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THE ROLE OF MUSIC ON THE YUGOSLAV COMPUTER DEMOSCENE

Abstract: The paper is based on the recent writings about the demoscenes, published in European countries, in order to examine Yugoslav demos from the late 80s/early 90s, adjusting the approach from similar publications that regard the demoscene as a kind of digital art, made by communities of groups or individuals dedicated to advanced programming or hacking/cracking/sharing/reusing of the existing software. Although the hackers and their works analyzed in this text were members of the groups mainly focused on the graphics programming, music in most of their demos was also made with special attention. Another evidence that hackers on Yugoslav demoscene did not take sound aspects of their demos lightly, were the so-called musical discs, ie. Music compilations created specifically for the demonstration of sound capabilities of the hardware of the machine for which they were made. This paper covers the scene for Commodore 64 computer, since this part of Yugoslav demoscene was the most widespread. Main part of the text is dedicated to the analysis of the music from the collective demo works, as well as musical disks devoted to a single composer. Special attention was paid to magazines on disks published by prominent C64 groups and articles that expose details about demo-making techniques of the time, especially those dedicated to music.

Keywords: demoscene, music, Yugoslavia, Commodore 64, SID chip

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Demoscene – Defining the Meaning of the Term

Within the fields of cultural studies and the history of computer music, the term demoscene refers to an informal community of groups or individuals, advanced users of computers, that is, hackers,¹ who use their programming skills, by creating a specific kind of computer art, to demonstrate the possibilities of a given hardware, showcasing at the same time their software-wielding capabilities.² The term “demo” is short for “demonstration”, which refers to a computer program that doesn’t have any practical use other than to demonstrate the possibility of a computer and/or the skill of the programmer. It can be said that the demoscene was formed during the 1980s in Europe as the result of small, home computers becoming widespread, and its formation was prompted by the creation of groups of enthusiasts whose programming skills were more advanced than those of an average user, and who viewed the limitations of microcomputers as challenges that needed to be overcome.

The term demoscene is already affirmed in the relevant writings produced over the last two decades, and as Markku Reunanen notes,³ its definitions are based in the scene theory by sociologist Michaela Pfadenhauer. According to her, the scene is a “[...] thematically focused cultural network of people who share certain material and/or mental forms of collective self-stylisation and who stabilise and develop these similarities at typical locations at typical times as a scene”.⁴ However, in the case of the demoscene, this definition also includes a specific understanding of space in the computer world, which does not need to refer only to physical, but to the digital space as well. It should also be noted that the so-called demo-parties were organized by the members of the demoscene, and in that case we are, of course,

¹ Richard Stallman, “On hacking“, 2002. <https://stallman.org/articles/on-hacking.html>

² Markku Reunanen, “How Those Crackers Became Us Demosceners”, *WiderScreen*, 17, 2014. <http://widerscreen.fi/numerot/2014-1-2/crackers-became-us-demosceners/>; Vincent Scheib, “Demos Explained; What are Demos? What is a Demo?”, <http://www.scheib.net/play/demos/what/index.html>; Dave Green, “Demo or Die!, Wired”, <https://www.wired.com/1995/07/democoders/>, Maureen Web, *Coding Democracy*, Cambridge, Massachusetts, The MIT Press, 2020; Emin Smajić, “Mali piratsko-srpskohrvatski rečnik”, *Svet igara*, 4, 1988, 43.

³ Markku Reunanen, “How Those Crackers...”, op. cit.

⁴ Michaela Pfadenhauer, “Ethnography of Scenes: Towards a Sociological Life-world Analysis of (Post-traditional) Community-building”, *Forum: Qualitative Social Research*, 6(3), 2005, <https://www.qualitative-research.net/index.php/fqs/article/view/23>

referring to a “typical location” in the common sense of the word.⁵ It is precisely based on this understanding of the term that the Yugoslav demoscene can be described, bearing in mind that its actors came from different cities, and that they were also members of foreign groups, all of whom shared the same methods of “self-stylisation” and originated in a similar way, which will be discussed in more detail later on.

The demoscene in Yugoslavia started to progress more significantly in the second half of the eighties, with the rising interest in small, home computers that, just like in Europe, became widely accessible to ordinary people (in the previous period, computers were mainly used for specific tasks in institutions or companies). From today’s standpoint, it seems that the offer of computers available at the time was quite varied – from popular American and British computers like Commodore 64 (henceforth C64) or ZX Spectrum, to less famous systems like Amstrad CPC and Atari, right up to models made locally, among them Galaksija+, Orik Nova 64 (under the Atmos licence), Orao (Eagle), Pekom, Lola etc. Given that none of these computer systems were “mute”, manipulating their sound possibilities was one of the areas in which one’s programming skills needed to be showcased, so local hackers, following their western role models, wanted to stand out by creating computer music as well.

One of the common restrictions they faced in this period was the software copyright, which was successfully cracked by programmers, which is why they became known as “crackers”. Groups of crackers broke the copyrighted software in order to make their own, pirated compilations of floppy disks and tapes, which were mainly sold by means of postal orders.⁶ To ensure that their work was recognizable, the disks they sold contained programs that the crackers themselves created, which served as a kind of advertisement, given that they were attractive to watch and listen to, while at the same time, they demonstrated the skill of a given group and doubled as a form of quality assurance of the “rips” that were offered (a “rip” in the hacker’s jargon refers to the segment of a program taken or stolen). Along with the crackers’ pseudonyms, the demos also had phone numbers, as well as the

⁵ In Yugoslavia, the international Transcom & Victory Copy Party 1990 was held on Palić, between the 4th and 13th of August 1990. Around 20 groups from Hungary, France and Yugoslavia participated in the event. <https://csdb.dk/event/?id=1470>.

⁶ Emin Smajić, “Mali piratsko-srpskohrvatski rečnik...”, op. cit., 43; Markku Reunanen, “How Those Crackers...”, op. cit.

home addresses of the programmers who made them, to facilitate contact with the buyers. Group members initially used pseudonyms in order to hide their identities, given that their activities weren't (always) legal (in Yugoslavia), while the practice later became a habit, which didn't always have a logical reason.

As Reunanen notes: "in the late 1980s the legal part of the cracking and warez scene slowly drifted away from the illegal part. Intros became more advanced, (mega-) demos (several advanced intros linked together) appeared. The demoscene was, sort of, born. A few individuals are still active in both, the demoscene and the warez/cracking scene."⁷ His outlook corresponds to the local definition given by Emin Smajić, who writes:

It all began with pirates who, in light of the shortage of programs, included demo programs in their sets of games... Within the demo programs, one could find announcements for the upcoming games, greetings to colleagues and collaborators, advertisements for new pirated offers, or, an arrogant hacker simply wanted to showcase their capabilities to the world.⁸

In this way, demos became more and more popular as the products of the groups of crackers spread through Europe, and by the mid-eighties, they stopped being related to piracy and became a form of digital, audio-visual artistic expression which, besides being fun, also had an educational use given that groups of hackers, but not (always) crackers, often competed in who would create the most complex graphical and sound piece. These groups were usually comprised of coders, visual artists and composers, who realized their collective artistic expression using computers and the forms of a demo.

Research Sources

Given that today, the demoscene is a common topic covered by academic writings, an abundance of foreign sources offer an insight into modes of production within the field. This research is also accompanied by polemics regarding terminology and methods used to understand the issue at hand, none of which influence the outcome of this paper, given that domestic researchers have only occasionally written about the topic.⁹ The musical aspect of the demoscene, as well as the chiptune aesthetics (which will be ex-

⁷ Markku Reunanen, "How Those Crackers...", op. cit.

⁸ Emin Smajić, "Mali piratsko-srpskohrvatski rečnik...", op. cit., 43.

⁹ One of the most complete bibliographies of foreign sources is available at http://www.kameli.net/demoresearch2/?page_id=4

plained in more detail later) have only recently become interesting to local researchers, even though a number of studies related to sound segments of demos and/or computer games have been published in Europe to this day. Bearing that in mind, one of the key goals of this paper has been to adapt the stances and methods from foreign writings to the artifacts of local production which, thanks to the vibrant activities of the online community, have been preserved to this day and, to a large extent, systemized by its members. Most of the material that was covered in the paper was created between 1988 and 1997, and is available on the Internet database of the C64 decmoscene,¹⁰ while one segment can be accessed on the website “Eks-ju računalniška scena”¹¹ (while a few artifacts exist on both websites). The magazines on disks and demo tracks in the .d64 or .p00 formats were collected from these repositories in order to enable their comparison and further analysis. In the same repositories, the sound segments of demos are available in the .sid format as well, albeit separated from their native context, which made the contemporary manipulation with this digital material much easier. As is most often the case when researching the history of computer art, other than the standard musicological skills of structural and harmonic analysis, the understanding of the mentioned material was greatly aided by the Vice emulator of the C64 system, created for contemporary computers, as well as by the knowledge of working with the original hardware, which was a prerequisite equal to the researchers’ understanding of the possibilities offered by the instrument for which the music they analyze is composed for.

I came to the decision to research the demoes created in the aforementioned period due to the fact that the earliest demo I could find was realized in 1988, while the upper boundary was set more flexibly, and is meant to tentatively delineate the period in which most groups that used the C64 moved to the Amiga, PC, or other systems. It is important to note that some of them continued, or renewed their activities, like the group *Tempest*, which is most likely the most long-lived in the Yugoslav space, whose members are still very active on the international C64 scene.

This is precisely why the central segment of the article will focus on the community formed around the C64, and its musical achievements in Yugoslavia near the end of the eighties. Namely, in this period the local groups connected with their colleagues from Europe, contributed together to the

¹⁰ C-64 scene database, <https://csdb.dk/>

¹¹ <http://retrospec.sgn.net/users/tomcat/you/index.php>

creation of a scene which is today, in a number of countries, recognized as being part of UNESCO's list of Intangible Cultural Heritage.¹²

At the beginning of the nineties, the Commodore Amiga became more visible on the local computer scene, and its appearance marks the move towards the era of 16/32-bit computers whose capabilities, especially when it comes to sound, were much closer to today's standards. The Amiga was a very powerful graphical and sound device and affordable at the same time, which resulted in it being very popular among hackers. The ability to polyphonically reproduce the 8-bit samples, introduced this computer into the world of professional musicians, and for this very reason, it became the symbol of the computer culture at the turn of the eighties. Music disks for this computer were numerous, and thanks to its advanced hardware capabilities, the sound segments in graphical demos could achieve the equal level of complexity as the graphical aspects. Even though a number of C64 groups gradually incorporated the new hardware and directed their creative potential towards it, understanding the Amiga demoscene would require separate research, given the specificities of its hardware which require methods of music analysis that are much more complex than those used to understand music produced by the SID chip.

I will not cover the music for other systems on this occasion, given that its volume is much smaller than that of the previously mentioned systems. This by no means implies that this part of the demoscene is less important, but rather that the other systems were not so widespread, and so their program arsenal is proportionately smaller. Also, the sound capabilities of those systems were not as strong as those of the C64, so the demos created on other systems are much more important from the programmers' than from the musical point of view.

The basic structure of a demo

The demo usually consists of an intro, the demo itself, as well as the unavoidable "scrollers" (textual, animated messages that flow over the screen, as if

¹² First in Finland in 2020 (<http://demoscene-the-art-of-coding.net/2020/04/15/breakthrough-finland-accepts-demoscene-on-their-national-list-of-intangible-cultural-heritage-of-humanity/>), then in Germany (<http://demoscene-the-art-of-coding.net/2021/03/20/demoscene-accepted-as-unesco-cultural-heritage-in-germany/>) and Poland in 2021 (<http://demoscene-the-art-of-coding.net/2021/12/17/demoscene-in-poland-gets-accepted-as-national-immaterial-cultural-heritage/>).

they were on an assembly line, showing the hacker's message to the public). Intro is the introductory demonstration that contains, other than a scroller, the logo of the group, and can be made of an animation, or a brief graphical segment that is repeated (often called a routine, given that this is usually a brief segment of a code that solves a programming task in an innovative and imaginative way, for example, a rotation of a 3D square, or a jumping ball). Also, the intro usually has music, which in most cases is not related to what is happening on the screen, but is reproduced independently, in a loop as well. The musical loop is also, more often than not, longer than the visual one, so after a while nothing new is happening on the screen, other than the text of the scroller moving, which is how the music comes to the forefront, ensuring that the viewer keeps watching the demo until the end of the group's message.

After one or more intros, the main demo will start, either animated in a similar way to the intro, but containing digital photos (pixel art slide show), or having short animated segments that, due to their complexity demonstrate the ultimate possibilities of the chosen hardware. Commonly, this presentation is accompanied by music, which is sometimes related to the visual segment, but which can also unfold independently. In rare cases, demos do not have the sound segment, which is usually explained by the lack of a computer's program memory, and therefore, its inability to reproduce both the image and the sound.

Reverse cases are more frequent however, that is, it is more common to encounter demos in which music is in the forefront, while the graphics are the secondary segment, placed in the function of the reproduction of sound. Such demos are called music discs, given that they usually contained about ten musical segments "pulled out" of other demos and games, united into a compilation intended solely for listening (Figures 1a and 1b). Such music discs demonstrate the popularity of compositions from demos, and can further be divided into those that represent the work of a single hacker, and compilations that contain the segments from the best demos, according to the members of a group that put the compilation together. It is not uncommon to find "borrowed" or "ripped" music accompanying an original graphical work in a demo, seeing that not all groups had composers whose skill was at the same level as that of graphic programmers, or did not have composers at all.

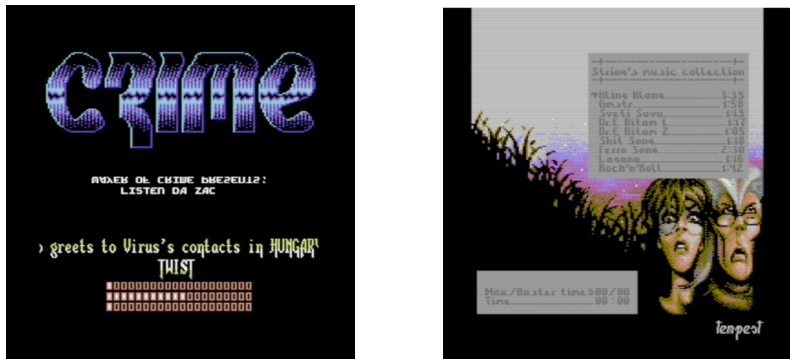


Figure 1a (left): Music disc for Dalton by the group Crime; **Figure 1b** (right): Music disk for String by the group Tempest

Music on the Commodore 64 scene

Musical demos are commonly associated with the term chiptune (referring to the music that originates in a computer chip), which implies that these are short segments, reproduced through a programmable sound generator, a chip that, during the eighties, was a common part of home computers and video game consoles.¹³ Despite the fact that, in the technological sense, music from the demos was created using the mentioned chip, the meaning of the term chiptune is not unanimously accepted, so I will not be using it in this text, in order to avoid any confusion. Also, this term was not used in the hackers' jargon during the period which is in the focus of this text, so its introduction would further complicate the terminological determinations.

Music in demos is usually a rhythmic composition, similar to dance numbers of the popular electronic music from the eighties and nineties, with “raw” timbral characteristics that are the result of the quality of the instru-

¹³ Chiptune (or chipmusic) is a term that can refer to a much wider field than just the demoscene, encompassing mainly music for video games, flippers, popular music, as well as cell phone tunes. More details in: Kevin Driscoll, Joshua Diaz, “Endless loop: A brief history of chiptunes”, *Transformative Works and Culture*, 2, 2009, <https://journal.transformativeworks.org/index.php/twc/article/view/96>; certain authors connect the chiptune as a stylistic feature to contemporary phenomena in popular music that are based on sound sources from the eighties computers. Cf. Vigard Kummen, *The Discourse and Culture of Chip Music*, University of Agder, 2018. Similar tendencies are described also as fakebeat. Cf. Marilou Polymeropoulou, “Chipmusic, Fakebit and the Discourse of Authenticity in the Chipscene”, *WiderScreen*, 17, 2014, <http://widerscreen.fi/numerot/2014-1-2/chipmusic-fakebit-discourse-authenticity-chipscene/>

ment that is used in its performance. A significant difference from listening to “real” music lies in the fact that these micro-computers could not reproduce any recorded sound (other than in cases when short samples were used), so they relied on the programmable sound generator, that was actually a digitally controlled synthesizer, to produce music. It can thus be said that the production of music in these systems was more like writing a score for a certain instrument, than reproducing the recording of a musical work.

The sound capabilities of the computers of the time differed from model to model, with most options offered by the so-called SID chip (Sound interface device), which was integrated into the C64. This hybrid analogue-digital synthesizer was comprised of 3 oscillators with four fixed wave forms (triangle, saw, square and noise), whose amplitudes were controlled with special envelope generators, while the three channels could be filtered with LP (low pass), HP (high pass) and BP (band pass) filters, with the possibility, due to certain imperfections in the chip’s design, to also reproduce samples in the 8-bit resolution. The chip also offered the possibility of ring modulation, as well as the creation of sync effects. Such a system was completely controlled by software through which sound parameters could be influenced by using different registers. Such an instrument was by far the most complicated on the demoscene of the time,¹⁴ so it is not surprising that it found its use in both professional electronic, as well as popular music, while it also enabled the creation of a separate musical genre within the computer world, called Sidtunes.

The musical content of a demo usually consisted of an original composition (or a few of them) or, more often than not, popular songs that were covered in a manner dictated by the features of the SID chip. Such content entailed, other than the synthesized equivalents for acoustic instruments that did not sound too similar to the original, very frequent and quick changes in sound parameters of one voice (channel), which achieved the effect of the

¹⁴ For the sake of comparison, it should be said that the ZX Spectrum, the second most popular computer (primarily in Europe, and especially in Yugoslavia) among the authors of demos fell, when it came to sound capabilities, much behind the C64, given that it had only one, small internal speaker (“beeper”) which could produce an 8-bit pulse signal in 10 octaves, which is a rather insignificant feature in comparison to the aforementioned system. However, this computer was very cheap and simple to use, and its limitations were provocative to hackers wanting to showcase their skills with very limited resources, so it is possible to find programs for this computer that emit samples of recorded music, or generate polyphonic music.

simultaneous sounding of more channels than the synthesizer could produce. This technique is very similar to the so-called latent polyphony in counterpoint, in which the frequent changes in the octave in one line, creates the impression of polyphony. As opposed to classical music, the computer can change not only the register (the octave), but also all other parameters of sound, so it is not uncommon to use one channel to play both percussive sounds, similar to those of drums or cymbals, and sounds reminiscent of the bass guitar (voice multiplexing). A second prominent stylistic feature of this music is the use of very fast arpeggios, usually spanning through multiple octaves, which results in a sensation that a continued harmonic accompaniment is present. As a reminder, given that the SID chip has only three voices, if they were to be used to form a chord, no other sound could be produced simultaneously. This is why it is very common to hear one voice oscillating between the notes of a chord, with their quick succession creating the impression of a prolonged vibrant chord, leaving the other two voices free to produce other parts of the composition.

The reproduction of samples of a recorded sound (of a voice or percussions) was considered to be a sign of a particularly high level of one's programming skills, given that almost none of the popular computers from the eighties were designed to accomplish such a task. This was an especially appealing endeavour to be undertaken using the C64, given that, as I already mentioned, the reproduction of samples on the SID chip was possible solely due to an error in the design, which means that turning a flaw into a desired and useful feature required a great knowledge of hardware details, as well as of properties of the digitally recorded music.¹⁵

¹⁵ With the appearance of the Amiga, this programming passion was satisfied, given that the Paula chip, among other things tasked to generate the sound on this system, was envisioned precisely as the player of samples, which was a feature that brought the quality of music for this computer much closer to that created on professional acoustic or electronic instruments. The sounds on the Amiga were divided among the two channels, so it was possible to create stereo compositions using this computer, together with 4 samples that could be simultaneously reproduced. Of course, all the techniques of using arpeggios and the dynamic changes of channel parameters were transferred from the earlier systems to the Amiga, which, by the mid-nineties, made this computer a dominant tool for the demo-makers across Europe. The only other system that was more common in this period was the IBM PC with its clones, which would, because of circumstances that had nothing to do with the computer's quality, "push out" from use all other computers (other than Apple) and become the synonym for computers by the end of the previous century.

Music and prominent composers in demos of groups from Yugoslavia

Groups of hackers from Yugoslavia were, much like their European counterparts, created during the mid-eighties, to offer cracking services to their users, which is visible in their names as well (Belgrade Cracking Service, North Slovene Cracking Service, Dubrava Cracking Service etc.). Later, at the end of the decade, this activity became secondary, much like with other similar groups in Europe, with programming bravado becoming their main pre-occupation. It seems that Yugoslav groups collaborated very well with their foreign colleagues, with some local members, like Dalton, whose work will be covered in more details later, also being part of international groups. As I already mentioned, local groups of hackers mostly comprised a programmer (coder), a graphical, that is a visual artist, and a composer, with these roles also often interlapping, and one member serving multiple functions. Composers were especially appreciated, given that there was a smaller number of them than other hackers, so most of them collaborated with multiple groups. Members of the group came from different Yugoslav cities, and they very often did not physically gather, but shared the data via mail or phone (through the modem). Also, there was a lot of overlapping among Yugoslav groups, so some hackers were members of multiple groups at the same time, while a number of groups lasted for a short time and/or quickly changed their members. As already mentioned, these groups mainly published computer programs and games, along with demo discs, among which magazines on disks began to appear at the end of the decade.¹⁶

These magazines united the techniques of making demos, journalism and communication strategies, given that they served as a media outlet of a group of hackers that published instructional articles, interviews, personal views and thoughts, as well as correspondence and polemics (often with true verbal “digital clashes”) with members of other groups (similar to musical fanzines). These magazines also published digital photos and musical numbers in separate columns. Moving through the magazine was done by means of a joystick or the keyboard, and its look did not mimic that of a printed newspaper, rather, hackers kept finding creative ways to present the content. The text was usually scrolled, or animated like a slideshow, with certain words changing color, or using unique fonts, with cryptic elements in the design (figures 2a and 2b). The best-known magazines in these parts were

¹⁶ More about magazines on disks in: J. B. Shelton, Glenn M. Kleiman, “Ready-to-Run Magazines”, *Compute!*, 48, 1984, 136.

Commodore News, made by the groups Crime and the Madonna Software Company, *Propaganda* by the group Chaos, and *Revija 64*, made by the members of Myth.



Figure 2a (left): cover of the magazine *Commodore News*;
Figure 2b (right): cover of the magazine *Revija 64*

Music had an important place within these outlets, primarily due to the established practice of playing music continuously while reading the magazine. Additionally, music had its own dedicated column, precisely due to the lack of original music for the demos that was subsequently “pulled out” from the magazines by hackers, and used in their work. In this way, those who were interested could obtain the routines used in certain compositional procedures, with the articles often revealing how the already affirmed composers created their numbers, either in interviews or in instructional articles like “Hacking Academy” (*Commodore News*, 6–8) and “School of Music” (*Commodore News*, 9–10), that are particularly important for understanding the scene from this distance in time.

The author of the hacker’s “School of Music” is Saša Stojanović Dalton from Niš, one of our most famous demoscene composers of the time. Other than being a member of the local groups, like Crime, during the eighties Dalton belonged to one of the largest European groups, Transcom from France. His numerous works are part of compilations and musical discs made by hackers around the world, and they were frequently published in local and foreign magazines as well.¹⁷

In the first article of the “School of Music”, Stojanović differentiates between music for demos made by composers with a formal musical education

¹⁷ <https://csdb.dk/scener/?id=9769>

and that which is the result of the work by enthusiasts and experimenters. According to him, such a division can also be explained by the use of software which dictates the level of the author's knowledge of music, given that the former used programs based on standard musical theory (notation), while others relied on their hearing, that is, the sensation regarding the result of their work after experimenting with the sound. However, Dalton emphasizes that good outcomes are possible in both cases, with the main difference lying primarily in the method of composition. It can be said that composers with a formal musical education write down the work first, and then "turn" that musical segment into code, while those who do not use musical notation, achieve the sound result through the "trial and error" process, that is, through immediate research into various sound possibilities through experimenting with the code. In that way, they understand the sound phenomenon they achieve (say, the beat of a drum or a sound similar to that of a trumpet) as a result of the execution of the code, which is a rather unique compositional process based in programming, rather than classical musical skills. In the second article from this mini-series, Dalton explains working with the *Future Composer* software in detail, revealing various specificities of the creational process, as well as explaining his own position as an author who is deeply familiar with creative strategies of both mentioned groups of hacker-composers.

Dalton's music is often based on well-known melodies from popular culture, like that from the movies *Electric Dreams*, or *The Good, the Bad and the Ugly*, or hits like "Johnny B. Goode", "Sealed with a Kiss" and "Another Brick in the Wall". The artist covers these hits by maintaining a sufficient amount of recognizability when it comes to melody and harmony, but at the same time fitting them into prominent rhythmic matrices, accompanied by syncopated sections of the bass. His works lean towards so-called classical rock music, that is, towards the well-known hits from the past which, cloaked in a "new garment" prompt the listeners to compare them to the originals and thus judge the author's skill of using the SID. Thus, Dalton's arrangements are very intense, without much "empty space", with the emphasis on the illusion of more layers in the texture than is offered by the chip, which reveals the artist's high level of craftsmanship and the ability to conjure up the sound plentitude of the original recording using an instrument whose features are much more modest than those of the instruments it is supposed to mimic. Another characteristic of his works is the already-mentioned use of arpeggios and latent polyphony, in order to create the illusion of the textural

growth, which is one of the reasons why Dalton's compositions can be compared to those of the most prominent authors of the world's demoscene. However, his covers of local hits, like "Maljčiki" by the Idoli, "Krokodili dolaze" (Crocodiles are coming) by Električni orgazam, or "Hajde da ludujemo" (Let's get crazy) by Tajči, are aspects of his work that point to his origins, despite his international reputation.

In this context, it is also important to mention Goran Beg from Belgrade, better known as String, a member of the group *Chaos* who, other than programming music, also did the graphics, and whose works were, other than in intros and demos, published as musical disks by local groups.¹⁸ Much like Dalton's, his music is, other than in cases of original compositions, often based in covers of popular melodies which, unlike those by other local authors, also step into the field of politics (as in the covers of the partisan song "Po šumama i gorama" (Through the valleys and over the hills) or the "Himna Svetom Savi" (Hymn to Saint Sava). In addition, his output encompasses the covers of "Ja ratujem sam" (I go to war alone) by Riblja čorba and "Verujem, ne verujem" (I believe, I don't believe) by Bajaga i instruktori. String's compositions are equal in quality to those created by western authors, however, for a number of his original works that are available today, one cannot determine with any certainty whether they are completed or not (the uncertainty is prompted by the titles like "Lagana" (easy), "Treća cool" (Third cool), "Prva kraj" (First ending), "Druga kraj" (Second ending) which themselves sound incomplete, so it is more difficult to speak of his output as a whole. Other than his works that are created in the spirit of synth-pop, his original numbers introduce very aggressive, repetitive segments, filled with very quick arpeggios and brief melodic fragments, close to techno-trance music (for example in "Druga kraj"), with another notable trait being the change in tonality, that is, frequent transpositions of repeated fragments and returns to the basic tonality (for example in "Fast Shit").

Successful covers of the greatest hits of local and foreign popular music are also one of the features of the work by Ivan Maljković, better known as Dr. Rox, who worked with hacking groups *Death Ray* and *Tempest* at the end of the eighties.¹⁹ Starting with the song "Model" by Kraftwerk, followed by Bajaga's hits like "Ruski voz" (Russian train) and "Verujem, ne verujem" (I believe, I don't believe), up to Bregović's "Đurđevdan" and the cover of folk

¹⁸ <https://csdb.dk/scener/?id=9053>

¹⁹ <https://csdb.dk/scener/?id=13105>

tune “Ruse kose”, the compositions of Dr. Rox encompass some very distant genres of popular music, united by the specific way of covering them, close to Dalton’s style. His style entails adapting the original to the capabilities of the SID chip, which results in, occasionally truly exotic harmonies, especially in cases where folk tunes were covered.

Of course, other than the three authors I mentioned, more hackers were active on the Yugoslav scene, writing music for demos, but in a somewhat reticent manner.²⁰ Because of the widespread practice of copying and “hiding” behind pseudonyms, it is not always easy, from this time distance, to determine the authorship of some numbers. Also, as I already mentioned, in a number of demos created by local groups, the music of other authors was used in the original, or slightly changed form. However, it is possible to conclude, based on the insights into the music of Dalton, String and Dr. Rox, that, speaking about their technical skill, the music they created is of equal quality to that of foreign authors, which is further confirmed by their international engagement. On the other hand, the diffusion of the music for demos can be understood as an indicator of the scope and influence of a given scene (bearing in mind the generally lesser number of composers compared to visual artists and coders), so it can be said that, given the complex social circumstances in the country at the time, the results that were achieved by the local authors are worth the researcher’s attention, as a sounding testimony to the beginnings of the era in which we are now living, which is marked by digital technology.

Influences of the demoscene on the popular culture in Yugoslavia

Just like popular culture had its influence on the demoscene, the demoscene also found its way into the artifacts of everyday life in Yugoslavia during the end of the eighties and the beginning of the nineties. One example of this reversed influence is the record by Bajaga i instruktori,²¹ which contains a demo for ZX Spectrum as an addition to the musical content. This demo can hardly be compared to other such works, as it is completely put in the function of the content of the album, introducing the tracklist as well as the lyrics. In addition, its graphical design is not at the same level as the “standard” demo products of the time. The ITD bend went a step further, and offered its

²⁰ They are, for example, Da Funk (<https://csdb.dk/scener/?id=2844>), Kruger (<https://csdb.dk/scener/?id=20283>), Phantom (<https://csdb.dk/scener/?id=1563>) and others.

²¹ Bajaga i instruktori, *220 (plava verzija)*, Beograd, PGP-RTB, 1985.

listeners a video game for the same computer as in Bajaga's case,²² which, even though strictly speaking it is not a demo, it can be understood as such in this context, given that it is more of a promotional gimmick than a "true" computer game, aimed at gamers. Speaking of computer games, I would also like to mention the music video of Lepa Brena's "Sanjam" (I dream), in which the motifs of the video game appear, with the singer as its main protagonist. In certain segments of the music video, we can also see parts of a demo, which was a very common practice, especially with "ripped" games. The cover of an album by the group Jolly Joker,²³ shows the image of a non-branded C64 (or, it could also be the VIC 20, given that the two computers are visually identical), with this computer also being used during the recording of the album. This is the case with numerous other artists from the popular electronic music domain, as well, since a number of them often emphasized that their music contained the sound of the SID chip (in the music by Denis&Denis, Data etc.).

Conclusion

Given that it is not possible to encompass the entire local output in this field with one paper, I chose to focus on the activity of three composers who produced most of the numbers in the domain, to map the range of the Yugoslav demoscene, and to do it using the example of its segment which, in the 8-bit era, gave the most interesting result when it comes to the musical quality of works – namely, the community gathered around the C64 computer. One should take into account that, the fact that a piece of music "sounds better" on the C64 than on the ZX Spectrum, for instance, does not necessarily mean that one's hacking abilities are superior in the first, to the latter case. On the contrary, one can say that, the greater the limitations, that is, the more reduced the possibilities of a computer system are, the more knowledge is required to overcome them. In this case, it is up to the listener to recognize the craftsmanship within the musical structure which produced that very music, regardless of the fact that, if viewed outside the context in which it was created, it sounds simple, or even banal. Given that SID was a chip that absolutely dominated the music in the period of the most intense development of home computers, it is understandable that the music created with it by groups of hackers, seems the most provocative for research from today's perspective.

²² Itd Bend, *Skidam te pogledom*, Zagreb, Jugoton, 1988.

²³ Jolly Jocker, *Jolly Jocker*, Beograd, PGP-RTB, 1985.

This computer offered the hackers the possibility to express their musical interests, but also to demonstrate, on their “home turf”, what the sound is of the music they create for one another. Such musical works, other than providing the opportunity for aesthetical pleasure, are also a specific form of communication between programmers who, just like “real” composers in many cases, copied each other’s works, changed it and covered the “canonic” musical norms, thus honing their techniques in accordance with jointly set aesthetic ideals. Thus, it is clear that researching the music of the demoscene reveals a number of different social and cultural relations that this, one could say, modest musical content (compared to a symphony, or even a pop song), establishes on multiple levels, starting with the “purely musical”, via a wider plan of digital, multimedia art, right up to the everyday political and cultural turmoil to which the local community responded in a unique and creative way, faithful to the time in which it worked.

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Summary

This paper was written under the influence of research in the European countries that focus on the importance of music for the development of computers in those societies, research conducted on the basis of an analysis of sound that appears in games, demos, and other computer programs. Given that writings about the demoscene view music simultaneously as a result of the programmer's "virtuosity", as well as an artifact that reflects the relationship between the computer community and the culture in which it operates, this research, focused on the context of Yugoslavia in the late eighties and early nineties, would enable a deeper understanding of the role music had on this productive scene, whose rise coincides with the break-up of the society in which it originated. The paper initially concentrates on the current research in the field, conducted in other European countries, and then proceeds to analyze the artifacts from the selected period, using the methodology adapted from similar publications which understand the demoscene as a phenomenon formed in communities of groups or individuals active in the field of creating new programs or hacking/cracking the existing ones. Even though the authors covered in the text primarily focused on the graphic aspects of programs, virtually every demo from the period contained music as well. Special attention in the paper is given to so-called musical discs, that is, programs that were created specifically for listening to music on computers, and demonstrated various sound capabilities of the machine for which they were made, as well as magazines on disks made by community members. The primary goal of the paper is to understand the Yugoslav demoscene using musicological procedures, viewing it as a substantial segment of the history of musical creation in the Balkans, as well as to position the local production in relation to European demoscenes, as an area of research which is of great relevance for our cultural history.