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"COMPUTERS IN YOUR HOME" DIGITAL REBUILD: REVIVING THE START OF THE PERSONAL COMPUTER REVOLUTION IN FORMER YUGOSLAVIA

Abstract. "Computers in Your Home" ("Računari u vašoj kući") is the issue #1 of Computers ("Računari"), the first personal computer magazine in former Yugoslavia. Published in December 1983, "Computers in Your Home" compared the first personal computers available on the market, introduced the readership to the BASIC programing language, but also presented the home computer Galaxy (Galaksija), with the detailed instructions on how to build it. The publication was very successful on the market, it was reprinted several times, selling close to 100,000 copies, and the Galaxy computer was built by more than 9,000 readers. Almost forty years later, the attempt is being made by PC Press publishing company to digitally rebuild this publication, as well as the Galaxy computer itself, using modern technology. The idea is not to just reprint the publication, but to prepare it from scratch, using digital photography and modern-day typesetting, to make the publication which looks just the same in terms of content, but much better in terms of technical quality, thus preserving the unique digital heritage for the future

1. Introduction

In the early 1980s personal computer revolution was mounting up in the western countries. With the introduction of first personal computers, like Apple II, TRS-80, and Commodore 64 in the USA, Sinclair ZX81, and Acorn BBC Computers in the UK, the first personal computer magazines, like BYTE, Dr. Dobb's Journal, and Personal Computer World were becoming important and well-sold publications. Many amateurs strived to learn programming in BASIC computer language, and talented BASIC and assembly language programmers were able to start small software companies and successfully sell original games and utility software [1].

In the former Yugoslavia little was known about personal computers [2]. Individuals were forbidden to import anything costing more than 50 DEM, so it was impossible to legally purchase even the cheapest personal computer. Computers were still smuggled across the border, but some of their owners lacked detailed information on how to use them.

The popular science magazine Galaxy ("Galaksija") is one of the few periodicalsin former Yugoslavia that, since January 1981, had a regular column dedicated to personal computers. The first articles were about the programmable calculators TI-59 and HP-41C, and soon the programmers' club was founded and the library of more than 400 programs written by domestic programmers was assembled

[3]. Encouraged by the interest in this topic, the editors of Galaxy magazine decided to prepare an independent publication, a special issue entitled Computers in Your Home ("Računari u vašoj kući").

2. Computers in Your Home publication

The publication was prepared during the second half of 1983 and published on December 24, 1983. The cover date is January 1984. It consists of 100 pages divided into 8 chapters: "Introduction", "Choosing the personal computer", "Peripheral equipment", "Commercial software", "Computer books and publications", "Galaxy computer", "The art of programming", and "Do you speak BASIC?". A 32-pages booklet about Galaxy BASIC wasincluded with each copy of Computers in Your Home. Most of the publication was written by Dejan Ristanović, with the section on the Galaxy computer written by Voja Antonić. The editor of the publication was Jovan Regasek, and the publisher was BIGZ, the large state-owned publishing and printing company.

The publication was very well received by the market. The initial run of 30,000 copies was sold within a week, further 30,000 copies were sold as well, and additional print was made later that year, for a total close to 100,000 copies. Other media published articles about personal computers, authors of the Computersin Your Home were often guests in radio and TV programs, and even the federal government in late 1984 revised its strict policy by allowing the import of low-cost personal computers. It was widely accepted that computer skills should be the literacy for the 21st century.

From this publication grew the magazine Computers("Računari"), which was published by BIGZ until 2000. Other computer magazines followed, such as My Micro ("Moj mikro") in Slovenia. The computer revolution in former Yugoslavia started.

3. Galaxy computer

Besides the articles about early personal computers, the publication Computers in Your Home [4]contained something special - a complete project for a self-build computer Galaxy ("Galaksija"). The computer was constructed by Voja Antonić, using standard electronic components - Zilog's microprocessor Z80A running at 3.072 MHz, 6 KB of static RAM, and 4 or 8 KB of ROM. By using software-supported video-signal generator, the constructor allowed the computer to have only 20 chips and a single-layer printed circuit board, convenient for the self-build project. The originally written BASIC interpreter contained 4 KB of heavily optimized Z80A code, and enabled the writing of moderately complex BASIC programs, with support for floating point numbers (trigonometric functions were provided later), alphanumeric strings and 48*64 block graphics.

Readers of the publication were able to legally purchase the motherboard, the keyboard, and passive components in Yugoslavia, and to order integrated circuits from Austria, packed in multiple shipments so that each shipment does not exceed the value of 50 DEM. The system software was provided for free and written to EPROMs by Mr. Antonić. With the effort to solder the chips and assemble the case themselves, readers were able to legally own a useful small computer.

The interest for this project was very strong. More than 8,000 readers of the publication ordered the motherboard, the keyboard and other components from the Galaxy editorial office, and a certain number of them independently produced the motherboard. The estimation is that about 10,000 Galaxy computers were self-build during 1984 and 1985. The project was purchased by Elektronika Inženjering company, and Galaxy computers were also produced commercially. Each school in Belgrade

received a Galaxy computer, so the total number of users is hard to evaluate. There was certainly enough of them to produce high quality programs for the Galaxy computer, written in BASIC and assembly language. Most of these programs were games: "The Castle", "Jumping Jack", "Game of Life"... to name just a few of them. Even the chess program was available for purchase.

4. The longevity of the project

Computers in Your Home and, especially, the Galaxy computer attracted the attention of the public much longer than it would be expected from a single publication and a small computer that was soon surpassed by much more powerful PCs. A lot of readers found their profession by reading this magazine and assembling the computer, so they talked a lot about it in the years to come.

The main on-line forum for exchanging ideas and opinions about computers and many other topics in the nineties, was created on Sezam, the biggest bulletin board system (BBS) in former Yugoslavia. Its popularity was mainly due to original software, that made posting and reading messages easy, and multiline telephone access points (dial-ins) that enabledmultiuser chats and games. Messages on this on-line forum were grouped into conferences and topics. A user could start a new thread of conversation by posting a new message but could also reply to an existing one. Messages that had replies, and thus were part of a conversation thread, are very interesting since it is possible to get from them some insight on how large an impact certain topic had on users. This is possible by using graph analysis and by analyzing social reply-to networks [5].

Magazine Computers had its own Sezam conference with 15 topics that covered broad types of subjects. There was a total of 508 active users that posted at least one message, and the conference was active for more than two decades. This shows how popular it was in technical circles. For deeper analysis, a social network of replies was created that connects users that reply to other users. Results from this project were compared to social network of all messages from Sezam, and there were more than one million of them.

After creation of social network of reply-to relations, it is possible to see that those participating in debates were very active. Out of 508 active users, there were 442 of them that created replies and 4111 relations in between them, giving a 9.1 degree of centrality. This means that on the average one user replied to 9 other users. Comparing those numbers to numbers from other topics, it is obvious that more users were engaged in discussion. Graph of degree distribution is flatter, and it shows that there were less users that created messages in large quantities, but more users that took part in the discussion. Further analysis using natural language processing (NLP) should give deeper insight into this topic.

5. Towards the digital edition

The complete text of Computers in Your Home was retyped by Ms. Ana Marković in January 1997 and is available on https://dejanristanovic.com/rac1/. Pictures, listings, and the booklet about Galaxy BASIC were added later. It was easy to produce a photographic copy of Computers in Your Home, but such an edition would not look good by modern standards. The fans of that edition would feel disappointed to look at it in that form;maybe it is better to leave it to their memory.

The reason for this potential disappointment is that the Computers in Your Home publication, unlike computers magazines in the technology leading countries, was

produced cheaply, printed on low-quality roto paper using poorly maintained, outdated printing presses. The color pictures look pale, offset color plates are misaligned, so everything looks smeared.

While it is possible to digitally enhance the scanned images of the magazine's pages, there are limits to what can be done. Therefore, Darko Staničić in 2005 suggested that the magazine should be produced again, using modern typesetting technology. His idea was to make the publication which looks just the same in terms of content, but much better in terms of technical quality. Later on, the project got supported by PC Press publishing company. The publication is planned for December 2023, to mart the 40th aniversary of the original release.

6. Typesetting the digital edition

Choosing adequate font presented the first challenge. After careful analysis, the basic fonts chosen for the digital reprint are from the Univers Black family (Univers is a registered trademark of Haas sche Schriftgiesserei AG.) for the cover and the articles' headlines, and Helvetica Neue for the remanding content.

Univers fonts were produced by Linotype-Hell foundry and are very similar to the one used by BIGZ in 1983, but not identical to the original. A search for the perfect match eluded us for 15 years, until digital foundries made adequate tools for online research.Helvetica Neue is a standard Adobe Collection font, digitized for modern computer systems by Linotype - the original font outlines are licensed by Heidelberger Druckmaschinen AG. That font is virtually identical to the one used in the original publication and differs only in some technicalities and specifics induced by desktop publishing revolution. For the layout of the running copy, Helvetica Neue Medium in TrueType format was used.

Figure 1. Page 4 of the publication Computers in Your Home, as a scanned original (left) and its digital transformation (right)

Since it was impossible to deduce the precise algorithm for hyphenation used by BIGZ's typesetter, the standard Adobe InDesign hyphenation was used, and after that each line was compared to the original. The differences were corrected manually (Figure 1).

7. Retouching and replacing the pictures

To optimize the process of restoration of illustrations and achieve the maximum possible quality, we need to know where those pictures came from. In the early 1980s the copyright laws in Yugoslavia were virtually non-existent, so images were taken without concerns from the western computer press. The quality of these printed originals was very good, but in the process of scanning, sizing, and printing on cheap roto-paper the quality significantly deteriorated. The originals were not preserved, and there is no information aboutwhich book or magazine was used as a source for each illustration.

As the time passes, more and more old computer magazines are available for free download on Archive.org and other sites. Therefore, it should be possible to locate at least some of the pictures used, since most of them probably came from the magazines published between January and October of 1983. Unfortunately, Google Images was not able to provide any useful assistance, so the slow manual search was the only option. Some of the images were indeed found, mostly in the advertisements published in Sinclair User and Personal Computer World magazines. For all the other illustrations, tedious editing in Adobe Photoshop is the only path to digital restauration.

It was noticed that, ironically, the images that were originally photographed for the publication are of the worst technical quality.Adequate lighting was not utilized during the photo shoots, and the process of scanning the 35 mm slides was not precise enough. It was decided that the photographs on pages 57-62 are technically flawed to such an extent that repair is not feasible. And these photos represent arguably the most interesting part of the publication, the assembly of the Galaxy computer.

It called for a radical decision - to take those photos again, using modern photo equipment. For that, it was necessaryto assemble a new sample of the Galaxy computer, and to emulate each of the 35 photographs as accurately as possible.

8. Re-creating the computer

Since most of the original photos show stages of the hardware assembly, from the gathered electronic and mechanical components to the final prototype, it was necessary to build a new prototype and take images of every phase to be sure they were virtually identical to the originals. Dr Boris Stanojević used high-resolution digital camera Canon EOS 6D with the lens 24-70 F4L and modern lighting to capture the contents. It gave us the opportunity to correct dominant color, vibrancy, and blur. Attempts were initially made to correct the imperfections of the composition and the relationship between objects and the background. This approach was abandoned because, as it turned out, it changed the visual appearance significantly.

From the very beginning of the work, there were a lot of problems concerning procurement of materials. Back in 1983, it was expensive and difficult to get a two-layer printed circuit board, so a single-layer printed circuit board was used. In contrast, today's manufacturers are reluctant to accept the production of low technology printed circuit boards, as the modern standard requires at least two conductive layers, solder mask, silk screen for component marking, and metalized holes in solder joints. It took several chats to help the manufacturer understand why it is important to produce boards using outdated technology.

The next problem was with the ordering of electronic components. Today, the classic digital 74LS integrated circuits are replaced by a wide range of different types of circuits, such as 74AHC, 74HCT, 74LV and the like, but the 74LS chipsare hard to find on the market. The same is valid for memory chips (both RAM and EPROM), as well as

for the Z80A microprocessor itself. These components can only be found at small Chinese Web shops who recycle old hardware and desolder chips from devices. A large number of these components turned out to be defective. A significantly larger number of memory circuits and microprocessors had to be ordered than was initially expected.

Figure 2. Page 58 of the publication Computers in Your Home,
as a scanned original (left) and with re-created new photographs (right)

Camera shooting was performed at two venues. Galaxy assembling and soldering took place in the author's apartment, and all other images were taken at the PC Press (https://pcpress.rs) editorial office. Great care was taken to find the same backgrounds, lighting softness, direction, and tools (which were surprisingly hard to obtain), and even to find a person whose hands look like the original model from 38 years ago. The presence of a large numer of people during shooting paid off as everybody was willing to spot a new detail and offer ideas on how to get images as close to the originals as possible (Figure 2).

9. Re-creating the cover page

In addition to images of soldering and assembling, there were a number of images showing fully finished computer prototypes. These images illustrate other articles which referred either to computers in general or described the principles of operation of the Galaxy computer. In most cases, these images contained a number of prototypes with different colors which were made for the purpose of presentations and exhibitions in the 1980s. All these prototypes (except one) have been lost, so it was necessary to create a concept by which these images would be efficiently and economically created. Only one sample was used, and was repeatedly colored in Adobe Photoshop, as needed.

In one of the original images, there were five colorful prototypes. One computer had to be shot from five different angles and each of them was cut separately. In the end, everything was assembled into one composite image. The team agreed to use the set of colors for computers which was slightly different from the original, and it was a kind of authors' "signature" on the reconstructed magazine edition (Figure 3).

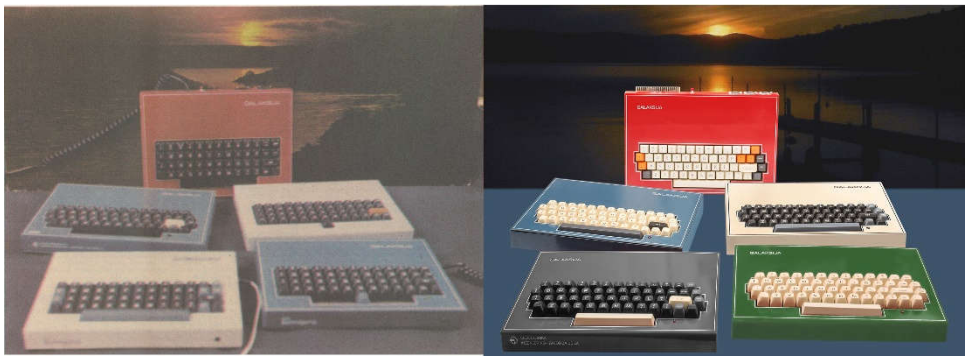

Figure 3. An attempt to re-create photography on page 66 of the publication. A single prototype was replicated 5 times, with the colors changed in Adobe Photoshop. Note that early prototypes (left) had a rectangular keyboard, unlike the new composition. Work is in progress.

Special attention was paid to the re-creation of the title page (Figure 4). The original image was poorly shot, poorly printed, and too dark. Luckily, it turned out the Galaxy computer pictured on the front page was preserved in its original form. The monitor was not preserved, and an identical model could not be purchased on the second-hand device market. A similar monitor was procured butit was not a satisfactory solution. After a long discussion, modeling expert Mr. Ivan Antonić was asked to create a 3D computer model of the monitor (Figure 4, right).

The background of the title page was the poster we could not find a copy of. The entire solar system presented on the poster was partly redrawn. Some planets were scanned from the original title page, cut separately, and digitally corrected to be used as patches on the new title page bitmap. The original monitor displayed the text "Napravi i ti računar Galaksija" ("You can build a Galaxy computer"). In the modern version it was drawn pixel by pixel in Adobe Photoshop, artificially blurred, skewed as it would be on the monitor and then added to the composite bitmap.

Figure 4. Original cover page of the publication (left), its restoration in Adobe Photoshop (middle), and an attempt to re-create the cover page using a modern, high-resolution photo of the computer and 3D model of the monitor (right)

10. Galaxy computer, 40 years later

In line with the global interest in retro computers [6, 7], almost 40 years later people still wish to build theGalaxy computer. In 2019 Aleksandar Marić and Vukašin Živaljević decided to make a documentary film entitled "Galaxy, the Computer That Refused to Die" ("Galaksija, kompjuter koji je odbio da umre"). They organized a crowdfunding campaign and collected enough money to make a movie, which is scheduled for a premiere in December 2021.

During that crowdfunding campaign, dozens of enthusiasts ordered Galaxy kits and assembled this retro-computer, functionally identical to the original Galaxy. One practical decisionfacilitated not only the purchase of set of parts, but also the work of enthusiasts who gathered in Novi Sad on May 29, 2020, at the event of soldering Galaxy computers. It is the replacement of a single-layer printed circuit board with a double-layer one, also designed by Mr. Antonić. Instead of 120 wire jumpers, an upper conductive copper layer was used, so there was much less work on soldering, and fewer errors. The manufacturer could make a standard two-layer board with conductive holes, and even markings for components, as the silkscreen image simulated jumpers on the board. After two soldering parties held in Novi Sad, the number of happy owners of Galaxy computer increased by a few dozens in the 21st century.

11. Conclusions

Design and implementation of the self-build Galaxy computer was a pioneer effort and an important contribution to the early development of personal computing in former Yugoslavia. Its popularity among enthusiasts, its affordability as well as usability, made it a hot topic at Sezam bulletin board, an original predecessor of nowadays social networks. The documentation of Galaxy was provided by the edition of Computers in Your Home ("Računari u vašoj kući"), which became the issue 1 of Computers ("Računari"), the first personal computer magazine in former Yugoslavia. The importance of the Galaxy computer in the computer history is demonstrated by including it in the fundus of museum of Science and Technology in Belgrade, as well as the Computer History Museum in the USA (Galaksija personal computer | 102766415 | Computer History Museum). We believe that digital rebuild of Computers in Your Home publication, as well as re-creation of the Galaxy computer itself, will contribute to the preservation of digital heritage of the technological, intellectual, and popular achievements in our country during the last two decades of the 20th century.

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High resolution photographs are available on https://pcpress.rs/download/galaxy.zip