

# The Computer Music Studio at Salzburg

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**Abstract:** The Computer Music Studio (CMRS) at Salzburg, founded by the Austrian composer Irmfried Radauer in 1976, is a small studio dedicated to using the computer as a compositional tool and musical instrument. It is open to composers who join the CMRS initiative and to students of composition and musicology at the Hochschule Mozarteum. The studio's emphasis is on software synthesis and conventional and algorithmic composition. Our main tools are a PDP-11/44 running Music-11 under Unix, and a CDP workstation. The PDP offers reasonable speed (ca. 14 times the CDP) and multiuser capability. Together with Music-11, we use the score language Score-11 on it, the musical user interface Mshell, and a series of compositional programs written by Radauer. The CDP system offers compatibility to this environment and more flexibility. On it we use CSound, the Groucho mixing tools, and the Phase Vocoder. Coupled to the CDP is a Midi keyboard which is used in conjunction with CLab's Notator, our S11input, MidiRecord, MidiPlay, and Midore. Note printing is done via Notator or Score on an IBM-PC.

The Computer Music Studio at Salzburg (Computermusik-Rechenzentrum Salzburg, CMRS) is a small studio dedicated to using the computer as a compositional tool and musical instrument. It was the first studio of its kind in the German speaking countries and, until recently, was also the only one. A lot had depended on private effort, so resources are limited — but that is probably true in many places.

Since the establishment of a chair for electronic and computer music at the music academy Mozarteum at Salzburg, held by Irmfried Radauer, the studio's priority is in the education of students of composition and musicology as well as for postgraduate study projects. Additionally, there is time and space available for composers who join the CMRS initiative.

The CMRS was founded in 1976 as an initiative by the composer Irmfried Radauer and was developed through his continuous effort. Radauer had been with the pioneers of computer music in Stanford in the sixties. Back in Austria in the early seventies, Radauer continued composing and lecturing computer music. Since no music hard- and software was at disposal, Radauer used computing resources at the Zentralsparkasse Wien and the Salzburger Sparkasse (two savings banks). Around 1980, Radauer began to turn the CMRS into a "physical" studio, located at the data processing department of the Salzburg University. At this time Stephen Pope started to work as a systems manager and installed hard- and software. The studio's official opening took place in 1983.

Formally the CMRS is a non-profit private organisation (eingetragener Verein). Manpower is provided by Irmfried Radauer's chair and by a teaching contract of Hans Strasburger with the music academy Mozarteum. Rooms are provided by the Computer Center of the Salzburg University through the effort of its director Peter Zinterhof. Equipment has been donated by several funds. Hans Strasburger also works full time as a vision scientist at the Institute of Medical Psychology of the Munich University and this Institute has given some help. In 1986 the studio has moved to a new university building in a beautiful environment.

The studio has two rooms: a machine room and musical work room. The machine room houses our main workhorse, a PDP-11/44 running the Unix (Version 7) operating system, and hardware for A/D and D/A sound conversion. The "/44" was a relatively fast PDP-11

operating at about twice the speed of a standard "/34" and it still offers about 14 times the speed of a CDP system. Nevertheless, it has now done its duty and will be replaced by a NeXT workstation in the near future. — The musical work room houses terminals to the Unix system, a CDP computer music workstation which I will describe below, an additional Atari ST-1040 plus disk, and a complement of audio equipment including a 20 channel mixer, four high performance tape decks, a Sony 701 PCM unit plus video tape for sound backup, a reverberation unit, etc. We have also started to acquire some Midi equipment: A Yamaha pf-85 electric piano; a Dynacord sampler is to come.

Our work during the last decade, described in the Appendix, has been focussed on Music-11. Music-11, written by Barry Vercoe at the MIT, was implemented in Salzburg by Stephen Pope together with a soundfile system by Robert Gross. In conjunction with Music-11 we use accessory tools like Score-11 by Aleck Brinkman, the musical user interface Mshell by Stephen Pope, Stephen Pope's VScore, and the series of compositional programs MuPro77 by Irmfried Radauer. Stephen Pope has installed this part of the system hard- and software in our studio during his work as a systems manager from 1980 to 1986.

Pure software synthesis had started to get "out of vogue", being outglamoured by developments in interactive real-time systems and by commercially available MIDI equipment. Two events at the ICMC 1986 in den Haag, however, have stirred renewed interest in software synthesis: The introduction of the CDP personal computer music workstation, and CSound, a portable successor to the Music-11 language. A third important step for the efficient use of software synthesis is this year's presentation of the Durham Transputer Music Workstation running CSound.

The CDP workstation, which has been developed by the York/UK based "Composers Desktop Project" is the first personally affordable general purpose computer music workstation. It offers high quality software synthesis, digital mixing, music analysis, composition, and MIDI control. Of equal significance is the concept of the CDP to be an open project, where anyone can contribute and share who is interested.

We have acquired and assembled such a workstation and it has been operational since January 1988. It is based on an Atari Mega-4 with a 360 MByte SCSI hard disk and has our Sony PCM connected to it via a Soundstreamer. The Atari is now upgraded to use a 16 MHz CPU, roughly doubling its performance. Since the Atari's speed is still limited, we have started to assemble a transputer network and link it to the Atari. For our main computationally intensive application, CSound, this should bring compilation time close to real time.

From the host of software available on the CDP we use CSound, the Groucho mixing and processing tools written by Andrew Bentley, and the CARL Phase Vocoder. As a graphical user interface we use NeoDesk. Other useful tools on the CDP are Spect, Cannon, Noise, and Scorp. We just acquired FOF synthesis implemented by Michael Clarke. CMusic, and the CMU Midi toolkit are at disposal. Our next step will be to port VScore and Score-11 to the CDP.

During the last two years we have established several links between Midi and software synthesis. S11input, a program developed for the Atari at our studio by Stefan Kohler, allows score data to be acquired by a Midi keyboard in the mode of a single step sequencer, or to be input with a mouse in a graphical environment. The data can either be fed to Score-11 on the PDP-11 and then sent to CSound or fed directly to CSound. The route via Score-11 has the advantage of allowing more intuitive editing of the resulting scores, since the notation is in a higher level language than CSound. The other advantage is that we can reuse the data for note-printing via Leland Smith's Score on the IBM-PC. Since Score-11 is not yet available on the CDP, we have also provided the direct link from S11input to CSound. A way of moving real-time score data to and from CSound is given by Andrew Bentley's MidiRecord and MidiPlay. A third way of feeding score data to CSound is by acquiring the scores with a standard sequencer package — we use CLab's Notator — and use Midore (by Op de Coul) as a link to CSound.

The CDP system is coupled as a terminal to the Unix system, so that score files, in-

strument definitions, and other ASCII data can be shared. We have conversion utilities for many different floppy formats available, so composers who have a personal computer at home can prepare files to be processed at the CMRS. Furthermore, the CDP system serves as a link to the Bitnet and WIN electronic mail networks.

Since 1976 lecturing and composing has been done in the CMRS. Much of our work has been sponsored by a research contract with the "Fonds zur Förderung der wissenschaftlichen Forschung" of Vienna (foundation for the support of scientific research, the Austrian version of NSF), with project leader I. Radauer. Details of our work are summarized in the Appendix.

## Appendix: Work at the Computer Music Studio Salzburg

Irmfried Radauer:

### I. Macrostructural algorithmic composition\*

Programs in Fortran, Ratfor and C for

- a) twelve-tone compositional techniques
  - b) stochastic compositional processes (Markoff series)
  - c) compositional programs MUPRO-77:
    - variable distribution functions (for all relevant musical parameters)
    - permutational techniques
    - tempered system, natural tone system, microtonalities
    - tonal or modal systems
    - interval series
    - heterophony and homophony
    - Kanon and Fugue composition, including all polyphonic techniques like invertible counterpoint etc.
    - techniques for processing of themes and motives
- several output formats are supported: Music-11, Score-11, Cmusic, and music printing

### II. Microstructural algorithmic composition\*

Programs in Music-11 for sound synthesis using

- a) additive synthesis
- b) subtractive synthesis
- c) frequency modulation (FM) synthesis
- d) waveshaping
- e) combinations of a) - d)

Investigation of sound quality and intensity of dissonant intervals and chords\*

Major Publications:

(Before CMRS:)

"Computer — Rationale Kompositionsmethoden — Musikalische Information". In: Kunstjahrbuch "Konfigurationen", Wien, 1970.

"Computer-Komposition". In: "Melos", Zeitschrift für neue Musik", Heft V, Mainz, 1974.

(Within CMRS:)

"Bereicherung oder Verarmung. Möglichkeiten der Computeranwendung in der Musik am Beispiel des Computermusik-Rechenzentrums CMRS in Salzburg". In: "Österreich zum Beispiel", Literatur, Bildende Kunst, Film und Musik seit 1986". Residenz Verlag Salzburg, 1982.

Major Lectures:

(Before CMRS:)

"Wirklichkeit und Mythos des Computers am Beispiel der Computer-Musik". Zentralsparkasse Wien, 1969

"Einführung in die Computermusik". ORF-Fernsehen, Wien, 1971

"'Euphorie', ein algorithmisches Orchesterwerk für 130 Instrumentalisten". Österreichische Gesellschaft für Musik, Wien, 1974

(Within CMRS:)

- “‘Ockeghem 77’, eine elektronische Computerkomposition”. Saarländischer Rundfunk, 1978
- “‘Evocation d’Ockeghem’, Computermusik von und mit I. Radauer”. Mozarteum Salzburg, 1980
- “Algorithmische Komposition und elektronische Klangerzeugung mit dem Computer (Colloquium)”. Mozarteum Salzburg, 1984
- “Musikalische Aspekte in ‘Gödel — Escher — Bach’ von Hofstadter”. Univ. Salzburg, 1986

Major compositions:

(Before CMRS:)

Numerous algorithmic compositions since 1961

- “Euphorie”, f. big orchestra, computer composition (premiere Wien 1973, record: IGMN 1976)
- “Tetraeder”, f. 12 instruments and computer tape (premiere Wien 1969, publisher: Edition Gravis)
- “My end is my beginning” (cooperation with Ch. Lantz and R. Moran), multimedia (premiere Berkeley 1968)
- “Akoasmen”, 4 channel computer music (premiere Wien 1969)
- “Trio für Flöte, Violine und Klavier”, computer composition (premiere Salzburg 1973)
- “Kontraktion”, f. orchestra, computer composition (premiere Graz 1974)
- “Streichquartett 14-3-71”, computer composition (premiere Wien 1972)
- “Bläserquintett”, computer composition (premiere Salzburg 1973)
- “Oasis I”, two channel computer music (premiere Stanford 1976)

(Within CMRS:)

- “Oasis II”, f. instrument ensemble and computer tape (premiere Wien 1976)
- “Oasis III”, f. instrument ensemble and computer tape (premiere Salzburg 1977)
- “Musik für die Felsenreitschule” (cooperation with J.M. Horvath and G. Wimberger), computer tape (premiere Salzburger Festspiele 1977)
- “Modelle”, f. flute, harp, and computer tape (premiere Salzburg 1978)
- “Ockeghem 77”, two channel computer music (premiere Stanford and San Diego 1977)
- “Evocation d’Ockeghem”, f. two orchestras and computer tape (premiere Salzburger Festspiele 1979, publisher: Edition Gravis, record: “Österr. Musik der Gegenwart, Elektronische Musik 2, ‘Tonband und ...’ ”, Österr. Musikrat 1988, Polygram)
- “Sphärenmusik I”, two channel computer music (premiere Salzburg 1983)
- “Sphärenmusik II”, two channel computer music (premiere Wien 1985)
- “Sphärenmusik III”, four channel computer music (premiere Wien 1987)
- “Die Kunst der Computer-Fuge” (1987/88) Programmgesteuerte Fugen, Kanons und Interludien in variabler Anzahl, Form und klanglicher Realisierung

**Klaus Ager:**

- “Immer klingen die weißen Mauern der Stadt”, computer tape (premiere Wien 1988, record: Österr. Musik der Gegenwart, Polygram, 1988)
- “Hölderlin Fragmente”, f. oboe and computer tape, 1988

**Herbert Grassl:**

- “Klagelied”, f. english horn and computer tape

**Joseph Maria Horvath:**

- “Verschiebungen”, quartet for instruments, 1973
- “Musik für die Felsenreitschule” (cooperation with I. Radauer and G. Wimberger), computer tape (premiere Salzburger Festspiele 1977)
- Music-11 simulation of Silbermann organs through additive synthesis based on spectral analysis\*
- Computer realisation of Bach’s “Vom Himmel hoch da komm ich her”

**Stefan Kohler**

- “Midi und Score-11. Versuch einer Verbindung beider Systeme (S11input).” Diplomarbeit an der Hochschule Mozarteum

## Stephen Pope

### Publications:

- Handbook for using musical software under the Unix operating system (German language, 150 pages), 1983\*
- "Introduction to the Mshell". ICMC 1982
- "Digital Signal Processing Tutorial", ICMC 1983
- "Music notations and the representation of musical structure and knowledge", Perspectives of New Music, Vol. 24 #2, 1986

### Compositions:

- "4" (presented at ICMC 1982)
- "Terpsichore" (presented at ICMC 1983)
- "Bat out of Hell" (presented at ICMC 1985)
- "Requiem Aeternam Dona Eis"
- "ARA"

### Program Development:

- Graphical tools for envelope and spectrum editing under Unix
- "msh", a music shell and DSP interpreter
- "vscore", score processing tools for Music-11

## Hans Strasburger, Dr. human. biol., Dipl. Math., Dipl. Psych.:

- Publications in the areas of Psychophysiology, Visual Perception, Electrophysiology, and Computer Science
- with Irmfried Radauer: "The Computer Music Studio at Salzburg", ICMC 1988
- "Assembling a large harddisk for the CDP system". Available from the CDP
- with Stefan Kohler (1989): "S11input Users Guide", submitted to the CDP
- CMRS systems manager since 1986

## Gerhard Wimberger:

- "Musik für die Felsenreitschule" (cooperation with J.M. Horvath and I. Radauer), computer tape (premiere Salzburger Festspiele 1977)
- Automatic generation of Cantus Firmus in the style of Palestrina (Fortran)\*
- Automatic generation of twelve-tone all interval series (Fortran)\*

Work for the "Fond zur Förderung der Wissenschaftlichen Forschung", Wien, is denoted by a '\*.