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MY MEMORIES OF BEGINNINGS OF THE INFORMATION AGE

At my age, people gladly remember all sorts of their beginnings. So do I gladly remember my beginner's work in the area of informatics. I hope that these memories will not be damaged by my number of neurons. In these memories I will talk about my first employment, analogue computer, designing digital computers, software development and teaching computer science. The memories encompass the period from 1950 to 1980. Of course, many things happened after this period, and especially important is invention of personal computers. But it might be another story.

1. First employment

At the very beginning of this story I have to mention my first employment. It was in 1950. At the end of the school year, my school organized a visit to the Radio Beograd studio. All of us were delighted by this visit and I thought how nice it would be to work there. After a month, at a graduation ceremony at the secondary electrical engineering school "Petar Drapsin", a Radio Beograd HR person showed up asking for three best students. I was one of them. He told us to come on August the 1st into HR department for permanent employment in the Radio Beograd. When we came to the HR department, I was told I would work in a studio, and my other pals - on a transmitter. This is how my earlier wish about the first employment accomplished. Work in Radio Beograd was very dynamic, with many different happenings. I remember that once I even was a speaker fortuitously. Morning program started at 5, speaker on duty was Mira Trailovic. Time for the program start was approaching and Mira was not showing up. After a lot of excitement, we decided that I will take a speaker role. So I was a speaker for fully 45 minutes, before Mira showed up, quite puffed out.

At that time, the radio programs were mostly live broadcasted, which was especially interesting to me. I enjoyed watching and listening to many performers of folk and classic music. I have always admired, and I do admire now, for skills of playing musical instruments. I took a liking to music and made a wish to actively engage in music. I had not had enough time for this until I retired. After retiring I came by spare time and, thanks to computers, also came by possibilities to be engaged in music even without acquiring skills for playing an instrument. I have developed a program that provides for different engagements in music, from music implementation and interpretation based on sheet music up to composing.

Figure 1. In Radio Beograd technics

On Radio Beograd we worked in shifts, so I often had free time before noon. So I decided I should have a hobby for my spare time. Since I had always liked mathematics, my choice was to study mathematics. I first went to the Dean of the Faculty of Science and Mathematics to inform myself about studying mathematics. The Dean was Professor Tatomir Andjelic and he suggested to me to choose applied mathematics and the best way for that was to enroll the Group for Mechanics that he has just opened at the Faculty of Science and Mathematics. So I graduated at the Group for Mechanics at the Faculty of Science and Mathematics in 1957. I soon decided I should find a job appropriate for the university degree.

2. Analogue computers

I left the studio technician job at the Radio Beograd, which I did as a student, and found a new job at the Rocket Institute. Work with computers, at 60-ties, assumed knowledge of applied mathematics, since computers were mostly used for analysis of mathematical models. My university degree perfectly fitted into work at the Rocket Institute, which was being established.

2.1. Computer on paper – nomogram. At that time, log calculators (Logarithms) and nomograms were used as computing devices. My first assignment was to design a nomogram for a quite complex mathematical model. By that time the Institute used services of a center from abroad. All I knew about nomograms, from my university courses, was that nomograms were drawings, often families of curves, on which some calculations may be performed. I knew nothing about constructing nomograms, especially for complex mathematical problems. I found some books in the library and started studying the problem. The reason this work stayed in my memory forever was

that, after some twenty days of work, I saw complete solution that I had been looking for, in my dream. I went to the Institute and without difficulties wrote down the whole procedure of construction of a very complex nomogram.

From the Rocket Institute, I was sent to work in the Laboratory for applied mathematics of the Vinca Nuclear Institute. The goal was to introduce myself with analogue computers.

2.2. Computer for linear algebraic equations. In the laboratory there was a computer for solving systems of linear algebraic equations. It was possible to solve up to 30 equations with 30 variables. We used that computer for solving systems for needs of the Institute, but also for some foreign institutes. Solving was based on analogue principle. So we could find solutions with up to two digits only. We upgraded the obtained solutions by means of mechanical calculators. I remember a case illustrating problems we were facing with solving large systems of linear algebraic equations. A professor from the Faculty of Civil Engineering contacted us and asked to solve for him a system of 72 equations with 72 variables. Our plan was to divide the system into three parts and to use both the computer and mechanical calculators. But convergence was so slow that after 20 days we concluded we could not solve that.

2.3. Repetitive Differential Analyzer. Another analogue computer that I found in Vinca, was a repetitive differential analyzer. Constructors of this computer were Professor Dusan Mitrovic and dr Rajko Tomovic. A small series of these computers was produced in the Electronic industry in Nis. I went to the Electronic industry in order to test the analyzer bought for the Military institute in Zarkovo. On that occasion I proposed some improvements on functions generator [5]. The Center for multidisciplinary studies also bought one of these analyzers. I worked with Professor Zvonko Damjanovic on modeling some photosynthesis problems. Phenomena were being described by a system of linear differential equations, which was ideal for analyzers. Center donated this analyzer to the Faculty and it was installed in my office. I have used it for several years for students' demonstration.

One of these computers was exposed at Belgrade fair. Comrade Tito visited the fair and I was in charge of demonstrating computer work. When Tito came, I greeted Tito and Jovanka and demonstrated on the computer how to investigate stability of an airplane. Tito carefully listened to my talk and then said it seemed to him that he had already had a chance to see something similar.

Of course, the system was used for solving differential equations. At that time, conditions for research in Vinca were ideal. I moved to Vinca for permanent job. Our main task was to perform services of solving mathematical problems and to publish scientific papers. Several of us published a number of papers in prestigious scientific journals [2-8]. Professor Tomovic had a perfect insight into what had been worked upon in renowned world science centers. One day he proposed to me to investigate possibilities of solving integral equations on differential analyzer. This was the very first time I heard of integral equation since it was not in the university curriculum. After the necessary studying the topic, I proposed a procedure for solving integral equations on differential analyzer, and then published a corresponding paper with professor Tomovic [3]. This paper has been referred in the book of T. Korn, famous American writer in the field of computers [20], as well as in the Russian Encyclopedia [21]. Invited by the Czechoslovakian Academy of Science, in 1965 I gave a lecture in Prague about solving integral equations on analogue computers.

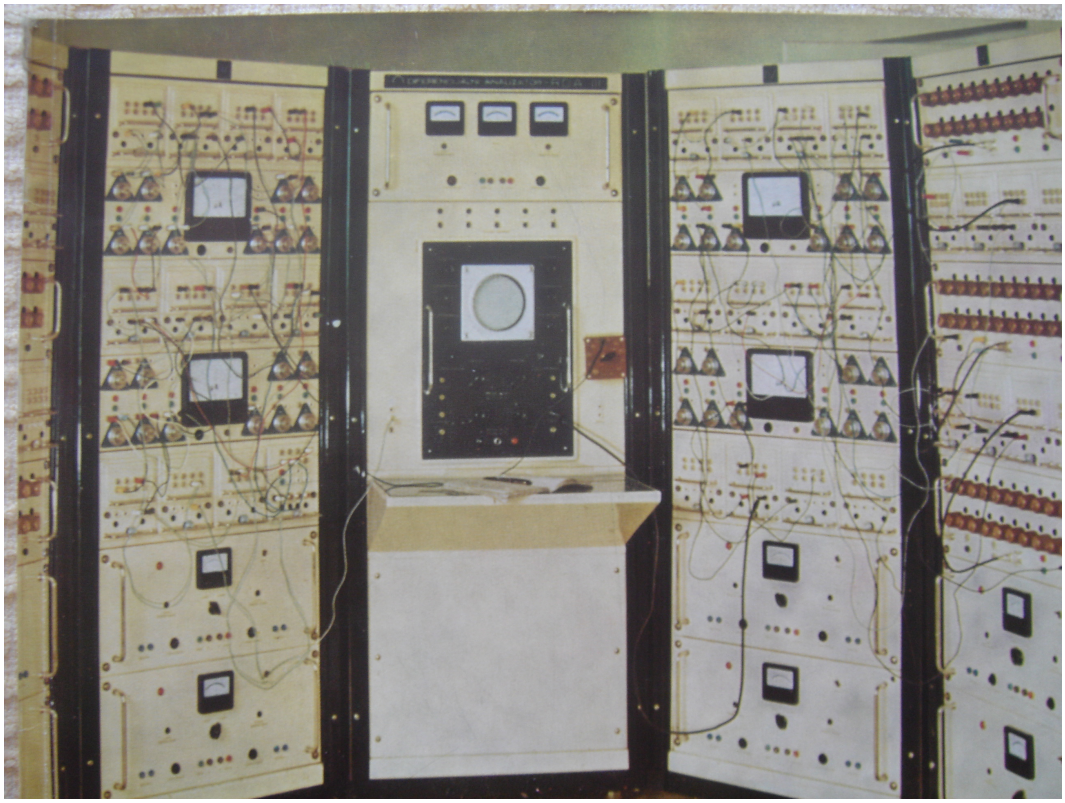

Figure 2. Repetitive Differential Analyzer

At that time, around 1960, computer CER-10 was designed and constructed. The name CER is an acronym of Cifarski Elektronski Racunar (Cipher Electronic Computer). It was the very first domestic digital computer developed in the vacuum tubes technology. It is necessary to mention here that at that time it was not clear whether the future of computer tools relies on analogue or digital principles. A great advantage of analogue computers was that complexity of mathematical models does not influence on how fast the results are obtained. I remember a lecture of professor Kogan who was a famous name in Soviet Union in the field of analogue technique, given in the Institute "M.Pupin" in 1966. Professor claimed that digital technique will not be able to compete with analogue one in problems to be solved in real time.

When I opposed this standpoint, he categorically rejected all my arguments. Later, after a year, we met again at a conference in Lausanne in 1967. He publicly apologized to me at a party in a hotel where we from Serbia met with the Russian team. Yes, it will become clear to all only after 1970: the future of computer technique is in digital, not in analogue principle.

Around 1962 things got changing drastically in many of our institutes. The focus moved to financial effects of scientific research. Laboratories from Vinca moved to the Institute "M.Pupin" and the Laboratory for digital technique was established.

2.4. Transistor analogue computer - TARA-50. Around 1965, a transistor-based analogue computer named TARA-50 was developed in the Institute "M.Pupin". It was a slow analogue computer, as opposed to fast repetitive computers. Chief constructor was Pavle Pejovic. I keep this computer in my memories because for my solving one type of Fredholm integral equation on it. I showed theoretically that, in case kernel of an integral equation satisfies some conditions, integral equation comes up to a differential equation, which is solved by iterative changes of initial condition [15]. This way an

iterative procedure has been applied on an analogue computer, which is not intrinsic feature of analogue computers. Most often, iterative procedures require storing functions, which is difficult to implement in analogue technique. This method requires storing one number, differential equation initial condition. Mathematical foundations of the method are presented in a separate paper [13].

3. Digital computer design

During the time period we are talking about, many believed that design and development of digital computers is a very perspective job. I myself believed in that, too. Here is what I did in the field and how I see that time period.

Figure 3. TARA Computer

3.1. CER-11. Institute "M.Pupin" made a contract with JNA (Yugoslav Army) for development of a larger digital computer named CER-11. I was assigned a task to develop a preliminary design project, together with Tihomir Aleksic. I had working experience with digital computers Univac-60 and IBM-705. Working on this project I became professional in digital computer design. Digital computer functions as an array of substitutes between registers, while some contents transform through logical networks and everything is precisely defined in time. Complexity is due to a large number of very elementary substitution steps. Preliminary design project described computer architecture and the instruction set in detail with procedures of their realization. The computer has been developed successfully and exploited for years in a JNA institute. It is interesting to look at some basic characteristics of that computer [5].

Main memory is ferrite, organized in registers. Each register consists of 8 subregisters. A subregister consists of 7 ferrite cores. Memory size is 8192 registers, i.e., 65536 subregisters. Content of a register is simultaneously read from the memory. Memory cycle is 2,6 microseconds. It was a one-address computer, a statement consisting of an operational part, address part, address of index register and type of modification. Arithmetic unit contains accumulator and index registers, set in a specific ferrite memory. This memory consists of 64 subregisters, where first 32 registers constitute the accumulator, and other subregisters constitute index registers.

Let us look at what were input and output devices. On input it was possible to attach two punch paper tape readers with reading speed of 500 to 1000 characters/sec. On output it was possible to attach paper tape punch with punching speed of 150 characters/sec, two teletypewriters with printing speed of 10 characters/sec and one parallel printer with printing speed of 600 lines/min. As far as it concerns software, we developed, in the Institute, an assembly language for the purpose of testing the system [31]. A more complete assembler has been developed by a team of programmers in JNA. A mobile version of this computer has been built, also for the JNA needs. After this computer, several computers for bookkeeping needs have been built. This was the first computer in the Institute "M.Pupin", developed in transistor technology.

Figure 4. CER-11 (mobile version)

3.2. CER-30. During 60-ties of the 20th century, widely used digital computing tools were desktop mechanical calculators. I proposed to start building electronic calculators. It was not accepted with argumentation that electronic version of calculators does not pay off. In cooperation with colleagues Bogdan Jankovic and Milojko Maric, we designed, on our own initiative, a project of an electronic calculator. Just to mention some of the original solutions in that project: acceptance of a program, unique algorithm of multiplication and division and cheap result indicator. Acceptance of a program consisted in an automatic memorizing of an array of operations that a user performs on a calculator, so that after a single executed example the user enters only data, and calculator itself chooses the operations. For this solution I was awarded by ETAN award for the best paper in the field of automation for the year 1964 [24, 26]. The unique

algorithm for multiplication and division significantly simplified realization of arithmetic operations [6], and thus reduced the number of transistors used, which was an important condition in building calculators. Finally, for building indication, only 25 transistors were used, although it was assumed that it is necessary to use about 250 transistors. This solution was given by colleague Maric.

After a lot of persuasion, a laboratory prototype of an electronic calculator has been built, named CER-30. The prototype was used by a number of associates for technical and accounting computations. However, there were many problems with organizing production in the Electronic industry, Nis.

3.3. TRS 501. Six years after CER-30 has been built, my colleague Maric and I succeeded in materializing our knowledge about electronic calculator design, in the development of a new calculator in the factory TRS in Zagreb. The calculator has been built in 3 months and exposed on the Electronic fair in Hanover in 1969. It was interesting to observe the presence of a large number of exposers from other stands, especially Japanese. We had an offer of a large American company working on development of electronic calculators. Their representative asked us to open up the calculator in order to count the number of built in transistors, since he did not believe our claim that the number of transistors used was about 250.

He counted transistors about an hour and investigated interior of the calculator. At the end he said that his company had been working around 3 years on calculator development but that our calculator is significantly better than what they had. We considered his offer to work for his company and we concluded that we lived here quite well and that there was no need to be strangers somewhere else. Later on we designed a version with printer for that company. However, integrated technology comes soon and the version with transistor component loses game. A possibility of moving onto integrated technology has been considered, but it required a lot of investment.

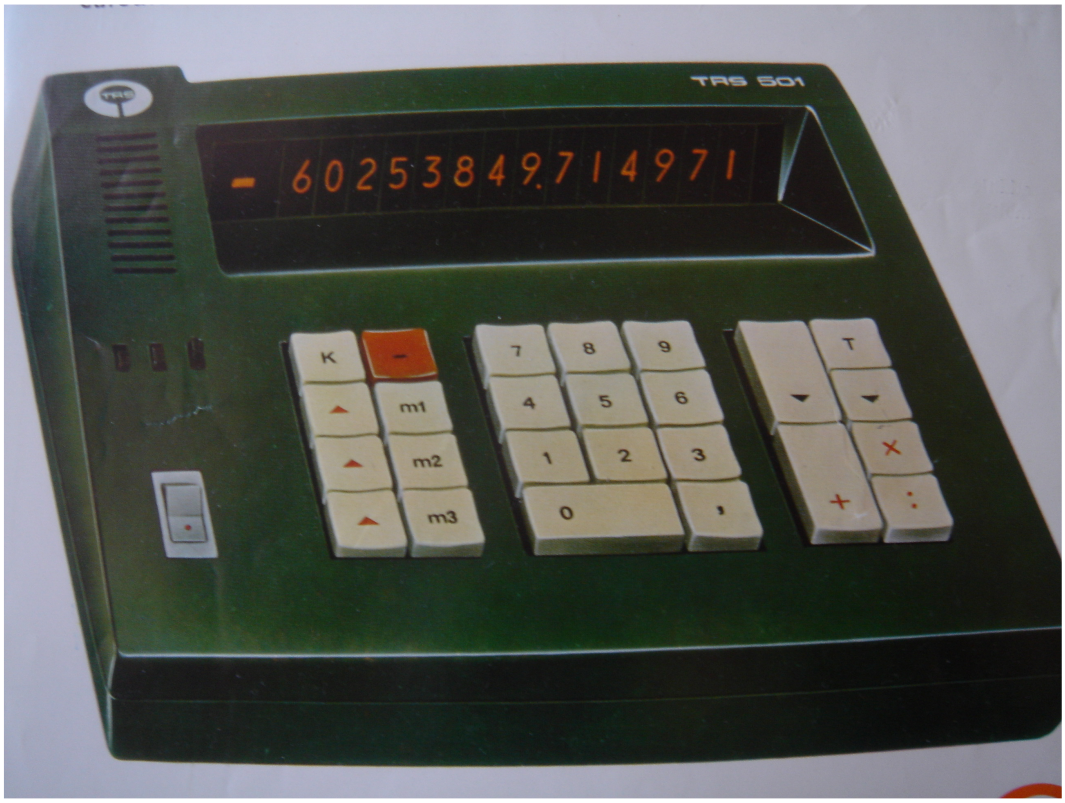

Figure 5. TRS 501 electronic claculator

3.4. Hybrid system HRS 100. At the end of 60-ties, in the Institute "M.Pupin" I participated in a project of developing hybrid computer for needs of the Institute for Automation in Moscow. On that occasion I stayed several times in Moscow where we discussed digital part of the system. This cooperation left a lot of pleasant memories. For me, the novelty in this project was the existence of the interrupt system. The Russian team was to develop analogue part and system software, and our team - hardware of the digital part only, named KOSMOS. However, we had to develop a kind of operating system kernel for the sake of testing the system. This part was done by my colleague Bogdan Jankovic and me. The hard part of the task was to resolve all the possible situations in the interrupt system, since it was new for us.

In special memories I keep a meeting in Moscow with their programmers. Professor Kogan, Russian team leader, invited me into his office and asked me to be an opponent to their programmers. They were working on an assembler for hybrid computer, and I was familiar with their work. There were about 10 of their programmers and I presented my objections. Basic objection was assembler extension with special mathematical functions, which was completely unnecessary for assembler as a language for system programming. Heated discussion developed in which majority accepted my objections. I think that their work style with opponents is a good format for many professional and scientific projects.

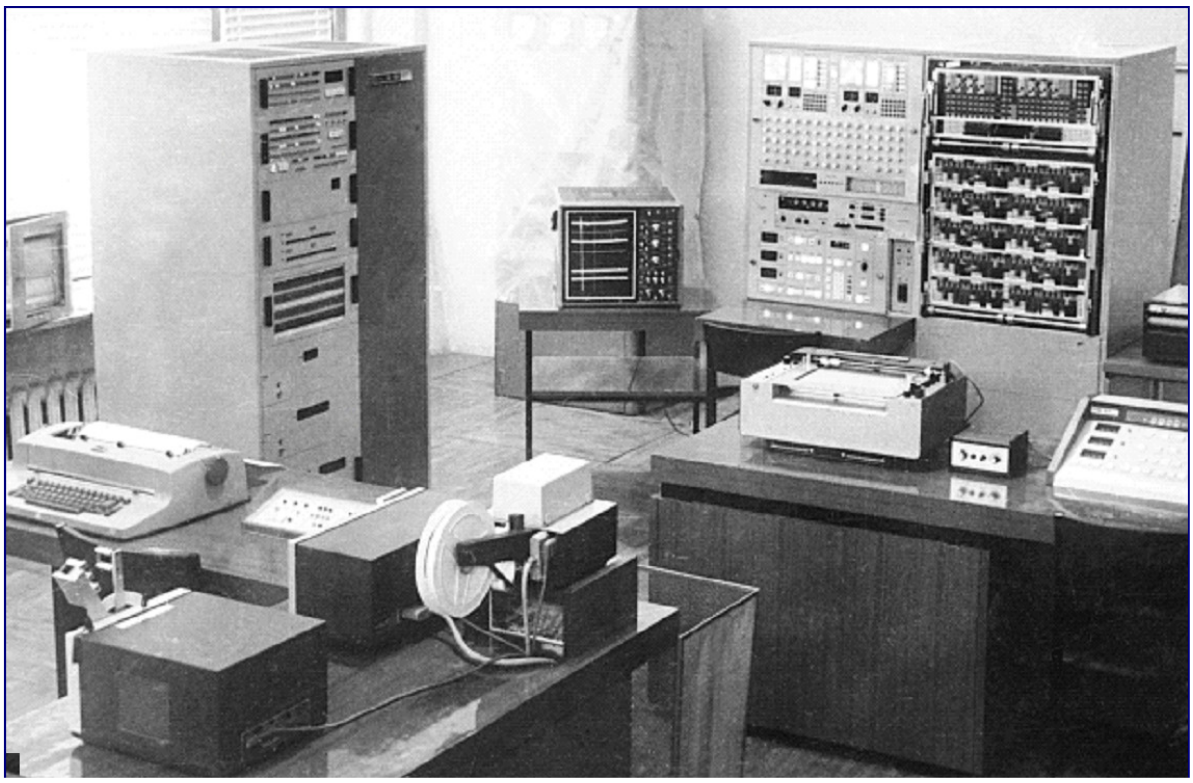

Figure 6. Hybrid system HRS 100

4. Software development

From early days of computer development, software is being divided onto system software and application software. At that time system software consisted of routines that support input and output devices, support development and testing applicative programs and development of compilers for symbolic and programming languages. We were developing these programs for domestic computers but also for other computers [34-36, 39]. Here I will mention some of the applicative programs I have been working on. At that time, there was a great need for applying computers, but only small number of people was capable of writing complex applicative programs.

The very first problem that I wrote a program for was solving a system of nonlinear algebraic equations. The reason I remember this forever is that I used a computer with external program. This is how it was. Sometime during 1959, I and Jovan Petric were sent by the Rocket Institute to attend a course for programming computer Univac 60, located at the IMT in Novi Beograd. The course was given by a Dutchman. When the course got forward, we asked him for his opinion about whether we could solve the mentioned system of equations on this computer. He laughed and categorically answered that it was not possible. We still wanted to try.

We took a programming panel and a bag with cables. Programming consisted in stabbing cables into holes on a programming panel, in accordance with operations to be executed. When all of these get connected on the panel, the panel is placed into the computer and program execution is started. Everything had to be programmed in 60 programming steps, thus the number 60 in the computer name. When assembling and testing programs, binary operations were often used, so that one often could hear "one plus one is zero and carried one". One day, a cleaning women that cleaned premises, angrily exclaimed before exiting "you guys should know that one plus one is two". We looked at each other and commented that she will for sure talk everywhere about ignorants working in the Institute. We managed to solve the problem in available 60 steps. When we talked once about this with Professor Tatomir Andjelic, he thought this was worth communicating in SANU (Serbian Academy of Science and Arts), and later a publication [1]. Unfortunately, I do not have a photograph of the programming panel we programmed, but it seems to me that it is interesting to see the photograph I found on the Internet, showing how programmers worked on ENIAC which was the first computer and, of course, with external program.

About 1960, the Vinca Institute made a contract with the factory "Rade Koncar" in Zagreb, for developing programs for electric motors design. I took a course in assembler programming for the computer IBM-705, which was then the largest computer in SFRJ and was located in the Federal Bureau of Statistics. It was probably the last computer bought in vacuum tube technology. Requests for programming I used to receive from the factory, from dr Zelenko. It was an interesting approach illustrating real benefits of computer application. Input data for this problem was technical specification of a motor and market prices of iron and copper. Such a computation could not be performed without computers.

For building hydropower on Djerdap a lot of computations were needed, and I participated in one of them. It was a forecast computation of what would happen in case of dam break. D. Muskatirovic performed the problem settings and I worked on programs for the computations [28]. The problem was formulated using partial differential equations and it was theoretically well defined in case of uniform river bed. But the problem was in the Danube bed, since the bed greatly spread downstream from Djerdap, so there was no way of bed uniformity. We overcame the problem by interpolation between uniform bed parts. Results obtained in such a way were in

accordance with experimental results obtained on the physical dam model. All the computations were performed at the company Energoprojekat on computer ELIOT, which had a specific, so-called Autocode that we were programming in.

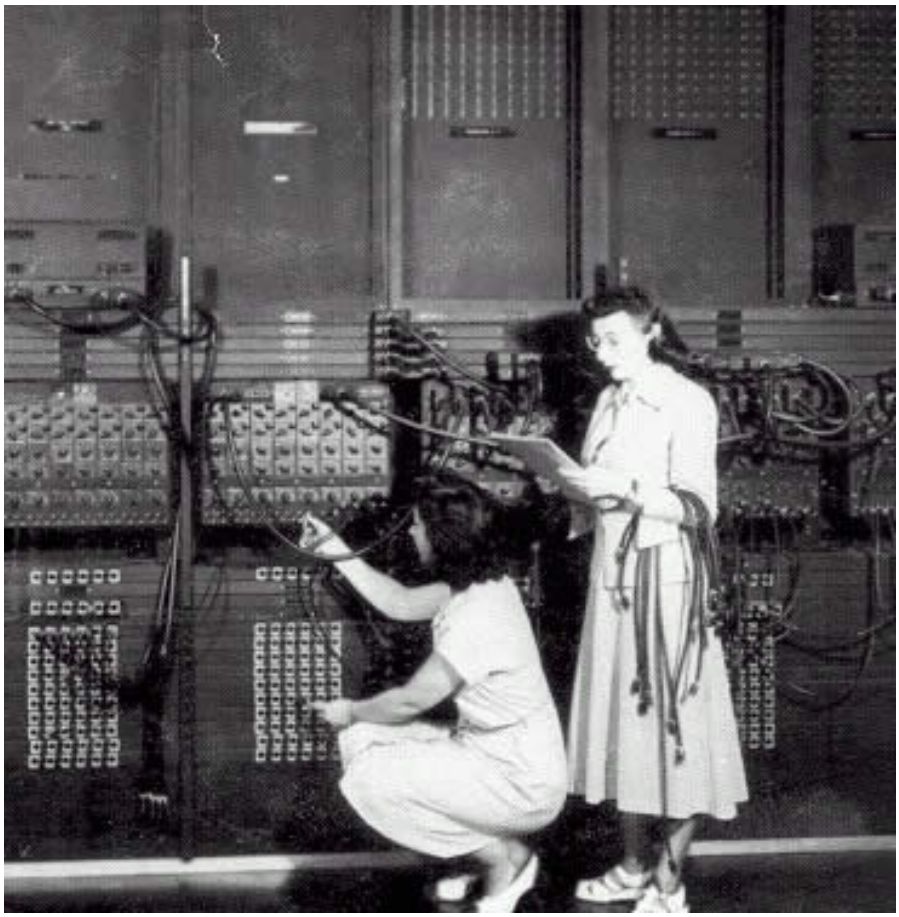

Figure 7. ENIAC programmers

There was another problem that I solved on the computer ELIOT possessed by the Transportation institute in Beograd. The problem was financed by a European railway institution, through the Transportation institute. Professor D. Juric from the Faculty of Mechanical Engineering and academician M. Vukobratovic were engaged for setting up the problem, and I was supposed to write the corresponding programs [11]. The problem consisted in calculating corrections that were to be carried out on coaches in order to move faster. What made me remember this work was complexity of the mathematical model. The problem has been formulated by 28 differential equations. Of course, program execution lasted very long. So we used to start running programs in the evening, and collected results in the morning.

At mid-70-ties, Sensitivity theory was actual in problems of automatic control [8]. At that time a paper of mine was awarded as the best paper in the field of automation at the ETAN conference. The paper is interesting because I used analytical methods on digital computer for analysis of mathematical models in the Sensitivity theory. For a given mathematical model of a system, partial derivatives of the model over desired parameter is first analytically determined using computer, and then numerical computation is performed [30].

At the end of 60-ties, graduate studies began to get organized at faculties. So I enrolled graduate studies in 1959 at the Faculty of Electrical Engineering. There was couple of students, mostly electrical engineers from the Vinca Institute. We took the exam in Servosystems from professor D. Mitrovic. At the end of the exam, professor said that all of us did well and passed exam with the mark 9, then he changed his mind, took my index and revised mark 9 into 10. He explained that all the other students were electrical engineers and similar contents had at undergraduate studies, but I did not. At the beginning of 60-ties, when Vinca obtained a project for preparation of building nuclear power plant, professor Mitrovic involved me in the team working on problems of automatic control for nuclear power plant needs. He explained that by saying that the job we were beginning to work on, no one ever did, and that he was convinced, knowing me from graduate studies, that I was capable of doing well even what I had never before. My topic was "Mathematical model of nuclear reactor for the needs of automatic control simulation". I considered it a big obligation and diligently worked on the topic for several months. Unfortunately, professor tragically passed, and work on the project ended soon. I keep this short collaboration with professor Mitrovic in pleasant memories.

My scientific work has always been linked to application of computers. For that work I was accepted in Serbian Scientific Society and New York Academy of Sciences. I obtained the certificate and a letter about acceptance into NYAS during bombing of Serbia in 1999. As I considered then - as well as I do now - Americans as the main culprits for bombing, I decided not to accept membership in an American institution.

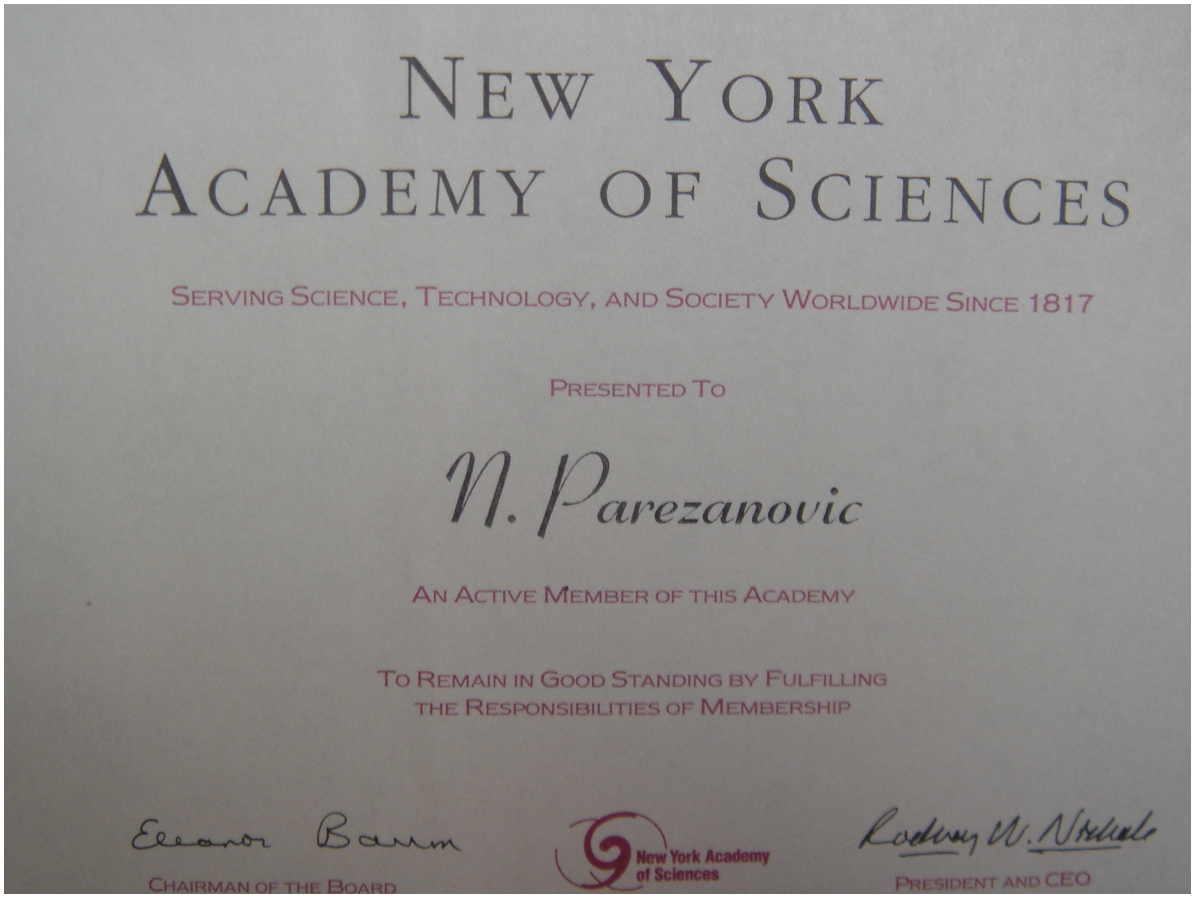

Figure 8. Certificate about acceptance into NYAS

5. Teaching computer science

At the beginning of 60-ties, computer science was a field that had just started increasing importance in practice. A great need for teaching computer science existed, but there were no teaching staff, and there were no literature from the field, either. Courses about computers and programming were given only in companies that started purchasing computers. Courses were taught mostly by foreign instructors, or our people previously trained abroad. In such circumstances, some graduate programs began introducing computer science courses. Invited by Professor Brana Ivanovic, I taught my first computer science course to graduate students at the Institute of Economics. I had to compose a curriculum not pertaining to a specific computer, but to general knowledge in computer science. My standpoint was that the course should include the following:

- Principles of operation of analogue and digital computing devices
- Organization of a computer system
- Understanding of how digital computers work
- What is system software and
- How applicative software is made.

When it was possible, demonstration of programs on a computer were presented, or students were provided with possibility to make a moderate program and run it on a computer. I taught many courses at different faculties: Economics, Transportation, Civil Engineering, Organizational Sciences (FON), Philosophy, Center for Multidisciplinary Studies, Military academies in Beograd and Zagreb etc. Since 1967 I began teaching computer science as permanently employed at a faculty. At first it was the Electronic faculty, Nis, and then the Faculty of Sciences and Mathematics in Beograd. I realized then that the basic teaching problem was lack of textbooks. So I began writing textbooks for different computer science courses. I wrote 30 books and textbooks, as an author or co-author [published textbooks 1-30]. Some of the textbooks had a number of editions. The book FORTRAN IV, for example, had over 20 editions. For this work I obtained Gold medal from the Publisher of textbooks and teaching tools. One of the problems in writing textbooks was terminology. In order to solve this problem, with a team of collaborators a translation has been made of English Dictionary of Computing, Oxford Science Publication, Oxford, 1985 [41]. In the Mathematical Institute of SANU I initiated edition "Contemporary computer technique", edition "Modular library of computer science" with the publisher "Nauka", and journal "Computer science in science and education" with the publisher "Nova knjiga".

Nowadays, when I think of those courses and lectures at different tribunes, such as Kolarac University, I remember that audience was very variegated, from pupils to retired people. One of the courses I remember especially well. It was the course for professors of the Faculty for Civil Engineering. One day professor Stipanic, who taught mathematics at the Faculty of Civil Engineering, invited me and asked to give a course for their professors. When I came at the first lecture, I saw gray hear of older professors in the room, and I looked like their student.

I felt uncomfortably and decided that my lectures should be concise and without a lot of details. So I commented that except decimal number system we may introduce arbitrarily many other systems, and then explained why we use binary system in digital systems and how we compute in such a system. When I came at the next lecture, professor Stipanic told me that my attendees wanted me to explain in more details computation in binary number system. I saw then that even trivial new things may appear strange even to high intellectuals.

Television was also involved in general education in the field of computer science. For RTS (Radio Television of Serbia) I wrote two series of 16 half-hour shows from computer science each. The first one was called "Racunarstvo" (Computer Science) and it involved play sequences with actors, and the second one was "Programiranje" (Programming) with two students and a host.

At these 60-ties, computer science began to enter undergraduate studies curricula on a number of faculties. At some of them I myself started with first courses, but I decided to choose the faculty I graduated at for my permanent employment. And thus I started teaching computer science at the present-day Faculty of Mathematics in 1969. At first I had no assistants so the Faculty engaged my colleague Bogdan Jankovic from the Institute "Pupin", with whom I had already collaborated in teaching in some industry organizations and institutes. Later, for teaching computer science Dusan Braticevic was engaged as an assistant. Teaching was significantly advanced by computer IBM360/44 installation at the Faculty of Science and Mathematics. It was in autumn 1969. More details about Computer center can be found in D. Vitas article: “About the development of informatics among mathematicians“ (*О развоју информатике међу математичарима*) [*Инфотека*, year 18. No. 1, June 2018]. Computer was purchased for the Mathematical Institute's needs, but it was installed at the faculty and agreed upon being used for students training. I was a Head of the Center for several years since it had been established. My students worked as programmers in the Center. We collaborated with many institutes and organizations. Through this collaboration and application software development, I also wanted the employees to recognize problems for their scientific work. Most of the employees did find topics for their master (6) and doctoral (5) works. Depending on the problem, some of them defended their doctoral theses at the corresponding faculties, such as Faculty of Civil Engineering or Faculty of Mining and Geology. Good applicative software can be developed only with full understanding of the problem to be solved by the software and, if possible, even more, which means to make original contribution in problem investigation. This way programming is a powerful stimulus in professional and scientific work. In my opinion, programming has not been used enough in contemporary education. Educational value of mathematics in problem solving cannot be denied. Programming, on the other side, except for solving problems, also requires good settings of the problem, the educational value of which is equally important as solving the problem, if not even more important.

For teaching computer science it is necessary to have equipment for students to test their programs. For these needs, the Faculty had a precious help from the Center for multidisciplinary studies headed by Professor Zvonko Damjanovic. When a card system, as IBM 360/44 was, became overcome, the Center provided for installing the computer with larger number of terminals for use in students’ education. Apart from this, computer DECLAB 11/40 with AD and DA convertors was installed in my office. This computer was used for graduate studies. I taught for several years at the Center for multidisciplinary studies. This collaboration with the Center was exceptionally interesting and useful. Postgraduates at the Center were mostly physicians. There was an outstanding collaboration with similar centers in London and Moscow. Professors from the Chelsea College in London and professors from the Moscow University often were in visit. There were common seminars handling applications of computers in education and scientific work. Results had been presented and they were published later [6, 27, 29, 34-36, 38].

Computer science pierced though as a discipline and traditional disciplines hardly made room for a new discipline. Many considered computer science as fashionableness not to last long. At my faculty it was the same. For a long time, people divided into those who know computers and those who do not. Former kept saying that we cannot without computers, later that we do not need them. Still, after a long time, in 1987 a Department for computer science has been formally established at my faculty, I being the first head.

Figure 9. Computer Science Department at Faculty of mathematics (1996)

Today, this Department counts more than 40 people. At the Faculty of mathematics, for the long time, the number of enrolled students has been the largest at the computer science and informatics modules. Many students of mine work in companies, schools and universities across Serbia, but also all over the world. For many of them I was a supervisor, co-supervisor or member of committees for defense of master (58) or doctoral (26) works.
This was elaborated in detail in an issue of the INFOtheca journal devoted to me [42].

Figure 10. (part of) Computer Science Department at Faculty of mathematics (2018)

For my work in education and spreading knowledge in the field of computer science i obtained two diplomas. The first diploma is recognition for development of multidisciplinary studies in the Center for multidisciplinary studies of the University of Belgrade, and the second diploma is from the Committee for application of

mathematical methods and computers in geology, mining and metallurgy for spreading computer knowledge.

A special honor has been made to me in 2017 by the Department of computer science by establishing annual award for the best student of computer science, named by myself.

Figure 11. Award for the best student of computer science (2017)

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