Computer History Museum

Oral History of Voja Antonic

Interviewed by:
Dag Spicer

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Spicer: Welcome today, here we are on August 17, 16th sorry, 2017 with Voja Antonic, the inventor of the Galaksija.

Antonic: Galaksija Computer.

Spicer: … computer, a famous computer in the former Republic of Yugoslavia. Thank you so much for being with us today and for bringing along a Galaksija for us to look at as well.

Antonic: Oh, it's my pleasure, thank you for inviting me.

Spicer: So tell us a little bit about how the idea for the Galaksija came about and a bit about its early history.

Antonic: About the early history, well, I think that the first beginning of computer history in Serbia was at year 1960. When we had our first computer, its name was NAR, N-A-- oh no, sorry, it was CER, C-E-R, C-E-R-10. It was the computer which was produced completely in Serbia and it was developed in Serbia by Serbian engineers. It was developed between 1956 and 1960 and at that time, there were only six countries in Europe which had their own computers: Poland, France, Great Britain, Russia, Germany and Yugoslavia. I said that I live in Serbia, but it was actually, we were a republic in former Yugoslavia. After that the borders have changed and now I lived in Serbia maybe about one month ago and I moved to US.

Spicer: I see. Welcome.

Antonic: Thank you. Thank you. And that computer, that was-- I was talking about [the] CER computer from 1960, it was developed in Vincha, it's a part of Belgrade actually, and it was created… but I don't know whether there was some tens of thousands of electronic tubes, transistors and relays and so on. But it was a computer which was actually operational and it was working very well. I know one interesting fact from the history of that computer, when at that time there was a war between Israel and Egypt, was it Egypt?

Spicer: Is this '73?

Antonic: Seventy, yes-- no, it was '60s.

Spicer: Sixty-seven maybe.

Antonic: Maybe.

Spicer: Yeah.

Antonic: Yes, it's possible, yes, '67.

Spicer: Right, the Six Day War.

Antonic: Yes. And some message… some encrypted message was decrypted by that computer and President Tito, who was the president of Yugoslavia, he sent a special messenger by plane who took the decrypted message to President Nasser. There were some political games at that time, I don't know anything about politics because I'm not interested in it, so please, sorry if I made some mistake. But that was the proof that computer could do the job of course. After some time there was a wide range of CER computers which were developed from that computer. Then I know that there was, after CER <inaudible> there was CER-20, 30, CER-200, 202, 203, and the whole family of computers which were based on that first one.

Spicer: And in what market were these computers headed, was it process control or consumer or business or science and engineering… who used these computers?

Antonic: I think that the range was quite wide, military, banking and science, I think so, it was used predominantly in Yugoslavia, in former Yugoslavia and in Russia, it was sold to Russia also.

Spicer: Okay.

Antonic: But I don't know too much about it.

Spicer: Tell us about the state of computing in Yugoslavia in the '70s. Before the Galaksija, what kind of people used computers? Could you go to university and become a computer scientist, for example? How widely used were computers?

Antonic: Well, I did not know too much about computers in the '70s, especially in the early '70s. At that time, there was not even the term 'computer' in use in Yugoslavia. I guess that almost nobody knew anything about computers at that time, the legal term at that time was 'electronic brain.' If you mentioned 'computer' to anyone at that time, hardly anyone could tell you what is a computer. So I guess that it was used predominantly in banking and some institutions that-- I didn't know anything about them at that time, maybe some special purpose which is not available to the people, to the public to that time.

Spicer: Right, military or something.

Antonic: So it was something like magic to me when I was reading about it, but even in elementary school, I was learning some concepts. Of course, at the time I couldn't connect them with computers but I was experimenting with transistors at that time because transistors --they were germanium transistors then -- and you couldn't buy them in Belgrade. I lived in Belgrade, you couldn't buy them there, but [you could] in Zagreb. They were produced in Serbia but you could buy them in Croatia, I don't know why. I had to travel to Zagreb to buy germanium transistors, I remember they were AC 540 and AC 541, the first transistors which I bought in Zagreb, it was in the street Frankopanska, there was a special shop, the only shop where you could buy transistors. And when I was in Zagreb a few years ago, my friends took me to the same shop, which is still there. <laughs>

Spicer: Oh really.

Antonic: You cannot buy germanium transistors now. But it's the same shop, the same place, I couldn't believe, for so many years.

Spicer: Wow, that's amazing.

Antonic: Yes, I was so excited to see that. Well, I bought those transistors and I experimented with them, so my lack of knowledge in electronics made me think about the digital approach only, so you don't have to know too much about electronics to use it for digital circuits. So the first thing that I invented was a flip-flop. I really thought that I invented it, it was a circuit which has two possible states with the same hardware and it was just like magic to me: nothing has changed, not a single molecule moved, but it has another state, it was just like magic to me. So it was my very early age, I was in elementary school and I didn't know that that's something that's so important. I thought that I was inventor then but of course I didn't know that it was invented long ago.

Spicer: Well you invented it on your own, which is quite remarkable, and to play with transistors when you're in elementary school is amazing.

Antonic: Yes. After that I built my first circuits with transistors, digital circuits, first digital clocks with Nixie tubes of course, and so on. But I still couldn't get it: what is a computer? how it works and where is the catch about computers? It was very hard to me. So once I got a very interesting book about just the Z80 [microprocessor], it was the time when the Z80 appeared. I think that it was year maybe '76 or '77 when the first Z80 microprocessor appeared on the market and I've got some book about it, programming instructions. I remember very well that moment when I opened the first page of that manual, actually I saw the first instruction load data from one register to another register and at that moment, everything became clear to me. I remember very well that I was so excited, I couldn't sleep for a whole night after

that, everything was clear to me: what a microprocessor is, how it works, why it works that way, how you can do the program which does something significant. And not only that, at that moment, it was also clear to me how I can make my own microprocessor, <laughs> which is really, I know that it's strange when I say it that way but I really remember that moment very well.

Spicer: Your own computer, or your own microprocessor?

Antonic: Microprocessor, from the beginning. Of course, Z80 microprocessors were very expensive at that time, I ordered two of them from U.S. and [while] waiting for them to arrive, I made my first EPROM programmer, which was a very strange concept without a microprocessor, of course. Later, some people asked me, "Why didn't you-- wouldn't it be more simple to do it with a microprocessor?" But I said, "Yes, but who will program that EPROM for that microprocessor to work in that programmer?" So I made a programmer, it was a very painful way to program the EPROM, you had to turn some knobs, some buttons and to watch the display in octal code and to press some buttons just to program one byte and then turn, program in the next byte, and so on. Of course, I didn't have an assembler, didn't have a computer at that time, I had to assemble the program manually on paper and that was really painful. But I didn't know at that time that there are some better ways, some more comfortable ways to assemble the program, so I was just satisfied with it.

Spicer: I'm curious about you importing parts from the West, was that very difficult or was it pretty easy?

Antonic: Yes, it was very, very difficult, it was very difficult. I had to go to Germany because it was not so far from Yugoslavia, I went to Munich and then I had to smuggle the parts because such was the law, you couldn't important anything which is more expensive than 50 Deutschmarks at that time. Of course, when you are going so far, 1,000 kilometers, you are not supposed to bring just goods in that value, you have to bring some more chips and then the electronics, electronic components. And so I had to be a smuggler at the beginning.

Spicer: Now the Deutschmark was very strong at this time, wasn't it worth about a dollar roughly US?

Antonic: Yes, I think so, but still 50 deutschmark was not enough…

Spicer: No, of course not.

Antonic: …to start creating anything.

Spicer: Yeah. And to that end, I'm jumping ahead a bit here but I know the Galaksija when it first came out, was 30,000 dinars?

Antonic: Dinars, yes. I don't remember exactly the price. I think that the parts for Galaksija were about 240 deutschmarks, the same value in dinars.

Spicer: Okay, yes, so I meant to ask, how much was a monthly wage at the time?

Antonic: I'm not sure about it actually.

Spicer: Like if you wanted to buy a Galaksija, would you have to have a pretty good job to be able to afford that or could a student buy it?

Antonic: Well I think that you could buy it with maybe one half or month's salary.

Spicer: Okay.

Antonic: Yes, yes, I think so. But actually it was not the first computer that I built.

Spicer: Okay, sorry, go back, tell us.

Antonic: Yes. There were several of them. The first computer which I bought actually was the TRS-80, it was ordered from the US and again, I couldn't just import it, so I asked my friend from US to send me in two packages, it has some flat cable between PCBs without connector, it was soldered to those PCBs and they had to cut that cable with scissors and they just couldn't believe that they have to cut it, they will destroy, I said, "Don't worry, I will repair it."

Spicer: Yeah, yeah.

Antonic: Somehow it arrived as technical dump <inaudible>, so garbage, technical garbage and I paid no custom tax for that.

Spicer: Oh yeah, so they probably saw the cut cable and thought, "Oh, this must be garbage."

Antonic: Yes, sure. And it was split in two packages and I got those two packages maybe in one month between.

Spicer: So that was a TRS-80 model?

Antonic: Model two.

Spicer: Model two.

Antonic: Two, yes, it was Level II BASIC, was it a model two or-- I don't know, it was a Level II BASIC and that's it. Then after that, I started building my own computers, I learned a lot from just disassembling the firmware from that computer, it's basic and I learned a lot about making the operational system concept for the computer. So I made my first computer after that, then I made my text editor, which was in its own hardware. So I started just producing those computers, different computers for different things. And one of them was actually the graphical working station, is it correct, to do the computer animation because I started studying film editing in film school in Belgrade, it was [at the] faculty of dramatic arts, I think. And I was interested in film at that time and movies and I made my first graphical workstation for computer animation at that time. I've never seen how it looks, there was no 3D rendering software at that time, but somehow I made it and it was of course the special hardware for it, it was with the graphic resolution 300 by 400 pixels with, it was gray scale with eight levels of gray. Because I didn't have the color monitor at that time, so there was no sense of making the color graphical unit.

Spicer: What was the microprocessor?

Antonic: The microprocessor was a Z80H which was faster, it was six megahertz. I made the software in the BASIC language so it was very, very slow. But the concept of that software is actually equal to the concept which today's 3D rendering software uses but only in wireframe mode, I had an object which was defined in space with three dimensions and the camera with a defined position, angle, field of view and so on. So I made my first shot of that computer animation in year 1979, 1979 and I took the first shot, it is on YouTube now, that shot, it lasts only six seconds.

You know how I made it, of course there were no hard disks and no mass data storage system, so I took one 16 millimeter Bolex camera from my friend, which works on TV, and that camera had a single step mode, single shot mode, single frame mode and I made the solenoid which can shoot one frame by frame when computer gives it a command to make one frame. So I put that camera in front of the monitor, monochromatic monitor, green monitor and to avoid that annoying noise, I made some wooden box over it, it was maybe one meter and a half, it was quite big so it looked to me just like coffin <laughs> but it prevented me from that noise because it took maybe one or two minutes for one frame to let BASIC draw

all pixels in the wide frame mode. And then the big solenoid was activated which was pretty noisy and then the computer just deletes the whole frame and starts drawing the new one.

Spicer: Were you pursuing a career at this time or were you studying?

Antonic: I was just studying.

Spicer: Was this a hobby or…

Antonic: It was a hobby, yes. Actually, yes, it was a hobby at that time, I was just studying, that's all. And then I took that film, that footage, to my professor Marko Babac and showed it to him. We saw that shot and he was really shocked, he never saw some picture which was created by computer and this was a moving picture also. So he asked another professor, Nikola Majdak to see it and they were both really shocked and they said, "Will it ever be possible to model and animate the human figure, the human figure?" And I said, "No way, there's no way." It was year '79.

Spicer: Yes. Interesting. And so did anything happen with this machine, was it commercialized or was it just an experiment?

Antonic: No. It was never commercialized, its fate was just like with all my other projects, I needed components to start building another project so I had to disassemble it and so it was ruined and just dropped. So I have only one very, very short TV shot which I found on YouTube where at one moment that graphical working station is visible, just a part of it, but I keep it just as a relic.

Spicer: Yes. Very good. What did you work on next?

Antonic: After that, I started working for the company Electronica Engineering in Belgrade and I made several projects for alarm stations which were microprocessor alarms which were also not known at that time, it was maybe year '80 and '81, it was also some new concept to make the alarm station with a microprocessor. And also I made a computer, a home computer which could be, I thought that it will be interesting for them to start producing it and selling it, it was named EL82 and the problem with that computer, maybe it could be commercially successful if we started producing it at the same moment, immediately but unfortunately, they thought that there is plenty of time, "Now we have a computer, it's our computer and we can wait and make the tactics as we wish and we shall see what we shall do with it." So the time has passed and it was obsolete of course. It was rather complicated, heavy and expensive and my next idea was how I can make it simple and cheap, and that's how the idea for Galaksija was born, just as simple and as cheap as possible.

Spicer: I wanted to ask you: at this time, the Galaksija came out I think it was seven years after the Altair, is that about right?

Antonic: Yes.

Spicer: So would it have been possible for people to import an Altair themselves or was it just not allowed or too expensive?

Antonic: You see, in those conditions, we were all masters of smuggling unfortunately, but that's the truth. And most of those Galaksija computers that were built, were built actually with smuggled material components. There was some organized selling of material but it was also halfway in the crime because such was the law, everything is forbidden, you cannot do anything and I cannot explain that but it's really hard to understand but it was so, if you want to do something, you're against the law, that's it.

Spicer: And yet it was okay for you to sell the machines once they were assembled.

Antonic: No. I didn't sell anything.

Spicer: Not you personally, but just as a kit, people…

Antonic: If you are a company then you can sell but if you are a person… , then you cannot sell anything.

Spicer: Right. So tell us about the story in that magazine that introduced the Galaksija and what happened, I'm very interested in how the magazine and the computer worked together to make this. I think there were over 8,000 Galaksijas sold, so it was pretty popular for…

Antonic: Yes, I was shocked to hear that number also. You see, I built the first Galaksija computer just to see how simple it can be and still work, and it worked fine and it was simple and I said, "Why wouldn't I just publish it somewhere as the do it yourself project and let anybody wants make it with his [own] hands, why not?" But there was not such a magazine which could accept it. Luckily one of my friends said, "There is a new magazine which will be started, its name is to be "Computers in Your Home." Actually it was the first name of that magazine. And the first issue should be released at the end of year 1983 and it was just maybe six months I had from that moment when I made the first sample of Galaksija computer and I said, "Well, I'll try, I'll talk with those guys, maybe they will accept it to publish that do it yourself project."

Spicer: You mentioned earlier that computers were called 'giant brains,' how would you say that in your language?

Antonic: They were called electronic brains, elektronski mozak, yes.

Spicer: And so not computer. Electronic brains they were called.

Antonić: They were just computers, but we didn't have that term in '60s.

Spicer: Okay <inaudible>

Antonić: When you look at the press from that time, you will see only the term "electronic brain."

Spicer: Right, but once the Galaksija came out, you would work on computers.

Antonić: Yes, yes, because at the late '70s, the first computers started, and then the term "computer" was legal--

Spicer: I see.

Antonić: In Serbia that time. So we imported that term together with the first computers.

Spicer: I want to dig a little bit into the technical aspects of the Galaksija. Tell me first of all about the circuit board. It was a single layer circuit board.

Antonić: Single layer, yes.

Spicer: Did you have that made in Yugoslavia, the board?

Antonić: Yes, yeah, sure. The first boards, I made them myself by hand, not by chemical process but by hand.

Spicer: Really? Wow.

Antonić: And just cutting a foil with the art knife, <laughs> so I <inaudible>

Spicer: Yes, and drilling holes, too, right?

Antonić: Yes, and drilling holes by hand, of course.

Spicer: Oh, wow. It's very difficult.

Antonić: Yes, it takes a lot of time. So those guys which were preparing the first issue of that magazine were actually-- they were very, very happy <laughs> when they heard about that idea. They said "Yes, we should all do it," and then from that moment on, everything was easy. I was just finalizing my original firmware for that computer, so the concept for the hardware was my original concept, so I wanted to introduce my original concept for firmware for operating system and BASIC language, and I did it. But the only thing that I was not familiar with and I didn't know how to do it was arithmetic, floating-point arithmetic, so I had to steal it somehow from level one BASIC, and I did it. <laughs> So the arithmetic in Galaksija was actually stolen, but everything else was my product.

Spicer: And so this was basically a construction article in the magazine, right?

Antonić: Yeah.

Spicer: People would read it. It would explain how to build it--

Antonić: Yes.

Spicer: How to run the software. And you personally programmed all the EPROMs, I think. Is that correct?

Antonić: Not all, but a lot of EPROMs, I had to build my own EPROM programmers which could program five EPROMs at a time. Five EPROMs, because I had five zero insertion force sockets. And it was pretty fast. I've got those EPROMs in envelopes, so I had to unpack them to put them in the programmer, program them, pack them back, and somebody from "Galaksija Magazine" sent them back to those guys.

Spicer: Right. Were these 2708s?

Antonić: They were 2708 and 27-- no, 2716 and 2732.

Spicer: 16. Oh, okay.

Antonić: 2716 was the character generator, and 2732 contained the firmware., So the whole firmware took only four kilobytes at that time.

Spicer: Wow.

Antonić: After that, I made an extension to that firmware. It was "EPROM B" with some more arithmetic functions and [an] assembler and disassembler, and so on.

Spicer: What kind of peripherals could you attach?

Antonić: Well, you had the universal parallel bus, and you could attach anything you wish to it, so it was open for--

Spicer: Expansion.

Antonić: Expansion, yes.

Spicer: I think you added the B model ROMs, [which] accommodated a printer as well, I think? Is that right?

Antonić: For printer? Oh, I don't remember. Yes, I think that it was you could list your program with printer. Yes, you are right. You are right.

Spicer: So what was the most surprising thing for you about the Galaksija?

Antonić: The reaction and the number of built units. When we prepared it, the author of the first issue of Galaksija was Dejan Ristaonvić, my friend, which I met when we had to start preparing that first issue. And so there were actually just two authors at that time. It was Dejan and me, and the editor for that first issue was Jovan Regasek. There were just three of us which actually did the first issue of that magazine. And when we finished our job and waiting for the press to release the first issue, we were sitting and having a little rest after such huge job, and Jovan Regasek asked "How many readers will build this computer?" And I said "I think that it's the time and optimist, but I would be very happy 50 readers <laughs> build this computer."

Spicer: Wow.

Antonić: And then Dejan said "Oh, no, I think that there will be 200," and Jovan said "Oh, no, don't be fooled. There will be 500," <laughs> and we said, oh, no, that's too much. But only one month after that, we got 8,000 letters of readers who made it and who just successfully made it, and it was working. It was incredible <laughs> for me.

Spicer: Wow.

Antonić: And so we estimate that there were about 10,000 of people who do it with their own hands.

Spicer: Do you know what kind of people these were? Were they young? Were they old?

Antonić: I think that there were predominantly young. Now I still get letters and emails from those people from all around the world and who say "You changed my life <laughs> with that project"--

Spicer: Yeah, nice.

Antonić: And so on. You can imagine about that, because they just made it with their hands and it worked, and it was just like magic for them. So I see why they just accepted it as their profession and they just fall in love with <laughs> that.

Spicer: Right. Did you have any competitors at the time?

Antonić: Not at the time, but maybe one year after that, there was a lot of competition.

Spicer: Was that the Lola 8 and---

Antonić: I beg your pardon?

Spicer: With the Lola?

Antonić: The Lola 8, there was Orao, which means 'eagle,' Galeb, which is 'seagull,' Pecom.

Spicer: Oh, yeah, Pecom.

Antonić: Yes. But most of those computers were just clones of Apple computers and some other computers, but all of them were actually clones.

Spicer: Like a Sinclair clone maybe or something?

Antonić: There was no Sinclair clone at that time.

Spicer: No? Okay.

Antonić: But mostly Apple clones, Apple II clones.

Spicer: So one of the really interesting things about your computer, the Galaksija, that I want to chat with you about is the distribution of software over radio.

Antonić: Oh. Oh, yes, yes.

Spicer: That is really interesting. Can you tell us a bit about that?

Antonić: Yes, sure. Actually, my friend Zoran Modli, who is a famous radio host in Serbia, it was his idea and the idea of Jovan Regasek, who was the editor of the first issue of the magazine. They just got the idea to publish it through the radio, because Zoran Modli had his radio show each week, and he just let--- because at that time, I guess that now I have to say that <laughs> at that time, there were no hard disks. There were no floppy disks. You had to record your software, your program, on a cassette recorder, and it was in the audio range.

Spicer: Right.

Antonić: So they thought that it could be recorded on the cassette just like any other audio recording, and, well, it lasted maybe for one or two minutes for the average program, so you could reload it back from the cassette. But thanks to the fact that it was in audio range, you could also publish it with any other audio media, so Zoran said why not publish it in his radio show? And I was quite skeptical about that. I thought that people would hate it, because it was really annoying sound, not pleasant for listening.

Spicer: Right.

Antonić: But he was brave enough to do so <laughs>, and he published not only the programs, but also he had his electronic magazine like data, not program data but readable data.

Spicer: Oh.

Antonić: So he published his first electronic wireless magazine at year 1983.

Spicer: Ooh. That's really interesting.

Antonić: <laughs> Yes, it's really interesting.

Spicer: So people would listen to his show and with their tape recorders ready…

Antonić: Yes, yes.

Spicer: And then the …

Antonić: And recorded it on the tape and use it to…

Spicer: Record it, yeah. And was it pretty reliable as a method?

Antonić: Yes, yes, it worked.

Spicer: Really?

Antonić: It worked fine.

Spicer: Oh, wow.

Antonić: Yes, it worked great.

Spicer: And was this the station? Was it Belgrade 202? Is that---

Antonić: It was, yes, exact, Belgrade 202, and Studio B also.

Spicer: Studio B, yes. Do you know of any other people that were doing this, distributing software over the radio?

Antonić: I don't know. I don't know <inaudible>

Spicer: Yeah, it's very unusual. I think it happened in East Germany as well…

Antonić: This is quite possible. Yeah, really--

Spicer: Because it's a really unusual-- Tell us a little bit about your colleague, Dejan Ristanović, who wrote the article initially about the Galaksija.

Antonić: <laughs> Yes, I owe him so much about that project, because he was actually the person who wrote the first issue of "Computers in Your Home" magazine. He helped me a lot while I was developing the operating system for Galaksija and its BASIC interpreter. We spent a lot of hours together working on it and making the concept, and at the same time, he also wrote his articles for that first issue. And <sighs> if it was a huge success about that do-it-yourself project, it is also his work and his big effort to do so.

So also I should mention Zoran Modli, which was radio host who did a lot of job just to promote computers to his audience, and also Jovan Regasek, which was the editor of the first issue.

Spicer: Right.

Antonić: Those several men started a computer revolution in Yugoslavia.

Spicer: Was there a forum or a way for people to exchange software, to share software?

Antonić: I think that most software was actually sold, so I remember that I made a lot of programs, and when I-- mostly through Zoran Modli's radio shows, it was displayed to the audience. After that, it was somewhere on the market, and you can buy it. I could buy it my own software <laughs> also from--

Spicer: Right. Did the magazine that first introduced publish software in later issues?

Antonić: <sighs> Well, yes, but something happened with that magazine. It just slowed down, and after some time, it just stopped. That magazine was dead after just a few years, but some other magazines took the same audience, and they just continued. Some of them even are active today.

Spicer: At the time, could you get Western magazines like "Popular Electronics" or "Byte" magazine or any of those?

Antonić: You could buy them. You could get them from the US, but not much. Not much the samples were in Serbia at that time. I was lucky to use those magazines, because my friend Zoran Vasiljevic had a lot of "Byte" magazines, "Byte" predominantly, and I could use them. Somehow they always came to me <laughs>, and so I had a nice library of "Byte" magazines, a nice archive of "Byte" magazines, and I learned a lot from those magazines.

Spicer: So just to recap, you had no formal training in engineering. Is that right?

Antonić: No.

Spicer: You just learned it all yourself? I think that's amazing.

Antonić: <sighs> Yes, it's another story with me. First you have to understand the political situation in former Yugoslavia. It's really not so easy to explain that. My wish was just to study electronics, of course. And when I finished my elementary school and had to start secondary school, I just wanted to go to the school, Nikola Tesla, which was for electronics exactly. But somehow, I could not pass the exam, and I could not start learning electronics in that school. I really don't know how that happened, because there was some exam at the beginning. I'm sure that I did it perfectly, because it was predominantly mathematics, that exam, and one year before that, I won the contest in the whole of Yugoslavia. I was the first in Yugoslavia in the physics and mathematics contest.

Spicer: Oh, my gosh. Wow.

Antonić: Yes, and I still have the golden medal from that contest. And can you imagine that just on the next year I couldn't pass the exam to learn electronics, which I wanted to learn?

Spicer: Yeah.

Antonić: I have the answer what happened, actually. I heard it later that those men who had just to check all those exams, they just didn't do that. So they randomly took some number of students, and they just declared that they passed the exam, and we, the rest <laughs>, just were cut away from it.

Spicer: Cut off, yeah.

Antonić: Yes, I couldn't do anything about it, so I learned some other school, which was for machine-- how shall I say that?-- the machine school.

Spicer: Right.

Antonić: But it was not the school that I wanted to learn about, and after that, I could not study electronics faculty, because just my rating was not so good for that. So <sighs> I have to self-educate myself somehow, and that's what I was doing for my whole life after that. That's it. <laughs>

Spicer: That's amazing. Wow.

Antonić: Yes.

Spicer: You've accomplished a lot.

Antonić: Yes. After a lot of time, after year 2000, I'd started also my own battle against the-- ha, that's another field, completely another-- against the self-prophets, astrologists, clairvoyants and so on. We had a lot of them during the wartime in '90s, and I wrote several books about that, and those books were very popular in that time, and I was invited to TV shows and radio shows also. And I just was talking about critical thinking and creative thinking, and it was interesting for some schools, and many secondary schools, predominantly secondary schools, invited me to talk the same thing to their students. And once I was in the same school that I was refused one <laughs> from, and I was talking to their students, and they knew that-- they just followed. I had a whole lot of my projects at that time. I published more than 50, I think about 100 do-it-yourself projects.

Spicer: Wow.

Antonić: And those students in that school, just after my talk at that school, said "Well, we love your projects, and it's really nice, everything about it. But why didn't you study our school?" <laughs> And then I tell them, yes, I wanted, but I couldn't <laughs>.

Spicer: Yeah, painful question.

Antonić: Yes, it's very painful. Everything about that, even when I think today about it, it's painful.

Spicer: Oh.

Antonić: But who knows what would happen? Maybe it's not important at that time.

Spicer: Yeah.

Antonić: Luckily, everyone who really wants to learn about something, he can learn about it, even before internet and especially now when we have internet.

Spicer: Right, right.   Was there anything else you wanted to talk about?

Antonić: I'd like to talk about the '90s.

Spicer: Sure.

Antonić: In that decade, we had a bloody war in Yugoslavia when Yugoslavia disassembled, and then we had state. Now we have Serbia, Croatia, Slovenia, Montenegro, Macedonia, and Bosnia. It was a very <sighs>, unhappy time. It makes me sad to think now about that time. It was a time of great poverty, death, war all around you, and everything was somehow going down at that time. At one moment, I had-- it was in year '95. After some tragical [sic] events in my family, I had to move, to leave the flat that I was in in only three days, and I had somehow to do a lot of things. I left alone with my son, who was less than two years old, and I had to move somewhere; I didn't know where. And at that moment, I just didn't know what to do with all my prototypes of Galaksija computer. I had six or seven of those prototypes.

Spicer: Right.

Antonić: And I just throw out all them in the garbage, so we don't have them now. <laughs>

Spicer: Right

Antonić: Sorry to say that.

Spicer: Oh <inaudible>

Antonić: I'd like if I didn't do it, but that's just what happened.

Spicer: That's in the past.

Antonić: Yes, and after that, I wanted just to start something new. I made one very handy instrument with a-- I started working with PIC microcontrollers, Microchips' controllers, and I made a very, very simple instrument, which is a handheld instrument, which is at the same time a logic probe and a logic analyzer and analyzer for serial protocols and some other functions that were in only one handheld battery operated, single-chip instrument. And the most amazing thing was that the whole firmware was packed in only one kilobyte of firmware.

Spicer: Wow.

Antonić: And I sent an email to the people at Microchip, and they said, no, we cannot believe that all those functions can be packed in only one kilobyte. Can you send us a sample of that instrument? I sent them a sample, and they said "That's really amazing. You should write an article about it. You have to build some five more samples to send us. We shall use it in our conferences just to show what is possible to do with the single microcontroller," and so on, so on. They also offered me to be a consultant for that area, and in return, they just asked me how much it will cost. I said "I don't need money. I need your in-circuit emulator system." They said, okay, that's all fine. I did that article. They published it as an application note, I think 689 application notes, AN689, at Microchip's site. And when time has come for them to send me that development system, they said "Evidently you are under embargo, and we cannot send you anything. We cannot communicate with you anything, and--"

Spicer: Oh.

Antonić: "And hopefully some better times will come, and goodbye." <laughs> That's all. It was also sad for me.

Spicer: Yeah.

Antonić: I got that in-circuit emulator some eight years after that, which was not significant to me anymore at that time, but all the same, I can understand why they didn't send me that. But <sighs>

somehow, everything that I started in those 10 years just didn't finish well. Everything was going down then, and each project finished in the same way. So after that-- when I was invited to do war by the army and how computers saved my life. <laughs>

Spicer: Oh, really?

Antonić: And there is one more thing about those tragic '90s. War was all around, and once I've got just the letter from the army where they invited me just to join the army, and <sighs> what could I do? I just packed <laughs> and just went there, and we had a few days of training in some small place around Belgrade. And at one break time, the officer asked everybody what he's doing at his home, what is his job? And when he asked me, I said him that it's something about computers. I didn't know how to explain it to him that I'm working with just embedded microcontroller projects. I said it's about computers, and he said "Oh, we have an Apple II computer which is broken, and no one could--- she's broken for years, and no one could repair it. Can you try?" And I said "Yes, but I cannot do it here. I can do it at home." And they drove me home with that computer, and of course I repaired it and came [back] the other day with that computer, and it was working perfectly. And at that moment, the officer came to me, gave me my ID and said "Now go home. That place where we are going is too dangerous, and we need you alive. Who knows when this thing will be broken again? So we need you. Go home--"

Spicer: Wow.

Antonić: "And be ready," and that was it. <laughs>

Spicer: Wow, that was close.

Antonić: That was it, yes, and then no one ever asked me about that-- nowhere ever contacted me about that computer anymore, so I don't know what happened, and I don't want to know it. <laughs>

Spicer: Right. Anything else you'd like to say?

Antonić: I think that that's all <laughs> about that.

Spicer: Yeah, well, I think this is been a great interview, and I thank you so much for sharing the computer Galaksija with us and for donating it to us. That is really wonderful.

Antonić: Oh, thank you. It's a great honor for me really.

Spicer: Oh, the honor is ours, believe me.

Antonić: Thank you.

Spicer: Thank you so much.

END OF THE INTERVIEW