calculator with optical display was developed. The calculator was based on 100 10-component integrated circuits produced in the factory RIZ in Croatia.

At that time, there were no LSI or VLSI-chips in the world, as well as integrated circuits of high and very high degree of integration. TRS's calculator was, by the number of components and external dimensions, one of the smallest desk calculators in the world. A couple of years passed till 1-chip calculators (desk and pocket) and calculators with printer appeared, when in 1972 the first pocket calculator and first desktop calculator with printer appeared. The first calculator in Croatia was designed in 1973, and the production was started by the company DigitronBuje.

It was the same year that TRS produced the first Croatian calculator with the printer. TRS also produced computer equipment for general purpose. At the end of 1969 TRS became a distributor of the company Nixdorf, developing a concept of distributed data processing. From the first computer independently produced in Croatia in 1974 to the end of 1988, TRS produced and installed a couple of thousand of their own computers of 700 and 900 series, equipped with mostly their own keyboards, video terminals and printers, as well as system and user software. In that period they collaborated with the company MDS and Metalka from Ljubljana in the production of 711 series computers as well as with the company IBM in the production of Series i and System 1, equipped with peripherals from Croatia, intended for use in the economy, schools, railways and others.

From 1973 to 1987 many other companies in Croatia started to produce computer equipment.

However, there was a non-market strategy of public and professional organizations that only one "large" manufacturer in Yugoslavia, and later one manufacturer in every republic, should be given a "mandate" from the state for exclusive production of computer equipment. The state ensured full protection. These companies: in Slovenia it was Iskra, in Serbia it was EI Nis, in Bosnia and Herzegovina these were Energoinvest, UNIS and Rudi Cajavec, whereas in Croatia such a company did not exist at that time.

The end of 1960s was a period when computers of 3rd generation started to be used, the computers with the real time applications, the possibilities of managing production processes, implementing communication systems, databases, multiprogramming and multiprocessing, which enabled, together with the faster processing units and larger storage of external memories, the development of integrated information systems in the economy and public administration.

With regard to equipment production, the main companies were IBM, UNIVAC, ICL, Burroughs, BULL GAMMA, Honeywell, PDP and others.

At the beginning of 1973 in Zagreb, Business community Impuls was set up in order to gather all the significant producers of telecom, electronic and computer equipment in Croatia. The founders were:
Nikola Tesla - Tvornica telekomunikacijskih uredjaja, TRS and ELKA - Tvornica elektricnih kabela, all Zagreb-based companies.

During 1974 there was an idea that the development of computer equipment production in Croatia can progress in collaboration with only one foreign partner - technologically developed and well off. Therefore, in 1976 the Government of the Republic of Croatia backed this initiative, so the Government contacted the companies ICL and SPERRY UNIVAC. In other parts of Yugoslavia the contacts were established as well, in Slovenia with the company Philips, in Serbia with the company Olivetti and Rockwell, in Bosnia and Herzegovina with NCR and Olympia. These contacts were the result of computer equipment import ban due to the lack of foreign exchange resources.

Continuing the development of computer science in Croatia, in 1966 Professor Soucek set up the first laboratory for Cybernetics, and in school year 1966/67 the first research electronic computing center: Znanstveni elektronski racunski centar - ZRCE (in 1973 it changed its name into today's: Sveucilišni racunski centar - SRCE (University computing center).

The same year a new subject was introduced: Digital computers, at the Faculty of Electrical Engineering and Faculty of Science, and in 1970 FEE introduced a new study for undergraduate students in the 3rd and 4th year of the study: Computer science, and the postgraduate study of the same name.

The books that Professor Soucek wrote at the time: Microcomputers in data processing and simulation (New York, 1973) and Microprocessors and microcomputers (New York, 1976), made a major contribution to the development of computer science in Croatia. Professor Soucek also delivered many seminars and lectures in that period around the world (New York, Boston, Paris, London, Rijeka, Opatija...). There was also a seminar on Microprocessors, a 3-day event in Croatia, which in 1978 became a scientific conference MIPRO, still being held every year.

After 1975

In this period there are a couple of companies that produced the equipment for process management in telephone exchange, CAD CAM systems and graphics workstation, personal computers and peripherals (printers, cash registers, video terminals, discs) etc.

With open market, production of hardware in Croatia developed more slowly. It is important to point out that Croatian hardware production in open market conditions, without a planned development policy, without funds and incentives could not be developed on a more significant scale.

It is encouraging that in the new circumstances the development of Croatian software accelerated, as well as network development, end-user training etc., the possibilities of buying state-of-the-art foreign hardware and software, and conducting more productive collaboration with the foreign partners increased.

There were predominantly leading manufacturers of computer equipment, such as IBM, SPERRY UNIVAC (UNISYS) and others, who continued their work by installing/building computers of great capacities, developing information systems with the support of highly trained Croatian experts, which later resulted in establishing private IT companies that positioned well in the foreign market.

B. Brief History of Computing and Informatics in Slovenia

Before 1965

First and foremost let it be said that the division of the history of computing and informatics is arbitrary and roughly follows the evolution of digital computers from electronic tubes to transistors to integrated circuits. Before 1965, the general awareness of computers, let alone of their potential to change our lives, was next to nil. Some more understanding was noticeable among technically educated persons that have seen computers as an aid to release them of burden of intellectually non-demanding but arithmetically very extensive tasks, such as calculating statics for many tens to hundreds statically undefined constructions. However, the slide rule was the main calculating aid in the technical domain while for extensive arithmetical calculations electromechanical devices were state-of-the-art. The first computer of the kind as we understand it today was Zuse 23. This period of computing[1] is in Slovenia characterized with purchase and deployment of the first digital computer in the country. From today's perspective it is hard to understand that the choice had to be made between a British Elliott 803 and a German Zuse23 computer. The US companies did not compete in this case. Eventually, in 1962 the Z23 has been introduced so year 1962 can be rightfully considered as the beginning of the computer era in Slovenia. Z 23 was used mostly in solving academic problems and research work in economics, electrical, machine, and civil engineering, and similar. It has been used in calculating the statics for the building of Ljubljanska banka. The system has been 120 times statically undefined and the engineers wanted to use the Z 23 for solving the problem. However, due to the capacity they had to reduce the 120 by 120 system to 90 by 90 by hand which took a team of three experts three months, and only after that the Z 23 has been able to take over and finish the task. The usage for business needs was at that time rather

1 At that time we cannot yet speak of informatics as a discipline to go hand in hand with computing.

beyond perception. However, Z 23 has made a public appearance during the 1967 European Figure Skating Championship in Ljubljana for calculating the scores.

From 1965 to 1975

It is remarkable to notice that in this period an extremely novel and for the circumstances very brave idea was born and also came into life. One Slovenian company - Intertrade - has succeeded in providing the license to import IBM computers and peripherals and to represent IBM in the territory of then Yugoslavia. From today's perspective, we can judge this move as the major breakthrough, not in deployment of general-purpose computers of third generation, but also as a motor for acceleration of many aspects of accompanying activities. If computers were to be productive they needed to be supported in various ways. Technical support is one of obvious activities that goes with any kind of technical apparatus. Customer support needed to be developed to assist customers in transferring parts – at that time – of their business activities to computers for which customers' personnel needed to be trained in systems analysis, programming, organizing data centers, and more. In parallel to all that, also the vocabulary of computing and informatics needed to be established as at that time there were no university study programs of computing and informatics. The only university educated persons that have had some knowledge of computing essentials were electrical engineers, due to their education and understanding of technical background. Faculties of computing and informatics were established only much later.

In this period all major computer companies were present in Yugoslavia but because of specific regulation of import and export regulations they could not establish their own offices to represent them there. Instead, they were represented by national companies that have carried out business in their name and on their behalf. The companies that were represented then were UNIVAC, National CashRegister, RCA, General Electric, Control Data Corporation, Honeywell, Burroughs, Digital Equipment Corporation, Olivetti and probably some others, as well as providers of IBM-compatible peripherals such as magnetic tape devices and magnetic disk drives. Of course, we must not overlook IBM, which has at the time contributed the most to development of the computing profession and must be credited also for the start of informatics science as we understand and know it today. Probably the IBM computers of the time were – technically speaking – no better or no worse than their competition but what provided for the leading edge was the support that has been organized using IBM know-how, experience and knowledge. The result was that at least Slovenian major companies and practically all federal institutions, notably Federal Statistical Office and Public Accountancy Service, were IBM customers. The prevailing argument was support, which was organized following the IBM model. An aspect of the support was that branch offices were set up in Belgrade, Zagreb and later also in Sarajevo so that customer and systems engineers were never far away. Rather soon Intertrade established customer training center in Radovljica, some 50 kilometers from Ljubljana near Austrian border, where customers' personnel from all Yugoslavia was trained in programming, systems analysis and accompanying skills necessary to implement computers most efficiently. IBM personnel were however trained within the established IBM training scheme mostly in IBM training centers In Europe but also elsewhere. The training center has later extended its operation to become a regional IBM training center for central and east Europe.

After 1975

Besides Intertrade, we must explicitly mention one more Slovenian company, Elektrotehna, which has succeeded to qualify as a representative for DEC. The division of Elektrotehna to do with DEC computers was named Digital and was rather successful in business which resulted in establishing a new company named Delta which was still a part of Elektrotehna group[2]. The circumstances - the business success, difficulties in providing necessary convertible currency, some enthusiasts from the Ljubljana faculty of electrical engineering, possibly also the aftermath of IFIP 1971 World Congress in Ljubljana – have resulted in an idea to start own production of computers. The project was to use the original equipment manufacturer approach to build a DEC compatible computer. The approach was promising as the US government was very careful about into which countries could US companies export computers. A Yugoslavian company, coming from one of the three countries that have started the idea of the non-aligned countries, seemed a good prospect to overcome the embargo that US imposed on export of computers. Nevertheless, as the essential component of computers, the micro circuits and chips, were not produced in Yugoslavia, Delta still needed to provide those from DEC, all the more so as the computer should have been DEC compatible. Eventually they succeeded and the first Slovenian computer, Delta 340, has been assembled. The focus was on technology process support, but also applications for business processes have been developed. The company later joined another business association, Iskra Group, and changed its name to Iskra Delta. The success continued partly for the political support it enjoyed, partly for daring business decisions, partly for understanding of importance of well-organized customer and technical support, and partly for own research and development. It also organized a training center in Nova Gorica next to Italian border. Further to Delta 340 the company developed a three-processor microcomputer dubbed both Triglav[3] (for the reason of national pride) and Trident (a name to sell better in western countries). At the time of its introduction it was probably among the best computers in this class in the world. The success story of Iskra Delta which just before its end employed over 2000 people ended in the end of 1990s with the massive political and economic changes that resulted in the dissolution of Yugoslavia, and the company has been closed down. The reason was according to the memoirs of the director of Iskra Delta a clash of interests between intelligence services CIA and KGB. However, using the Occam razor for the explanation, it seems more likely that the management did not understand the reality of the world. To become a global player, massive resources are needed which just were not there.

Later, in the beginning of 1980s, also Intertrade developed an ambition to produce its own computers. Was it a result of a feeling that the company is not able to join the prestigious race or anything else is hard to tell. Also the time was different in that personal computer has already its entrance and was obviously here to stay. The fact is that the company started assembling IBM PC and made a moderate success. Together with the computer the project team under the leadership of Matjaž Čadež developed some general purpose application programs. The one that comes to mind was PCPIS, a word processor that has been a notable achievement at the time. However, even before the 1990s also this production was closed down. The global players are now represented in Slovenia as independent companies, established under Slovenian law and carrying out business

2 The story is rather simplified as the regulatory system was much different from what it is now or what it has been in the Western world of the time.

3 Triglav, 2864 m high, is the highest peak of Slovenia and was also the highest peak of Yugoslavia.

just like they do elsewhere in the world.

What can we say for the end of this brief history of computing and informatics? It was good while it lasted but seems like the dreams to conquer the world with homemade computers have come to an end.

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4. Museums of Computer History

4.1. The Museum of Computer History - Teaching Support for Computer Organization Subjects

Ana Pont Sanjuán, Antonio Robles Martínez, Xavier Molero Prieto, Milagros Martínez Díaz

Introduction and motivation

When teaching computer introductory courses, especially those related to computer organization and architecture, offering an applied point of view by providing current examples is generally a complicated task. To know the basic principles of a computer requires simplifications and abstractions that usually are far from the current technology. Nevertheless, proceeding in this way is necessary in order to prepare a solid background that further enables to understand current concepts and more complex and sophisticated paradigms.

This simple vision of a computer is usually of low interest and motivation for our students, which are now very familiar with devices and applications based on the latest technologies that are difficult to relate to the contents of the course. So, it's a challenge for us to find the way to motivate our students to appreciate and study computer introductory subjects and to make contents more attractive for them.

On the other hand and unfortunately, with the new curricula Spanish students have lost the opportunity to pursue optional subjects including those related with Computer History. However, we defend that knowing Computer History is of crucial importance for the future engineers and will permit them to really appreciate and love their profession. In fact, many important universities include this topic in their computer curricula [1].

The knowledge of the history and evolution of any science and technique allows not only to better understand the present but also provides a wide cultural experience increasing the sensibility and commitment with the community and environment. In this vein, [3] explains how teachers and students can benefit from Computer History.

Due to all the reasons explained before we consider that to spread Computer History among our students is not only a way to motivate them but also can help to reach the competencies of the academic degree [7]. In that sense, the Museum of Computer History at the Universitat Politècnica de València provides us an extraordinary opportunity to reach this twofold objective:

1. To motivate our students and make it easier to better understand Computer Organization and Computer Architecture subjects.
2. To increase the technological culture of our students through the knowledge of computer history and evolution.

Some of similar proposals found in the open literature [2] and [6] recommend introducing Computer

History in the first courses. Then, we planned the visit to the Museum as an activity for the second year students taking the Computer Organization subject.

The remainder of this paper is organized as follows: Section 2 provides an overview of our Computer History Museum. Section 3 presents the main contents of the Computer Organization subjects at Universitat Politècnica de València. In section 4 we explain how the activity was organized and carried out for more than 400 students. Then, we show how the students' opinion was gathered and the experience assessed. Finally, some conclusions about the experience are presented in Section 6.

The Museum of Computer History

The Museum of Computer History [museu.inf.upv.es] offers to the visitor its collection as a travel through the history of computer science. Inaugurated in 2001, and therefore one of the pioneers in Spain, has recently been recognized as an official museum of the Valencian autonomous community for its commitment with the community and its major vocation of public service.

The patrimonial diffusion project of the Museum is primarily aimed at young students of our education system and also at public in general. Its primary objective is to present the history of computer science (its origins, technological changes) and to encourage critical reflection about other aspects less known but of great importance to our society (e-waste and recycling, data privacy, human rights,...). Within the Museum a wide range of educational and cultural activities are organized, such as guided tours, workshops (and also game workshops) with old computers, retro programming courses and competitions.

The permanent exhibition is organized into a set of showcases and informative panels as well as large devices, arranged over three floors in one of the buildings where the facilities of the School of Informatics are located, see Figure 1.

Figure 1. Front building of the School of Informatics - venue of the Museum of Computer History. (The front looks deliberately like a punched card).

In particular, this exhibition contains a representative sample of computing of the last three decades of the twentieth century. Figure 2 shows a view inside the Museum and the permanent exhibition.

Figure 2. Permanent exhibition

The exhibition criteria used is chronological, although it's subjected to minor modifications due to the restrictions imposed by the available exhibition area. On the other hand, and facing the necessity of materiality that inevitably sets an exhibition, objects (both computers and other devices) are accompanied, when possible, by the programs they used, materialized either by tape or disk drives, or through advertising or code listings as examples. The context of each object was also enhanced with photographs of relevant personalities, programs or other items that help to situate its scope. Figure 3 shows an example of the collection presented.

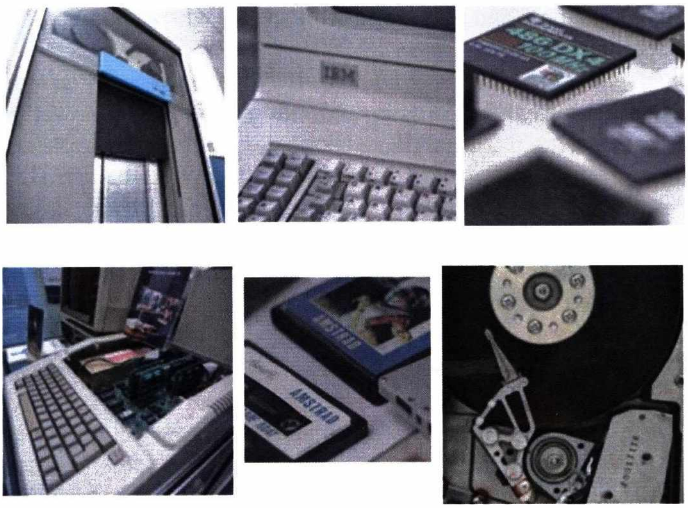

Figure 3. Some examples of the exhibiton

About computing in the late '70s, dominated by large corporate systems (mainframes), at the exhibition it can be contemplated, among others, a card puncher, ferrite core memories, a line printer and tape and magnetic disk drives of big proportions. The bulk of the exposure is determined by the home computing that was developed in the '80s, historical moment in which coexisted a large number of microcomputers and 8-bit applications. Samples made by Sinclair, Amstrad, Commodore or Atari can be seen, as well as the MSX, the first IBM PC and the first

Apple Macintosh. From this period the Museum also has several minicomputers like DEC PDP-11 and Quattro/30 Nixdorf, which marked the development of medium size systems at affordable prices that were able to run applications reserved exclusively to large computers.

The '90s are represented by the two types of personal computers that eventually took over almost the entire market: the ones compatible with the IBM PC and Apple computers both used through window-based graphic systems (GUI, Graphical User Interface). On the other hand, workstations also have a prominent place in the Museum. Appeared in the late 80's, they are mainly intended for scientific and technical applications with an important graphical role.

It is also possible to contemplate the size evolution of personal computers through several laptops (or transportables, as they were known at the beginning). The range of devices covers, on the other hand, a set of exhibitors with a wide range of microprocessors, memory modules, storage devices (punched cards, discs, tapes) and interconnection devices, as well as a special showcase dedicated to video games, an industry closely linked to the computer field that started to be important in the late ´70s

Finally, the permanent exhibition includes a series of informative panels as Figure 4 shows designed with a pedagogical approach that addresses various issues around the computer world: the history of computers and programming languages, the role of women in the development of computing science, some curiosities about technical terms and computer devices, the evolution of storage devices that eventually have been incorporated to computers, the concept of the ecological rucksack, the electronic waste, the toxic materials present in electronic devices and the advertising world on computer science.

Figure 4. Panels of the permanent exhibition

Computer Organization course

Computer Organization is a core subject for the Degree of Computer Engineering at the UPV. It is a 9 ECTS (European Credit Transfer System) course, 6 of these credits are given in classroom and 3 in labs, and it is taught in second year.

Previously, students have taken 24 ECTS of basic training in computing through subjects like: Fundamentals of computers, Programming, Digital systems, etc.

Then, the objective of this Computer Organization course is to introduce the main concepts and components of computer structure and architecture both from a quantitative and qualitative point of view. To this end, the contents of this course and topics covered are:

1. **The basic processor**
   Unit 1: Datapath and control unit design
   Unit 2: Basic pipelining
2. **Arithmetic Unit**
   Unit 3: Arithmetic for integers
   Unit 4: Arithmetic for floating point
3. **Memory Hierarchy**
   Unit 4: Main Memory
   Unit 5: Cache Hierarchy
4. **The input/output basic system**
   Unit 6: I/O interfaces and adapters
   Unit 7: I/O synchronization
   Unit 8: I/O transfer
5. **Buses and peripheral devices**
   Unit 9: Peripheral devices
   Unit 10: Buses and interconnection structures

The microprocessor MIPS R2000 is taken as example not only during this course but also in previous and later subjects. This processor and its assembly language is the base for explaining basic concepts of computer architecture and organization and the key knowledge to design cost-effective computer systems in a similar way as presented in the book «Computer Organization and Design: The Hardware/Software Interface» by Patterson and Hennessy [8] that is recommended as text book.

Despite this basic and classic point of view, the course also presents current technological examples to illustrate mainly the memory and I/O related units and focuses on the evolution of processors and devices during their recent history.

So, we firmly claim that the Computer History Museum is a very valuable opportunity to put in context the topics of the course because it allows to place in time the progress of computing both in its hardware and software components and applications. Therefore the historical and social vision that the Museum offers to the visitor can provide an additional value to motivate the study of computer architecture.

The Experience

The visit to the Computer History Museum was planned at the beginning of the scholar year in order to motivate students in the study of the subject Computer Organization from another point of view. Seeing how computers have evolved during time, so much in some aspects and so little in others, enables students to perceive the essence of the basic, the importance of the basis transmitted in the subject and the reason why this knowledge becomes so important. What is the common denominator of everything that has been showed to them? How will things be done in future? These questions must allow setting the basis for a new perception of the subject.

The visit has been organized in two parts or activities clearly differentiated. The first one was a short lecture, which took place in the assembly room, where the students learned about the history of computer science. It also had the purpose to awake their sensibility towards the history of this science and the sociological and environmental aspects involved. The meeting was complemented with the projection of some videos showing the early stages of computers and programming, including commercial spots and other visual resources to make the exposition more enjoyable. This part had an approximate length of one hour.

The second part was a tour through the permanent exposition of the Museum, which can be seen in glass cabinets with informative boards over three floors in the same building. The students followed the tour, stopping to read and assimilate the contents during approximately another hour.

From the organizational point of view, the main problem was to manage a visit for a large number of students. During the academic year 2013/14, the subject had a total of 423 students, organized in 7 groups, all of them in morning time except one.

Nevertheless, only 269 students showed finally their interest in attending the event. As the maximum capacity for the assembly room is 150 people, two turns were planned. In order to make a simple distribution of the students four class groups were assigned to the first turn and three groups to the second one, thus balancing the number of attendees. Figure 5 shows some moments of the first part in the assembly room.

Figure 5: Moments of the first part of the visit

Despite this distribution it was also necessary to make the second part of the activity as self-guided visits. So, to perform and direct the self-guided visit, the students were given a questionnaire about the most interesting aspects of the exposition. With these questionnaires, it was intended to keep the interest in the exposition and, at the same time, to guide the students through the contents with a logical view. The surveys were given to the students at the entrance to the assembly room, were filled during the visit, and finally were given to professors for the evaluation. Figure 6 shows some moments of the self-guided visit.

Figure 6: Self-guided visit supported by the questionnaire.

The design of the survey for the self-guided visit required a careful elaboration from our side. We generated four different models, with a total of 22 short answer questions each. Almost all questions could be answered by searching through the information in the posters and boards, such as names, dates, etc. Also, in some cases, it was necessary to make small calculations such as to compare the capacity of a current hard disk drive against a hard disk drive from the '80s.

Below some questions are shown, which form part of the survey given to the students to answer during the visit:

- What type of numeration used the calculating machine that Blaise Pascal designed in the year 1642?
- With what type of technology Charles Babbage designed his Analytic Machine?
- With what technology Konrad Zuse built his Z1 machine on 1938?
- Who synthesized in 1945 the basic components that any programmable computer should have?
- The DEC PDP-11 computer presents on its architecture an innovating characteristic in comparison to the rest of the machines of its time. Which is that innovation?
- How many kg does the HP 3121D storage unit based on floppy disks weight?
- What is the name of the word processor that formed part of the software distributed with the Amstrad PCW-8256 computer?
- Who designed the Apple II computer?
- What's the meaning of the term "direct" in the DASD (direct access storage device) acronym that IBM uses to refer to magnetic hard disk drives?
- How many plates had the IBM 10SR device (DASD, direct access storage device)?
- What was the fundamental use of the Tatung Einstein TC-01 computer?

- What type of interface has in common the storage systems of the HP Apollo Series 700 and SGI Indigo2 IMPACTTM workstations?
- What means that the IBM PC had an open architecture?
- In which microprocessor is based the MSX standard?
- What chemical substances are used to create the magnetizable layer of storage devices? Indicate at least two.
- The IBM 5211 printer, why is it called a line printer?
- Which was the first computer using the stored-program concept?

Each of the two turns of students spent around two hours to complete the whole activity.

Seeing the development of this experience, it seems interesting and supplementary to connect the contents explained in class with the contents seen at the Museum. For example, we can lay out the evolution of processors from the simple educational models to the modern ones with an historical vision. This way, the characteristic of architectures such as CISC and RISC become much more understandable with the perspective of years, the role of the assembly language in the development of computer architectures is much closer, the evolution of the scientific calculation needs and their relationship with graphic applications and current virtual reality justifies better the effort made in the design of algorithms and arithmetic circuits and, overall, it's an invaluable help when introducing the peripheral and storage devices.

Also, the constant references to the historic evolution of computer science helps to better assess this science by our students and to understand the human and technological efforts, which, during its short life, have been done and keep being done to transform it into an essential tool.

Once answers were processed, it was detected that 95% of them were correct. Regarding mistakes, there were at most one or two per questionnaire, and in few cases they raised to three. Also, very few questions were left unanswered.

Experience evaluation

As it was the first time we carried out the visit to the Museum, an evaluation of the experience to identify its strengths and weakness was mandatory with the aim of improving it for next year. To this end, we conducted an on-line student satisfaction survey through the UPV educational platform named PoliformaT. It was conducted the week after the visit, so that students had enough time to reflect about the experience.

Getting students fill out any kind of survey is always complicated, especially if it is on-line. In order to assure a sufficient number of responses that allow us to draw valid conclusions, we imposed the survey completion as a condition to validate the attendance of each student to the visit. Thanks to the features provided by PoliformaT, the survey was anonymous.

In the survey design we followed the recommendations made by [4] about satisfaction surveys. We intended to evaluate four key aspects or dimensions related to the experience, as can be seen in Table 1, namely, the activities performed in the assembly room previously to the visit (conference, documentary, and audiovisual spots), the Museum tour, the experience organization, and overall evaluation.

To this purpose, we designed a survey with 10 questions following 5 response options: Strongly Agree (SA), Agree (A), Neither Agree nor disagree (NAD), Disagree (D), and Strongly Disagree (SD). Table 1 shows the different survey questions grouped by each analyzed dimension. In their design we tried to translate the objectives of each different analyzed dimensions into specific questions, which were aimed to convey to the student the idea behind each objective.

Finally, a total of 200 surveys were processed, which represents 75% of the students that attended the Museum visit. This provided a sufficiently representative sample that permits us to extract valid conclusions.

The survey result is shown in Figure 7. More than 80% of the students positively assess (SA/A) the activities prior to the visit, specially the lecture and the documentary. They have allowed them to discover aspects related to the History of Computers that they ignored, which was one of the goals of the experience. Despite the fact that 93% of the students showed the contents of the Museum interesting, only 75% recognized that it had aroused their curiosity. We have to admit that arousing curiosity among our students is not currently an easy task. Therefore, we value as very positive that the contents of the Museum have been attractive for such percentage of students. In this sense, it must be highlighted the fact that 70% of the students recognized the usefulness of filling out the questionnaire after the visit.

	Dimension 1: Activities before the visit
Q1	*The lecture prior to the Museum tour has helped me to discover computer science issues that I ignored*
Q2	*I found attractive and informative the documentary movie about the history of computers*
Q3	*Videos helped me to contextualize the exhibits*
	Dimension 2: Visit to the Museum
Q4	*I found interesting the contents of the Museum*
Q5	*Some of the contents, devices and computers exhibited by the Museum aroused my curiosity*
Q6	*The visit has helped me to compare the current computers usages with respect to the past*
	Dimension 3: Experience organization
Q7	*The way the visit has been organized and conducted seems to me appropriate*
Q8	*The questionnaire filled out after the visit helped me to appreciate details that otherwise would have gone unnoticed to me*
	Dimension 4: Overall evaluation
Q9	*I would recommend this experience to other students*
Q10	*I consider that the Museum visit has motivated me to study the Computer Organization subject*

Table 1: Questions of the satisfaction survey

The way the visit has been organized is valued as positive only by 60% of students, and about 20% of them were disappointed. Regarding this, we must recognize that there was some discomfort among students that usually attend evening courses, due to the fact that the visit was scheduled only in morning time, which, in our opinion, may be the reason for such disagreement. This shows once again the enormous difficulty to organize any kind of activity, learning experience or novel teaching methodology when there are hundreds of students. Often, when Spanish university professors are criticized by the supposed lack of higher educational innovation, nobody takes into account the huge difficulty to organize and manage large groups of students.

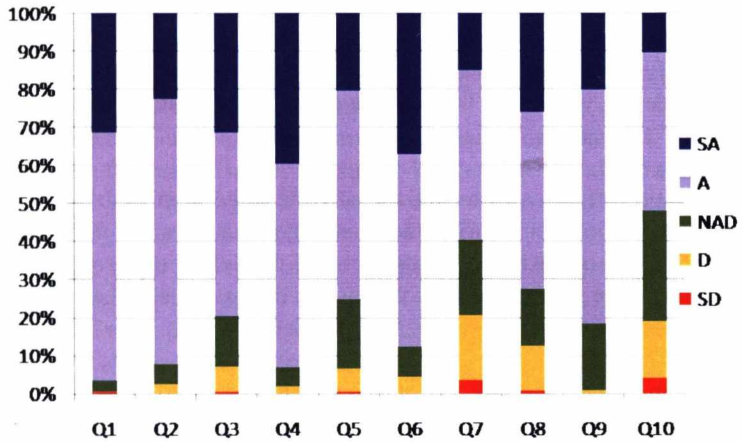

Figure 6: Results of the satisfaction survey

Regarding the overall evaluation, it is observed that 80% of students would recommend the visit to the Museum, which is highly positive because shows that they have liked and entertained themselves with the experience. However, only 50% of students recognize that the visit has motivated them to study the subject with more interest, existing even 20% that claim that it hardly has motivated them. On the other hand, from a deeper response analysis we have observed that more than half of these students recognize that the visit has aroused their curiosity.

Considering that the main goal of the Museum visit was to motivate students, it could be thought that the experience result has been somewhat poor. However, we have to take into account the huge difficulties to make this kind of subjects attractive for them. Thus, from a more positive point of view, we could claim that half of the students that attended the visit became more predisposed to learn the contents of the subject.

Moreover, the fact that this activity, by its own nature, has not allowed to motive a part of students does not mean that they cannot become motivated by other activities planned for this purpose during the year, such as the visit to a High Performance Computer Cluster. This leads us to recognize the importance of providing a diverse set of activities able to meet most of the expectations.

Summary and conclusions

It is a privilege for the Universitat Politècnica de València to include a Museum of Computer History in its campus. The Museum is an additional tool to contribute to spread science and technology. This Museum has been recently recognized as official museum and it is one of the pioneers in Spain.

Professors of Computer Organizations and Architecture courses at the UPV have found in the Museum a great opportunity to motivate our students and make the understanding of these subjects easier. To this end, during the academic year 2013/14 we have organized a visit and a series of activities around the Museum.

The main concern in the organization of these extra activities is the large number of students involved (a total of 423). Despite this, finally only 269 students attended the visit. The experience was developed in two parts. The first one consisted in a short lecture followed by the projection of a documentary and some video spots. The second part was the visit to the contents of the Museum that in this case was self-guided.

The capacity of the assembly room, where the talk and movies were presented, was the main drawback in the organization and forced us to schedule the activity for two different groups. As it usually happens when different schedules are offered, some students disagreed with the assigned turn and complained about it.

Also the large number of students that participated in the experience made impossible the traditional guided visit. To deal with this we prepared a self-guided visit that obviously required a proactive attitude from the students because they had to complete a questionnaire whose answers could be found during the itinerary. This attitude is not always present in a percentage of our students, who are apathetic or show low interest. This fact was detected in the indifference with which the prepared survey was completed by some of them.

Nevertheless, from a general point of view the experience was qualified as very positive both by students and professors. We are now closer to the main objective proposed. The Museum of Computer History has motivated a high number of our students to better deal with computer architecture topics. It also has contributed to spread the history and culture of computer science and has encouraged critical reflection about social and environmental consequences of the current massive use of computers and other intelligent devices.

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4.2. History and Highlights of a Computer Museum

István Alföldi, Mihály Bohus, Dániel Muszka, Gábor Miltényi

Less than 100 years ago who would have thought among the pioneers that they were making history?

History: the past of the future

In the middle of the 1970s Győző Kovács, General Secretary of the NJSZT then suggested, that the rapidly outdated computer pieces should be preserved for the posterity.

From the beginning, his old colleague from Szeged, Dániel Muszka, was his ally. Their proposal was accepted by the NJSZT and the Technical Museum gave a home and some publicity. In the frame of the NJSZT, a technical history committee was founded. The collection initially started at the Algyő estate of the predecessor of MOL Rt., and continued in the storage of some computer center in Budapest, and a company in Cegléd that lent their storage facilities without charge. From 1991, the collection operates in the frame of a foundation that was founded by the NJSZT, the Technical Museum (currently: Hungarian Museum of Sciences, Technology and Transport) and the State Computational Services.

The collection includes exhibits from cardpunch data preparation machines to „big monsters" (Razdan-3, Minsk-22, Minsk-32, ICT, Elliot, Siemens, IBM, Honeywell, etc.), from the first PCs to the beginning of internet and, of course, the Hungarian products, which we are very proud of, such as M-3, drum-memories, Kalmar-type logical machine, KFKI, EMG, GAMMA, SZTAKI, BME, VILATI, VIDEOTON, SZKI and other locally constructed machines.

The machines and related objects show a great deal of multi-variance. This is the consequence of the international political situation in the past since import was usually allowed from countries belonging to the „socialist bloc" (e.g. Soviet Union, German Democratic Republic or East Germany, Czechoslovakia, Bulgaria, Poland). Only privileged Institutes with special requirements and special dollar-budget allocated to them were allowed to import hardware from countries in the „West".

A portion of the items at the Szeged-Algyő warehouse was used for the 1989 exhibit at the city of Nyíregyháza. Dr. Heinz Zemanek, the Austrian Professor, who was the pioneer of European Computational Technology, opened the Exhibition. It was Professor Zemanek who first called the collection „unique of its kind".

1997 brought a decisive turn in the history of the collection. The University of Szeged provided a place for all the collected items.

In 2007, by the permission of the Ministry of Education and Culture the collected material known henceforth as Information Technology History Museal Collection (professional classification: museal collection of public interest) can play a role in the cultural life of Hungary. The people who are concerned about the fate of the collection know that in the past years several locations, several possibilities came up for the permanent exhibition. In the end the interactive information technology history exhibition was realized in Szeged, in the building of the Szent-Györgyi Albert Agora. The John von Neumann Computer Society – thanks to István Alföldi, managing director, who has been solicitous about the fate of the collection from the beginning – offered outstanding financial and intellectual support not only to create the exhibition, but also bore the brunt of the operation, with the following slogan: "*To protect the values of the past, to adapt to the present, to influence the future.*"

John von Neumann Computer Society

John von Neumann Computer Society is a financially stable non-governmental organization devoted to a knowledge based information society, a professional representative of info-communications domestically and internationally, and the leading domestic professional organization of science and application of information technology.

As a professional forum independent of any institutions, the Society plays a crucial social role in
1. Domestic promotion of computer literacy, achieving digital equality;
2. Protection and promotion of the professional-cultural heritage and the values of the profession;
3. Promotion of computer culture and the newest professional and scientific information, and
4. Talent development.

In order to achieve these objectives, it performs and offers representative, organizational and coordinating duties and services:
- Supports research and development activities in the field of information technology, and aids their promotion and recognition;
- Operates creative professional communities;
- Maintains international professional relationships and aims to expand them;
- Is devoted to transmitting the values of the information society to the civil society;
- If requested, it prepares professional opinions on initiatives, documents, research, development and retraining programs related to knowledge based information society; it draws up opinions, coordinates and actively participates in tenders;
- Using several decades of professional experience, it initiates and manages national training programs (e.g. ECDL), involving half million people, in order to achieve digital equal opportunities;
- In order to help improve the living standards of the society, it considers supporting health (lifestyle, public health, prevention, health of the nation, aftercare, etc.) by IT tools as one of its major objectives;
- Devotedly supports the cause of computer talent development: it organizes national and international competitions and provides preparation, it operates workshops and awards scholarships;
- Provides an opportunity for students and young professionals to take part in professional public life;
- Recognizes professional achievements annually by handing out awards founded by the society;
- Assembles an internationally relevant collection about IT history with its partners in order to protect the values of its past, and it undertakes to operate it in the future;

The Museum

(Main parts of the following texts are based on the book: Gábor Képes-Géza Álló: The past of the future, From Neumann to internet.)

The museum occupies two levels with 1300 square meters. Downstairs we may mostly see objects belonging to an extraordinary world, unknown in everyday life. They were rated as unique even in their own time; even though the objects displayed upstairs were produced en masse – besides their significant sociological effect – they are fondly remembered. The results of the 20th century, presented with the technology of the 21st century in the interactive information technology history exhibition.

Official opening of the Museum was 25th of June 2013. Marina von Neumann Whitman, John von Neumann's daughter, was the honorary guest of the „Past of the Future - From Punched Cards to Information Society" opening conference.

Marina von Neumann Whitman, Professor of economics, Michigan University, delivered her contribution and told us about her life and career as an economist, and about the role ICT plays in our world today. She talked about her father, John von Neumann, who was both a theoretician and a scientist searching for quick, hands-on solutions to topical issues, as well as about the Hungarian "fellow geniuses", called the Martians. She described the two different paths daughter and father had taken that led to both of them acting as advisors to American presidents.

The outstanding values of our exhibition

Kalmár's logical machine

Professor Kalmár, with his co-workers started to build an electronic computer in the mid-1950s, but in the end instead of this – continuing the example of the Ferranti logical machine – he created a logical machine with completely original design.

The machine consists of six operational boxes, each of them is realizing basic operations with two variables, these being the so-called logical gates, so using them, optional logical functions can be created. The important innovation is that the boxes represent the "true" (T) or "false"(F) value of the logical variables not with voltage levels, but with short circuits –physical connections. Because of those the input points are realized with three connecting sleeves instead of two, and the middle sleeve is in short circuit with one or another on the side depending on whether the

László Kalmár (1905-1976)

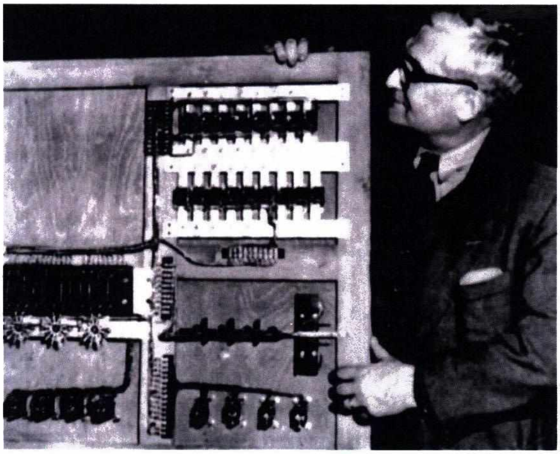
Was amongst the first in the country who recognized that the future belongs to digital technology: As early as the mid-1950s he took-up computer science – or cybernetics, as it was called back then. His major endeavour was to make it possible to automatically solve, with machines, tasks phrased in the formalized language of logics. But even the philosophical question of how to justify the validity of a solution with mathematical precision was of interest to him.

With his exceedingly widespread international relationships he stepped into the latest contemporary development results too. In view of this information, in 1956 he established the Mathematical logics and its applications Department of the Mathematical Institute of The Hungarian Academy of Science in the frame of the Szeged University, and he designed the logical operation executing machine in its Machine Research laboratory

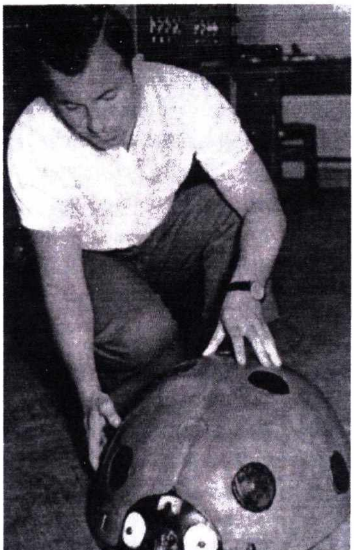
Under his initiative, the Cybernetics Laboratory was founded in 1963 at the university, of which he was the scientific leader until his death.

input variable has T or F value. The same thing is valid for the output function values that naturally depend on the elementary function "wired" into the box for what answers they give to the input variable combination.

The input variable combinations can be automatically generated with the help of the marker machines used in the telephone exchanges, for example with 3 marker machines all the possible combinations of 8 or 9 input variables can be realized (256, or 512 possibilities). Although the logical machine was built for educational purposes, it was theoretically suitable for the examination of telephone exchanges and railway security systems as well. Kalmár's logical machine, as the first messenger of the Hungarian information technology, was made in 1957, and – together with the Ladybird of Szeged – was introduced with great success in 1960 at the Budapest Industrial Expo.



Further on, the "Kiblab", also played the role of the university computing center as the first computing center in the country outside Budapest. In 1973 the Hungarian Academy of Science called upon him to review the world of the computers and the higher level programming languages, and evaluate their prospective development, because the exceptional backwardness of the country became obvious. The conclusions of the analysing series of essays are still valid today, although his suggestions for modernisation made in the last volume for the computers programmable on a high level machine language became outdated by today due to the fast development.



The Ladybird

Dániel Muszka as a young co-worker of László Kalmár, built his Ladybird to model Pavlovian conditional reflexes, based on the idea of psychologist József Király. We chose the "Ladybird" – that can be seen as the „alive" symbol of the idea of cybernetics – as the symbol of our museum. Not accidentally, since after the aforementioned exhibition, in the 1960sthe "artificial bug" introduced on Hungarian Television became a real media star, perhaps the most well known representative of Hungarian cybernetics, and within that the school of László Kalmár.

But what are the things this lovely little device can do? First of all, it can "see", with the help of the three photocells in it: if we light up the suitable one with a torch, it turns right or left (moves one of the two little – originally windscreen wiper – motors in it), or keeps on rolling straight. But it is able not only to "see" but to "hear" as well, thanks to the built-in microphone: if we blow a whistle, the lamps at its eyes flash to its rhythm. If we press any of its spots, it perceives it as "pain", and starts to beep ("cry") and is not willing to follow our orders (the light of the torch). However if we "stroke" his back – to be more precise, the small hidden sliding studs –it calms down in time and is willing to move again. Its most important feature is that it is "teachable": if we whistle at it while following the light of the torch, in time it learnt to listen to the whistle, and after turning the torch off, started to the sound of the whistle. The original vacuum tube version was made in 1956-57, receiving its power through the cables dragging after it. Later several of the same size as the original models were made already "fed" by batteries.

The Ladybird is very popular even today. It was VIP attraction even at the Robotville Festival in London in 2011.

Cybernetics – Learning and playing

The inventions of Tihamér Nemes emulated certain human activities: his logical machine modeled thinking, his walking machine modeled human moving, and through simulating seeing he became the pioneer of the modern television. He had completely extraordinary creations as well: the chess playing and chess puzzle solving machine, the letter reading machine, the speaking writer machine, and the playing machine paved the way to understanding human intelligence.

In the 1960s Mihály Kovács together with his students built cybernetic toys, which he introduced to the press as well. Such were for example: the Card playing machine, the Miracle mill, the Logi and the Eureka; in 1963 with his students – after Shannon's example – he created the second Hungarian artificial animal, the Artificial Mouse, that finds the cheese in the maze. In the middle of the 1960s he patented together with his fellow teacher, Lajos Terényi, the Didaktomat teaching machine, which partially was designed and built by students.

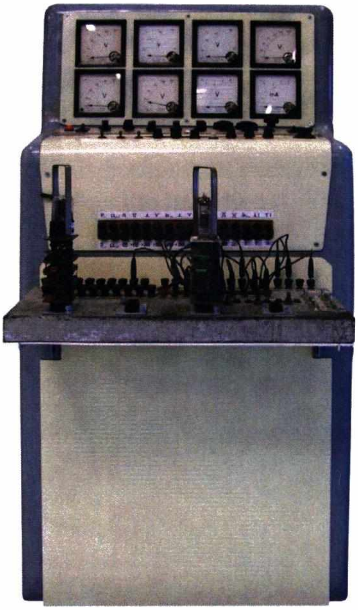
His student, Ferenc Woynarovich made the Mikromat cybernetic building kit. To introduce the basic principles of computer science, the computer model built of printed circuits contained four relays and eight bulbs and could be programmed by wires. With the help of this kit – for example with the construction of the game "The wolf, the goat, the cabbage and the farmer" one could easily learn the operating principles of the calculating and logical machines.

The Mikromat was the first cybernetic device in the Hungarian homes: since1967 it was manufactured by a cooperative and it could be bought in shops. For its usage, a guidebook was published titled Practical way to cybernetics written by Mihály Kovács. Certain writers in the field consider such cybernetic kits – for example the Canadian Minivac-601 that served as a model to the Mikromat – as the ancestors of the personal computers: these raised interest towards computing.

The M3

The first computer built in Hungary – the M3, according to the contemporary press, was put into operation on 21st of January 1959, opening a new era in the history of information technologies in Hungary. Unfortunately the machine wasn't preserved, it was disassembled in 1968, but we exhibit a few remaining partial units, as the relics of computer history.

The first Hungarian vacuum tube computer, the M3 was built based on Soviet documentation. The MTA KKCs started the work in 1957 with many young engineers and mathematicians, among whom several became renowned personalities of the computer field in Hungary. The original Soviet design was significantly reworked, and modified to fit Hungarian component supply possibilities. The capacity of the first magnetic drum was initially 1 Kword (31 bit/word ≈ 4 KB) and that was increased to 1,6 Kword, later another magnetic drum was connected to it so the full capacity increased to 3,2 Kword. The writing of the data and the read-back happened through 8 read/write head units with 5 tracks each, at a speed of approximately 50 words/second. In the course of further developments, a 1 Kword (= 4 KB) capacity ferrite core memory unit was connected to it as well, by which its operating speed increased to 1000 operations/second. At the beginning, a Siemens 5 track punched tape Teletype served for data input and output. Later it was changed to a fast FACIT 8 track punched tape reader and a Creed puncher. In the machine, 2500 vacuum tubes operated altogether, with an electrical consumption of 10 kW and MTBF ≈ 7-8 hours.



The M3 operated in the first computing center of the country, the MTA Computing Center, where amongst many interesting tasks economic calculations in connection with the planned economy as well as solutions of different mathematical and engineering problems were performed– such as, for example, the checking of the statical calculations of the Erzsébet bridge that was being built at that time. The first Hungarian "computer music" also started to play on the M3 machine.

At the sunset of its life, in 1965, the M3 was moved to Szeged, to the Cybernetic Laboratory of the University of Szeged, its transportation and re-installation operation rated as a significant engineering achievement. It operated there until 2nd of January 1968; later most of its units were used as components by the departments of the university, a few parts still remained.

The Razdan-3

One of the treasured objects of our collection– also treasured for its rarity – is the transistor computer named Razdan-3, designed in the Research Institute of Mathematical Machines in Yerevan between 1958 and 65 and manufactured from 1966. In Hungary, only two computers like this operated, one in the University Computing Center from 1968, and the other one in the industrial research institute

VEIKI, this latter one was preserved. Both machines were in operation for 15 years, in the first 7-8 years for 5-6 days a week in 3 shifts, later in 2 shifts.

The active elements of the original machines were transistors, but the components were already attached to changeable cards reminding of integrated circuits. Since the machine was designed for military purposes, they were aiming for specifically safe solutions; for example, all data was stored on the magnetic tapes twice (redundantly) with a special error-correcting code that had great importance in the case of the magnetic tapes, which were important in the case of archiving. The machine had to be placed in an air-conditioned room approximately ≈50 m2 in size.

The VEIKI created an information system on the machine for the maintenance of the power plants, which was programmed partially in machine code, partially in ALGOL language. Instead of the earlier, considerably more unreliable telephone notification system – when the hand-written reports were stored –, in the computer system the data was recorded onto punched tape, they were read in through telex machines, then organized and evaluated by a program.

<u>The Minsk 22</u>

The Minsk computer family manufactured in Minsk for 10 years is practically speaking the descendant of the vacuum tube M3 computers developed in Moscow. The first member of the family, the Minsk 2, was the first semiconductor computer of the Soviet Union, the Minsk 22 is the already corrected and updated version of this. The one on exhibit was bought in 1968 by the National Committee for Technological Development for the University of Szeged, to replace the M3, already 9 years old, to support the applied mathematician training started by the initiative of Laszlo Kalmar. Until 1974 the machine operated in the Cybernetic Laboratory – hallmarked by the name of Professor Kalmar - at University of Szeged, then it operated in another computing center until 1979.The Minsk 22, also a word-organized machine, had a main memory with an 8 Kword (37 bit/word) capacity ferrite memory, an operation speed of ≈ 10 000 operations/second, and a somewhat unreliable (non-standard), 800 kwords capacity magnetic tape memory unit. Two types of printers belonged to the configuration: a 60 line/minute speed chain printer from10 decimal digits and + sign for printing numeric data, and a 100 line/minute speed rotating cylinder printer to print alphanumeric data. For data entry it originally had an 80-column punched card reader, the FACIT reader operating with 5 and 8-track punched tape was added to the machine in the Cybernetics Laboratory, which, similarly to most computers of the era required an air-conditioned room. Otherwise it operated really reliably, 5-6 days, sometimes 7 days a week, for 24 hours a day; giving it a total operational availability of around 90%.

The Minsk 22 served to solve scientific and research tasks, but it was drawn into several application projects and used for interesting educational tasks as well, for example, a student solved the simulation of Kalmár's fictional machine on it as his thesis.

The Minsk 32

The microprocessor machine was controlled by 4 selectable micro-programs, its operation speed was 25 000 operations/second, its main memory was 64 Kword capacity, and already outstanding quality IBM compatible magnetic tape units could be attached to it as background storage. It had further peripheral devices as well: punched card reader (600 cards/minute), punched tape reader (5-8 track, 1500 characters/second), punched card puncher (100 cards/minute) and a line printer (128 characters/line, 400 lines/minute).

The most widely spread Soviet computer at its time was manufactured until 1975. In Hungary it was primarily used to solve scientific-technical and planning economic tasks, for example at the military, or evaluation of geophysical measurements.

The EMG 830

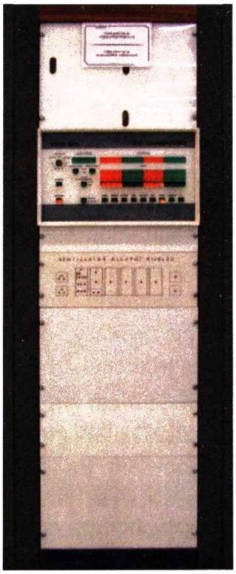
The first computer originally designed in Hungary was the transistor computer named EMG 830 with its modern architecture deserving recognition.

The EMG 830 was a completely Hungarian designed, middle category computer for digital administration applications, built from silicon based semiconductors. Its architecture is typified by the modularity and the buses; its modern architecture greatly superior to the similar middle category machines. The operation speed of the machine was 25 000 operations/second, and the maximum main memory capacity was 32 Kword (24 bit/word). The main parts of the configuration: CPU with the main memory, magnetic tape memory, changeable magnetic disc memory, fast access (fixed) magnetic disc memory and a control panel equipped with an IBM produced type ball typewriter, combined with punched tape units.

For the prototype operating at EMG for a longer period, several smaller and larger programs were written, partly to solve economic tasks, partly to support the development. Among the latter we emphasize the compiler developed at INFELOR, which translated blueprints written in the Grafokód language into a controlling punched tape for the first precision plotter operating in the country, the Graphomat.

The R10

In the end of the 1960s – by the suggestion of Alexei Nikolayevich Kosygin, Soviet prime minister at that time, the socialist countries agreed on a common computer development program, named the Unified Computer System (ES), whose purpose was to make up for the depressing trailing in advancement of the computer field which had occurred because of the wrong development politics of the Stalinist era. This was planned to be achieved by the organized copying of the most-known computer family of the age, the IBM 360 (later 370) and developing modern programs.



As a result of this project, the computer field started to develop significantly in Hungary as well. With the use of increased financial resources the computer stock of the country significantly increased, especially with machines acquired by import from the West – UNIVAC, CDC, Honeywell, Bull, ICL, Siemens and, naturally, IBM. Unfortunately, these great efforts didn't really deliver the expected results: our initial 4-5 year handicap had increased by the end of the 1980s.

The smallest member of the ES was the R10 computer. The first version of this (1010B) based on the license of a French machine (CII 10010) was developed at SzKI. The mass production of the R-10 version accepted later at the official approbation process, started around 1973 at Videoton. The machine proved to be very profitable as an on-line data collecting system. Its versatility was increased by the fact that – as real-time peripheral devices–, analogue input and an analogue-digital converter existed for it as well.

The Videoton Computer Factory produced in the 1970-80s the central unit of the R10 computers (being part of the ES series), which was a micro-programmed minicomputer, built from TTL (Transistor-Transistor Logic) circuits with 4-32 Kword (16 bit/word) capacity ferrite core memory. The peripherals of the computer consisted of VT 340 or other screen/monitor terminals, and punched card punched tape units, with an 800 kB capacity SAGEM fixed disc driver, later the 8" floppy drive, attachable as well.

The R10, that could be well used for general data processing, traffic control, technical scientific calculations, measurement data collector and processor could be programmed in assembly and

FORTRAN languages, but BASIC and COBOL compilers also belonged to the offer.

The R10, produced until the beginning of the 1980, was introduced successfully in the socialist bloc and of course in Hungary as well. For example – at that time rated as strictly confidential – in connection with the economic type processing of space photos. It became especially popular in the Soviet Union, when Videoton – in cooperation with SzKI – joined the seabed research program launched there. As a low performance, and in its category relatively cheap computer, it worked out wonderfully as a satellite machine of the bigger machines of the ES.

The MCD 1

Marcell Jánosi (1931-2011)
He was originally the chief constructor of magnetophone development of Budapest Radiotechnology Factory (BRG). He received the patent for the flexible disc placed in a cassette case, named MCD-1 already in 1974. He wanted to create a real "first mover" product, that could bring name and extra profit to his country.

In the second half of the 1960s, alongside the punched card and punched tape data media, the magnetic drums, the magnetic tapes, and the different fixed-magnetic disc card storages became more and more widely spread. Only in the beginning of the 1970s did the flexible magnetic disc, the "floppy", appear worldwide as a comfortable data storage solution, first in paper envelopes with a large 8" diameter, later, in a less vulnerable plastic case, the "small" with a diameter of 5,25".

The key innovations of the MCD 1 floppy were the compact case and a central disc of not more than 3" diameter, which was assembled in a rectangular case that comfortably fitted in a vest-pocket; its driver was approximately one tenth the size of the big floppies of the age, but had the same storage capacity! The Hungarian mini-floppy stayed a curiosity of Hungarian technology history. Only a few thousand copies were made of them in the beginning of the 1980s, although it was introduced in the Western press as well, and in a minimal number a version fitted to the ZX Spectrum computer was also put on the market. However, its "clones" and improved versions spread all over the world: the 3", then the 3,5" diameter cassette mini-floppies were present in the bag of all PC users until the millennium. But Hungary couldn't profit from this.

The GD 71

The first graphic display in the country was developed at SzTAKI, which in its basic configuration was connected to the TPA 70 computer.

The graphic display manufactured in 1971, named the GD 71, is approximately 150 kg, it consisted of a round CDC produced cathode ray tube screen, a TPA 70 driver computer, a keyboard, a light pen, and a track-ball. With the help of the CAD program it was possible to draw graphic pictures, represented with vectors, on the screen.

The IBM 360

Among the systems that entered the market in the 1970s, the IBM 360 family unequivocally had the most effect on the history of computing. The modern computer practically was born with this integrated circuit built family. By the IBM 360 family – with the contraction of the punched card and punched tape standards – the internationally accepted, standardized character code tables were created which are still used today, not only the 9 track magnetic tape storage, but the keyboards, the monitors and other I/O devices as well. As we mentioned before, this machine also served as a model for the ES developed in the socialist countries.

The IBM 360 computer family – to whose development 300 patents were used – was a universal system, so its members could be built to solve all sorts of tasks from scientific technical tasks through data processing and process control to remote data processing. Accordingly to this, IBM offered a very wide range of peripheral devices.

The IBM 360/40 machine exhibited here has an IBM 2040 type central unit. The machine is already byte-organized: the capacity of the main memory of the central unit depending on the configuration could be between 32 and 256 KB. As a consequence of the diverse configurations, several operation systems and several programming languages as well – apart from the assembly – FORTRAN, COBOL, PL1 (Programming Language One) and RPG (Report Program Generator) – were available for the users.

The ABC 80

As a result of the cooperation between BRG and the Swedish Luxor company, the ABC 80 school computer was produced in hundred size series, they appeared in the luckier educational institutions in the very beginning of the 1980s. It was worth it for the Luxor company to hand-over the central unit of its machine, for they received the Hungarian BRG supplied outstanding quality data tape recorders designed by Marcell Jánosi for the computer. The ABC 80 computer built with a 16KB RAM main memory a generation of young engineers got to know the BASIC language. To the machine, a series of educational, programmer booklets.

The Primo

The Primo first Hungarian produced home computer available in shops, was put on the market in 1984. The machine was developed by Microkey Research, Development, Production Association, then was produced by the subsidiary company of MTA SzTAKI, the Cosy: it was promoted with full page newspaper advertisements, with a flush of promotions such as winner games, free gifts like, card-calendars, timetables.

With the advertisements and the low price they mostly targeted children and young people. To the fame of the machine also contributed the program lists appearing in the book published to the TV BASIC course, and the articles of the Mikroszámítógép Magazin and the Bit-let, as well as the Primo Füzetek published individually. The Primo existed in 16, 32 and 48 KBRAM main memory versions. The Hungarian developed – designed by Gábor Örley – capacitive keyboard was placed directly on the PCB, and since it didn't contain moving components, lived for almost "forever", on the other hand because of their adjustable sensitivity smaller errors were frequent – for example spontaneously repeating characters. The specifically designed form – reminding to an earlier Tandy type – was made of plastic.

The burnt in BASIC programming language, the television set – generally Yunost – that could be used as a monitor, and the everyday used Hungarian BRG MK 27 or MK 29 – tape recorder made the Primo a competitive priced, simple, traditional home computer. The more ambitious programmers could, besides BASIC, write programs in Forthand assembly languages; the necessary compilers could be uploaded from the cassette enclosed with the machine, on which, in addition to the demo programs the "adapted copies" of many world-success ZX Spectrum game programs could be found. It acquired cult. For example the game titled "Keljfel Jancsi <Get up, Johnny>" became popular, in addition to the numerous skill-based and educational programs, typographical application programs existed as well.

Computer networks

It seems likely that from the achievements of the previous end of millennia primarily the information system enveloping the whole world is becoming permanent, so at our exhibition we show the history of the Internet in a separate room. This packet-switching telecommunication system and the world wide web built on it brought the era of the information society, the era of digital culture. We exhibit those hardware elements, which are indispensable in the operation of the network, with special consideration paid to the devices rated as pioneering ones in Hungary.

In 2012 about one billion of us are using internet: the usage of computers doing data exchange with each other is now part of our everyday life. In the second half of the last century every data source was already connected to each other, these days – as an experiment – interplanetary Internet is also working. However, the history of data transmission goes back further in time: the telegraf of Samuel Morse was born in 1844, and the last member of the worldwide telex network, used for 70 years, finally stopped in Hungary in 2002. The nearly 50 years old computer communication system which was built on these experiences, was revolutionarily changed increasing the efficiency of information transmission by replacing the telephone line connection with packet switching, since through this several logical connections could be realized simultaneously on one physical line.

All objects of the collection are equally typified by the data transmission capacity, the technology and the application possibility. We gathered wires with different connectors to show the communication transmission media – incase of wired solutions: metal wire, coax- or optical cable; in case of wireless solutions: radio-or microwave, and laser, satellite, wifi or wimax data transmission – on the chip, on the motherboard, on local and long distance networks, and to demonstrate interfaces. It is worth observing the variety of the connectors.

Terminal networks

From a distance we can reach our computers through terminals. The first user terminals were the teleprinters and the telex machines (Siemens, RFT). Our classic object is the Teletype produced device from 1963 (ASR33) that was also used for the controlling of the computer (console typewriter), and had an 8 channel punched tape I/O device as well. The approximately 10 year younger DecWriter III also belongs to this group. We mention another two types, the IBM 2741 and the typewriter of Videoton with Latin/Cyrillic keyboard that was sold together with a desk. The monitor terminals were already much more comfortable, mostly with 24 lines, 80 characters/ line monitor (character generator) serial interface. The first generation (Videoton VT 340, IBM 3278) was made in a wired design, the second (Orion ADP 2000, Videoton VDT 52100,Videoplex, Tatung) already with 8-bitprocessors.

The terminals of the special purpose computers that could also be used individually are worth to mention: the TAP 34 manufactured by the Telephone Factory, with the CP/M operating system and two 8" floppies; the French MiniTel and the Austrian MUPID BTX teletext information system terminals; and a small mobile data recording terminal. All the game purposed and home or professional – Sinclair, Commodore, IBM – personal computers belong here. By the beginning of the 1970s in Hungary, around all mainframes was built a terminal system consisting of a few terminals.

Data networks

The task of the data networks is that through them we send data from one data station to another. Practically speaking, the system is a special computer network, comparable to the network of the motorways, in whose intersections small computers control the traffic. If at least two computers are connected to the data network, we talk about a computer network.

The remote communication initially happens through 300 baud acoustic modems, then with the help of 1200 baud modems, through the telephone network. The modems, capable of dialing, handling connected telephone lines, matching the so-called Hayes compatibility standard, which we display here in operation, are significant. In point to point communication, the transmission speed approaches 2 Mbaud; we may also see a few of these pairs (Nokia BB512, RAD ASM 40, Mainstreet 2702).

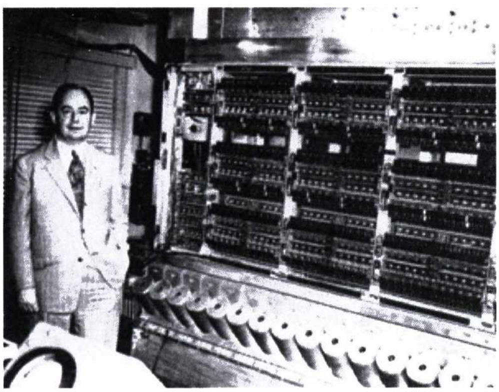
In the construction of the worldwide data networks an important role was played by the Digital Equipment Corporation (DEC). In the computing centers DEC mini's were used for the execution of connecting functions, and here we can see two of them. Among the factory networks the SNA network of IBM stands out. The UNIX base computers operated the UUCP mailing and the USENET news systems through rented and connected lines.

The development moved towards the autonomous packet-switching data networks. Out of the three protocols – X.25, ATM (Asynchronous Transfer Mode), IP (Internet Protocol) – the first two have only museum value, and are decaying.

In Hungary, the X.25 network was first built by MTA SzTAKI for its own usage. The successful, pioneering work was not only useful in the university education but also in the configuration of the data network in Hungary. Due to its impact MATÁV started to construct the national X.25 network with the Tertacom devices of SzTAKI; and later expanded this service with Siemens devices.

To represent the IP data network system, by now almost totally dominant, we exhibit among others Cisco and Hewlett-Packard (HP) devices. In Hungary the Internet appeared in the academic sphere in 1991 (National Information Infrastructure Development Program, that was soon followed in the business sphere as well (Datanet, MatávCom, Elender).

John von Neumann (1903-1957)



One of the greatest mathematicians of the 20th century was born into a lucky environment, his amazing skills were enabled to bloom due to an intellectual background impregnated with art and culture.

He spent his university years partly in Budapest, partly in Berlin – he studied philosophy, mathematics, physics and chemistry –, and continued his studies in Zürich where he earned a diploma in chemical engineering in 1925 from the EidgenössischeTechnische Hochschule, and he received his PhD in mathematics from the Pázmány Péter University, Budapest with Summa cum laude. After this, the young scholar lived in Western Europe for a while: he published his set theory and quantum mechanics studies in Berlin, while in Göttingen he became part of the center of the European scientific life led by David Hilbert. He became a full professor of mathematics at Princeton University in 1931 – at the age of 28 –, and since 1933 until his death he held such a position also at the Institute for Advanced Study (IAS) in Princeton.

From his first marriage (between 1930 and 1937) he had one daughter, his only child. After his divorce he remarried in 1938. His second wife was a programmer, who wrote programs for the ENIAC and the IAS machines among others.

The principle of the "stored program" was developed during the group discussions analyzing the deficiencies of ENIAC –according to Goldstine the main ideas came from Neumann –, and the team started to design the corrected version already in 1944 by the name of EDVAC (Electronic Discrete Variable Automatic Computer).

Eckert and Mauchly wanted to protect the innovations with a quaternary patent (Eckert-Mauchly-Goldstine-Neumann), however Neumann opposed it and in his study written in 1945 (First Draft of a Report on EDVAC) described in detail the organization and operation of an electronic, digital, binary computer in which the data and the program are both stored in the computer's memory in the same address space. This publication made impossible to patent the basic solutions of EDVAC. Even though Neumann was attacked for publishing the study as a sole author –without mentioning the names of the other members of the team – in the contemporary scientific world it spread like this, and the principles are connected to his name as the "von Neumann architecture".

The Neumann Room

This room contains personal accessories of John von Neumann – diplomas, awards and a film with an interview of Neumann, whose name is used proudly by our Society.

This volume contains the revised and edited proceedings of the 8th IT STAR Workshop on History of Computing, held on 19 September 2014 in Szeged, Hungary.

It brings to the forefront national and regional programs and processes in Central, Eastern and Southern Europe leading to the construction of the first computers and their applications. The social impact of this activity is examined with emphasis on research, education and economics. The computer pioneers, constructors, policy makers and managers are spotlighted, with recollections of their achievement and their motivation as role models to current and future generations. The role of ICT History museums to help understand the technological processes and the driving forces of innovation is considered.

The book offers a unique contribution to history of computing worldwide.