Behind the Silicon Curtain

Computer Art in the Eastern Bloc

Todor Bozhinov

Master thesis in Digital Media
University of the Arts Bremen

Master of Arts in Digital Media
University of the Arts Bremen

Behind the Silicon Curtain

Computer Art in the Eastern Bloc

Todor Bozhinov

Address:
9 Tulcha Str., Apt. 3, 5800 Pleven, Bulgaria

Matriculation number:
31811

Supervisor:
Prof. Dr. Frieder Nake

Reviewers:
Prof. Dr. Frieder Nake
Joachim Hofmann

Submitted on 07.09.2015

HFK BREMEN
Hochschule für Künste
University of the Arts
Bremen

Abstract

English

From the end of World War II until the revolutions at the turn of the 1990s, an Iron Curtain divided the capitalist Western Europe from the Soviet-dominated, communist Eastern Bloc. Does a Silicon Curtain still keep the history of Eastern Bloc computer art away from researchers? Elaborating on computer art in each Eastern Bloc country and attempting to place the events in a political and social context, this master's thesis aims to be a dent in the curtain and to throw light on computer art in the Eastern Bloc.

Keywords: computer art, history, computing, Eastern Bloc, Iron Curtain

Deutsch

Vom Ende des Zweiten Weltkriegs bis zu den Revolutionen an der Wende der 1990er, ein Eiserner Vorhang teilte das kapitalistische Westeuropa vom sowjetisch dominierten, kommunistischen Ostblock. Hält ein Silizium-Vorhang noch die Geschichte der Ostblock-Computerkunst weg von den Forschern? Diese Masterarbeit versucht, eine Beule in den Vorhang zu schaffen und Licht auf die Computerkunst im Ostblock zu werfen, indem sie die Computerkunst in jedem Ostblock-Land einzeln erarbeitet und die Ereignisse in einen politischen und sozialen Kontext stellt.

Schlüsselwörter: Computerkunst, Geschichte, Computing, Ostblock, Eiserner Vorhang

Acknowledgements

First, I would like to thank Prof. Dr. Frieder Nake for inspiring me to look at the political and social context of art and aesthetics as well as for his invaluable advice, supervision and motivation during my research and writing.

I would like to extend my gratitude to the editors of the Monoskop wiki, a valuable online resource on modern art and new media, and indirectly to its founder Dušan Barok of Slovakia. Without this resource, tracking down references on Eastern Bloc computer artists and writing this master's thesis would have been a much more time-consuming and demanding task.

To my parents Krastinka and Plamen, I owe the desire to learn, improve and perpetually strive for the best. In Bulgaria's most horrible years of economic crisis and post-communist chaos, they gave me the opportunity to educate myself and to dream of what was then almost impossible.

To my friends in Bulgaria, Germany, Chile and all over the globe, I am thankful for the immeasurable support, entertainment and motivation as well as the fruitful discussions over politics, history, culture and art without which this thesis would have been left entirely without the background it deserves.

Table of contents

Computer art in a divided world: introduction

When some of the earliest works of computer art were first exhibited in 1965, this happened in a divided world. After World War II, „an „Iron Curtain" [had] descended across the continent"[1] of Europe, splitting it and most of the rest of the world into two inimical camps: the capitalist West and the communist East. At times, it feels like another curtain has shrouded computer art in the Eastern Bloc not only from its counterpart in the capitalist West, but also from the relative intensity and quality of research that western computer art has enjoyed in recent years. In this thesis, I use the term "Silicon Curtain" – a portmanteau of "Iron Curtain" and "Silicon Valley", the centre of world computing and innovation – to describe the imaginary barrier creating this information vacuum.

The digital computer had arrived in the 1940s, fuelled by the needs of the military efforts in the context of World War II, the deadliest armed conflict in human history. It was indeed in the ashes of World War II that the Iron Curtain arose to separate the areas of control of the former Allies. This political and social division would affect practically all areas of human life in the second half of the 20th century – and of course, the entire early history of computing and the nascent computer art.

For almost half a century, between the mid-1940s and the late 1980s, Eastern Europe embarked on a widely different social and economic course. With a few exceptions, the eastern part of the continent was dominated by the Soviet Union, at the time one of the two rival superpowers. The Soviet Union and Eastern Europe stood in opposition to the capitalist West, championed by the other superpower, the United States of America. The nature of the Soviet-type planned economy and civil restrictions imposed on Eastern Europe led to a markedly different development of computing and the arts there.

Because of these specific conditions, the history of computer art is largely viewed as the history of Western computer art only. Though it had to endure political opposition, a lack of technical equipment and limited communication (within the Eastern Bloc as well as with the West), computer art did exist in the communist East and artists from Eastern Europe did form an important part of computer art's early history.

With this master's thesis, I intend to explore the development of computer art in the individual countries of communist Eastern Europe: Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania and the Soviet Union (the countries of the Eastern

[1] From Winston Churchill's „Sinews of Peace" speech delivered in Fulton, Missouri, in 1946. Phillips, Steve. *The Cold War: Conflict in Europe and Asia* (London: Heinemann, 2001): 23. ISBN 9780435327361.

Bloc) as well as to a lesser extent the outliers, the isolated Albania and the non-aligned Yugoslavia, which were also communist states but stand in contrast to the others due to their different political association.

The two outliers and neighbours, remarkably, could not be more different with regard to their computer art scenes. In the case of Albania, no computer art was produced under the hardline regime of Enver Hoxha and his successor. Yugoslavia, by contrast, was for some time one of the world centres of computer art. Thanks to its foreign policy of non-alignment and the pioneering "Computers and Visual Research" section of the internationally important *New Tendencies* movement, based in the modern Croatian capital Zagreb, Yugoslavia took a very prominent role in the early use of computers in art. For a short time, artists and engineers from all over the world as well as local enthusiasts embarked on a historically significant journey of "visual research" towards the limits of computer technology.

Because of its vast importance, "Computers and Visual Research" and the *New Tendencies* could not have possibly been omitted from this thesis, despite Yugoslavia's position clearly outside the Eastern Bloc. In this work, "Computers and Visual Research" has been treated as a bridge between Eastern and Western computer art and the small but important Eastern Bloc (specifically Czechoslovak) participation has been discussed in more detail.

While it cannot be a complete monography, nor does it attempt to be one, this master's thesis aims to be a useful companion to anyone interested in a relatively in-depth introduction to the alternative timeline of computer art: that of computer art under Soviet-dominated communism. By studying the links between West and East and placing this master's thesis in the context of early Western computer art and the early history of digital computing, I hope to show that while it was to some degree isolated, Eastern Bloc computer art rightfully belongs next to Western computer art in the chronicles of the first attempts to use a computer for artistic purposes.

Indeed, the names of major movements like the *New Tendencies* of Yugoslavia and pioneering individual artists and theorists like Zdeněk Sýkora and Jiří Valoch of Czechoslovakia have begun to appear in studies of early computer art next to historic Western events and important artists. But the early computer art explorations of many others who dared to oppose the official artistic canon of socialist realism and experiment with digital technology and aesthetics are still undeservedly in the dark. And while this master's thesis is more a humble torchlight rather than the proper floodlight these brave artists and engineers are worthy of, my hopes are that it would still cast some light on their work and life.

Of curtains and puppeteers: the Eastern Bloc in a nutshell

World War II, which took place from 1939 to 1945, is one of the events that most clearly defined the latter half of the 20th century. In it, an eventual coalition (the Allies) of the Western powers (the United States, the United Kingdom and France) with the Soviet Union defeated Nazi Germany and its affiliates, the other Axis powers (Italy and Japan and several smaller forces).

As the victorious outcome of the war was becoming clear to the Allies, the fate of Europe was discussed on the Yalta and Potsdam Conferences, attended by the leaders of the United States, the United Kingdom and the Soviet Union. After the Potsdam Conference in the summer of 1945, the Soviet Union annexed lands or installed Soviet satellite governments throughout Eastern Europe, effectively creating a Soviet sphere of influence.[2]

Already devastated by a prolonged and deadly war, Eastern European countries had to endure major economic, social and political transformations in order to function as what Stalin and the Soviets imagined to be socialist people's republics. The bourgeoisie's power and influence had to be completely negated, land and industry was nationalized and supporters of the regime took complete control of public institutions. Life in Eastern Europe was practically turned upside down in the early 1950s.

All of these societal changes prompted an increasing divide between East and West and certain disagreements in the Soviet camp as well. The Soviet Union rejected the Marshall Plan proposed by the United States and positioned itself in opposition to the capitalist West. In 1948, soon thereafter, Tito's Yugoslavia abandoned its alliance with the Soviets, becoming a non-aligned communist state that conducted its own specific foreign policy.

Life behind the scenes

Politics in the Eastern Bloc were structured such that the bulk of power lay with the general secretary of the national communist party's central committee. Though parliament continued to exist and elections were conducted regularly, their role was merely to formally approve decisions already taken by the true holders of power. Most parties other than the ruling communist party were banned, resulting in a mockery of an election process.

[2] Wettig, Gerhard. *Stalin and the Cold War in Europe* (Lanham, Maryland: Rowman & Littlefield, 2008): 96-100. ISBN 0-7425-5542-9.

Eastern Bloc societies all faced certain internal and external restrictions. In most cases, freedom of travel and expression were severely limited. To most citizens, travel to the West was virtually impossible and even moving between cities was a significant bureaucratic hassle. Censorship in the media and the arts eliminated any information potentially detrimental to the regime; independent media or artists' organizations were as a rule not permitted. Atheism was promoted and religious activities were suppressed.

Modelled on the notorious KGB, each Eastern Bloc state had its own secret police force, which closely monitored society through surveillance and intelligence methods. The threat for those who attempted to work against the collective was to serve excruciating time in a labour camp or even to be executed.

Figure 1: Prefabricated apartment buildings constructed en masse under communism to solve the housing shortages still dominate Eastern European cities.

State-run economy and trade emphasized heavy industry and mass collective agriculture. Five-year plans set mid-term national economic goals that had some success in boosting local production and industrializing previously largely agricultural societies. However, the inefficient economic system usually resulted in slow economic growth and regular food shortages. The ensuing urbanization meant that housing in the cities became scarce, a problem solved via the widespread construction of cheap, prefabricated, often low-quality apartment buildings built to largely identical designs.

Though under strict state control, life in the Eastern Bloc was not always peaceful. Societal and economic problems led to several attempted revolutions, most notably in Hungary in 1956 and Czechoslovakia in 1968, though also to the 1953 revolt in East Germany. All of these were brutally crushed by Soviet armed interventions, followed by executions and the imposition of new restrictive measures.

The wind of change

Economic decline in the 1980s and the liberalization reforms instituted by Gorbachev in the Soviet Union opened the door to the end of communist rule in Eastern Europe. The Soviets lost their grip on most of the Eastern Bloc in 1989, when revolutions, often peaceful

but sometimes violent as in Romania, brought the first free elections in decades and paved the way to democratic rule.

The Soviet Union itself ceased to exist in 1991. Czechoslovakia split into the Czech Republic and Slovakia, Yugoslavia disintegrated violently and by and large, the 1990s were a time of economic struggle for the former Eastern Bloc as they restructured into market economies. The transition was to some degree successful, as many former Eastern Bloc members joined NATO and the European Union in the 2000s.

Brief history of computing

The war that accelerated it all

The history of computing is long and complicated. Analog computers, which rely on physical technology, may have existed for around 2000 years: the Antikythera mechanism of Ancient Greece is often regarded as the earliest known analog computer. The mechanism is commonly interpreted to have constituted a mechanical computer that was used for calendar calculations.[3]

With the demand for increasing computing power in the wake of, during and after World War II, the 20th-century analogues to these mechanical computers were quickly superseded by digital technology. In contrast to analog computers, electronic digital computers use symbols to represent data; they store information in a *digital* (discrete) rather than *analog* (continuous) manner.[4]

World War II was unique not only as the deadliest conflict in world history (with between 50 and 85 million deaths),[5] but also for the belligerent sides' heavy investment in science and technology in an effort to improve their war capabilities. Though the history of computing predates World War II, the war accelerated the development of computing technology by orders of magnitude, as the first digital computers were built for military computational needs and were funded generously by the major powers at play.

---

[3] Swedin, Eric G.; Ferro, David L. *Computers: The Life Story of a Technology* (Baltimore, Maryland: JHU Press, 2007): 1. ISBN 978-0-8018-8774-1.

[4] Compare real numbers like π and $\sqrt{2}$, which are *continuous* and cannot be expressed digitally, to *discrete* numbers like 1, -10 and 1.8495, which can.

[5] Sommerville, Donald. *The Complete Illustrated History of World War Two: An Authoritative Account of the Deadliest Conflict in Human History with Analysis of Decisive Encounters and Landmark Engagements* (Leicester: Lorenz Books, 2008): 5. ISBN 978-0-7548-1898-4.

The digital computer: whodunit?

It has long been a matter of dispute among academics as to who conceived and created the first digital computer. Modern computing owes a significant amount to the theoretical work of Alan Turing, the British "father of computer science". His Turing machines, on which he worked from 1936 onwards, were the theoretical blueprints of how a general-purpose computer would function. Furthermore, he formalized the concepts of computation and algorithm, which lie at the base of computing as we know it. Of course, Turing's contributions cannot be seen as exclusive, as they were both preceded and followed by much important work by others. However, he, more often than anyone, has been credited with giving rise to the Digital Age.[6]

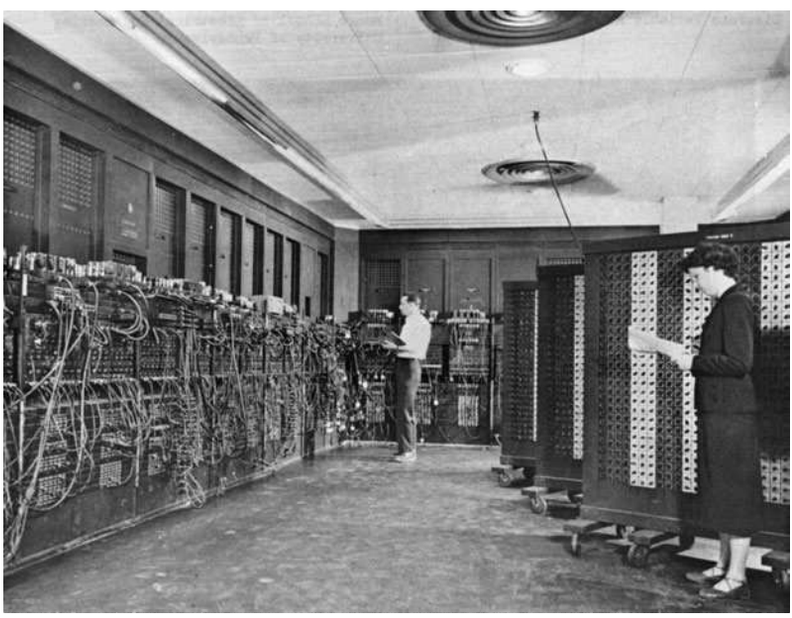

Figure 2: ENIAC, unveiled in 1946, was one of the earliest digital computers.

It was also around that time that the first actual digital computers were designed and put to practical use. Invented in 1937 and tested in 1942, Bulgarian American John Atanasoff's little-known ABC was the first computer to be digital and automatic. However, it was not programmable and could only solve linear equations.[7] German engineer Konrad Zuse's Z3 machine of May 1941 was programmable and automatic, but electromechanical rather than purely electronic.[8] Designed by Tommy Flowers, the British Colossus computer of December 1943 was both fully digital and programmable, but in contrast to the previous two, its programmability relied on plugs and switches, as it lacked electronic memory.[9] Of the three, only Zuse's Z3 can be said to have been Turing-complete, that is, able to logically simulate any computer algorithm.[10]

However, perhaps the most famous early digital computer was the American ENIAC, unveiled in early 1946, just after the war. ENIAC was fully electronic, digital,

---

[6] Beavers, Anthony. "Alan Turing: Mathematical Mechanist" in *Alan Turing: His Work and Impact*, ed. Cooper, S. Barry; van Leeuwen, Jan (Waltham: Elsevier, 2013): 481–485. ISBN 978-0-12-386980-7.
[7] Burks, Alice R., and Arthur W. Burks. *The First Electronic Computer: The Atanasoff Story* (Ann Arbor, Michigan: University of Michigan Press, 1989). ISBN 9780472081042.
[8] Rojas, Raúl."Konrad Zuse's legacy: the architecture of the Z1 and Z3," *Annals of the History of Computing* 19 (1997): 5-16.
[9] Flowers, Tommy H. "The design of Colossus". *Annals of the History of Computing* 5 (1983): 239-252.
[10] Rojas, Raúl. "How to make Zuse's Z3 a universal computer". *Annals of the History of Computing* 20 (1998): 51–54.

reprogrammable and Turing-complete. A true general-purpose computer conceived by John Mauchly and Presper Eckert, it was nicknamed a "Giant Brain" by the contemporary American press. ENIAC also directly influenced the birth of the computer industry we know today – its engineers founded the first ever computer company, the EMCC, in 1947.[11]

Table 1: Outline of selected early digital computers

Year	*Name*	*Inventor*	*Digital?*	*Fully electronic?*	*Turing-complete?*	*Programmable?*	*Stored-program?*
1939	ABC	John Atanasoff, USA	Yes	Yes	**No**	**No**	Yes
1941	Z3	Konrad Zuse, Germany	Yes	**No**	Yes	Yes	Yes
1943	Colossus	Tommy Flowers, UK	Yes	Yes	**No**	Yes	**No**
1946	ENIAC	John Mauchly & Presper Eckert, USA	Yes	Yes	Yes	Yes	Yes

Eastern Bloc computer industry

Regardless of which individual rightfully claim the title of "inventor of the digital computer", even before World War II, the technological developments that would pave the way to digital computing were largely in the hands of the United States and the United Kingdom.[12] The Soviet Union produced its first digital computer in 1950: the MESM, designed by Sergey Lebedev in Kiev.[13] Though about half a decade behind the UK and the US, Lebedev's computer was nevertheless the earliest stored-program computer to operate in continental Europe.

Just like in the West, in the early days of Soviet computing, the chief and often only objective were military calculations. Computers were meant to aid the Soviet defence programmes in developing nuclear weapons, ballistic missiles and an anti-missile defence system.[14] MIT computing historian Slava Gerovitch argues that throughout its existence, the Soviet computing industry was torn between two clearly clashing objectives: to

[11] McCartney, Scott. *ENIAC: The triumphs and tragedies of the world's first computer* (New York City, New York: Walker & Company, 1999). ISBN 9780802713483.
[12] Cortada (2009): 507.
[13] Graham, Loren R. *Science in Russia and the Soviet Union: A Short History*. (Cambridge: Cambridge University Press, 1993): 256. ISBN 0521287898.
[14] Gerovitch (2001): 264.

"overtake and surpass" Western scientific achievements, and yet at the same time to "criticize and destroy" the capitalist ideology of Western scholarship.[15]

While the Soviet Union has been perceived as technologically backward in relation to the Western powers, its computer industry did in fact develop largely in parallel to the West from the 1940s to the mid-1960s.[16] The post-war years under Stalin were a period of ambitious large-scale industrial development in the Soviet Union and science and technology had reached the levels of a cult in the Stalinist Soviet society.[17]

Furthermore, while computers were not applied as extensively as in the US, in the 1970s the Soviets did boast a larger computer industry than either the UK or France. As many as 500,000 people were directly or indirectly involved in the Eastern Bloc computer industry at the time.[18] Up until its dissolution, the Soviet Union maintained an entirely government-administered technology industry. This stands in contrast to France and the United Kingdom, where the government acted through mild incentives or direct policies, but largely left the computer industry to private business, in accordance with their capitalist economies.[19]

By the 1960s, the computer "came of age all over Europe"[20] and all of the Eastern Bloc countries had their own computer industries, associated with that of the Soviet Union. By the early 1960s, the Soviet satellite states in Eastern Europe each had the technological capacity to construct digital computers. Independently, Yugoslavia had developed its own computer industry: CER-10, the first Yugoslav computer, was constructed at the Mihajlo Pupin Institute in Belgrade in 1960.[21]

From the 1970s on, though, the Soviet Union enacted several failed policies in its computer industry, which set it markedly behind the West in that sphere's development. The Soviets focused on the IBM 360 technology, which was quickly outdated. Moreover, they split their industry into three, dividing microelectronics, general-purpose computers and control computers between three different ministries with little to no coordination between them. As a result, despite their very heavy investment in computer technology, "the Soviets never caught up with the West" after the 1960s.[22]

---

[15] Gerovitch (2001): 255.
[16] Cortada (2009): 507.
[17] Gerovitch (2001): 254.
[18] Cortada (2009): 508.
[19] Cortada (2009): 507.
[20] Cortada (2009): 500.
[21] Protić, Jelica, and Dejan Ristanović. "Building computers in Serbia: The first half of the digital century". *Computer Science and Information Systems* 8 (2011): 549-571.
[22] Cortada (2009): 509-510.

In the context of the birth of computer art in the mid-1960s, it is obvious that the technological conditions necessary for its appearance in communist Eastern Europe were at least partially available. As demonstrated in the table below, all Eastern Bloc nations and Yugoslavia had developed their own digital computers by 1963.

The one exception is Albania, which left the Soviet sphere of influence in 1961.[23] Albania sided with China in the Sino-Soviet split and as a result ended up in a state of considerable isolation within Europe, left without support by neither of the superpowers nor any of their continental allies. Albania only developed its own digital computer technology in 1975, aided by Chinese specialists.

Of course, internally developing computer technology is only one metric as to the technological level of a country with regard to computing. Foreign-built computer technology could have been imported and adapted for local use. But nevertheless, it reveals a lot about the degree of investment in local computer technology that Eastern Bloc governments exhibited.

[23] Logoreci, Anton. *The Albanians: Europe's Forgotten Survivors* (London: Victor Gollancz Ltd., 1977): 128-129. ISBN 9780891588276.

Table 2: Timeline of the first digital computer designed in each Eastern European country				
Year	*Country*	*Name*	*Chief designer*	*Notes*
1950[12]	Soviet Union	MESM	Sergey Lebedev	
1956[24]	East Germany	D1	N. J. Lehmann	
1957[25]	Czechoslovakia	SAPO	Antonín Svoboda	
1957[26]	Romania	CIFA-1	Victor Toma	
1959[27]	Hungary	M-3		
1959[28]	Poland	XYZ		
1960[20]	Yugoslavia	CER-10	Tihomir Aleksić	Not part of the Eastern Bloc.
1963[29]	Bulgaria	Vitosha	*Bulgarian Academy of Sciences*	
1975[30]	Albania	?	*Tirana University*	Not part of the Eastern Bloc after 1961.

[24] Bruderer, Herbert. *Konrad Zuse und die Schweiz: Wer hat den Computer erfunden?* [Konrad Zuse and Switzerland: Who invented the computer?] (Munich: Oldenbourg Verlag, 2012): 62. ISBN 9783486716658.
[25] Durnová, Helena. "Sovietization of Czechoslovakian computing: The rise and fall of the SAPO project". *Annals of the History of Computing* 32 (2010): 21.
[26] Filip, Florin G. "Information technology culture dissemination in Romania." *Knowledge, Technology Transfer and Foresight* (Springer Netherlands, 1996): 150.
[27] Kovács, Győző. "The short history of M-3, the first Hungarian Electronic Digital Tube Computer". *IT Star Newsletter* 6 (2008): 4-6.
[28] Łukaszewicz, Leon. "On the Beginnings of Computer Development in Poland". *Annals of the History of Computing* 12 (1990): 103-107.
[29] Nitusov, A. Y. "Computer Development in the Socialist Countries: Members of the Council for Mutual Economic Assistance (CMEA)". In *Perspectives on Soviet and Russian Computing* (Springer Berlin Heidelberg, 2001): 208-219. ISBN 9783642228155.
[30] Szuprowicz, Bogdan. "China Planning To Export Computers". *Computerworld* 14 (1980): 81.

Brief history of Western computer art

Generative beginnings: the first wave of computer art

The computer was still a bulky, complicated and hostile-looking machine in the 1960s. But its "coming of age" did mean that it was accessible to more and more people. And particularly, to a different kind of people from the military scientists who had monopolized its use in the decades before. In the 1960s, computers arrived in Western universities, places with much fewer restrictions and a natural potential for contact between fields and disciplines than military laboratories.

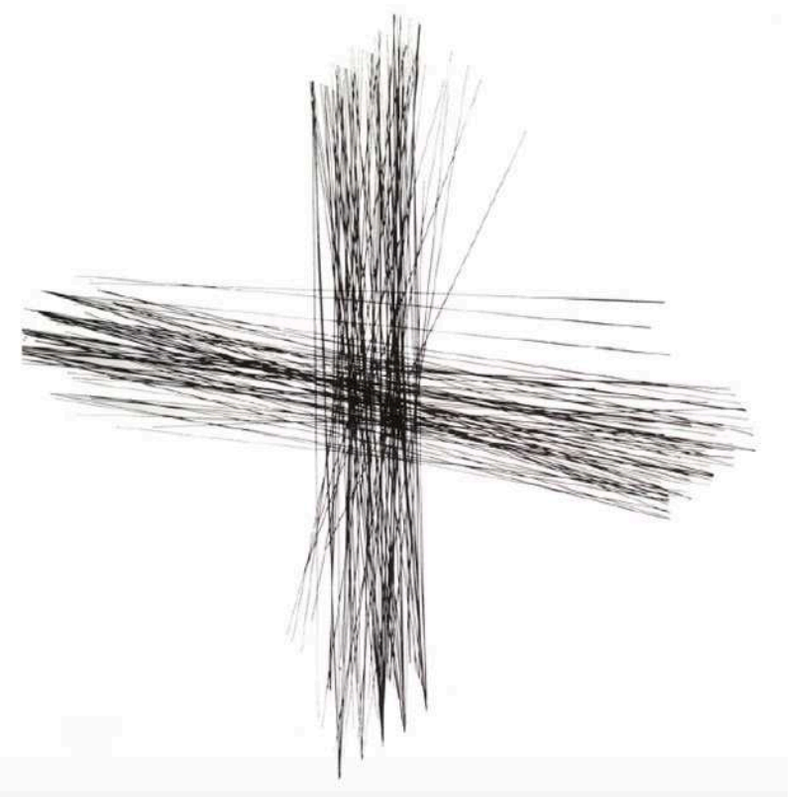

Figure 3: Georg Nees' Andreaskreuz *of 1965, one of the first exhibited works of computer art.*

Curiously, the first three exhibitions of computer art happened almost simultaneously, all in 1965. On 5 February 1965, philosopher Max Bense invited a group of artists, students and scientists to a seminar room at the Technical University of Stuttgart in West Germany. In the room, around a dozen computer-generated graphic works by engineer Georg Nees were exhibited for two weeks, marking the first exhibition of computer art in history.[31]

In his article on the first decade of computer art, Frank Dietrich calls this seminal moment a "historical breakthrough": the first time a computer was involved in "the exclusive domain of the humans: the act of creation". [32] And behind all this was Max Bense's theoretical work on generative aesthetics, his search for the laws of aesthetics; his brief three-page text in the 19th issue of the *rot* publication in 1965, accompanied by the artworks of Georg Nees, has to be considered essentially a manifesto of computer art.[33]

Also in 1965, but from 6 to 24 April, Béla Julesz and A. Michael Noll exhibited their computer artworks at the Howard Wise Gallery in New York. Another show took place in

[31] Nake (2009): 77.
[32] Dietrich, Frank. "Visual intelligence: The first decade of computer art (1965-1975)". *Leonardo* 19 (1986): 159-169.
[33] Nake (2009): 80.

Stuttgart from 5-26 November 1965 too: featuring computer art by Georg Nees and Frieder Nake at the Galerie Wendelin Niedlich.[34] To sum up this breakthrough year in the words of Nake, "The computer was about twenty years old, when computer art appeared. Was this late? Was it early? It was in time."[35]

All of the participants in this first phase of computer art were engineers or mathematicians rather than "professional" artists. Only in the second phase did professional artists dare interact with the world of computing, as opposed to people without a formal artistic background engaging with aesthetics. To Frieder Nake, one of the key participants in the birth of computer art, this distinction is "ridiculous" and he blames it on the art world's notorious exclusivity.[36] Indeed, up until the mid-1990s, computer art remained on the fringes of modern art and curators and art historians would undeservedly ignore it.[37]

Herald of a digital future: *Cybernetic Serendipity*

The best-known event of early computer art, which has been seen as a true landmark and has attained the status of a legend, was the *Cybernetic Serendipity* exhibition in London from 2 August to 30 October 1968. Curator Jasia Reinhardt, Associate Director of the Institute of Contemporary Arts in London, was much like other early pioneers inspired by philosopher Max Bense to „look into computers", and the resulting work was this seminal exhibition at the new ICA quarters at Pall Mall.[38]

Cybernetic Serendipity took place in a turbulent time in history, contemporaneous with the Prague Spring and its subsequent suppression by a Soviet-led invasion as well as the anti-Vietnam War protests in Chicago. One year earlier, in 1967, the Summer of Love had heralded a sexual and cultural revolution. Yet the exhibition has been widely criticized for largely ignoring these social phenomena of its time. And furthermore, it widely sought sponsorship by the military-industrial complex, which may have prevented any attempt for social critique at the exhibition.[39] Corporate giants like IBM, Boeing, General Motors, Westinghouse and the military itself, represented by the U.S. Air Force research labs, aided

[34] Ibid.
[35] Nake, Frieder. "Paragraphs on computer art, past and present". *Proceedings of CAT 2010 London Conference* (2010): 56.
[36] Nake, (2009): 81.
[37] Fernández, María. "Detached from HiStory: Jasia Reichardt and Cybernetic Serendipity". *Art Journal* 67 (2008): 6-23.
[38] MacGregor (2002): 11:13.
[39] MacGregor (2002): 12.

with funding and participation to the success of *Cybernetic Serendipity*.[40] The exhibition's budget amounted to the significant $45,000-48,000,[41] of which a large part must have been contributed by the corporate world.

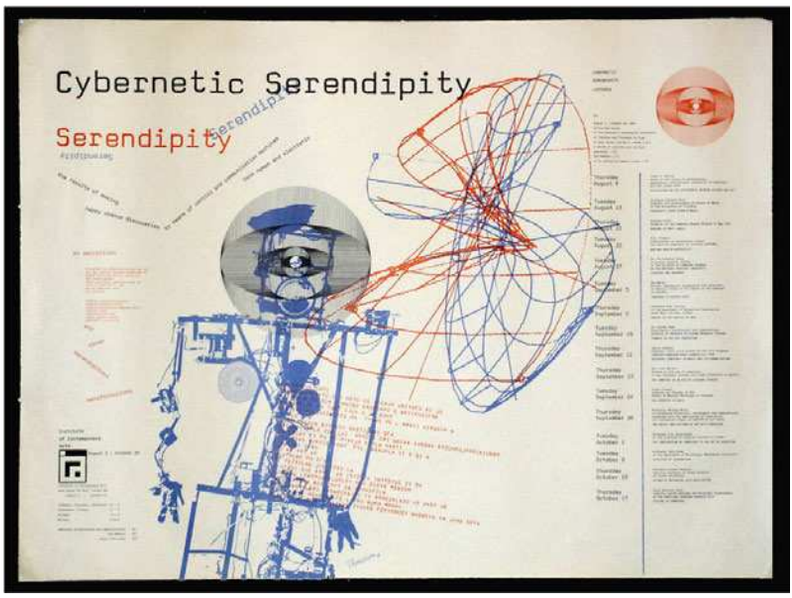

Figure 4: Poster inviting visitors to Cybernetic Serendipity *in 1968.*

Cybernetic Serendipity may be characterized as the key event of the second wave of computer art, in that it for the first time involved professional artists engaging in aesthetic experiments with computers. Though to be fair, digital computers were rather underrepresented at the London exhibition – many of the artworks were created by analog means and only two digital computers were exhibited. Of these, one did not feature any aesthetic effort at all, and the other, a music composition machine, was removed prematurely by its owner.[42]

Regardless of its less-publicized shortcomings, *Cybernetic Serendipity* fully deserves its fame for its merits for the acceptance of computer art in the art world and the public eye alike. 130 people contributed to the exhibition, of whom 43 were from the creative field and 87 had a technical or scientific background. The impact on society cannot be overestimated – between 45,000 and 60,000 people "of all ages, all types, all nationalities, all classes" visited the exhibition over its three-month span.[43] The reviews in the press were laudatory and resounding – *Cybernetic Serendipity* was "guaranteed to fascinate anyone from toddling age to the grave" and it "lured … people who would never have dreamed of attending an ICA exhibition before".[44]

In short, *Cybernetic Serendipity* told the (Western) world that computer art had arrived.

[40] Usselmann (2003): 390.
[41] Rosen (2001): 29, 41.
[42] Edmonds (1994): 12.
[43] Usselmann (2003): 389.
[44] Usselmann (2003): 390.

Straddling the barrier: computer visual research at *New Tendencies*

On the very same day that *Cybernetic Serendipity* opened in London, another key event of early computer art commenced in Zagreb, in the non-aligned People's Republic of Yugoslavia. The colloquy "Computers and Visual Research" (*Kompjuteri i vizuelna istraživanja*) was organized as part of the *New Tendencies* movement, an international collaboration of artists that hosted five exhibitions in Zagreb from 1961 to 1973, with several others in Western Europe.[45]

New Tendencies sought to demystify art, to engage the visitor through interaction and to make him an active participant. Thus, art would become more democratic, more social, less a stroke of genius than programmed, systematic research into aesthetics. With its avant-garde abstract and object-oriented ideas, *New Tendencies* had achieved worldwide renown by 1965; at the same time, the movement found itself in an undeniable crisis. An exhibition at the Museum of Modern Art in New York had established *New Tendencies* on the global stage, but many members felt that the public had misunderstood their ideas. Their work was seen more as "design and decoration" rather than visual research, and the severity of the situation threatened the very existence of *New Tendencies* itself.[46]

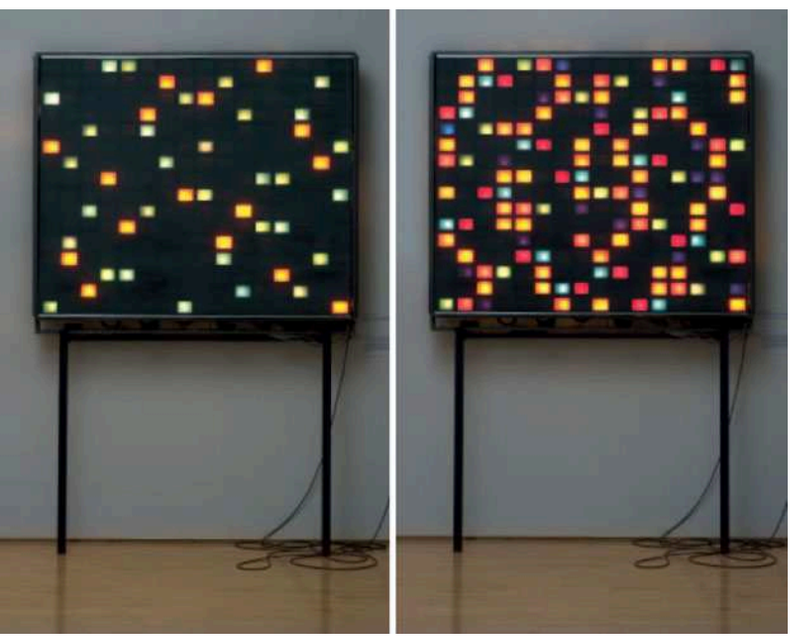

Figure 5: Croatian engineer Vladimir Bonačić exhibited the only computer-based interactive objects as part of "Computers and Visual Research".

In 1968, the colloquy "Computers and Visual Research" breathed new life into the stalling artistic movement. Based on the generative aesthetics of Max Bense and Abraham Moles that had also inspired *Cybernetic Serendipity*, the colloquy promoted an active collaboration between artists and scientists within the emerging realm of computer technology. By avoiding the term "art", the colloquy put artists and scientists on equal, neutral ground, where they would feel equally comfortable to pursue visual research with the new technological means.[47]

[45] Rosen (2011): 49.
[46] Rosen (2011): 11.
[47] Rosen (2011): 45.

Participants included already established figures of Western computer art like Georg Nees, Frieder Nake, A. Michael Noll, Marc Adrian, Charles Csuri, Kenneth Knowlton and Leslei Mezei, but also local Yugoslav artists and scientists like interactive computer installation art pioneer Vladimir Bonačić.[48]

It is no coincidence that *New Tendencies* and its computer art colloquy happened in Yugoslavia. In fact, "there was practically no chance" that a movement with such a conceptual profile could have been based anywhere else. The New Tendencies members were vehemently opposed to the capitalist-dominated workings of the Western art market; at the same time, the political and social situation in the Eastern Bloc was such that modern art trends were not tolerated by the Soviets and their puppet regimes. As a non-aligned communist state "outside of the existing Cold War division of the world" into opposing blocs, Yugoslavia was the only possible location for *New Tendencies*. And as a city with a modern art scene bustling at the time and rich artistic traditions between West and East, Zagreb was a natural hub of the movement.[49]

Eastern Bloc participation in "Computers and Visual Research" was limited to two Czechoslovak individuals. Theorist and curator Jiří Valoch, then 21-year-old and fresh from organizing the *Computer Graphic* exhibition in his home country amid the Prague Spring, lectured at the 1968 colloquy.[50] His compatriot Zdeněk Sýkora, who had exhibited non-computer works at *New Tendencies 3* in 1965 already, was present in 1969 to showcase his computer collaboration with programmer Jaroslav Blažek.[51]

Engineer Lubomír Sochor, who had been the only Czechoslovak representative in Valoch's first exhibition, was set to take part in "Computers and Visual Research" as well, but there is no information that his works were ever exhibited during the event.[52] The Russian kinetic art group Dvizhenie, headed by Lev Nusberg, and an "Anonymous Collective" of Hungarian artists participated in several editions of *New Tendencies*, but not in the "Computers and Visual Research" sections of the events, as their artwork did not involve computers.[53]

While the Eastern Bloc was only marginally represented in the Zagreb events' computer art agenda, *New Tendencies* does constitute an important (and rare) point of contact between Eastern and Western computer art. For a few years only at the turn of the 1960s, the

[48] Rosen (2011): 243.
[49] Rosen (2011): 24.
[50] Rosen (2011): 283.
[51] Rosen (2011): 361.
[52] Rosen (2011): 284.
[53] Rosen (2011): 542-547.

emerging Czechoslovak computer art scene could be in touch with the latest developments in this genre. This was very likely a decisive factor in Czechoslovak computer art's markedly more advanced development than the scenes in other Eastern Bloc countries.

Though *Cybernetic Serendipity* and its wide-reaching echo may have announced computer art to the Western public, *New Tendencies'* "Computers and Visual Research" may well have had a more significant impact for the formation of a symbiosis of artists and scientists, a true "third culture" necessary for a vibrant community dedicated to visual research using the new computer technology.

Furthermore, "Computers and Visual Research", having built upon *New Tendencies'* established artistic tradition based on Concrete, neo-Constructivist, Kinetic and Optical art,[54] clearly reveals how the computer arrived in art, in the terminology of Austrian theorist Peter Weibel, not as a violent "intrusion", but as a result of a natural demand among artists and researchers – a welcomed "inclusion".[55]

[54] Rosen (2011): 11.

[55] Rosen (2011): 47-48.

Computer art in the Eastern Bloc

It might be natural to assume that as computer art was being born in the West, where conditions were ripening for such a merger of art and technology, the East would have been silent, inactive and clueless. Like this study attempts to show, however, this was far from the case.

Despite the more difficult access to technology, the negative official policy towards modern art and the restrictive societies that were the norm in the Eastern Bloc, computer art did exist and did happen in this part of Europe. And quite remarkably, it was right up there with the West from the very beginning.

In the following sections, the development of computer art in each country of the Eastern Bloc is reviewed separately. Some historical notes and remarks on the artistic conditions in each state are offered as context and comparisons are made between countries as well as with the West.

Czechoslovakia

Historical and cultural context

A landlocked country in Central Europe with its capital in Prague, Czechoslovakia existed with interruptions between 1918 and 1992. It was born out of the desire of the Czech and Slovak people to form a country after the fall of the Austro-Hungarian Empire after World War I, and lasted until the two peoples' peaceful "Velvet Divorce" on 1 January 1993. Today, Czechoslovakia's heritage and territory belongs to two countries: the Czech Republic and Slovakia.

After its occupation by Nazi Germany in World War II, Czechoslovakia was reinstated as a communist republic under Soviet domination. It was a member of the Warsaw Pact and the Eastern Bloc. Czechoslovakia's development as a communist state was marked by regular, often violent protests. A brief but notable period of liberalization under Alexander Dubček in the first half of 1968 called the Prague Spring was brutally suppressed by a coalition of Warsaw Pact states led by the Soviets.

Politically, from 1969 Czechoslovakia was a *de jure* federation of two constituent people's republics. However, as the institutions of both were centrally controlled by the Czechoslovak Communist Party, the federal aspect remained relatively limited.

While it was among the most economically developed communist states, over time Czechoslovakia nevertheless fell behind the West, with which it had been largely at par before communism, in terms of economic development and standard of living.

The Czech Republic and Slovakia have an illustrious artistic past. Composers like Bedřich Smetana and Antonín Dvořák, painters like Alphonse Mucha, Koloman Sokol and František Kupka and film directors like Miloš Forman stand out in their creative history.

Like elsewhere during communism, however, the Czechoslovak art was largely under government control. A single professional organization, the Union of Artists, was responsible for official artistic life in the country. And the Union of Artists exclusively promoted the descriptive art form of socialist realism, which was meant to glorify the proletariat and the achievements of the communist regime and promote communist values. Modern art in any form was frowned upon and discouraged by the Union of Artists.[56] However, at the same time the 1960s were a period of a more and more pronounced "thaw" or "defrosting" in Czechoslovak society and art after the end of Stalinism, which allowed for a greater degree of free expression.[57] In general, Czechoslovakia also exhibited more political freedom and less direct Soviet control than other Eastern Bloc states, even Hungary and Poland.[58]

Czechoslovak computer art

Thanks to the work of Martin Šperka and other researchers, the history of computer art in Czechoslovakia has been brilliantly documented.[59]

Its roots can be traced back to 1962, when Miroslav Klivar, an artist and theoretician, published his article "Cybernetics and Theory of Reflexion Related to Art" in a Slovak cultural journal. The article reported on some first computer experiments in the United States and commented on simulating creativity via machines.[60]

Eastern Bloc beginnings: Sýkora & Blažek

Notably, the first practical engagements in computer art in Czechoslovakia are among the first anywhere in the world. In 1966, just a year after the first ever algorithmic art was exhibited in Stuttgart and New York, painter **Zdeněk Sýkora** began his collaboration with mathematician **Jaroslav Blažek** to create computer-aided fine art.[61]

---

[56] Šperka (1994): 45.
[57] Piotrowski (2009): 63.
[58] Piotrowski (2009): 55.
[59] Ibid.
[60] Šperka (1994): 47.
[61] Ibid.

Sýkora (1920-2011) was a painter and native of Louny in the northwestern Czech Republic whose fascination with computer art followed a natural progression. A student at the Mining University in Příbram before World War II and then at the Charles University in Prague just after the war, Sýkora became an assistant at the latter's art education institute in 1947.[62]

He became interested in geometric, abstract compositions employing repeatable basic elements in 1961 and joined the art group Crossroad (*Křižovatka*) in 1963.[63] Already then, he instinctively applied quasi-algorithmic rules to his compositions, as shown in his early *Gray Structure* (1962-1963). The oil painting is a mesh of basic rectangles, each constructed by four internal triangles and a central rhomboid. While the rhomboid is usually white, the triangles may be black, light grey or dark gray. To this, Sýkora applied the rule of two areas of the same colour never touching each other. In addition to noticing a distinct sensation of movement, Sýkora also realized that were he to continue with his artistic explorations, the required combinatorics would be much more efficiently solved via a computer.[64]

For his computer artworks, Sýkora approached Jaroslav Blažek, who wrote a program for a West German-built LGP-30 computer. The program incorporated aesthetic combinatorial rules designed by Sýkora. The entire process involved an intriguing collaboration between the artist and the computer. At first, the artist would place several key elements on a grid and indicate areas where he desired a higher or lower colour density. Then, the computer would "fill out" the rest of the grid, obeying four algorithmic rules set by the team and related to the colour and shape of the basic elements.[65] The computed numerical grid would finally be used by the artist to create an oil-on-canvas painting; as such, it must be noted, Sýkora's works are not computer graphics.

This approach was applied to several of Sýkora and Blažek's works from the second half of the 1960s. Examples include the *Black-white Structure* painting from 1966 and its larger-scale ceramic cousin from 1969. In the same year, Sýkora and Blažek expanded the algorithm to also compute colour pairs. The outcome was the oil on canvas piece *Multi-coloured Structure*,[66] among other works.

[62] Rosen (2011): 562.
[63] Ibid.
[64] Sýkora & Blažek (1970): 409.
[65] Sýkora & Blažek (1970): 410-411.
[66] Sýkora & Blažek (1970): 413.

Sýkora first exhibited his computer art in late 1967. The exhibition *Constructive Tendencies from Czechoslovakia* took place in Frankfurt, West Germany, and presented six Czech artists, including Sýkora. The event was hosted by the premises of the Goethe University in Frankfurt and lasted from 3 November to 15 December 1967.[67] Sýkora was also present at the "Computers and Visual Research" colloquy in Zagreb, part of the *Tendencies 4* exhibition in the spring and summer of 1969; there, he was one of very few artists who had exhibited at *New Tendencies* before, having been represented with non-computer works in 1965.[68] In the 1969 colloquy and exhibition, Sýkora showcased his *Black-white Structure*.[69]

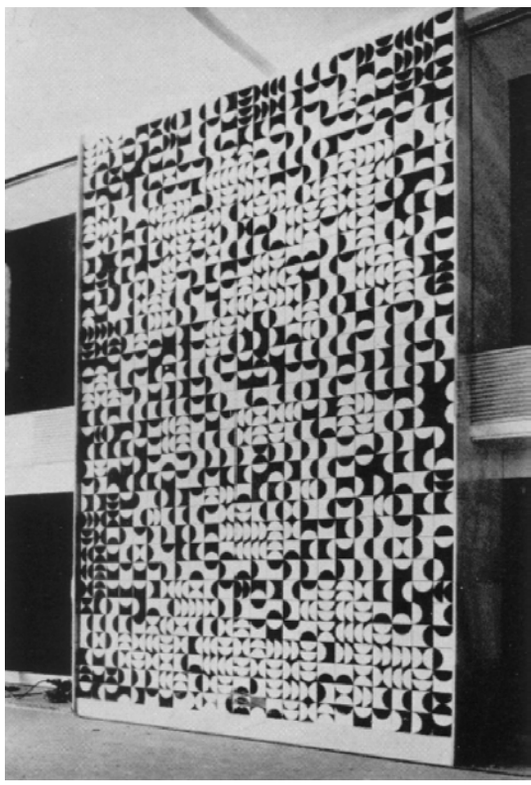

Figure 6: Sýkora's ceramic Black-white Structure *from 1969.*

Sýkora considered himself "a component of his artworks, but not their determining force", a statement contrasting with the classical notion of aesthetics, wherein the artist creates the artwork as the sole decision-maker.[70] Sýkora believed that his interaction with the computer undoubtedly influenced his artistic work, making it more exact and logical and allowing him to violate artistic conventions with regard to composition and repetition.[71]

In a curious parallel between West and East, Czech researcher Jan Andres compares Sýkora's work with that of French abstract artist François Morellet. Though they both mostly lived in small towns on either side of the Iron Curtain and met less than a dozen times, Sýkora and Morellet were able to communicate and forged a lifelong friendship.

Curiously, the two explored geometric art using diametrically different methods and "theoretically antagonistic positions", but Andres finds distinct "outward parallels and [an] internal complementarity" in the art of Sýkora and Morellet from the 1950s and 1960s. Morellet never used a computer and favoured a deterministic approach; on the other hand, Sýkora was a computer art pioneer who believed in wild randomness, a high variability and a complete absence of deterministic limitations. Yet a quick comparison between Morellet's *Répartition aléatoire de 40000 carrés suivant les chiffres pairs et impairs d'un annuaire de*

[67] Klütsch, Christoph. "The summer 1968 in London and Zagreb: starting or end point for computer art?". *Proceedings of the 5th conference on Creativity & cognition* (2005): 109-117.
[68] Rosen (2001): 539.
[69] Rosen (2001): 393.
[70] Gassen (1995): 44.
[71] Gassen (1995): 87.

telephone from 1958 and Sýkora's *Square Structure* from 1963 is enough to reveal a strong outward similarity, despite the markedly different underlying methodologies.[72]

Valoch and the first computer art exhibitions in Eastern Europe

In February 1968, winter weather may have still reigned over Czechoslovakia, but the Prague Spring was beginning to bloom. The Slovak reformist Alexander Dubček had been elected First Secretary of the Communist Party on 5 January and his efforts to liberalize the regime into a version of "socialism with a human face" were already unravelling. Dubček sought to grant wide-reaching rights to the Czechoslovak society, including a freedom of speech and movement unmatched in the Eastern Bloc, as well as the abolishment of media censorship.[73]

Undoubtedly, this climate of optimism and positive change would have affected the republic's artistic life at the time. And it is no coincidence that precisely then, the first exhibition of computer art in Eastern Europe was organized in Czechoslovakia thanks to the efforts of theoretician, curator and artist **Jiří Valoch**. Valoch's travelling exhibition was named *Computer Graphic* and preceded *Cybernetic Serendipity* in London and the "Computers and Visual Research" event of the Zagreb-based *New Tendencies* by several months.[74]

In February 1968, the Czech city of Brno welcomed an exhibition of computer artworks by several pioneers of computer art: Charles Csuri and A. Michael Noll of the United States, Leslie Mezei of Canada and Frieder Nake and Georg Nees of Germany. A single Czechoslovak representative was included in the exhibition, the engineer **Lubomír Sochor**. In March and April respectively, the same exhibition subsequently travelled to two other Czechoslovak towns, Jihlava and Zlín (from 1949 to 1990 known as Gottwaldov). All of these are today in the central and eastern Czech Republic.[75]

In Brno, *Computer Graphic* was hosted by the Brno House of Arts (*Dům umění města Brna*), which still exists today as a local gallery with a focus on contemporary art. The Jihlava venue was the Regional Gallery of Vysočina (*Oblastní galerie Vysočiny*). And in Gottwaldov/Zlín, the exhibition took place at the Regional Gallery of Contemporary Art (*Oblastní galerie výtvarného umění*).

---

[72] Andres, Jan. "Zdeněk Sýkora and François Morellet: Parallels and Complementarity". *Leonardo* 47 (2014): 27-31.
[73] Williams, Kieran. *The Prague Spring and its aftermath: Czechoslovak politics, 1968-1970*. (Cambridge: Cambridge University Press, 1997). ISBN 9780521588034.
[74] Nake (2009): 85.
[75] Šperka (1994): 47.

Valoch also issued a catalogue of the exhibition. Besides selected reproductions of artworks by Nake, Nees and Sochor, it included brief Czech-language texts by Valoch on programming art, an excerpt by Max Bense on generative aesthetics, remarks by Frieder Nake on computer art and a few notes by Lubomír Sochor on the algorithmic creation of his computer graphics.[76]

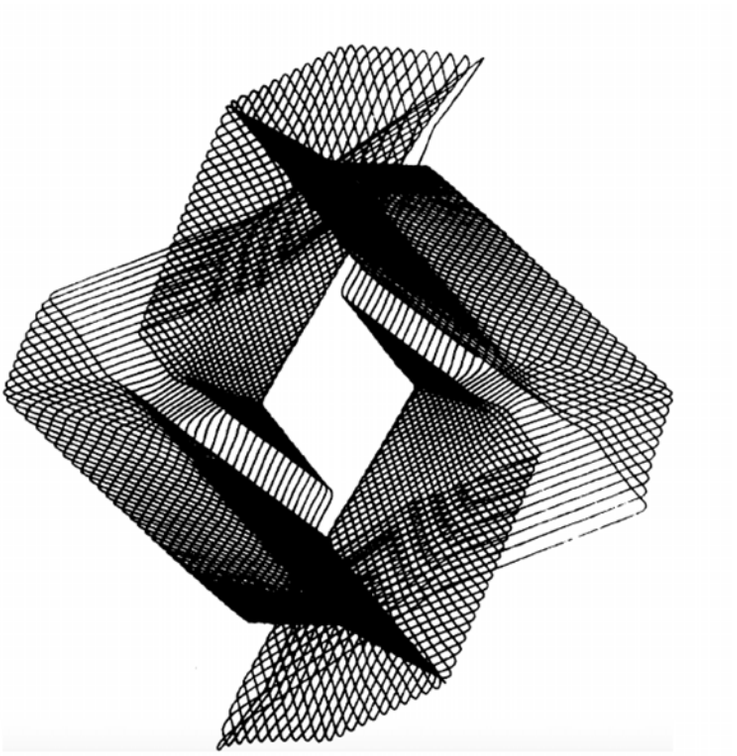

Figure 7: Lubomír Sochor was the only Czechoslovak author represented in Jiří Valoch's seminal 1968 exhibition.

Sochor, born in 1938, had studied telecommunication engineering before finding employment in the fields of servomechanics, automation and analog computing. In October 1966, he was hired by the Prague military hospital's (analog) computer centre and it was there that he first engaged in his exploration of computer technology to create aesthetic visuals.[77]

In his lecture at the "Computers and Visual Research" colloquy of the *Tendencies 4* exhibition in Zagreb later in 1968, Valoch describes Sochor's analytical research approach to computer graphics. Valoch notes that before he experimented with computer graphics, Sochor did not consider himself a creator, nor "someone with extraordinary aesthetic interests". In his lecture, Valoch also emphasizes that Sochor uses analog computing technology rather than digital means and contrasts between Sochor as an engineer curious about art and Sýkora as an artist with an interest in technology.[78]

Computer Graphic reveals that during the genesis of computer art, a significant degree of co-operation must have existed between East and West. Valoch must have been allowed to communicate with Western artists both in neighbouring West Germany and far away in North America. And Valoch's relations with the Western artists and theoreticians of computer art date to before the onset of the Prague Spring in January 1968. Frieder Nake's text for the catalogue, for example, was completed in October 1967, and he personally attended and gave a lecture at the exhibition's opening in Brno.

---

[76] Valoch, Jiří. *Computer Graphic: katalog k výstavám* [Computer Graphic: Exhibition catalogue]. (Brno: Dům umění města Brna, 1968).
[77] Rosen (2011): 284.
[78] Rosen (2011): 283.

Clearly, the Prague Spring was not the only factor that made this co-operation across the Iron Curtain possible. Even prior to the Prague Spring, conditions in Czechoslovakia must have been tolerant enough to contemporary art and to professional communication with the West to make *Computer Graphic*'s planning and organization possible.

There appears to be no data as to how many people visited the travelling exhibition in its three locations; most likely such statistics were never actually kept at all. But the social conditions in the country had been newly liberalized, the novelty factor of computers was at the time quite alluring and the status of the venues where the exhibition took place is respectable without a doubt. The venues were all eminent state-funded regional galleries, either the only or perhaps one of very few in the respective towns. Based on all of this, it can be assumed that a significant number of local art enthusiasts were able to peek into the world of computer art for the first time in Eastern Europe.

Valoch, born in 1946, was a 21-year-old student of German and Czech studies and aesthetics in Brno at the time he organized and curated *Computer Graphic*. After the event, he continued his engagement with the theory and practice of contemporary art. The same year, he was again a prominent participant and lecturer at the "Computers and Visual Research" colloquy in Zagreb, where he discussed the role of the computer as a creator or a tool in art.[79] Subsequently, the possibility of placing him in the jury for the planned next year's edition of the event was discussed by the Organizational Board,[80] but he ended up not being selected to sit among the seven members and he was absent from the 1969 colloquy.[81]

In the 1960s and 1970s, Valoch authored multiple works of concrete and visual poetry, experimenting with twisting the border between word and image. From the 1970s on, he was also the curator of the Brno House of Arts, the first stop of the *Computer Graphic* exhibition.[82]

After the downfall of Czechoslovakia, Valoch was revealed to have been an agent of the country's communist-era State Security (*Státní bezpečnost,* StB) secret police force. Valoch began cooperating with StB from 1973 on, when he was formally recruited under the codename "Václav".[83] Whether this follows up on prior informal ties with StB that would

[79] Rosen (2011): 283-284.
[80] Rosen (2011): 287-288.
[81] Rosen (2011): 363.
[82] Hošková, K. "Umění ve veřejném prostoru" [Art in public space] (Bachelor thesis, Faculty of Pedagogy of the Masaryk University of Brno, 2013): 16-17.
[83] (2008-2013). *Evidenční záznamy podle § 7 zákona č. 107/2002 Sb* [Accounting records in accordance with § 7 of the Act no. 107/2002 Coll.]. Archiv bezpečnostních složek („Security Services Archive"). Records 24114, 35507.

go some way to explain his extensive contacts with the West, or whether this affected his subsequent work in computer art and his curatorship, remains unclear.

Capital debut: *Computer and Art* by Klivar

Valoch's *Computer Graphic* was not an isolated case in Czechoslovakia. Incredibly, despite the turbulent end of the Prague Spring, an exhibition of computer art was held in the capital Prague in September 1968, organized by the Slovak artist **Miroslav Klivar**.[84]

As its name subtly reveals, the liberal regime of the Prague Spring did not last long. Dubček's reforms came as a shock to the Soviets, who felt that if the trend continued, it might lead to Czechoslovakia slipping away from the Soviet orbit like Yugoslavia had done in the 1950s. Furthermore, the Prague Spring threatened to cause a chain reaction of similar reforms in other Eastern Bloc states. Negotiations to curb the reforms were unsuccessful, and on the night of 20 August 1968 the troops of four Warsaw Pact states – the Soviet Union, Bulgaria, Poland and Hungary – invaded Czechoslovakia to oust Dubček and crush the liberalization efforts. The Czechoslovak government did not resist the invasion and the country was swiftly brought back under Soviet control. However, the population opposed the invaders through numerous acts of non-violent resistance.

In this climate of fear and uncertainty, computer art debuted on the stage in the Czechoslovak capital. *Computer and Art* was hosted by the Film Club (*Filmový klub*) in Prague, a member of a chain of cultural institutions typically showing art cinema. *Computer and Art* featured only Western artists; unlike Valoch's exhibitions, there was no Czechoslovak participation. The exhibition presented works by Georg Nees and Frieder Nake, two German computer artists who had also been part of Valoch's tour, as well as by the American Kerry Strand.

[84] Šperka (1994): 47.

Born in 1932 in Košice, eastern Slovakia, Klivar graduated from the Charles University in Prague in the 1950s. Throughout his life, he has remained an influential art critic and artist who has experimented with a variety of media, from poetry, painting and performance to algorithmic and video art.[85]

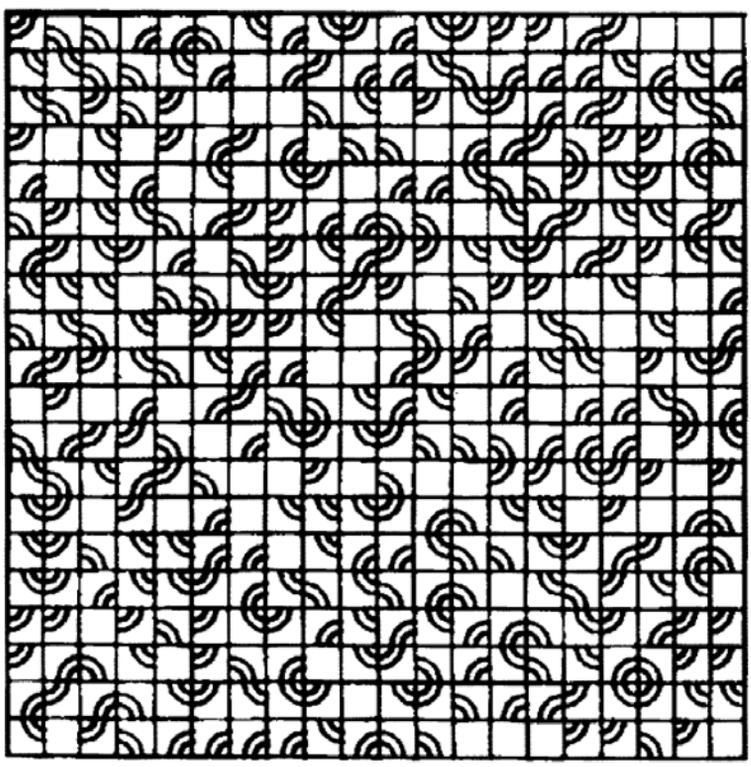

Figure 8: Miroslav Klivar's Structure II *computer drawing of 1979.*

Czechoslovak computer art in the 1970s and 1980s

In 1972, another notable artist (and a woman) entered the world of Czechoslovak computer art. **Zdeňka Čechová** authored computer graphics as well as designs for carpets, tapestries and other textiles, all-computer generated.[86] Later, she would expand into multimedia and video art in an artistic career which continues to this day. Nowadays, she presides over the Union of Czech Computer and Multimedia Artists and teaches at the Czech Technical University in Prague.

The collaboration of sculptor **Jozef Jankovič** and computer scientist **Imro (Imrich) Bertók** led to the creation of some of the first computer art in Slovakia, the eastern republic of the federation. Beginning in 1973, Jankovič and Bertok used digital computation to design reliefs and metal sculptures, which were often displayed in public spaces. In Jankovič and

[85] Zapletalová, B. V. *Algoritmický obraz v českém výtvarném* [The algorithmic image in Czech fine arts] (Master's thesis, Faculty of Pedagogy of the Masaryk University of Brno, 2014): 35.
[86] Šperka (1994): 47.

Bertók's common work, the outline shape of the human body is the common starting point of algorithmic manipulation and transformation.[87]

A metal wall sculpture on a hospital in Bratislava, for example, used computer technology to morph human faces and body parts into signals resembling those of an electrocardiograph. A second Bratislava hospital artwork by Jankovič is a computer-aided cast sand relief which morphs a human body shape into a circle and a human heart into a rounded square.[88]

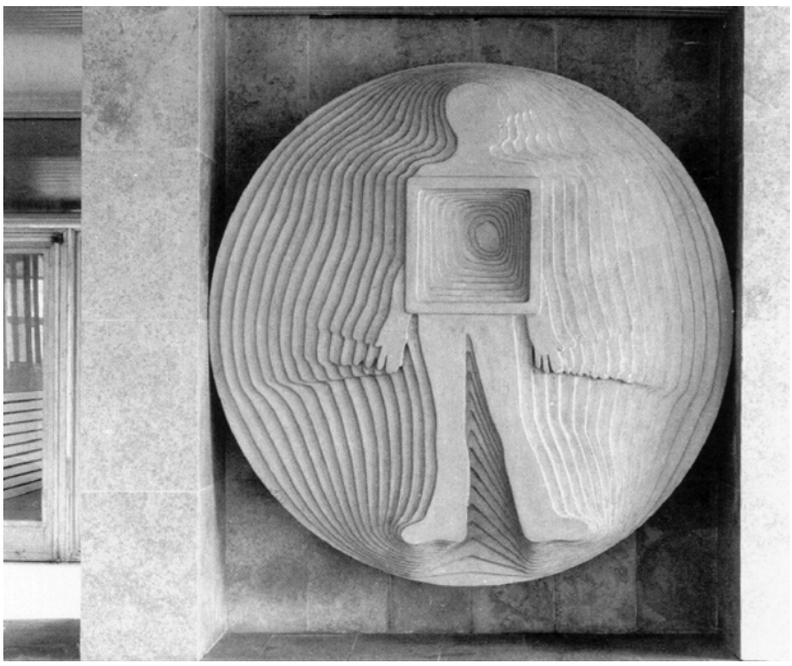

Figure 9: A computer-aided relief by Jozef Jankovič in Bratislava, 1984-85.

Before commencing his collaboration with computer scientist Bertók, Jankovič was already an established sculptor with a career spanning 20 years and he had experimented with computer graphics as a means of artistic expression on his own. Working together, the duo used different minicomputers to subject the human body shape to "computer experiments and program investigations", a process they compare to a human's struggle for survival and social and technical progress.[89] Commonly, the artist would design the initial human body shape, a set of algorithms conceived by the programmer would modify it (in their work at the turn of the 1980s, using an epicycloid curve) and the final output would then be determined by the artist's aesthetic vision.[90]

Jankovič's works, as a rule figurative in character in contrast to the complete abstraction of Sýkora's art, unwittingly have a lot in common with some earlier works of the Computer Technique Group (CTG) of Tokyo, Japan. Just like Jankovič, this Japanese group of artists was fascinated with transforming natural shapes through what they called "computer metamorphosis". A couple of famous CTG works from 1968, *Return to a Square A* and *Return to a Square B*, show the gradual transformation of a female profile to a square and back. Of course, CTG's works were largely computer prints rather than computer-aided sculptures as in Jankovič's art.[91]

---

[87] Bertók & Jankovič (1986): 28.
[88] Šperka (1994): 49.
[89] Bertók & Jankovič (1986): 27.
[90] Bertók & Jankovič (1986): 28.
[91] Taylor (2004): 89-90.

Another Slovak sculptor, **Juraj Bartusz**, involved the computer in his artistic practice around the same time as Jankovič. Bartusz exhibited in Košice and Bratislava in 1973 and 1974. His computer-aided metal sculptures were often based on the shape of the human body, though highly stylized and sometimes involving a degree of interaction (adjustability by the observer). Bartusz worked in a team with the programmer Vladimír Haltenberger, who was instrumental in computing the smooth boundary curves employed in the sculptures.[92]

Throughout the late 1970s and 1980s, a community of computer artists and computer graphics enthusiasts developed in Czechoslovakia. Computer art exhibitions were held regularly and nationwide computer graphics conferences followed suit every three or four years. The Czechoslovak Computer Art Exhibition took place three times between 1982 and 1989 as part of scientific conferences.

In some cases, scientific institutes would host unofficial art exhibitions, as official galleries were very hesitant to host "underground" modern art. Gradually, computer graphics in Czechoslovakia entered the realms of computer animation, architectural design and television titles.[93]

Šperka argues that "the use of computers was the only unifying force among computer artists. There was no group of computer artists cooperating and creating in one style or movement. Everybody had his or her own expressive language." While the work of Czechoslovak computer artists was undoubtedly unique in each individual case, it is apparent that a community of computer artists did exist. And it is not unreasonable to think that the pioneers of computer art in Czechoslovakia communicated with each other, inspired each other, shared ideas and mathematical and programming knowledge. After the Prague Spring, Czechoslovak computer artists were part of the "vibrant underground scene" of the Czechoslovak avant-garde. In contrast to official, government-sanctioned art, this "second circuit" was unofficial and to an extent private; it was exhibited at non-traditional institutions and existed in a "parallel cultural sphere [which] also had its own information distribution channels and its own hierarchies of value".[94]

True, the Czechoslovak computer art scene was not a unified movement like the *New Tendencies* of Yugoslavia, but its lack of homogeneity may have also contributed to its

[92] Šperka (1994): 48.
[93] Šperka (1994): 49.
[94] Piotrowski (2009): 248.

vitality, flexibility and ultimately, to its survival and unparalleled blossoming under the shadow of communist rule.

Soviet Union

Historical and cultural context

Founded in 1922 in the wake of the October Revolution of 1917 and the ensuing Russian Civil War, the Soviet Union was an enormous country in Eurasia. Officially titled the Union of Soviet Socialist Republics (USSR), it was the world's first communist state and the largest country in the world at the time, taking up one-sixth of the world's land area. Its economy and government were highly centralized, although it was a federation of constituent republics. As a single-party state, the USSR was controlled by the Communist Party (the Bolsheviks), and all of its land and industry were owned by the government.

The Soviet Union's first leader was Vladimir Lenin, a theorist of communism whose rule (1922-1924) was brief but highly influential. Under his more radical successor Joseph Stalin (1924-1952), the Soviet Union underwent a period of intensive industrialization, but also of an almost complete disregard for human rights, with millions being sentenced to forced labour in Gulag camps.

Though the Soviet Union had signed a treaty of non-aggression with Nazi Germany early in World War II, it was nevertheless invaded by Hitler in 1941. Millions on either side died in what was the bloodiest conflict in world history, but the Soviet Union prevailed, even marching into Berlin in 1945.

The Allied victory in World War II and the Soviets' decisive role essentially determined the USSR's near-complete dominance over Eastern Europe after the war and its decades-long position as one of two world superpowers, along with the United States. After failed attempts at liberalization and restructuring under Gorbachev in the 1980s, the Soviet Union disintegrated in 1991 into Russia and fourteen other post-Soviet states.

The artistic history of Russia and the Soviet Union includes some of the world's foremost artistic geniuses and most notable masterpieces of art. Writers like Pushkin, Dostoyevsky and Tolstoy, composers like Tchaikovsky and Shostakovich and directors like Eisenstein and Tarkovsky are worldwide household names in their respective art form. In the visual arts, the Soviet Union initially developed a strong avant-garde movement. Artists like El Lissitzky, Casimir Malevich and Wassily Kandinsky (though an émigré) were at the helm of modernism in the 1910s and 1920s.

But in the 1930s, the Soviet Union disbanded all independent art unions. They were replaced with the state-controlled Union of Artists, which pursed a single art doctrine: that of socialist realism, meant to glorify the achievements of the communist regime. Independent artistic activity was largely suppressed or at least discouraged by the Soviet authorities.

A Central Committee decree of 1937, for example, stated that "socialist realism was the sole theory and method of artistic expression suitable to Soviet society and demanded that all artists conform to its principles regardless of the mode of their past work."[95] Though the end of Stalinism in 1956 led to a certain "thaw" in the Soviet Union's attitude towards art, its leader at the time Nikita Khrushchev was notoriously opposed to modern art and independent culture.[96] Regardless, an underground scene of Soviet non-conformist artists did exist from the mid-1950s until the *perestroika* and *glasnost* reforms of the mid-1980s led to the almost complete liberalization of Soviet art.

Soviet computer art

Despite the Soviet Union's rich tradition of avant-garde art, as demonstrated above, the social and political conditions in the country prevented the establishment of a computer art scene up until the late 1980s.

Soviet theoreticians were largely opposed to cybernetics and computerization in art, which they saw as potentially causing the "elimination of the artist as a creative personality" and leading to a "formalist cybernetic anti-art".[97] Science researcher Bulat Galeyev of the Prometheus Institute also underlines that in the USSR, "the emphasis was mainly on the "science" from the triad art-science-technology".[98]

As a result of the state policies on computing, the people in the Soviet Union who had access to computers were almost exclusively scientists, and any aesthetic experiments with digital machines were driven largely by their curiosity as to the computer's abilities.[99] In the USSR, these first experiments date to the late 1950s and 1960s and were limited to electronic music (R. G. Bukharev, M. S. Rytvinskaya, V. I. Sharonov, A. M. Stepanov, R. H. Zaripov) and machine poetry (B. V. Biryukov, I. B. Gutchin).[100] Significant works of visual computer art are not known to have appeared in this period. The later appearance and

[95] Fox, Cindy J. "The Politics of Culture in the USSR: Art and the Soviet Government", *The Fletcher Forum of World Affairs* 1 (1977): 204-225.
[96] Piotrowski (2009): 107.
[97] Lukichev (2012): 3.
[98] Galeyev & Mikheyev (1994): 369.
[99] Lukichev (2012): 4.
[100] Lukichev (2012): 4-8.

general scarcity of graphic output devices in Soviet computing may be one reason,[101] along with the negative attitude towards avant-garde visual art in the Khrushchev era.

Breakthrough in computer animation: *Kitty*

However, the Soviet Union did produce one of the earliest works of computer animation.[102] In 1968, a team led by mathematician **Nikolai Konstantinov** showcased *Kitty* («Кошечка», *Koshechka*), a film of about a minute and a half depicting a cat in motion. A Soviet-built BESM-4 mainframe computer was used to solve the set of differential equations necessary for the animation of the cat's remarkably realistic movement.[103]

Figure 10: Konstantinov's Kitty *of 1968 was a one-of-a-kind experiment with computer animation in the Soviet Union.*

A "living legend" of Soviet mathematics and maths education, Konstantinov worked on *Kitty* together with two Moscow State University graduate students, Viktor Minakhin and Vladimir Ponomarenko. Konstantinov's curiosity about motion and biology, coupled with his interest in computing, led to the development of this computer-animated film. A program would calculate the current state of the moving cat and print it on paper using alphabet characters – in this case only the Cyrillic letter "Ш". The sheets of paper would then be photographed and placed in the correct order to create the illusion of motion.[104]

Konstantinov saw *Kitty* as a proof of concept of how computers can be used for realistic character and object animation. The film was created on his own personal initiative, without any government support or sanctioning, though his resulting research was eventually published in a cybernetics journal some six years later.[105]

As a result of the imprecise text-based image rendering, the shape of the cat's body in the film was undisputedly inaccurate. In contrast, Konstantinov spent a great deal of time modelling the cat's gait, which resulted in "an uncannily lifelike cat that has been captured

[101] Zariņa (2011): 458.
[102] Lukichev (2012): 10.
[103] Zariņa (2011): 458.
[104] Wilson (2013): 14.
[105] Wilson (2013): 6.

within highly stylized means". To model the cat's movement, Konstantinov imagined and described it in code as a three-dimensional set of trapezoidal shapes, with the paws restricted to following an elliptical path. Curiously, Konstantinov and his team found it difficult to observe a real cat in motion due to the animal's unpredictability. Instead, a member of the team imitated a cat by walking on all fours, his movements were recorded and subsequently described through equations.[106]

Kitty remained Konstantinov's only experiment in computer animation, and it is likely that he was completely or almost completely unaware of the birth of computer art elsewhere.[107] In the 1970s, the film was regularly shown as part of Math Olympiad events, but it did not generate any significant interest among Soviet scientists or artists and as such, it did not have a long-lasting influence.[108] In his detailed article on Konstantinov's film, cinema researcher Booth Wilson acknowledges that *Kitty* emerged in "*sui generis* circumstances" through an "unusual convergence of science, technology, and art".[109]

Naiveté and lack of access: computing and the arts in the Soviet 1960s and 1970s

It was also around the time of *Kitty's* appearance, the late 1960s, that examples of naïve "ASCII art" began to appear in the Soviet Union. These drawings, by default anonymous and with a dubious aesthetic value, used symbols from the ASCII standard (essentially, text characters) to encode a graphical image. Typically, these were created by computer scientists and engineers for their own private use. Surviving examples from Soviet Latvia range from portraits of Lenin through depictions of the scientists and their colleagues to naked female bodies.[110]

The case of Latvian artist **Jānis Borgs** is a striking example of how limited artists' access to computer technology was in the Soviet Union. A modernist with political views radically opposed to those of the Soviet regime, Borgs had nevertheless briefly ended up as headmaster of the Riga Art High School in the 1970s. For an exhibition of works by the high school teachers, he created a set of drawings of "arrangements of black lines" which he himself deems "entirely incongruous" and "absolute nonsense". The generative composition of these artworks relied on a principle of programmed randomness, which the artist admits was meant to make use of computer technology, but was instead achieved entirely manually.[111]

---

[106] Wilson (2013): 17.
[107] Wilson (2013): 9-10.
[108] Wilson (2013): 20.
[109] Wilson (2013): 23.
[110] Zariņa (2011): 459.
[111] Borgs (2010): 43.

This self-described "imitation of computer art"[112] was a direct consequence of the chronic lack of access to computers among Soviet artists. However, it is also a hint that avant-garde artists in the Soviet Union were aware of computer art in the 1970s; it was not an unknown concept, but rather an unachievable reality due to technological restrictions and the reigning official policy on art. Computing and the visual arts simply did not meet in the Soviet Union in the 1960s and 1970s. While engineers were using computers to create naïve portraits of Lenin, artists with modernist views and a desire to employ computers in their artistic activity were out of luck.

It was in the late 1980s, after Gorbcahev's *perestroika* and *glasnost* reforms and as personal computers were becoming more widely available, that computing and the visual arts were finally able to rendezvous on Soviet soil. The first exhibition of computer art in the Soviet Union took place in Protvino near Moscow in September 1987. Titled *Dialogue: Computer and Art*, the exhibition was part of the 4th All-Union Conference on the Issues of Machine Graphics. The exhibition presented mostly works of applied art and design, including computer graphics for use in science, technology, architecture and light industry visualizations.[113]

A one-of-a-kind regional issue of the journal *Leonardo* dedicated to "Art, Science and Technology in the Soviet Union" had been planned since 1990. And though it was only released in 1994, it still offers unique insights into the state of the art-science-technology "triad" in the 1980s. Yet even then, by the admission of the special issue's guest editor Bulat Galeyev, "computers in [Soviet] art were not widely used until recently", though this trend had undergone a dramatic upheaval after the collapse of the USSR in 1991.[114]

In a separate article detailing on the Prometheus research institute's participation at an arts festival in Prague in 1991, Galeyev reveals that his group also experimented with involving computers in art. More specifically, their video installation *Dog Barks, Caravan Keeps Moving* included a computer-programmed laser setup projecting an animated camel over cityscape and landscape footage.[115]

---

[112] Ibid.
[113] Lukichev (2012): 13-14.
[114] Galeyev & Mikheyev (1994): 369.
[115] Galeyev, Bulat M. ""Prometei" in the Stalin Catacombs: Festival of Light, Prague, CSFR, 28 July-4 August 1991". *Leonardo* 27 (1994): 440-441.

In *Leonardo's* special Soviet issue, only one of the presented articles specifically deals with native computer art. Moscow-based artist **Roman Ilinski** and critic **Marina Iskander** presented three works of computer art, all produced in 1989. Ilinski's works attempt to strike a balance between art and technology and he believes that the works' reproduction on paper using a netted raster adds distinct nuances. In his computer art, Ilinski used algorithms from applied mathematics to apply distance transformation to manual drawings. Thus, he achieved an effect comparable to an engraving, yet with a distinct digital feel. The halftones purposefully feature Moiré patterns, which contribute to an overall impression of "seeming-otherworldliness".[116]

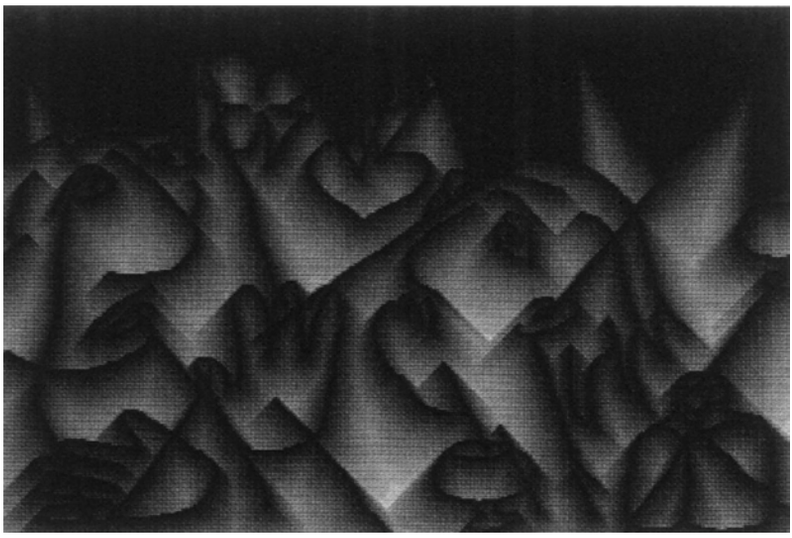

Figure 11: With Ilinski's works from 1989, Soviet computer art was finally exposed to a global audience.

Even at this stage, the late 1980s, the Soviets continued to consider computer art "an experimental platform for various technical and theoretical developments", rather than an aesthetic phenomenon in its own right.[117] Perhaps it is not surprising, then, that Soviet computer art remained underdeveloped and did not play an important role in the country all the way until is breakup in 1991. While individual examples of Soviet computer art exist, owing to multiple factors these failed to gain any kind of momentum. As a result, they remained isolated, *sui generis* aesthetic experiments and did not in any way influence Soviet-era avant-garde art.

Poland

Historical and cultural context

A sizable country in north-central Europe, Poland was reinstated as a republic after World War I, after it had been partitioned among Russia, Austria and Prussia in the 18th century. At the start of World War II, the young Polish state was invaded on either side by Nazi Germany and the Soviet Union. Poland was the site of great atrocities during the war, including many concentration camps and all Nazi death camps as well as the infamous Katyn massacre.

---

[116] Ilinski, Roman, and Marina Iskander. "Interactive Graphics: The Quasi-Infernal Aspect of Creation and Perception". *Leonardo* 27 (1994): 403-404.
[117] Lukichev (2012): 13-14.

After the war, the devastated Polish state fell within the Soviet sphere of influence and was restored as a people's republic and an Eastern Bloc member. After the death of Stalin in 1953 and of hardline Polish president Bolesław Bierut in 1956, Poland experienced a political "thaw" under Władysław Gomułka and his successor Edward Gierek. Under communist rule, regular food shortages plagued Poland and tensions against the government were high; often, only the threat of a potential Soviet invasion would thwart an armed uprising.

The 1980s were an eventful period in Poland, where the Solidarity (*Solidarność*) movement led by Lech Wałęsa survived the martial law of Wojciech Jaruzelski to become a leading political force in Polish society by practicing a wide-reaching civil resistance to the communist government. In 1989, Solidarity was victorious in Poland's first democratic elections and heralded the fall of communism in all of Eastern Europe.

Poland is a country of a rich artistic heritage, exemplified by figures like composer Frédéric Chopin, film directors Andrzej Wajda and Krzysztof Zanussi, writers Henryk Sienkiewicz and Stanisław Lem and fine artists Jan Matejko and Stanisław Wyspiański.

Polish computer art

Much like in neighbouring East Germany, Polish computer art developed relatively late and in a fragmentary manner, thanks to the individual efforts of technology-curious artists.

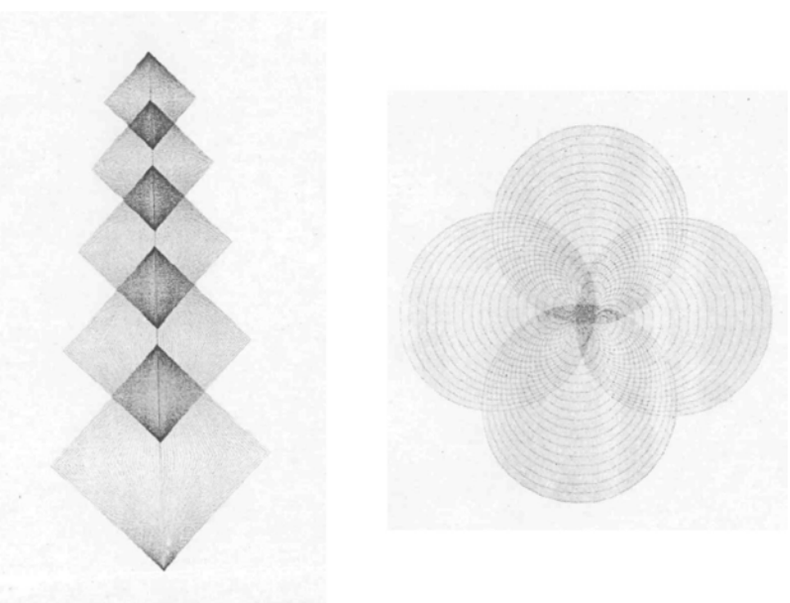

Figure 12: Two simple computer graphic experiments were published with Gerard Zieliński's short text in 1972.

As early as June 1972, Polish mathematician and computer art enthusiast **Gerard Zieliński** published a short text on the potential uses of computer technology in art. Though Zieliński's own endeavours were largely confined to the field of computer-composed music (by then he had already composed a piece on an ODRA 1204 computer using the ODRA-ALGOL programming language) and his text mostly focuses on this medium, he does give brief examples of the possible use of computers in visual aesthetics.[118]

Two simple computer graphics are shown alongside the text. These were programmed

[118] Zieliński (1972).

by Zieliński's colleagues **K. Doktór**, **A. Szustak** and **T. Wiewiórowski** on a Polish-built K-202 minicomputer using the ASSK-3 language and subsequently printed on a UCC plotter.[119] The graphics, however, are very basic and must be seen as technological experiments rather than aesthetic endeavours; with these, Poland was getting its foot in the door of computer art rather than forcing that same door wide open.

Beginning in 1980, artist **Jan Pamuła** created a series of computer graphics and computer-aided paintings involving complex compositions of rectangles. Pamuła relied on statistical and mathematical algorithms for the composition of his works.[120]

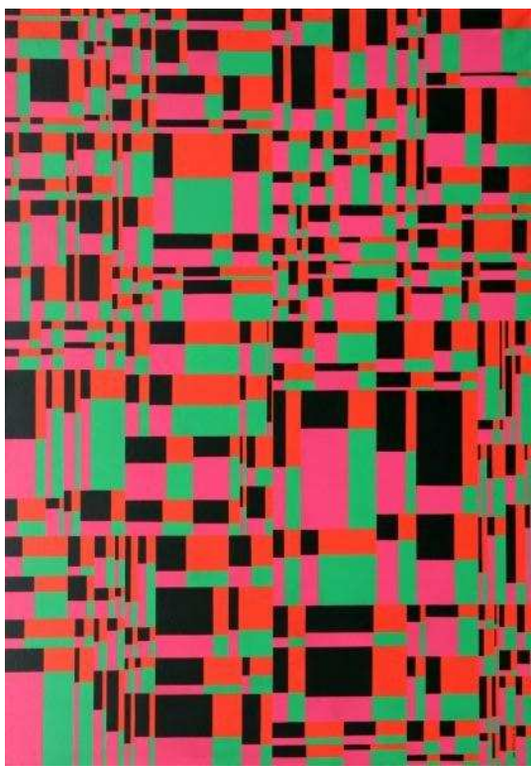

Figure 13: A work from Jan Pamuła's Computer Series *of 1982.*

Born in 1944 in Spytkowice near Kraków, Pamuła spent most of his adult life in the latter city and graduated from the Kraków Academy of Fine Arts in 1968. The works of Pamuła's *Computer Series I* and *II* reveal a strict systematic description of reality where randomness interplays with intuition and rationalism with emotion. Though Pamuła's interest in geometry began in the 1970s, the beginnings of his computer artwork can be traced to a visit to the Centre Georges Pompidou in Paris in 1980.

The computer enabled Pamuła to generate much more complex compositions than possible manually, resulting in a vastly more fruitful artistic expression with the computer as a key part of the aesthetic process.[121]

Film director and pioneering video artist **Wojciech Bruszewski**'s endeavours to involve a computer in his artwork began in the mid-1980s. Previously, Bruszewski had experimented with film as early as the 1960s as part of the Zero-61 artist collective in Toruń and the Workshop of the Film Form in Łódź.[122] Bruszewski counts among the originators of video art and transmedia art with a computer component as well as interactive and generative art in Poland.[123]

---

[119] Zieliński (1972): 9-10.
[120] „Jan Pamula" (Haus der modernen Kunst). http://www.hausdermodernenkunst.de/kuenstler/jan-pamula. Accessed on 22 July 2015.
[121] Pobiedziński, Miłosz. "Jan Pamuła - malarstwo, obiekty..." [Jan Pamuła – painting, objects…] (Galeria ESTA). http://www.galeria-esta.pl/info.php?id=40. Acccessed on 22 July 2015.
[122] Piotrowski (2009): 301.
[123] Kluszczyński, Ryszard (2014): 71.

A native of Wrocław, Bruszewski was born in 1947. His first computer works were produced on an Amiga personal computer and among them, the generative radio installation *The Infinite Talk* stands out. Devised in 1988 at the Ruine der Künste gallery in West Berlin and broadcast constantly up until 1993, the piece involves two virtual voices, a man and a woman, reciting passages of classical works of philosophers like Plato, Schopenhauer and Russell, all on the topic of infinity. The fragments were randomly selected by a computer program.[124] As a result of its continuous computer generation, the talk could go on forever, making it a talk about infinity and a talk infinite in length at the same time.[125]

Throughout the early 1990s, Bruszewski also devised a number of computer-generated sonnets in a constructed "absolute language" with a rich vocabulary and a formalized grammar.[126] During all creative periods he went through, Bruszewski was fascinated by randomness and employed various principles of generativity, whether he used a computer to accomplish this or not.[127]

Bruszewski was a long-time lecturer at the Academy of Fine Arts in Poznań and in 1989, he established the academy's Computer Graphics and Design Workshop.

In late 1989, around the end of communism in Poland, the southwestern city of Wrocław hosted the Sound Basis Visual Art Festival, also known as WRO (*Festiwal Wizualnych Realizacji Okołomuzycznych*), for the first time. The festival has continued its existence ever since as a prestigious biennale of new media art. It has devoted some attention to computer art and computer animation from its very inception, alongside other media like video, installation and performance.[128]

In a setting comparable to that in East Germany, Polish computer art developed only relatively late. True works of art were only produced beginning in the 1980s and only a few experimentalists were active in the field. It can only be assumed that similar reasons lie behind this: political uncertainty, limited official support for modern art and difficult access to computing technology for non-scientists. In terms of its development, Polish computer art under communism remained markedly less advanced than the likes of its other Central European neighbours, Czechoslovakia and Hungary.

---

[124] Kluszczyński, Ryszard (2014).
[125] Sienkiewicz , Karol. „Wojciech Bruszewski" (Culture.pl, 2006, 2009). http://culture.pl/en/artist/wojciech-bruszewski. Accessed on 22 July 2015.
[126] Ibid.
[127] Kluszczyński (2014): 79.
[128] Kolodziejski, Richard. "WRO: Festival Wizualnych Realizacji Okolomuzycznych (Sound Basis Visual Art Festival)". *Leonardo* 24 (1991): 617-618.

Romania

Historical and cultural context

A Romance-speaking country nested between Eastern, Central and Southern Europe and surrounded by Slavs and Hungarians, Romania has always been a curious case in European geography. A union of the principalities of Wallachia and Moldavia, Romania became independent from the Ottoman Empire in 1878 and a kingdom in 1881. Though it was initially defeated by the Central Powers in World War I, Romania made use of their eventual losses elsewhere to vastly increase its territory.

In World War II, Romania sided with the Axis Powers; its government under Ion Antonescu favoured fascist and Nazi policies and committed significant troops and resources to the Axis war effort on the Eastern Front. Though Romania changed sides to the Allies as the conflict neared its end, it was nevertheless occupied by the neighbouring Soviets, who established a satellite people's republic.

Communist Romania was initially under heavy Soviet control. Soviet troops remained in the country until the mid-1950s and its oil fields were exploited for the purposes of the USSR's industry. Hardline Stalinism seemed to have persisted until 1965, when autocratic ruler Nicolae Ceaușescu took charge of the country and gradually distanced himself from the Soviets. Initially a popular figure, from the early 1970s Ceaușescu grew more and more authoritarian, even Neo-Stalinist. He promoted a wide-reaching cult of personality and carried out unpopular austerity measures. His unwillingness to cede power in 1989, as communism was crumbling all over Eastern Europe, culminated in a bloody revolution in which he was captured and swiftly executed as Romania began its twisting journey towards democracy and eventual EU and NATO membership.

Romanian culture has been enlightened by many important figures, some of them of international prominence. Key Romanian representatives in the arts include composers George Enescu and Ciprian Porumbescu, fine artists Constantin Brâncuși and Ștefan Luchian, writers Mihai Eminescu and Eugène Ionesco and filmmakers Liviu Ciulei and Cristian Mungiu.

Romanian computer art

Considering Romania's political and economic position, a far cry from the more progressive and more developed people's republics of Central Europe, the extent of Romania's computer art scene is a remarkable achievement.

A post-Stalinist "thaw" in Romanian social and cultural life happened much later than elsewhere, with the exception of Hungary. Romania's cultural liberalization was born out of the rise to power of Ceaușescu in 1965, though it only lasted till the early 1970s, when he abandoned the idea of allowing for greater artistic freedom. The brief years of relative liberalization permitted the formation of a new Romanian avant-garde, which continued to exist even after Ceaușescu's reorientation towards Neo-Stalinism.[129]

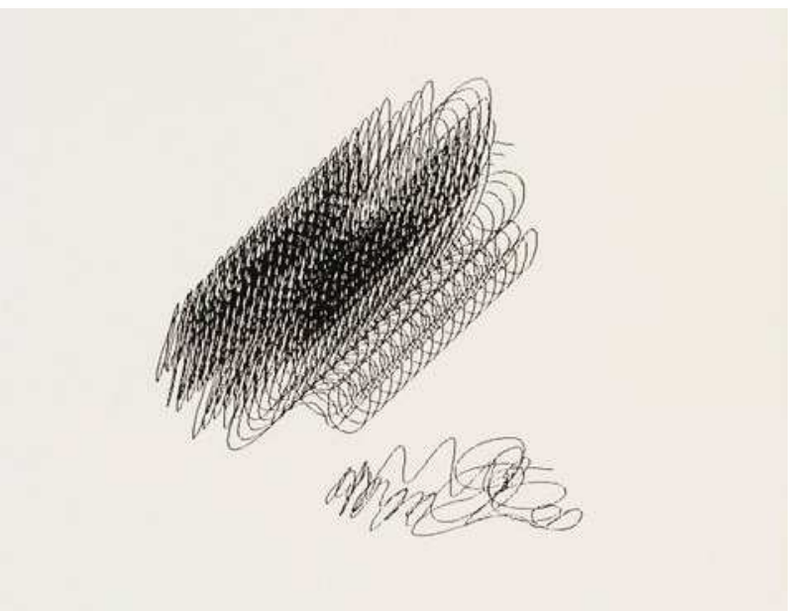

Figure 14: Mihai Nadin's Freeform Construction by Iteration*, a computer graphic from 1966.*

At the same time, the renewed political repressions caused many prominent artists and intellectuals to emigrate from the early 1970s on, a trend that also greatly affected Romanian computer art, as evidenced below.

Born in 1938 in Brașov, computer graphics pioneer **Mihai Nadin** experimented with the computer generation of aesthetic imagery and music, beginning in 1962. Nadin's background in engineering and computer science, coupled with his education in philosophy and specific interest in aesthetics, resulted in his early works exploring colour, pseudo-3D space and iteration.[130] After emigrating to Western Europe and subsequently to the United States, Nadin went on to become a leading authority on human-computer interaction and computer science. Currently, he is the Professor of Computer Science and Interactive Media at the University of Texas at Dallas.

Another multidisciplinary figure, **Sherban Epuré** was torn between science and the arts from an early age. Although he studied electronics at university and proceeded to work as a semiconductor researcher, by 1961 he knew he wanted to devote his life to art and creative expression instead. He was successful in joining the state Alliance of Fine Artists several years later on account of his paintings.[131]

The brief liberalization during Ceaușescu was a decisive moment, a short calm between two storms, for a Romanian computer art scene to form. Access to foreign literature was

[129] Piotrowski (2009): 8-100.
[130] Nadin, Mihai. "Computer graphics (since 1962)". http://www.nadin.name/research/forefront/compgraphic/compgr.html. Accessed on 12 August 2015.
[131] Epuré (2006): 403-404.

temporarily more available, leading to a "stream of new books and information to the underground", upon which a small scene of enthusiasts could form. Though each of these pioneers would be interested in different fields and disciplines, their passions would often overlap and they shared a common interest in science and the arts.[132]

Personally, Epuré was fascinated by the field of cybernetics and by 1967, two directions of "graphic scenarios to be expressed in mathematical statements" had emerged in his work: the S-Band and the Meta-Phorm. Epuré strove to make his artwork machine independent, but also machine compliant – computer technology was not available to him, nor did he trust contemporary technology's ability to execute his processes. Thus in his early Romanian period, he resorted to executing his art manually: "[his] mind was the computer and [his] hand the plotter". This situation strongly reminds of Latvian experimentalist Jānis Borgs, whose lack of access to computer technology took him to a similar direction.

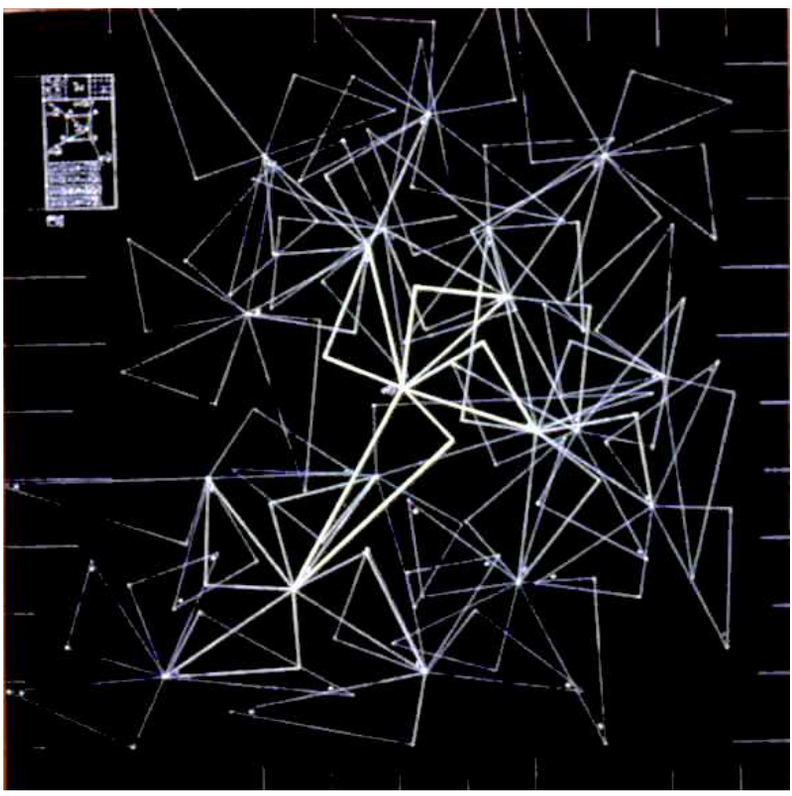

Figure 15: Epuré's Point Population *of 1972 algorithmically explores points grown in a Cartesian field.*

Epuré exhibited his variations of S-Band and Meta-Phorm graphics in many Romanian galleries between 1969 and 1978. However, he was continuously denied an international passport to travel abroad and meet like-minded artists. Furthermore, from 1976 on, his avant-garde art practice was treated increasingly negatively by the authorities, placing him in an isolated, marginal position. Ultimately, this led to his emigration to the United States in 1980, after three years of efforts to leave Romania. In New York, Epuré has continued his artistic work, taking up programming, adapting his methods to new technology and further exploring the aesthetics of geometry.[133]

In the context of what he calls "intrinsic art", Epuré describes his Meta-Phorms as "a visual representation of mathematically described behavioral interactivity used as a theme for artistic expression". In contrast, his S-Bands are "an art machine aiming to create a large

[132] Epuré (2006): 404.
[133] Epuré (2006): 405.

variety of unique non-repetitive artworks from the same method and algorithm", drawing inspiration from the aesthetics of Romanian folk art.[134]

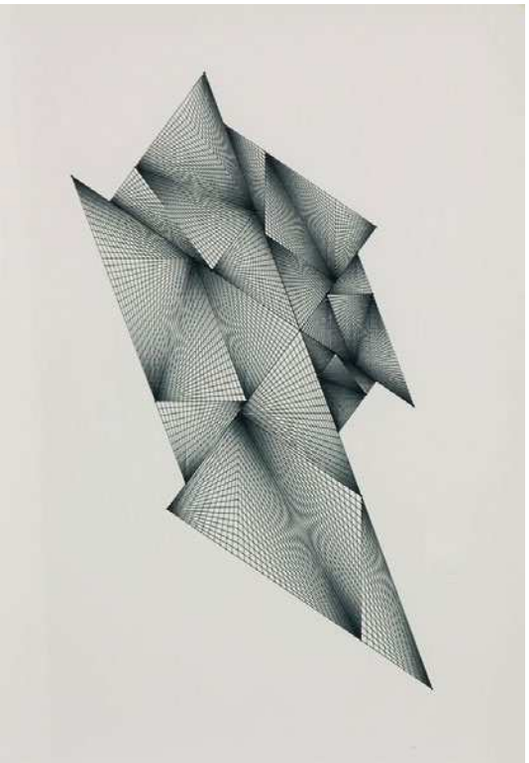

Figure 16: One of Florin Maxa's hexagonal Metamorphoses *from 1973.*

An artist who initially exhibited a decisively minimalist approach, **Florin Maxa** was born in 1943 and took up the computer as a medium in 1973. At the time, he focused on the hexagon as the central "building block" of his art pieces, often being transformed into a free shape, even deconstructed. In 1974, Maxa's computer graphics were displayed as part of the group exhibition *Art and Energy* and then in February 1976 at the *Metamorphoses* show in the Eforie hall. Both took place in the capital Bucharest.[135]

Maxa had another solo exhibition in 1980, also in Bucharest. However, the pressure of the Romanian communist government upon him was such that one year later, he burnt many of his existing works as an act of protest and defiance against the regime. The few that survived were exhibited in a joint retrospective with Japanese artist Kazuko Miyamoto at the EXILE gallery in New York City in the spring of 2015.[136]

Unlike Maxa, who came from an artistic background and studied painting at the University of Art and Design in Cluj-Napoca, **Mihai Stanislav Jalobeanu** was a representative of the technical culture in computer art. Born in 1941, Jalobeanu attended the mathematics department of the same Translyvanian city's Babeş-Bolyai University at approximately the same time as Maxa. His expertise in abstract algebra, molecular physics and computer science, including programming for the mainframe computers of the time, meant that he approached computer graphics from a very different perspective.[137]

In 1974, Jalobeanu contributed an important text on aesthetic computer graphics, *Images, their Production and Processing with today's Computing Systems*, to a collection edited by Solomon Marcus that included another notable contribution on the topic by Mihai Brediceanu.[138]

---

[134] Epuré, Sherban. *Intrinsic Art. Method and process* (Woodside, New York, 2014): 8-9.
[135] Sabau (2005): 26.
[136] "Kazuko Miyamoto <> Florin Maxa: A dialogue (New York)" (New York City: EXILE, 2015). http://thisisexile.com/exhibitions/kazuko-miyamoto-florin-maxa-a-dialogue/. Accessed on 12 August 2015.
[137] „Mihai Stanislav Jalobeanu" (Ad Astra). http://www.ad-astra.ro/whoswho/view_profile.php?user_id=3633. Accessed on 12 August 2015.
[138] Sabau (2005): 26.

Jalobeanu's artistic engagement with computers is contemporaneous with Florin Maxa's. In 1974, he exhibited at the Students' House of Culture in Cluj-Napoca and the Alfa Gallery in Arad. He debuted in the capital Bucharest in January 1976 with the *Computer Graphics* solo show at the Galeria Nouă.[139] Subsequently, Jalobeanu seems to have mostly abandoned his artistic practice; perhaps Ceaușescu's tightening grip on public life may explain this at least partially. He devoted himself to scientific endeavours and in the 1990s and 2000s became an advocate of distance learning and the use of the Internet in education.

A small collective of computer art enthusiasts formed at the Electronic Computing Centre in the western Romanian city of Arad in the early 1980s. The group was championed by mathematician **Lucian Codreanu,** who had previously been a member of the Sigma Group of experimental artists in nearby Timișoara. Other active participants in Arad's small computer art scene were **Mihai Săbăilă, Stelian Porumb, Gheorghe Chevereșan, Sorin Gules** and **Traian Roșculeț.** The group's computer-assisted artworks were exhibited at the *Art and Computer* exhibition in Arad's Forum Gallery in July 1985, causing some uproar and controversy among local artists.[140]

Though hampered by political repression stronger than in most other parts of the Eastern Bloc and a chronic lack of computer technology, Romania developed a remarkably strong computer art scene. As early as the mid-1970s, computer art was exhibited in galleries in the country. Artists and scientists were working together to create computer art and raise awareness of the new computer medium among the interested public.

Though Ceaușescu's repressive measures intensified at the time, resulting in many artists leaving the country or even destroying their works in an act of protest like Maxa, the activity at the Electronic Computing Centre in Arad kept Romanian computer art alive despite the hardships of the 1980s.

[139] Ibid.
[140] Ibid.

Hungary

Historical and cultural context

A landlocked country along the Danube in Central Europe, Hungary was for centuries part of the Austrian Empire and later the dual monarchy Austria-Hungary. In 1918, in the wake of World War I, it was reformed as an independent country, and the Treaty of Trianon of 1920 deprived it of significant territory and population. The irredentist Regent Miklós Horthy was in power in the interwar period, siding with Hitler in World War II.

Soviet troops occupied Hungary in 1945, establishing a people's republic headed by Mátyás Rákosi and espousing Stalinism as a satellite state of the Soviet Union. In 1956, a nationwide uprising seeking more human rights and an exit from the Soviet sphere of influence was brutally crushed by the USSR's armies. This failed Hungarian revolution was the first act of anti-Soviet resistance of this scale anywhere in Eastern Europe.

In the ensuing years under János Kádár, Hungary's political and economic development was marked by less censorship and fewer civil restrictions and some aspects of a free market and private ownership. As a result, Hungary was one of the Eastern Bloc's members with the highest standard of living and level of development. Like elsewhere, communism ended in 1989, and the removal of restrictions to travel to Austria in that year has been described as "the first tear in the Iron Curtain".

Hungary's contribution to European culture is significant, and it has been made famous by the names of notable figures like composers Franz Liszt and Béla Bartók, writers Sándor Petőfi and Imre Kertész, film director István Szabó and fine artists László Moholy-Nagy and Victor Vasarely.

Hungary's rich artistic tradition was kept alive in the first years of communism, and the eclectic European School of Hungarian artists advocated a utopian "new Europe", united in culture after the destruction and animosity of World War II. Stalin's death in 1953 initially had a huge influence on the liberalization of Hungarian art leading up to the failed revolution of 1956. The uprising's suppression, however, was associated with a crackdown on modernism; only one modernist exhibition took place in Hungary up until the late 1960s. Subsequently, under Kádár's mild form of government and the ensuing economic prosperity, modern art was tolerated and accepted in Hungary; neo-expressionism had a practically official status in the 1980s.[141] As a result, Hungary's "thaw" may have started later, but it developed very steadily and gradually.[142]

[141] Piotrowski (2009): 62-63.
[142] Piotrowski (2009): 100.

Hungarian computer art

It is in the 1970s, in this context of gradual liberalization and relative economic prosperity, that the birth of computer art in Hungary must be placed. And curiously, unlike we have seen elsewhere, early Hungarian computer art is tightly associated not with new perspectives in the visual arts (as in Yugoslavia and Czechoslovakia) nor with naïve computer technology experiments (as in the Soviet Union). Instead, computer art in Hungary emerged within the framework of experimental cinema, and more specifically from **Béla Balázs Studio**, an avant-garde filmmaking community based in Budapest.[143]

Gábor Bódy was at the time an aspiring Hungarian director who had only graduated from university in 1975 with his first feature film, *American Postcard*. Though young (born in Budapest in 1946), Bódy was already an influential experimentalist and an important figure at Béla Balázs Studio, where he had launched several avant-garde projects. His film *Pszichokozmoszok* (*Psychocosmoses*), created in 1976 with the aid of eminent theoretical nuclear physicist **Sándor Szalay**, was the first Hungarian computer-animated film and the first work of computer art in Hungary.[144]

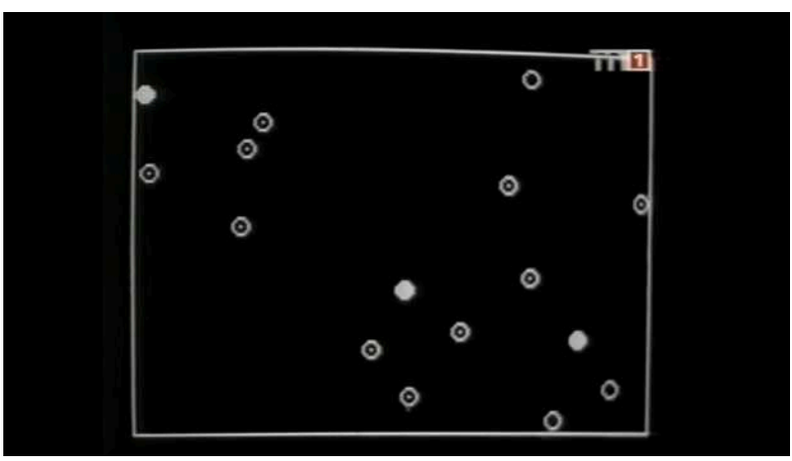

Figure 17: A still from Gábor Bódy's 1976 computer-animated film Psychocosmoses*, the debut work of Hungarian computer art.*

A black and white motion picture with a duration of about thirteen minutes shot on 35 mm film, *Psychocosmoses* is a computer simulation of biological and physical processes. Bódy was directly inspired by Conway's Game of Life and by the "organized chaos" of Brownian motion. Essentially, this short film shows the possible outcomes of a computer program that, based on certain parameters, either brings the entire system to order and stability or to the complete chaos of randomness. Thus, in this case, a scientific simulation is interpreted through the eyes of an artist.[145]

Bódy had already included computer animation in a previous production for Hungarian television, *Film Course*. With *Psychocosmoses*, which was entirely computer-produced, he explored the topic of randomness. Brownian motion inspired him with its "absolutely accidental movement", which to him looked decidedly more realistic than any human

[143] Peternák (2005): 338.
[144] Lipiński, Kamil. "On the re-emergence of motion and innovations in the Gábor Bódy's intermedia experiments". *Journal of Aesthetics & Culture* 7 (2015): 1-8.
[145] Peternák (2005): 338.

attempt at spontaneity. By giving his particles certain parameters of behaviour (such as "shyness, aggression, neutrality"), he sought to have a certain feeling emerge from within the motion, thereby creating a "psychic space". Admittedly, Szalay's programming was not perfect, and the final product included "bugs": some of the particles would stick to each other upon contact, an occurrence Szalay could not explain.[146]

Unlike Konstantinov's *Kitty*, Bódy's first venture into computer animation was not an isolated event. In fact, had **Gyula Száva**, a colleague of Bódy's from Béla Balázs Studio, had access to adequate computer technology, he would have likely preceded Bódy by some two years. The earliest drafts for Száva's computer-animated film *Rating* (or *The Affair*) date to 1974. However, the motion picture was only produced in 1980-82, as a collaboration with programmer **Ferenc Deák**.[147] Deák had a Hungarian-made TPA1001 / i computer available at the Department of Nuclear Physics of Eötvös Loránd University.

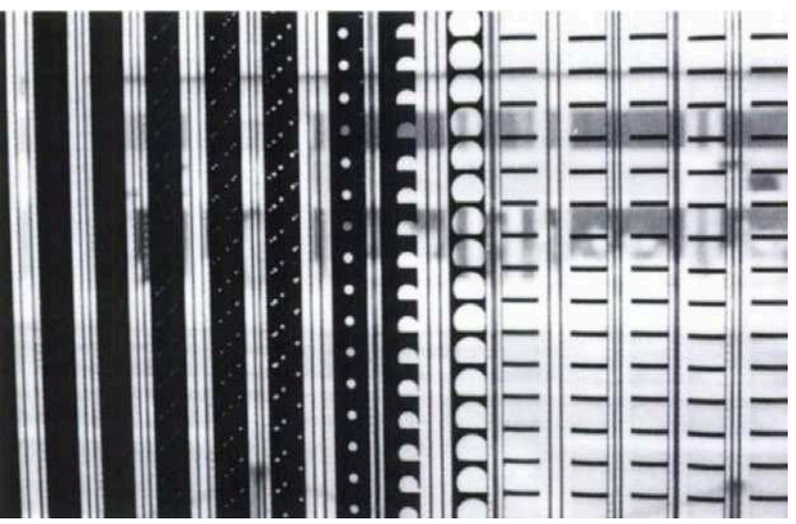

Figure 18: A still from Gyula Száva's Rating*, one of the first Hungarian computer-animated films, 1980.*

Also shot on 35 mm film in black and white, *Rating*'s 20,000 frames were all directly recorded from the computer monitor onto film tape, leading to technical difficulties such as varying lightness in parts of the image. Száva's original idea was to have the film's accompanying music generated by the video signs, but he had to scale down due to further technical constraints. Nevertheless, electronic music was composed for the 14-minute film by postmodern composer László Vidovszky.[148]

Száva's exploration of computer art also included a large banner he designed for the 1983 art and film festival in Budapest. During the exhibition, Száva's banner covered the façade of the Hungarian National Gallery in Buda Castle. The same banner was then shown at the *Limits Unlimited* (*Entgrenzte Linien*) exhibition in Graz, Austria, in 1987, as part of the *Topologies* installation. For the installation, it was supplemented with sound, in this case too by his associate Vidovszky.[149]

[146] Peternák (2005): 341.
[147] Peternák (2005): 338.
[148] Peternák (2005): 344.
[149] Peternák (2005): 339.

Around the same time as Száva's, yet another Hungarian computer film was produced. Directed by **István Bartók**, *Dimensions* appeared in 1980 thanks to a collaboration with programmer **Miklós Bathór**. Like Száva and Bódy's pioneering works, Bartók's computer film also relied on 35-mm black-and-white technology. However, it did not come out of Béla Balázs Studio, but instead from Pannónia Film Studio, Hungary's largest animation studio and a *de facto* monopolist at the time. This is clear evidence that the wave of Hungarian computer-animated cinema at the turn of the 1980s was not restricted to the experimental setting of Béla Balázs Studio, but had rapidly spread beyond it.[150]

In the 1980s, computers also came to be used in installations and still images in Hungary. **Krisztián Frey**, who divided his time between Budapest and Zurich, created still works of computer art as early as 1980. In his works, Frey defines just a few parameters, in his own words "constructing possibilities" and leaving the rest to chance. Frey described his art as "Stochastic Suprematism" due to the inspiration he drew from the unpredictability of randomness and Malevich's fundamental philosophies.[151]

In the installation art genre, **András Mengyán**'s environmental piece *Programmable Space I-III* was the trendsetter. Mengyán's installation combined sound, film and different wavelengths of light to create an immersive aesthetic experience that the author calls a "space movie". *Programmable Space I-III*, which spanned three rooms and relied heavily on computer technology, was first exhibited in 1985 in the Hall of Art (*Műcsarnok*) on the famous Heroes' Square in Budapest. The exhibition was continued ten years later, in 1995, at the same venue.[152]

[150] Ibid.
[151] Peternák (2005): 345.
[152] Peternák (2005): 339.

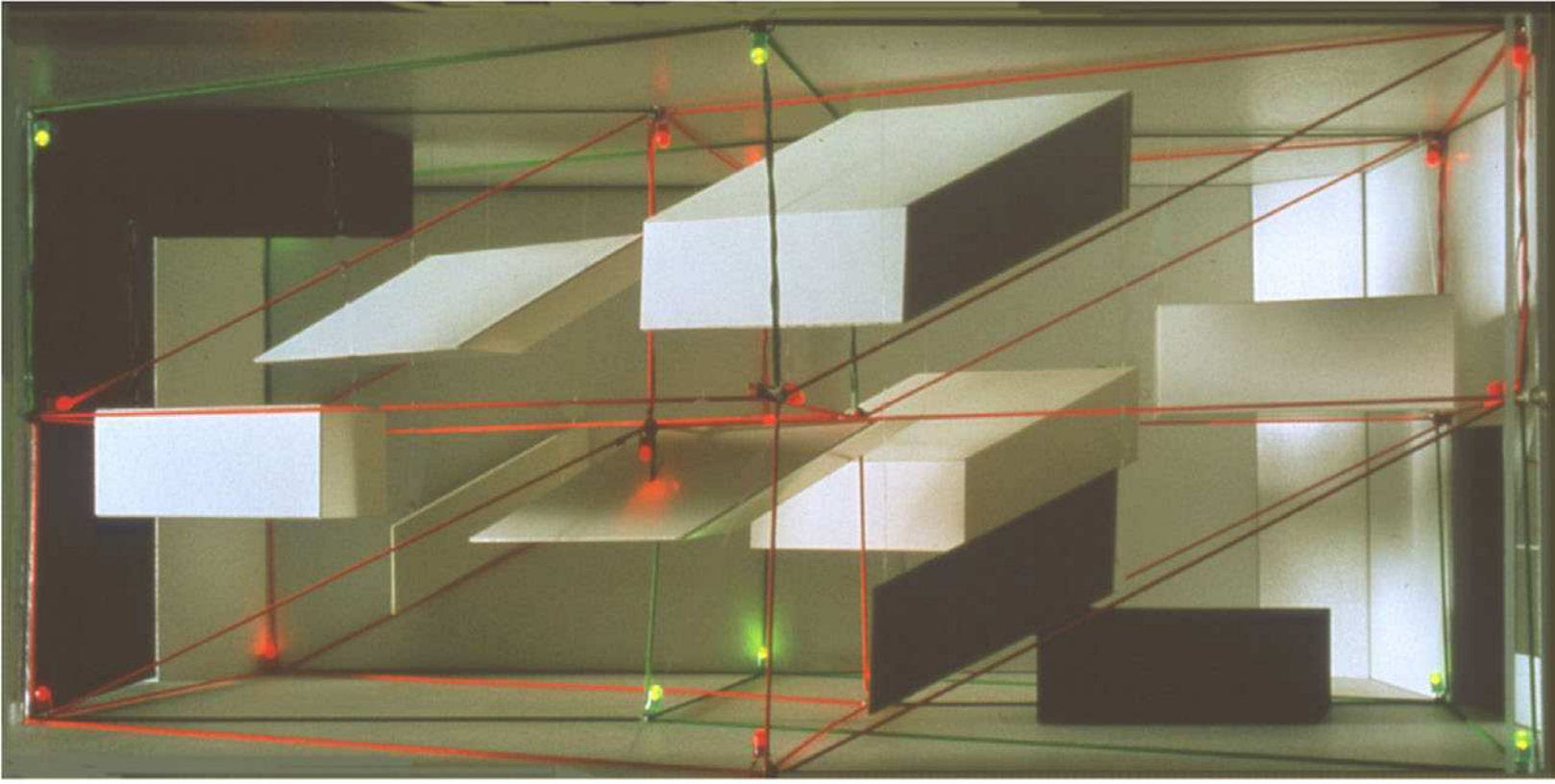

Figure 10: Inside András Mengyán's computer-aided installation Programmable Space I-III, *1985.*

Award-winning cartoonist **Géza Halász** has been using a computer for his artistic practice since 1986. On his website, Halász conjectures he might be one of the first cartoonists to have used a computer professionally.[153]

Other than the show of Mengyán's immersive piece, the first exhibition of computer art in Hungary was *Digitart*, which took place at the Museum of Fine Arts in Budapest in late 1986. This event was the first chance to work with computer technology and animation software for many artists. This was made possible by the support of the Hungarian Academy of Sciences' Computer and Automation Institute and chiefly of the distinguished engineer Tibor Vámos. To the general public of Budapest, *Digitart* presented mostly printed works by the artists **Áron Gábor, János Sugár, László Révész, Károly Hantos, Zsigmond Károlyi, László Kiss** and last but not least, **Tamás Waliczky**.[154]

Previously a painter, photographer and animator for Pannónia Film Studio, Tamás Waliczky first employed computers in his artwork in 1983, when he was hired by the Caesar CG Studio in Budapest as a game graphic designer. Since then, he has concentrated solely on digital artworks, resulting in what Lev Manovich calls a systematic "aesthetic investigation" by a "maker of virtual documentaries", a creator of post-cinematic cosmologies.[155]

---

[153] Halász, Géza. "About me". http://www.zu.hu/about-me.html. Accessed on 4 July 2015.
[154] Peternák (2005): 339.
[155] Manovich, Lev. "The Camera and the World: New Works by Tamás Waliczky". *Continental Drift* (1998).

During communist rule in Hungary, prior to 1989, Waliczky's work included pieces like *Computer Mobiles (Human Motions)* and *Pictures*, computer animations created on an Atari 520 ST computer, and the austere black-and-white animation *Is There Any Room For Me Here?*.

On 15 January 1989, the same year that he co-founded the Novotrade CG Studio, Waliczky published a notable *Manifesto of Computer Art*, which expresses his views on this relatively new art form's development. In the manifesto, Waliczky warns that "we should not let customary programmes force us to make customary films", "instead of finding [our] own special ways".[156]

Figure 19: With Gramophone*, Waliczky became the Eastern Bloc's first and only Golden Nica winner in 1989.*

Also in the seminal 1989, Waliczky achieved an honour never bestowed upon another person from the Eastern Bloc before or after. He was awarded the most prestigious award for computer graphics, the Golden Nica, at the Prix Ars Electronica in Linz, Austria, for his computer graphic *Gramophone*. The artwork, which is part of the *Machines* cycle, reveals the imagined inner workings of a gramophone and aims to capture the "essence of the machines that surround [us]".[157] The *Machines* cycle borrows the aesthetic of old black-and-white photography as an honour to the time of the inventors and as a reminiscence to an age when machines seemingly had a personally, perhaps even a sense of humour.[158]

Thus, Hungary's slow but unstoppable artistic "thaw", which started only in the 1970s but never decelerated, met the end of communism with perhaps the highest achievement of Eastern Bloc computer art. By winning a Golden Nica in Linz, Waliczky symbolically ripped the Iron Curtain of computer art open – much like his country had done by removing its border fence to Austria in the same year.

---

[156] Waliczky, Tamás. "The Manifesto of Computer Art" (Waliczky.net, 1989). http://www.waliczky.net/pages/waliczky_manifest_eng.htm. Accessed on 4 July 2015.
[157] "Gramophone" (Ars Electronica Archiv). http://archive.aec.at/submission/1989/CG/21926/. Accessed on 4 July 2015.
[158] Waliczky, Tamás. „Machines" (Waliczky.net). http://www.waliczky.net/pages/waliczky_machines1.htm. Accessed on 4 July 2015.

With its beginnings to be found uniquely in the context of experimental cinema, Hungarian computer art expanded to installations and static visual pieces in the 1980s. It reached its peak in 1989 just as the country was experiencing democratization associated with the end of communism, János Kádár having stepped down in 1988.

East Germany

Historical and cultural context

East Germany, or officially the German Democratic Republic (GDR), stands out among other former communist states in Eastern Europe. Unlike any of the other Eastern Bloc states, East Germany did not exist as a separate entity before World War II. Neither did it reform itself as one after the end of communism at the turn of the 1990s, nor break apart into individual states like Czechoslovakia or Yugoslavia.

Rather, East Germany was carved out of the Soviet-occupied sector of Nazi Germany in 1949, after the Nazis had been conclusively defeated by the Allies. In contrast, the western sectors occupied by the United Kingdom, France and the United States served as the foundation of West Germany, the Federal Republic of Germany that we know today.

A bastion of communism at the western extremity of Soviet power, East Germany was under the close watch of the Soviets, who were wary of losing it to Western influence both due to its geographical position in the heart of Europe and due to its strong cultural ties with West Germany. To counter this, Soviet troops were stationed in East Germany continuously throughout its existence and the notorious Berlin Wall was built in 1961 to prevent any contact with West Berlin, a West German enclave deep within East German territory. A series of strikes that escalated into a brief but wide-reaching uprising in June 1953, shortly after Stalin's death, was violently suppressed by the East German government and Soviet forces, leaving no hope for a post-Stalinist "thaw". Under Walter Ulbricht, East Germany followed a curious policy of "Stalinist de-Stalinization". Essentially, Ulbricht was a Stalinist leader whom Khrushchev favoured, believing he could keep East Germany under control.[159]

Ulbricht's successor Erich Honecker was in power from 1971 until he was ousted weeks before the fall of the Berlin Wall in 1989. Though he was another hardliner loyal to the Soviets and opposed to social liberalization, Honecker advocated a brand of "consumer socialism" and carried out a set of economic reforms. These actions further increased the living standard in East Germany, which was the highest in the Eastern Bloc yet still markedly behind that of Western nations like West Germany.

[159] Piotrowski (2009): 63-64.

The turbulent events of 1989 led to the historic breach and dismantling of the Berlin Wall, a physical barrier between East and West that had embodied the Iron Curtain better than any other border facility, in November of that year. In an unprecedented act, East Germany reunified with West Germany in 1990. Its national institutions were abolished and replaced by the West German government apparatus and economic measures were taken to reduce the inequality between the western and eastern regions of modern Germany.

Due to East Germany's unique and complicated position, its rich cultural tradition was largely ignored in the early years of communism. Modernist tendencies were frowned upon and like elsewhere, socialist realism was promoted by the government as the only 'proper' genre.

Nevertheless, East Germany bears the world-renowned artistic context of German culture, with writers like Johann Wolfgang von Goethe and Friedrich Schiller, composers Johann Sebastian Bach and Ludwig van Beethoven, cinema pioneers Fritz Lang and F. W. Murnau and fine artists Albrecht Dürer, Caspar David Friedrich and Paul Klee.

East German computer art

Because of East Germany's official attitude towards art, computer art in the country developed only fragmentarily and in isolated cases, away from the government-sanctioned art policies. With technical production, means of distribution and funding monopolized by the official Union of Artists of the GDR, avant-garde art in East Germany mostly relied on basic media of expression and the direct involvement of the public through various creative experiments.[160] Furthermore, the aesthetic potential of technical achievements like video, computer graphics, lasers, holography and multimedia was largely ignored in the GDR, a fact that may be linked to the official anti-modernist tendencies in East Germany.[161]

The first attempts at computer art in East Germany are linked to the **VBK-Videowerkstatt**, or the video workshop of the Union of Artists. The video workshop was a prominent event for experimental cinema and video art that took place four times a year, beginning in 1984.[162] There were efforts to establish a committee for computer animation in 1987 in order to further boost this "new and quickly developing area".

Furthermore, higher education institutions like the Burg Giebichenstein University for Industrial Design in Halle and the Art University in Berlin-Weißensee were exploring the

[160] Beutelschmidt (1997): 114.
[161] Beutelschmidt (1997): 116.
[162] Beutelschmidt (1997): 118.

possibilities of involving computer technology in design and the applied arts and specifically to design patterns, spatial presentations and information visualizations. Much like elsewhere, however, artists' access to hardware and software was severely limited, even though some artists were "otherwise very interested" in computer technology. All of these factors naturally limited the influence of computers in East Germany's artistic scene. Computer artworks were criticized in East Germany as too abstract, insubstantial and incompatible with socialist realism, effectively stripping them of recognition for their aesthetic qualities.[163]

In East Germany's anti-modernist climate, the work of concrete constructivist **Horst Bartnig** stands out. Inspired by Malevich, Bartnig's art relies on a strict system incorporating the repetition and variation of individual elements that serve as building blocks. Bartnig's artworks involve mathematical models of varying complexity and an interplay of shapes and colours.[164] However, Bartnig rejects the role of randomness in his art. He tends to calculate every possible position and interaction of the elements rather than employ a random number generator.

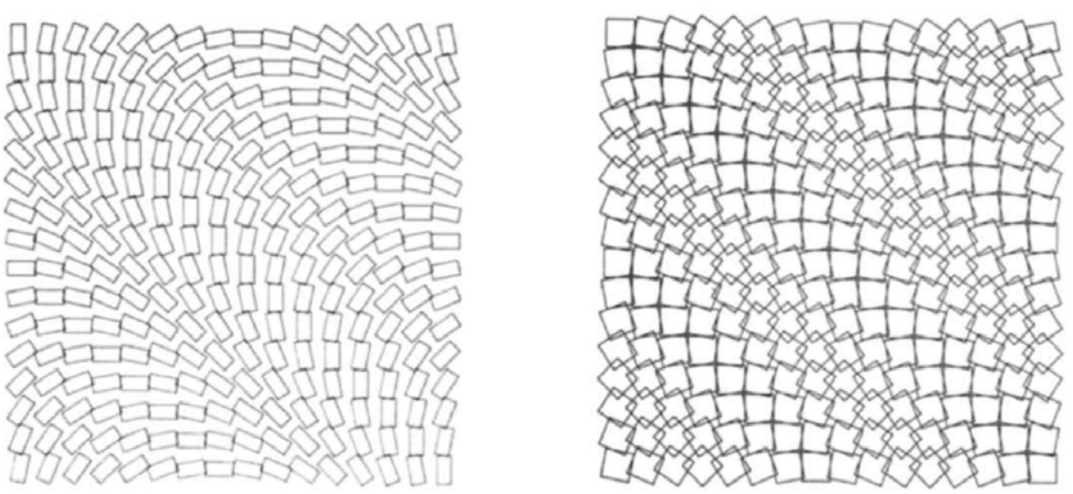

Figure 20: Two images from Horst Bartnig's Computer Graphics *series of 1982-83, each using 256 elements but revealing an increasingly complex interaction between them.*

A native of Militsch in Silesia (today Milicz in western Poland), Bartnig was born in 1936 and studied at Magdeburg's University of Applied Arts between 1954 and 1957. His first experiments with concrete constructivism date to 1964.[165]

In 1979, Bartnig began an extensive collaboration with various mathematicians and programmers from the GDR Academy of Sciences' Central Institute for Informatics and

[163] Beutelschmidt (1997): 119-120.
[164] Scharfenberg (1986).
[165] „Horst Bartnig" (Museum Ritter). http://www.museum-ritter.de/sprache2/n2175248/i1906258.html. Accessed on 16 July 2015.

Computer Technology in the Berlin locality of Adlershof. With the assistance of these technical specialists, Bartnig would typically generate hundreds of computer graphics based on his logical formulations until he would settle on a composition fit to paint on a large canvas.[166] Based on his creative process, much of Bartnig's work post-1979 must be classified as computer-aided art rather than computer art. Bartnig's computer workflow only concentrated on the early steps, such as drawing contours or achieving a preliminary visualization of all possible combinations; in principle, these actions could be carried out by hand by the artist and in that sense, he saw the computer merely as a facility.[167]

To Bartnig, the computer was surely a means of artistic exploration and iteration. Though his ultimate medium for artistic expression tended to remain the canvas, which would lend a certain sense of finality to his work, a sense highly atypical for computer art, which glorifies process.

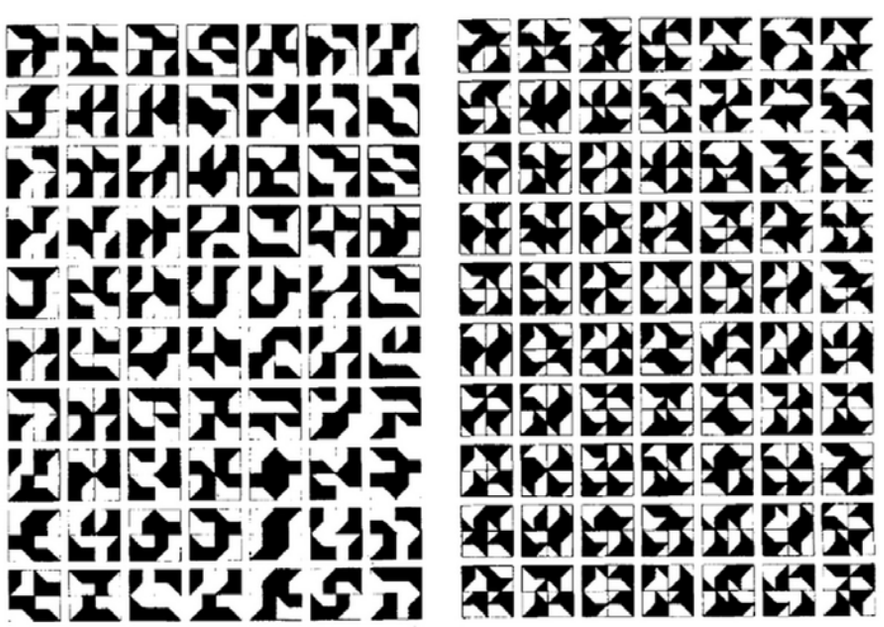

Figure 21: Another pair of computer-aided compositions by Horst Bartnig from 1984.

Prominent Leipzig-based artist **Peter Sylvester** is also known to have experimented with computer technology. A famous serigrapher who was among the most experimental artists in East Germany, beginning in 1976 Sylvester used a device invented by the GDR Academy of Sciences, the Densitron, to edit his graphic works. The Densitron was computer-based image analysis system that was at least partially analog.[168] Sylvester visited the GDR's Institute for Isotope Research to access the device and experiment with its properties on

[166] Ibid.
[167] Scharfenberg (1986): 890, 893.
[168] Hanisch, Patti. "Naturwissenschaft und Kunst, Kunst und Naturwissenschaft: Versuche der Begegnung" [Natural Science and Art, Art and Natural Science: Endeavours of Contact]. *Symposium 1. bis 3. Dezember 1994 an der Universität Leipzig* (1995): 70.

his aquatint prints.[169] Thus, Sylvester created curious mixed media works that cannot quite be ascribed to computer art, but their process bears a striking similarity to the way digital filters are applied via software like Photoshop or web services like Instagram nowadays.

A member of the NBK-Videowerkstatt, **Wolfgang Schnecke** was a scenographer, film director and media designer whose relationship with aesthetic computer graphics began in 1985. Schnecke used a Commodore VIC-20 personal computer and the BASIC programming language to create graphics incorporating geometric shapes and surfaces, often with symmetrical and ornamental characteristics.[170]

Schnecke's artistic engagement with a computer produced works like *Cube*, *Zebra*, *Skyline*, *Shadow* and *Pagoda*. In 1989, the *Galerie visuell* in Berlin hosted a solo exhibition of Schnecke's computer art, organized by the Staatlicher Kunsthandel, the GDR's national art trade authority.[171]

Figure 22: The cover of Horst Völz's 1988 book Computer and Art.

In 1988, information scientist and physicist **Horst Völz** published the first edition of his short book *Computer und Kunst* ("Computer and Art"). In his work, Völz introduced the reader to the efforts to quantify aesthetics and to the interplay between art and technology. Further on, he gives practical examples of how the BASIC programming language can be used to generate computer graphics with an aesthetic value, before closing with a few remarks about the 'borders' of computer art.[172]

As we have seen, computer art in East Germany has its beginnings relatively late in the communist period, only at the very end of the 1970s. Only individual artists were able to experiment with computer technology in the GDR, typically with the engineering support of the GDR's Academy of Sciences. Attitudes towards modernism and the incorporation of computers in art were negative in East Germany, which largely discouraged such artistic endeavours. As a result, despite the rich German artistic tradition and the relatively higher economic development, East German computer art remained less prominent than in Czechoslovakia or Hungary.

[169] *Nova acta Leopoldina* 90 (2004): 226.
[170] Scharfenberg (1986): 891.
[171] Ibid.
[172] Völz, Horst. *Computer und Kunst* [The Computer and Art] (Leipzig, Jena, Berlin: Urania-Verlag, 1988). ISBN 3332002201.

Bulgaria

Historical and cultural context

Re-established in 1878 after five centuries of Ottoman rule, Bulgaria lies in the eastern Balkans, west of the Black Sea and north of Greece. A monarchy with a mostly agricultural economy before World War II, Bulgaria's history had been marked by continuous armed conflicts with its neighbours due to its claims on their ethnic Bulgarian territories. For its aggressive foreign policy and dedicated military, Bulgaria came to be known as "Prussia of the Balkans" at the time.

A relatively passive supporter of Nazi Germany in World War II, Bulgaria was overrun by a Soviet invasion and a native communist uprising in September 1944. A socialist republic under strong Soviet influence was established to replace the monarchy, with prominent communist politician Georgi Dimitrov in charge. Under Dimitrov and his successor Valko Chervenkov, Bulgaria industrialized quickly, but also turned into an oppressive totalitarian state as exemplified by Stalin's USSR.

The country was ruled by Todor Zhivkov from 1954 up to the fall of communism in late 1989. Zhivkov's Bulgaria closely replicated the government policies and political trends in the Soviet Union. On the surface, it was a blindly loyal Soviet satellite, though in practice it regularly exploited this political closeness for its own economic gains at the expense of the Soviets. Zhivkov's 35-year rule brought unprecedented economic and political stability, but also prevented any degree of liberalization and democratization as attempted in Hungary or Czechoslovakia.

Much like other former Eastern Bloc members, Bulgaria did away with communism in 1989 and underwent a painful transition to a democratic government and a market economy throughout the 1990s and early 2000s.

Bulgaria's most eminent creative figures are relatively unknown on the world stage, and the country is renowned more for its rich folklore tradition and ancient culture than for the names of individual artists. Nevertheless, writers Ivan Vazov and Hristo Botev, artists Vladimir "The Master" Dimitrov and Christo Javacheff, composers St. John Koukouzelis and Pancho Vladigerov and film directors Metodi Andonov and Rangel Valchanov have attained some international acclaim.

During the communist period, Bulgarian art was under strong government control. Though the post-Stalinist "thaw" of the 1960s did result in the development of alternative art, it still remained close to the government's prescribed aesthetics of socialist realism. This

so-called „April Generation“ of Bulgarian artists was active invariably within the official artistic institutions, such as the Union of Bulgarian Artists. And while they were allowed greater freedom in aesthetic and thematic decisions, they did not constitute a proper avant-garde.[173] Furthermore, prominent members of the "April Generation" were in charge of the Union of Bulgarian Artists and the National Gallery, a clear evidence of their close ties to the government.[174]

In general, the development of Bulgarian culture stagnated up until the 1980s, and the changes in the government's policies towards art or the shuffles in leadership did not have a significant influence on the Bulgarian artistic scene.[175]

The case of internationally renowned environmental artist Christo, who found it necessary to leave Bulgaria and the Eastern Bloc in 1957, is particularly exemplary. A student at the National Academy of Arts in Sofia, Christo (born Christo Javacheff) made the courageous choice to flee to the West in hope of a more accepting creative environment. Together with his wife Jeanne-Claude, Christo reimagined outdoor cityscapes and landscapes like New York's Central Park, Paris' Pont Neuf and Berlin's Reichstag, which he wrapped in white fabric entirely.

An independent art tradition truly challenging the dogmas of socialist realism only appeared in Bulgaria in the more liberal 1980s, exemplified by younger post-modernist figures like Latchezar Boyadjiev and Nedko Solakov. Polish art historian Piotr Piotrowski partially explains this absence of an alternative challenge to the government-supported artistic establishment in Bulgaria with the lack of a strong avant-garde tradition before communism[176] and the Bulgarian government's customary strong involvement in art patronage from the late 19th century on.[177]

Bulgarian computer art

Having summarized condition of Bulgarian art under communism, it should come as no surprise that the beginnings of computer art in the country should be sought neither among the artistic circles nor before the 1980s.

Indeed, the first aesthetic experiments with computers in Bulgaria we owe to curious computer scientists and engineers. Electronic and subsequently computer music had been

[173] Piotrowski (2009): 27.
[174] Piotrowski (2009): 98.
[175] Piotrowski (2009): 63.
[176] Piotrowski (2009): 28.
[177] Piotrowski (2009): 97.

established in Bulgaria by the mid-1970s thanks to the efforts of Simo Lazarov, Sergey Dzhokanov and Vladimir Dzhambazov.[178]

However, computer graphics and related aesthetics endeavours came at an even later time. In the 1980s, Bulgaria had grown to become the major producer of microcomputers and personal computers in the Eastern Bloc, reportedly because the Soviets regarded them as having inferior importance to mainframe computers, on which they preferred to concentrate directly.[179] Bulgaria's highly successful Apple II and IBM PC clones, Pravetz 82 and Pravetz 16, were the basis for a blossoming microcomputer industry that at one point produced 40 percent of all computers in the Eastern Bloc and employed around 300,000 people.[180]

As a result of Bulgaria's booming computer industry, by the late 1980s the country found itself in the unique position that "students in Bulgaria had access to more computers than their peers in any other Eastern European country". Thousands of Pravetz computers were made available to high schools in Bulgarian towns, [181] and computer clubs where youngsters could use computers on their own were organized throughout the country. The wide availability of computers precipitated a great amount of experimentation in programming and computer graphics among this so-called "Pravetz Generation".[182]

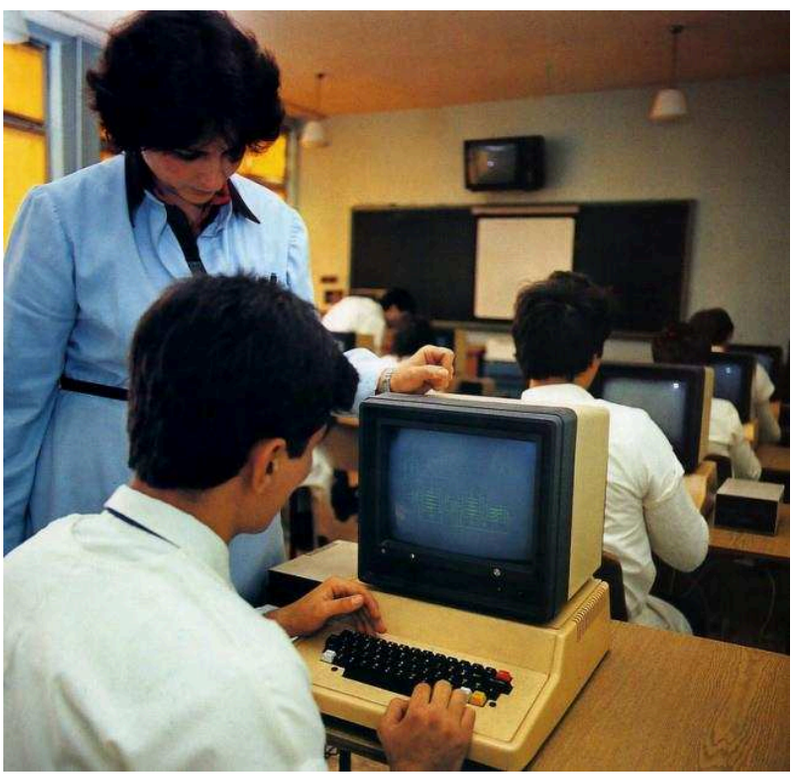

Figure 23: In the late 1980s, computer technology was more available in Bulgarian schools than anywhere else in the Eastern Bloc.

In this context, **Rosen Petkov** stands out as a late pioneer of computer art in Bulgaria. In 1989, he founded the Student Computer Art Society (SCAS) in the computer club of the Lilyana Dimitrova Youth House in Sofia. SCAS went on to publish the first Bulgarian

[178] Petkov (2012): 210.
[179] Petkov (2012): 200.
[180] Bennahum, David S. "Heart of Darkness". *Wired* (November 1997). http://archive.wired.com/wired/archive/5.11/heartof.html. Accessed on 1 July 2015.
[181] Ibid.
[182] Petkov & Markova (2001): 47.

magazine focusing on computer graphics, the monthly *Graphics with a Computer*, beginning in 1991. The first exhibition of computer art in Bulgaria, co-organized by SCAS and Balkanmedia, took place in the Cathy art gallery in Sofia in 1992.[183] Computer graphics only became a separate subject at the Technical University of Sofia in 1991 and New Bulgarian University's computer arts program was established in 1993, with a curriculum supplied by SCAS.[184]

As detailed above, computer art in Bulgaria did have its beginnings in the final years of communist rule in the late 1980s. With the liberal reforms echoing the Soviet *perestroika* and the surge of the local personal computer industry, conditions were ripe for aesthetic experiments with computers. However, these did not develop into a computer art scene before 1989. In fact, the onset of these efforts is marked exactly by this key year in which Todor Zhivkov was overthrown and Bulgaria commenced its thorny transition to democracy and a market economy.

It was only throughout the 1990s that a contemporary art scene formed in Bulgaria, when various artists presented artworks incorporating video, lasers, holography and computer-based interactivity. And even then, the focus was mostly on video installations rather than computer art.[185] The lack of tradition, it seems, has sentenced Bulgaria to a negligible role in the history of computer art worldwide.

Albania

Historical and cultural context

Somewhat tucked away in the southwest corner of the Balkans, Albania was formed in 1912, as a result of the Balkan League's anti-Ottoman campaigns in the First Balkan War. Before World War II, Albania was notoriously politically unstable, transforming itself into a principality, a republic and a kingdom before being occupied by fascist Italy.

After World War II, the local communists prevailed to make Albania a people's republic under Communist Party First Secretary Enver Hoxha. A hardliner, Hoxha isolated Albania from both Yugoslavia and the Soviet-led Eastern Bloc and sides with faraway China in the Sino-Soviet split. Hoxha effectively banned religion and eliminated any sort of political opposition, but also brought stability and industrialized the traditionally agricultural country. Hoxha eventually split from Maoism, but Albania remained incredibly isolated. Almost schizophrenically fearing a foreign invasion, Hoxha had over 700,000 bunkers built

[183] Ibid.
[184] Petkov & Markova (2001): 48.
[185] Vassileva, Maria."Progress of Media Arts in Bulgaria" (ArtUp!, Goethe-Institut, 2012). http://www.goethe.de/ins/tr/lp/prj/art/med/bgt/bul/en9800806.htm. Accessed on 1 July 2015.

all over the country, enough to accommodate the entire population. Albania remained shrouded and self-isolated behind a "Double Iron Curtain" throughout communist rule.

Albania abandoned communism in search of a democratic government in the early 1990s. With a pyramid scheme causing a nationwide rebellion in 1997 and backlash from the Kosovo War a few years later, the transition has been particularly difficult.

Art in communist Albania was under complete government control and subjected to a local kind of socialist realism. Modernism was fiercely denunciated and no "thaw" occurred in the 1960s, when the Eastern Bloc states experienced the benign effects of the end of Stalinism. In fact, a plenum in 1973 meant art was sentenced to stick within "the most conservative and outmoded traditions" of realism,[186] and artists displaying any modernist tendencies were imprisoned and repressed.[187] Albanian culture was driven entirely by ideology and served as a propaganda tool spearheaded by the official Union of Albanian Writers and Artists.[188]

Albanian computer art

Considering Albania's almost complete self-isolation, it is safe to assume that the country had very little computer technology available, and access to it must have been severely restricted. With this and the state of visual arts throughout Albania's communist period, it is quite clear computers were not used for artistic purposes at any point before the end of communism in the early 1990s.

In the words of Albanian artist and professor at the Academy of Visual Arts in Tirana Eduard Muka, an exhibition funded by the Soros Foundation in 1992 was the first to show any kind of different artistic approach from socialist realism. In the same interview, Muka notes that new media were completely unknown in Albania at the time, though by 1996 contemporary artist **Anri Sala** had organized a "computer show". This is likely to have been the first step to Albanian computer art, already five years after the transition to democracy had begun.[189]

[186] Mata (2011): 75.
[187] Mata (2011): 81-83.
[188] Mata (2011): 77.
[189] Muka, Eduard. „Media Art in Albania, First Steps". Interview conducted by Geert Lovink. In *zpk 3* (Budapest: Metaforum, October 1996): 198. http://v2.nl/archive/articles/media-art-in-albania-first-steps. Accessed on 2 July 2015.

Conclusion

In the formative and maturing years of computer art in the West, Eastern Europe was controlled by restrictive, totalitarian communist governments. Both avant-garde art and any experimental use of the often lacking (or obsolete) computer technology were frowned upon or at least not given much government support. With scientists limited to what Politburo deemed national research priorities and artists confined to the bland genre of socialist realism, you would think that computer art never happened east of the Iron Curtain.

Yet, you would be completely wrong. Though Eastern European computer art may have largely evaded significant publications on the history of the computer medium (perhaps with the notable exceptions of the Yugoslav *New Tendencies* movement and Czech pioneer Zdeněk Sýkora), it nevertheless left behind a significant number of works and exhibitions by talented artists and experimenters.

Amazingly, Czechoslovakia was right there with the first nations to create and exhibit computer art in 1968, thanks in no small part to the efforts of Jiří Valoch. Overall, the country produced perhaps the most extensive computer art scene in the Eastern Bloc, which continued to develop and exhibit without many setbacks all the way until the end of communism.

In the heartland of totalitarian communism, the Soviet Union, in contrast, computer art hardly managed to appear. Only individual brave souls were able to explore the medium until the very end of the communist era.

In Poland and East Germany, computer art appeared only relatively late, at the turn of the 1980s. It owes its very existence to individual avant-garde artists who approached computer technology to facilitate or enrich their already existing artistic processes. As a result, a full-fledged scene never formed in these two countries.

In Hungary, computer art arose from the country's strong tradition of experimental film. Talented avant-garde filmmakers of the Béla Balázs Studio and other groups explored the potential of the computer to create a new kind of cinema as well as video art.

Neighbouring Romania hosted a surprisingly vibrant computer art scene in the mid-1970s, considering the unfavourable political climate under the hardliner Ceaușescu. Artists and scientists collaborated successfully, though for a relatively short time, pressured by the repressive measures of the regime.

Despite Bulgaria's surprising role as an Eastern Bloc leader in personal computing in the 1980s, computer art largely passed by the country. The first attempts to use the computer for aesthetic purposes there coincide with the very end of communism.

And in remote Albania, which isolated itself from the Eastern Bloc and backed China in the Sino-Soviet split, computer art was completely non-existent under communism. It was only in the 1990s that the computer was first considered as a possible artistic medium.

Overall, there was doubtlessly less computer art produced in the Eastern Bloc that in the West throughout the three or so decades when computer art and the Iron Curtain coexisted in Europe. Still, it would be wrong to dismiss Eastern Bloc computer art as something that never happened, to leave it out of any historical studies of the computer's role in art. Incidentally, most if not all works documenting computer art's history tend to largely ignore Eastern Europe. In fact, it almost feels like a Silicon Curtain still keeps Western researchers away from Eastern European computer art to this day.

As has been demonstrated in this master's thesis, this is a rather unfair state of affairs. Clearly, this master's thesis, as a work of such relatively limited size, can only serve as a starting point to further research into the depths of Eastern European computer art. Nevertheless, I hope that it can inspire and assist additional efforts to document the turbulent, dramatic, often sad but immensely diverse story of computer art in the Eastern Bloc.

Bibliography

Books and theses

- Gassen, Richard W., ed. *Zdeněk Sýkora, Retrospektive: Wilhelm-Hack-Museum, Ludwigshafen am Rhein, 3. November bis 30. Dezember 1995* [Zdeněk Sýkora, Retrospective: Wilhelm-Hack-Museum, Ludwigshafen am Rhein, 3 November to 3 December 1995] (Ludwigshafen: Wilhelm-Hack-Museum, 1995).
- Klütsch, Christoph. *Computer Grafik: Ästhetische Experimente zwischen zwei Kulturen. Die Anfänge der Computerkunst in den 1960er Jahren.* [Computer Graphic: Aesthetic Experiments between Two Cultures. The Beginnings of Computer Art in the 1960s] (SpringerWienNewYork, 2007). ISBN 9783211394090.
- Mata, Fjoralba Satka. „Albanian alternative artists vs. official art under communism“ in *History of Communism in Europe* 2, ed. Pălășan, Corina, and Cristian Vasile (Bucharest: Zeta Books, 2011). ISBN 9786068266145.
- Peternák, Miklós. „Hungarian Computer Art“ in *Beyond Art: A Third Culture: A Comparative Study in Cultures, Art and Science in 20th Century Austria and Hungary*, ed. Peter Weibel (Springer Science & Business Media, 2005). ISBN 9783990430392.
- Petkov, Rosen. *За старите книги и компютърните изкуства* [Of Old Books and Computer Arts] (Sofia: Student Computer Art Society, 2012). ISBN 9789549231168.
- Piotrowski, Piotr. *In the Shadow of Yalta: Art and the Avant-garde in Eastern Europe, 1945-1989* (London: Reaktion, 2009). ISBN 9781861898630.
- Rosen, Margit, ed. *A Little-Known Story about a Movement, a Magazine, and the Computer's Arrival in Art* (Cambridge, MA: MIT Press, 2011). ISBN 9780262515818.
- Sabau, George. *Contextual History of Kinema Ikon* (Arad: Art Museum Arad, 2005).
- Taylor, Grant D. "The Machine that Made Science Art: the Troubled History of Computer Art 1963-1989" (PhD dissertation, University of Western Australia, 2004).
- Zieliński, Gerard. *Zastosowania komputerów w sztuce* [The Use of Computers in Art] (Warsaw: Computation Centre of the Polish Academy of Sciences, 1972).

Journal and magazine articles

- Beutelschmidt, Thomas. „Kunst und elektronische Medien in der DDR. Alternative Versuche mit Video und Computergrafik am Rande des Kulturbetriebes“ [Art and Electronic Media in the GDR. Alternative Endeavours with Video and Computer Graphics at the Edge of the Cultural Domain]. *Ästhetik & Kommunikation* 98 (1997): 113-121.
- Bertók, Imrich, and Jozef Jankovič. “A Collaborative Investigation of the Line: Interactive Computer-Aided Drawings”. *Leonardo* 19 (1986): 27-30.
- Borgs, Jānis (2010). “Taking a different direction... ,” *Studija* 76 (2010): 38-44.
- Cortada, James W. “Public Policies and the Development of National Computer Industries in Britain, France, and the Soviet Union, 1940-80”, *Journal of Contemporary History* 44 (2009): 493-512.
- Epuré, Sherban. “An Artist's Journey in Art and Science: From behind the Iron Curtain to Present-Day America”. *Leonardo* 39 (2006): 402-409.
- Galeyev, Bulat M., and Yevgeny Mikheyev. “Introduction: Prometheus: Art, Science and Technology in the Former Soviet Union”. *Leonardo* 27 (1994): 367-370.
- Gerovitch, Slava. “'Mathematical Machines' of the Cold War: Soviet Computing, American Cybernetics and Ideological Disputes in the Early 1950s”, *Social Studies of Science* 31 (2001): 253-287.
- Kluszczyński, Ryszard. „Spaces of generativity. An introduction to the art of Wojciech Bruszewski“. *Art Inquiry* 14 (2014): 71-79.
- Lukichev, Ruslan Vladimirovich. "Генеративное искусство в СССР: генезис и тенденции" [Generative art in the USSR. Genesis and trends]. *Fourth Russian Culturological Congress* (2012).
- MacGregor, Brent. "Cybernetic Serendipity Revisited." *Proceedings of the 4th conference on Creativity & Cognition* 11 (2002): 11-13.
- Nake, Frieder. “The Semiotic Engine: Notes on the History of Algorithmic Images in Europe”. *Art Journal*, 68 (2009): 76-89.
- Petkov, Rosen, and Aneta Markova. „Multimedia Development in Bulgaria“. *Balkanmedia* 10 (2001): 47-51.
- Scharfenberg, Peter. “On symmetries in the graphic art of Horst Barting”. *Computers & Mathematics with Applications* 12 (1986): 883-893.
- Šperka, Martin. "The Origins of Computer Graphics in the Czech and Slovak Republics." *Leonardo* 27 (1994): 45-50.
- Sýkora, Zdeněk, and Jaroslav Blažek. “Computer-aided multi-element geometrical abstract paintings”. *Leonardo* 3 (1970): 409-413.
- Usselmann, Rainer. “The Dilemma of Media Art: Cybernetic Serendipity at the ICA London.” *Leonardo* 36 (2003): 389-396.

- Wilson, Booth. “Computer Animation across the Iron Curtain: Early Digital Character Design in *Kitty*”. *Animation Journal* 21 (2013): 4-25.
- Zariņa, Solvita. “Brief History of Computer Art and New Media Art in Latvia.” *15th International Conference on Information Visualisation* (2011): 457-460.