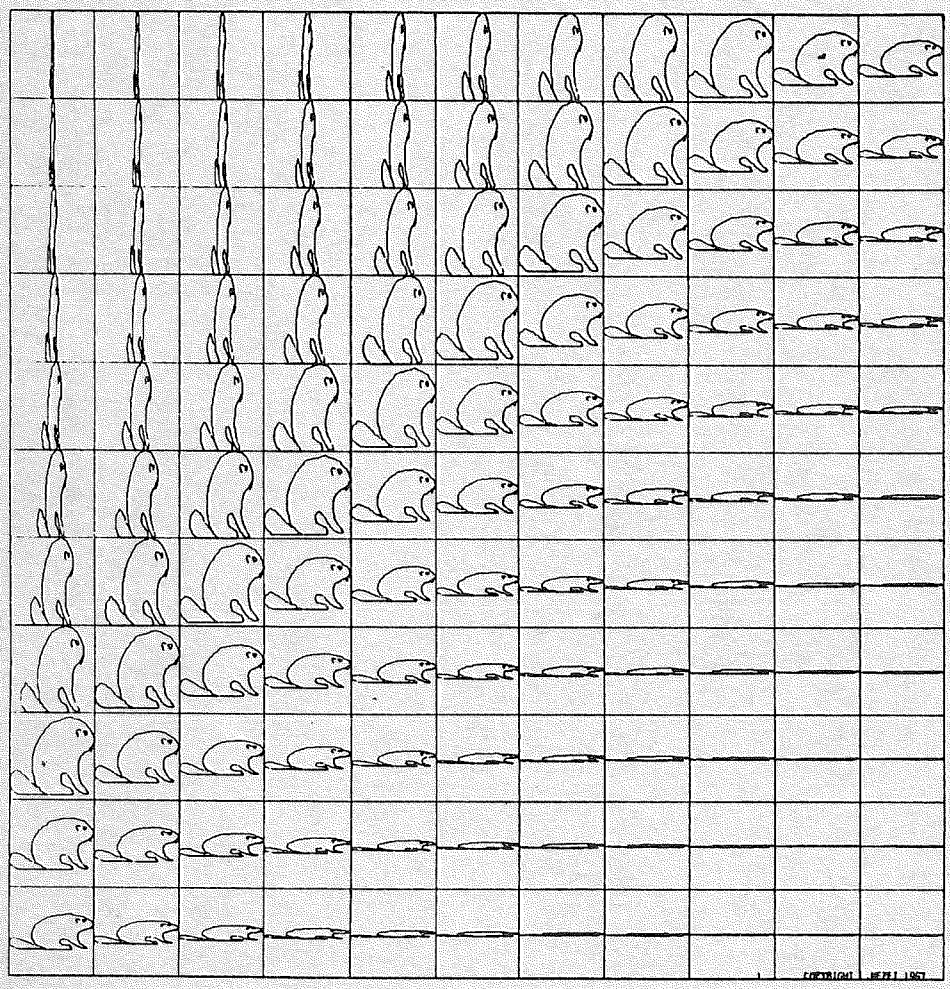
Computer Music 1976/77:
a directory to current work



William Buxton (Editor)

ERRATA

Page 49: Under Principal Sources of Funding

Mme M. Falabert
should read

Mme M. Salabert

Page 53: Under Address

Insitut...
should read

Institut...

Page 63: Under Address

Université de Paris III
should read

Université de Paris VIII

Page 64: Under List of Works

2) Re-Cosa...
should read

2) ReCosa...

Page 64: Under Computers and Digital Hardware

Télémécanique T1600:32K (8 bit)
should read

Télémécanique T1600:32k (16 bit)

Computer Music 1976/77:
a directory to current work

Computer Music 1976/77:
a directory to current work

edited for

The Canadian Commision for Unesco

255 Albert
P.O. Box / C.P. 1047
Ottawa, Ontario
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by

William Buxton

Structured Sound Synthesis Project
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published by:

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by Leslie Mezei

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to mary

Contents

Preface

The prime motive in preparing this document was to facilitate access to information in the rapidly expanding field of "computer music". In so doing, we have had to limit the scope of our study primarily to those activities related to the composition of music and synthesis of sound with the aid of a digital computer.

The information was collected by means of a questionnaire which received wide distribution and response over the past 12 months. In presenting the information, we have retained the format of the questionnaire in order to keep the editing at a minimum. This ensures the integrity of the respondents' texts, at the same time enabling us to publish the results before they are entirely obsolete. Therefore, no synopsis or interpretation of the results is included. Readers are left to draw their own conclusions; we have tried only to present the material to enable them to do so.

The questionnaire responses are sorted alphabetically by country, and within each country alphabetically by institution or name -- whichever is appropriate. The table of contents at the front of the book follows this format; the index at the end is compiled according to individuals' names. There is also an Appendix including addresses of persons or institutions that responded to the questionnaire but that were not currently active in computer music. Finally, the Introduction contains the historical background to this document. This is the first in a series of projects in computer music being co-ordinated by the Canadian Commission for Unesco. It is hoped that the following ones will meet with equal success.

No book, and especially no document of this kind, can be put together without the help of many dedicated people. First, we are indebted to those who

Préface

Au cours de la rédaction de ce document, nous avons visé surtout à rendre facile l'accès aux renseignements dans le domaine de la composition musicale par ordinateur. Pour ce faire, nous avons dû limiter la portée de notre étude aux activités ayant un rapport avec la composition musicale et la synthèse du son à l'aide d'un ordinateur.

Les renseignements ont été recueillis au moyen d'un questionnaire, qui reçut une bonne distribution et une excellente réponse dans les 12 derniers mois. Nous avons retenu le format du questionnaire dans la présentation, afin de minimiser les annotations. De cette façon, nous avons pu assurer l'intégrité des réponses., et en même temps, nous avons pu publier nos résultats avant qu'ils ne soient périmés. En conséquence, nous n'avons inclu aucune synthèse ou interprétation des résultats. Le lecteur doit tirer ses propres conclusions; nous n'avons présenté que les renseignements qui lui permettront de le faire.

Les réponses au questionnaire sont classées en ordre alphabétique, par pays, et, dans chaque pays, en ordre alphabétique par nom de l'individu ou de l'institution. La table des matières au début du livre suit ce format; l'index à la fin du livre est arrangé selon les noms des individus. On pourra trouver dans l'appendice les adresses des individus ou institutions qui ont répondu au questionnaire, mais qui ne travaillent pas pour le moment dans la composition musicale par ordinateur. Enfin, l'historique de ce document est détaillé dans l'introduction, Cette étude est la première d'une série de projets sur la musique et les ordinateurs, coordonnées par la Commission Canadienne pour l'Unesco. Nous espérons que les projets à venir seront couronnés d'un succés semblable.

Nul livre, et surtout nul document semblable, ne peut être assemblé sans l'aide de maintes personnes dévouées.

took the time to respond to our questionnaire, for without them there would be no book. We are grateful to Olga Jurgens and her staff at the Canadian Commission for Unesco who made a Herculean contribution through providing all manner of support, not least of which was the initial distribution and collection of the questionnaires. To my colleagues of the Canadian and International Committees, especially Dennis Patrick of the University of Toronto, I express my thanks for their aid in the planning and design of the questionnaire as distributed. Finally, I would like to acknowledge the contribution of the Dynamic Graphics Project of the University of Toronto (which provided the computer text-editing facilities), as well as that of my assistant editor David Sherman, whose ability as linguist, stenographer, editor, and layout artist can only be described as wizardry. Even then, the document could not have been typeset without the assistance of my collegue Bill Reeves.

If in going through this document the reader finds certain errors or omissions, it is not the result of a lack of effort on the part of the abovementioned people; rather, it is the result of trying to make the information available as soon as possible to optimize on its potential utility. For this reason too, I apologize in advance to non-anglophone readers for not having prepared translated versions of the manuscript. Unfortunately, it has been a question of either realizing the document in its current format, or not at all. This has been purely a question of limitations on my time imposed by other obligations as well as financial constraints. In spite of this unilingual presentation, it is hoped that the standardization of the format, etc., will provide a useful resource, even for those who are not native English speakers.

J'aimerai tout d'abord remercier tous ceux qui ont répondu au questionnaire. Je suis aussi endetté à Olga Jurgens et aux employés de la Commission canadienne pour l'Unesco, qui ont fourni un appui herculéen dans tous les étapes de l'étude; la distribution et le rassemblement des questionnaires figurent parmis les tâches qu'ils accomplirent. Je remercie mes collègues des Comités canadien et international, et surtout Dennis Patrick de l'Université de Toronto, pour leur aide dans la planification du questionnaire. Enfin, j'aimerais reconnaître le travail du Dynamic Graphics Project de l'Université de Toronto (qui a fourni les services de rédaction par ordinateur) ainsi que celui de mon adjoint, David Sherman. Son habilité comme linguiste, sténographe, rédacteur et artiste de disposition typographique me fait penser à la sorcellerie. Aussi, le document n'aurait pas été composé sans l'aide indispensable de mon collègue Bill Reeves.

Toute erreur ou omission que le lecteur trouvera dans ce document est le résultat, non d'un manque de travail de la part des personnes nommées ci-dessus, mais plutôt du fait que nous avons tenté mettre les renseignements à la disposition de tous aussitôt que possible, afin de maximiser leur utilité potentielle. Aussi aimerais-je faire mes excuses aux lecteurs non-anglophones pour le manque d'une traduction du document entier. Malheureusement, j'ai du choisir entre le format actuel du document et l'abandon du projet. En effet, le temps à ma disposition était limité, à cause d'autres devoirs et de contraintes financières. En dépit de la présentation unilingue, j'espère que le format standardisé, etc., fournira une ressource utile, même pour ceux dont la langue maternelle est autre que l'Anglais.

W. Buxton
Toronto
October 1977

Introduction

1) *Background*

The project "Artistic Creation and Contemporary Technology: A Case Study of Musical Composition" is part of the European Joint Studies series. These projects are an outcome of the Intergovernmental Conference on Cultural Policies in Europe which was held under the auspices of Unesco in June 1972 in Helsinki, Finland, in which Canada participated. One of the most important recommendations of the Conference which is now known as "Helsinki Recommendation 15" suggested that European Member States of Unesco carry out joint comparative studies involving persons or institutions from a group of countries on cultural policy subjects of particular interest to them. Although Unesco was asked to act as the general liaison agency, the coordination of particular studies was entrusted to the National Commission for Unesco in interested member states. The Recommendation, of course, represents an attempt to create a more meaningful cultural exchange between different European countries including Canada.

After the Helsinki meeting, nineteen European countries expressed the wish to participate in the joint studies. A meeting to discuss these was convened in Bonn, in March 1975, by the National Commission of the Federal Republic of Germany. The aim was to select subjects for the studies by groups of countries, determine the coordinators, and agree on a timetable and general methodology. Fourteen projects were selected. In addition to the Canadians who agreed to coordinate the study on music composition and computers, specialists from France, Hungary, Italy, the Netherlands and Sweden expressed interest in participating.

As coordinator of the project, it was its responsibility to prepare the outline of the study. In order to achieve

Introduction

1) *Historique*

Le projet "Création artistique et technologie contemporaine - Etude d'un cas : la composition musicale" fait partie de la série "Etudes conjointes des pays de l'Europe". Ces projets sont les resultats de la conférence intergouvernementale sur les politiques culturelles en Europe qui a eu lieu sous les auspices de l'Unesco en juin 1972 à Helsinki, en Finlande, et à laquelle le Canada a participé. L'une des recommandations, dite "no. 15", suggérait aux Etats européens membres de l'Unesco d'organiser pour des personnes et institutions des études de nature comparative sur des sujets bien délimités et d'intérêt commun. L'Unesco devait jouer le rôle d'organisme de liaison, mais la coordination des études particulières était confiée aux commissions nationales des Etats membres intéressés. La recommandation est évidemment une tentative de création de meilleurs moyens d'échanges culturels entre des pays européens, dont le Canada fait partie au sein de l'Unesco.

Dix-neuf pays de l'Europe ont exprimé leur désir de participer aux études culturelles communes. La commission nationale de la République fédérale d'Allemagne organisait, en mars 1975 à Bonn, une première réunion d'organisation dont les buts étaient de choisir les sujets d'études pour les divers groupes de pays, de choisir un pays coordonnateur pour chacun des sujets d'étude et d'établir un calendrier et une méthodologie générale. Quatorze projets furent retenus en tout; la commission nationale du Canada s'est offerte à titre de coordonnateur du projet 14 (projet en rubrique) auquel s'intéressèrent des specialistes de la France, de la Hongrie, de l'Italie, des Pays-Bas et de la Suède.

A titre de coordonnateur, la Commission canadienne pour l'Unesco avait pour tâche de préparer les grandes lignes de l'étude; elle a dans ce but organisé une rencontre entre des compositeurs, des

this, the Canadian Commission called a meeting of composers, technicians and institutions involved in musical composition and computer research in Canada. The meeting was held in Toronto, on March 27, 1976. The group that met is now co-ordinating the Canadian participation in the study. Members of this Canadian Committee are:

techniciens et des représentants d'institutions qui s'occupaient activement de composition musicale et de recherche en informatique au Canada. Cette rencontre a eu lieu à Toronto, le 27 mars 1976. Le groupe des personnes qui se sont réunies à Toronto coordonne aujourd'hui la participation canadienne à l'étude. Les membres de ce Comité canadien sont:

Norma Beecroft
William Buxton
Peter Clements
Daniel Hennequin
David Keane
Paul Pederson
Barry Truax
Walter Boudreau
Gustav Ciamaga
James Gabura
David Jaeger
Dennis Patrick
Eric Regener
Olga Jurgens (program officer, Canadian Commission for Unesco)

2) *Course of Project*

In view of the rapid developments occurring in the field and the diversity of existing approaches, the Canadian Committee felt a need for international exchange of information. To meet this objective, a three-part plan of action was proposed: (a) the drafting of a questionnaire to gather and distribute factual data quickly from persons and institutions active in the field; (b) to commission several detailed studies on various sub-topics in the field; (c) to sponsor an international workshop to bring together people active in computers and musical composition. Toward these goals, and in a (successful) attempt to involve participants from other countries in the planning stages, a further meeting was held in Paris in June 1976. The participants in this meeting, who form the core of the "International Committee", finalized the details of the questionnaire and agreed on proposals for the detailed studies and workshop. The International Committee reconvened in Canada in August 1977, where it completed formulation of its proposals on these projects, which are outlined below. Members of the International Committee who attended one or

2) *Progrès du projet*

Etant donné les développements rapides dans le domaine de la composition musicale par ordinateur, et la grande variété d'approches possibles, le Comité canadien a ressenti un besoin pour un dialogue international. Afin de réaliser ce but, un plan d'action en trois étapes a été développé: (a) la rédaction d'un questionnaire pour rassembler et distribuer rapidement les renseignements obtenus des individus et institutions qui travaillent dans le domaine; (b) la mise en oeuvre d'une série d'études detaillées sur différents sujets dans le domaine; (c) la création d'un atelier international où se rassembleraient des personnes qui travaillent dans la composition musicale par ordinateur.

Dans ce but, et afin d'obtenir (avec succès) une participation internationale dans la planification, le comité convoqua une réunion à Paris en juin 1976. Les experts qui participe`rent à cette réunion, et qui forment le "Comité international," mirent au point les plans pour le questionnaire, les propositions pour la série d'études et l'atelier. Le Comité international s'est réuni une deuxième fois en août 1977, au Canada. Les plans ont été

both of the above-mentioned meetings are:

élaborés et complètes à cette réunion. Les membres du Comité international qui assistèrent à au moins une de ces réunions sont:

Marc Battier (France)
Walter Branchi (Italy)
Peter Clements (Canada)
Daniel Hennequin (Canada)
Gottfried-Michael Koenig (Netherlands)
Marcello Panni (Italy)
Jeane-Claude Risset (France)
Barry Truax (Canada)
Tamas Ungvary (Sweden)
Barry Vercoe (United States -- advisor)
Olga Jurgens (program officer, Canadian Commission for Unesco)
Gilles Lefevre (director, Canadian Cultural Centre, Paris)
M. F. Pires (Cultural Development Division, Unesco)

3) *Questionnaire*

The use of a questionnaire to gather and disseminate factual information quickly was the first of the three phases of the project proposed by the Canadian Committee. The publication of this document completes this phase, and while much of the data will be quickly dated, it is felt that the information will be of value to all those in the field: professionals, students, and even historians.

3) *Le questionnaire*

Le rassemblement et la distribution de renseignements au moyen d'un questionnaire était la première des trois étapes proposées par le Comité Canadien. La publication de ce document termine cette étape, et, quoique les renseignements rassemblés seront vite périmés, nous espérons qu'ils auront une valeur pour tous ceux qui travaillent dans ce domaine: experts, étudiants et même historiens.

4) *Detailed Studies*

The purpose of the detailed studies is to both survey and evaluate current work in the areas and assess its potential significance to the future of contemporary music. Toward this end, detailed studies have been commissioned from specialists in the participating countries, as follows:

4) *Etudes détaillées*

Le but des études détaillées est de passer en revue le travail actuel dans chaque domaine et d'évaluer son importance pour l'avenir de la musique contemporaine. Les études suivantes ont été commandées à divers experts dans les pays participants:

French National Commission:
Composition and methods of synthesis
Swedish National Commission:
Computer-aided analysis of performance and its relation to computer music systems
Italian National Commission:
Music education and the computer

Canadian National Commission:
Composer-machine communication: the influence of new technology.

These studies are intended to be completed before, and serve as a partial basis of, the international workshops described below.

5) *International Workshop*

The purpose of the workshop(s) is to bring people, equipment, and resources together face-to-face. The approach planned for this encounter is two-staged. The first is a number of (simultaneous) "pre-workshop" study weeks. The second is the final workshop.

The purpose of the pre-workshop study weeks is to provide participating composers with a wide variety of practical and theoretical experience as a preparation for their participation in the final workshop. The study weeks are planned to take place at various host institutions in North America and Europe. In a sense this is also an experiment in multi-cultural exchange, in that it is intended to allow interested persons to be introduced to studios, facilities and working methods in other countries that would otherwise be difficult of access.

It is hoped that a wide variety of studios in many countries will make some or all of their facilities available to these participants during two specific weeks in August 1978 for two groups of composers. Each group will visit the host studio for one week only. Each participant will choose in advance the two particular studios he/she wishes to visit.

As of the time of publication (October 1977), it is the intention of the Canadian and International Committees to conclude the project with the inter-

Ces études doivent être complétées avant les ateliers de travail, où ils serviront de base aux discussions.

5) *Ateliers internationaux*

Le but des ateliers est de rassembler personnes, outillage et ressources. Cette rencontre sera divisée en deux étapes. La première comprend plusieurs semaines d'études (simultanées) pour l'atelier de travail. La deuxième est l'atelier international lui-même.

Les semaines d'études ont pour but d'offrir aux compositeurs participants l'occasion de faire divers travaux pratiques et théoriques en préparation à leur participation à l'atelier-rencontre qui sera l'étape finale du projet. Comme ces semaines d'études auront lieu dans diverses institutions d'Amérique du Nord et d'Europe, elles constitueront une expérience d'échanges multiculturels, puisqu'ils permettront aux personnes intéressées de se familiariser, mieux que de toute autre manière, avec les studios, les installations et les méthodes de travail d'autres pays.

Les organisateurs ont l'espoir que de nombreux studios de divers pays accueilleront, en mettant à leur disposition une partie ou le tout de leurs installations, deux groupes de compositeurs au cours des deux semaines d'août 1978 pendant lesquelles aura lieu l'atelier de travail. Chaque groupe visitera le studio hôte pendant une semaine seulement. Chacun des participants choisira à l'avance les deux studios qu'il désire visiter.

A l'heure où nous mettons sous presse (octobre 1977), les Comités international et canadien prévoient la conclusion du projet par l'atelier international; cet atelier aura lieu en Europe, la semaine

national workshop. planned to take place in Europe during the week of August 28, 1978. Plans are to have six papers to be given by invited specialists, research reports with accompanying discussion, five evening concerts, and various meetings on specific topics.

6) *Conclusions*

It is hoped that the net result of this project will not only be in the nature of the exchange of factual information -- which is often of only short-lived value -- but will help foster lasting cultural and human exchange among people of different nations. This was, after all, the underlying motive of the Helsinki Agreement in the first place. If the cooperation exhibited in the compilation of this document and the planning of the next two phases is an indication, we cannot help but succeed.

du 28 août, 1978. Les plans comprennent six exposés donnés par des experts invités, des rapports de recherche à être discutés, cinq concerts en soirée et des réunions sur divers sujets d'intérêt particulier.

6) *Conclusion*

Nous espérons que ce projet résultera non seulement dans un échange de renseignements--dont la valeur ne peut être que temporaire--mais aussi créera des échanges culturels et humains durables entre les participants de différentes nationalités. C'est d'ailleurs là l'esprit de l'Accord de Helsinki. Si nous continuons à coopérer comme nous l'avons fait pour la compilation de ce document et dans la planification des deux prochaines étapes, nous ne pouvons que réussir.

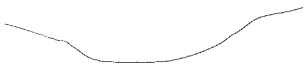
Olga Jurgens
Program Officer/chargée de programmes
Canadian Commission for Unesco/Commission canadienne pour l'Unesco

William Buxton
Editor/éditeur

for: / pour:

The Canadian and International
Committees of Project 14 of the
European Joint Studies.

Les Comités canadien et international
de Projet 14 des "Etudes conjointes
des pays de l'Europe"



Name

Canberra School of Music

Address of Institution

P.O. Box 804
Canberra City
A.C.T. 2601, Australia

Type of Institution

School of Music

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
John Crocker	Technical	Senior Technical Officer		
Anthony Furse	Technical	Designer		

Areas of Activity

Development of a synthesizer: so far there have been no significant musical products

HARDWARE

Computers and Digital Hardware

QASAR/M8: 32K (8-bit) -- 16K core, 16K display

Peripheral Devices

Data Storage

IBM type 1 diskettes

Input Devices

Teletype, VDU (14" TV screen, typewriter keyboard, 48-note music keyboard)

Output Devices

TTY

Sound Generation

Digital

None

Hybrid Systems

None

Mixed Digital Systems
Yes

Other Peripheral Devices

Analog
8-track recording studio:
One 16x4 tascam mixer console
One 8-track MCI tape recorder
Four Phase linear 400 amplifiers (stereo)
Eight AR3a loudspeakers
One Studer stereo tape recorder

Proposed Hardware Developments
Delta modulation

Access to Computer
Dedicated computer

Availability of Technical Assistance
Resident Senior Technical Officer; designer lives 200 miles away (in Sydney)

Operating Systems
Support for VDU, disk drives and piano keyboard

Turnaround/Response Time Characteristics
Immediate output, 8 simultaneous channels (8 voices, 48-note keyboard); octaphonic effects possible

Additional Comments

The Qasar M8 synthesizer under development in our studios is being designed and built by Anthony Furse, manager of Creative Strategies, Sydney. Production versions will be made by Fairlight Instruments, also of Sydney.

The M8 was designed from the "ground up", based on a dual processor CPU board employing Motorola M6800 micorprocessors.

At the present stage of development, the user creates a library of waveforms which are each constructed on 32 bar graphs on the TV screen (using light pen and keyboard). The graphs represent the fundamental and 31 harmonics. The relative phases are also definable.

These waveforms are then called out by the "formant generator", where the user also specifies envelope -- so a complete sound consists of a formant, wherein up to 32 waveforms may be called out of the waveform library, each one attacking (getting louder), staying steady, or decaying. One after the other to produce a sound of varying envelope and harmonic structure,

Eight such sounds may be played simultaneously on the keyboard.

Thus far, all programming has been in assembly language, but a high-level language called MUSEQU 8 is contemplated that will provide sophisticated construction, editing and performing of massive sequences on electronic sounds.

Name

University of Melbourne

Address of Institution

Faculty of Music
University of Melbourne
Parkville, Vic.
Australia

Type of Institution

University

Principal Sources of Funding

Gulbenkian Foundation, University research funds, Faculty of Music funds

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Barry Conyngham	Musical composition	Co-ordinator	Artistic, research	Part-time
Rex Harris	Computer science, mathematics	Associate	Research, creative, mathematical	Part-time
Carl Stevens	Music	Research assistant, programmer	Research, creative	Full-time
John Roe	Elec. engineering	Technical	Hardware and software development	Full-time
J. Semkiw	Computer engineering	Technical	Hardware development	Part-time
Les Craythorn	Technical officer	Technical	Hardware design, construction, maintenance	Part-time

Date of Inception of Studio and Computer Work

1976

Areas of Activity

Direct synthesis/hybrid system with E.M.S. Synthi 100 (4-track) and Music V (4-track)

Type of Instruction Offered

Computer Music (full special study, final year, undergraduate degree)

Background of Computer Users

Composers, computer scientists or electrical engineers

List of Works

No full-length pieces completed; various re-creations of traditional music

Publications and Available Manuscripts

Barry Conyngham & Andrew Mander-Jones, *Direct Computer Synthesis of Music* (Australian Computer Society, Pulication 7, 1976)

Barry Conyngham & Rex Harris, *Taming the Ghost in the Machine - Creative Software for Music Synthesis* (pending publication)

Public Presentation of Works

Concerts; projected: disks and cassettes

Policy for Exchange/Rental of Tapes and Related Materials

Exchange welcome

Policy for Composers' Rights and Contracts

Copyright rests with the University for all software and hardware development, and with composer for original music.

HARDWARE

Computers and Digital Hardware

Interdata 832: 256K (16-bit)
PDP 11/10: 8K words (16-bit)

Peripheral Devices

Data Storage

Disk for Interdata 832, Floppy Disk for PDP 11/10

Input Devices

Decwriters and V.D.U.'s for both systems

Output Devices

Line printer, Decwriters

Sound Generation

Digital

4 channel, 16-bit DAC for Interdata

Hybrid Systems

24 channel multiplex D/A for PDP 11/10 to E.M.S. Synthi 100

Other Peripheral Devices

Analog

2 channel Revox (1/4-inch tape); 4 channel Sony (1/4-inch tape)

Digital

8 channel Optro (1/2- or 1-inch tape)

Proposed Hardware Developments

1) Single track A/D input for Interdata (MUSIC V) system
2) Touch-sensitive input devices

Access to Computer

The Interdata is housed in the Computer Science Department; access to principal users is 24-hour and to others is 9:30-6:00. Cost is absorbed by the University. The PDP 11/10 is housed in the Electronic Music Studio of the Faculty of Music and has the same access.

Availability of Technical Assistance

Professional programming, operating and technical assistance available on call

Operating Systems

Interdata time-shared; keyboard I/O
PDP dedicated

Turnaround/Response Time Characteristics

Immediate turnaround on both systems

SOFTWARE

Functioning Systems

Name/Author: MUSIC V (Melbourne) -- Mathews, Risset, modified by Harris
Language/Requirements: Fortran, Interdata machine code, 51K, 2 Ampex 40-megabyte disk drives
Purpose and Features: Direct sound synthesis; while this is a time-shared system, the users have immediate call on the D/A output device
Availability/Documentation: Complete

Systems Under Development

Name/Author: MUSIC FM -- Harris & Conyngham
Language/Requirements: Program written in Fortran
Purpose and Features: A modification of Pass Three of MUSIC V to facilitate a thorough investigation of FM methods of synthesizing instrumental tones.

Name/Author: MUSEMS -- Roe & Stevens
Language/Requirements: RT-11 machine code with macro facility 8->24 floppy disk
Purpose and Features: Hybrid system controlling E.M.S. Synthi 100

Name/Author: MUSIC 11-10 -- Stevens
Language/Requirements: same as above
Purpose and Features: Direct sound synthesis; an intermediate system to prepare and develop material for Interdata based systems

Proposed Systems

Name/Author: MUSE 1 -- Conyngham
Language/Requirements: Fortran VDU with light-pen
Purpose and Features: Upper level composer input program. Will enable composer/user to communicate in symbolic formulas to realize artistic structural concepts

Additional Comments

This is a new system developed only recently and results from and excellent relationship between the Music, Computer Science and Engineering Departments of the University of Melbourne. Many of the research areas piloted by Mathews, Risset and J. Chowning will be investigated here. The project is not restricted to University personnel and visitors are welcome from within Australia and overseas. To the best of the group's knowledge this is the first direct synthesis system operating in Australia and the hybrid system is common to only one or two other institutions.

Australia **Sydney, Univ. of**

Name

Prof. Peter Platt

Address of Institution

Department of Music
University of Sydney
Sydney 2006
New South Wales, Australia

Areas of Activity

We have a small electronic studio which will develop more as more funds become available. No computer music at present. However, the Physics Department of the University of Sydney has not only computer facilities, but also several members of staff who are interested in computer music. We hope to connect our studio up to the computer in the near future.

Name

Albert S. Bregman

Address of Institution

Psychology Department
McGill University
1205 McGregor Avenue
Montreal, Quebec
Canada H3A 1B1

Type of Institution

University

Principal Sources of Funding

National Research Council of Canada

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Albert S. Bregman, Ph.D.	Experimental Psychology	Research Director	Scientific research on auditory perception	Half-time
Philippe Grall	Elec. engineering	Programmer and engineer	Technical	One-third time
Jean Beninger	Psychology	Research assistant	Technical	One-third time
Kathryn Dewar, Ph.D.	Experimental Psychology	Research associate	Scientific study of auditory memory	One-quarter time

Principal Users

1) Albert S. Bregman 1971-76
2) Gary L. Dannenbring 1971-76
3) Kathryn Dewar 1974-76

Date of Inception of Studio and Computer Work

June 1971

Areas of Activity

Scientific research on auditory perception and memory

Type of Instruction Offered

Use of computers in psychological research

Background of Computer Users

Generally undergraduates, graduate students or Ph.D's in Experimental Psychology with a modest knowledge of computers and some musical training.

Publications and Available Manuscripts

A.S. Bregman & J. Campbell, "Primary auditory segregation and perception of order in rapid sequences of tones", *Journal of Experimental Psychology,* 1971, 89, pp. 244-249

A.S. Bregman & G. Dannenbring, "The effect of continuity on auditory stream segregation", *Perception and Psychophysics,* 1973, 13, pp. 308-312

A.S. Bregman & A. Rudnicky, "Auditory segregation: stream or streams?" *Journal of Experimental Psychology:* Human Perception and Performance, 1975, 1, pp. 263-267

G.L. Dannenbring & A.S. Bregman, "The effect of silence on auditory stream segregation", *Journal of the Acoustical Society of America,* 1976, 59, pp. 987-989

G.L. Dannenbring & A.S. Bregman, "Stream segregation and the illusion of overlap", *Journal of Expermimental Psychology,* Human Perception and Performance, 1976 (in press)

A.S. Bregman, "The formation of auditory streams", in A.F. Sanders (ed.) *Attention and Performance VII* (in press)

Public Presentation of Works

Journal articles, papers presented at conventions and conferences on experimental psychology and on acoustics

HARDWARE

Computers and Digital Hardware

PDP 11/20: 28K words (16-bit)

Peripheral Devices

Data Storage

RK05 cartridge disk drive; DECtape

Input Devices

DECwriter; light pen; ADC

Output Devices

DECwriter; HP plotter

Sound Generation

Digital

DAC with direct memory access interface

Hybrid Systems

Computer control of Wavetek function generator

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Tape recorders, filters

Proposed Hardware Developments
1) Graphic tablet input
2) PDP 11/34 processor
3) Second RK05 cartridge disk drive

Access to Computer
Rental of system at $15/hr. to research users

Availability of Technical Assistance
Programming and technical assistance available at $30/hr.

Operating Systems
DEC monitors for single-user operation: DOS-11, RT-11
Both systems allow the programmer fairly direct access to the peripherals.

SOFTWARE

Functioning Systems

Name/Author: TONES -- Bregman & Bernstein
Language/Requirements: PAL 11 language, 70K, uses filter, Wavetek oscillator/amplifier, DAC, digital I/O register, DECtape
Purpose and Features: Used for acoustic research; features frequency-amplitude glides whose properties are on-line controllable. Controlled by a phrase-structure language. Sound is created by Wavetek function generator.
Availability/Documentation: Available on DECtape.

Systems Under Development
MITSYN -- Henke (MIT)
Language/Requirements: Fortran, MACRO, 100K, uses same devices as STOP (see below), also graphics tablet and CRT display.
Purpose and Features: General purpose acoustic analysis and synthesis. Features graphic input of scripts and analysis of waveforms.

Proposed Systems
STOP -- Bregman & Bernstein
Language/Requirements: Written in Fortran, PAL 11, 70K, uses DAC with DMA, filter, disk
Purpose and Features: Used for acoustic research. Features multiple simultaneous frequency/amplitude glides, controlled by a phrase-structure language. Direct digital synthesis of sound.
Availability/Documentation: Available on DECtape

Additional Comments

While the system can create music, it is used primarily for psychoacoustic research.

Name

National Research Council

Address of Institution

National Research Council
E.E. Division
Ottawa, Ontario
Canada K1A 0R8

Type of Institution

Federal Government Research Institution

Principal Sources of Funding

Federal Government Research Institution

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
J. Ken Pulfer	Elec. engineering	Director of program (currently director of Engineering Division)	Technical aspects of man-computer communications, music	Full-time 1969-72
Peter Tanner	Computer Science	Programming	Programming	Summer student 1970-72
John Chong	Elec. engineering	Produced computer-controlled Electronic Synthesizer	Music, electronics	Summer student 1971-72

Principal Users

1) Larry Crosley 1969-71
2) Ben McPeek 1971-73
3) Morris Surdin 1972-74
4) Jerry Dennison 1971-72
5) Sam Dolin 1971-73
6) National Arts Centre - Ottawa School Board Project 1973

Date of Inception of Studio and Computer Work

Development took place during the years 1968-72; use of the system continued until 1974

Areas of Activity

Computer-aided composition; facilitation of interaction between musicians and computers

Type of Instruction Offered

Users of the system were taught individually. Due to the nature of the system, only two or three evenings were needed before the user could use it quite well. A staff member was always on hand to "babysit" a user after these initial sessions.

Background of Computer Users

No technical background required; the users represented a variety of musicians with quite divergent musical interests

List of Works

1) Theme Music for *Weekend* (Crosley), CBC TV 1971
2) Music for *The Johari Window* (Crosley), Carleton University film
3) Music for several Nova Scotia government films (Crosley)
4) CBC commercials (McPeek) -- some realized with conventional instruments
5) A great number of unpublished, unpresented works by about 50 musicians

Publications and Available Manuscripts

J.K. Pulfer, "Man-Machine Interaction in Creative Applications", *International Journal of Man-Machine Studies*, 3/1/1971

J.K. Pulfer, *Programmer's Reference Manual for a Digital CRT Display*, ERB-788, Department of Electrical Engineering, NRC, Ottawa 1968

J.K. Pulfer and P.P. Tanner, *Marvelous Music Machine Manual*, unpublished user's manual, DEE, NRC, 1970, 1971 and 1972

P.P. Tanner, *Some Programs for the Computer Generation of Polyphonic Music*, ERB-862, DEE, NRC, 1971

J.K. Pulfer, "The Headless Musician/Compositeur Electronique", *Science Dimension*, June 1970

G. Collins, "Canada, Computers and Music", *CIPS Computer Magazine*, June 1973

P.P. Tanner, *Musicomp, An Experimental Computer Aid for the Composition and Production of Music*, ERB-869, DEE, NRC, Ottawa 1972

J. Chong, *Paramus - Analogue Addition to NRC's Music System*, unpublished report, DEE, NRC, 1972

Public Presentation of Works

The music has been used in TV commercials, TV introductions, and background music on films; also at a concert at the National Arts Centre with the Arts Centre Orchestra. This performance was the result of a project where specially-chosen high-school students used the computer to aid in the composition of several musical works. Tapes of the music have been played at various conferences and computer shows.

Policy for Exchange/Rental of Tapes and Related Materials

Tapes of works produced with the aid of the computer are freely available on a loan basis.

Policy for Composers' Rights and Contracts

The composers own all rights to their work.

HARDWARE

Computers and Digital Hardware

SEL 840A: 16K words (24-bit)

Peripheral Devices

Data Storage

Moving head disk, 1 Mword storage; 7-track tape unit

Input Devices

Specialized terminal including finger buttons, foot pedals, shaft position encoders and vector display; graphics tablet; four-octave keyboard

Output Devices

Calcomp 565 plotter, little used

Sound Generation

Digital

2 DACs (12-bit); 1 DAC (8-bit)

Hybrid Systems

None

Mixed Digital Systems

None

Other Peripheral Devices

Analog

2 band pass filters

1 4-track 1/2-inch Ampex tape recorder

1 full track 1/4-inch Ampex tape recorder Unit containing 3 level controlled amplifiers, 4 voltage controlled filters, 10 voltage controlled oscillators, noise source and a doubly balanced monitor

Access to Computer

During the early part of the program, any interested musician could use the system. The computer was available for musicians in the evenings only. After the research effort was ended, small charges were made for commercial use of the system.

Availability of Technical Assistance

A staff member was always present to aid a musician in the operating procedures. Users did not do any programming, but their comments provided the main guidance for system development.

Operating Systems

The mini-computer operating system was written in-house. All operations were carried out at the vector display terminal. All programs and data were stored on disk and accessed by the user with a hierarchical menu structure.

Turnaround/Response Time Characteristics

Music written into the computer could be played in real-time with the touch of a button. The play-back could be activated at any stage of the musician-computer interaction.

SOFTWARE

Functioning Systems

Name/Author: 1st play -- Pulfer (1969)
Language/Requirements: Assembler, uses DACs
Purpose and Features: Software sound generator, monophonic, featuring preset selection of timbres
Availability/Documentation: Available with limited documentation (same applies to all programs below)

Name/Author: 2nd play -- Pulfer 1969
Language/Requirements: same as above
Purpose and Features: Software sound generator, monophonic, featuring hand-drawn waveforms

Name/Author: POLY -- Tanner
Language/Requirements: same as above
Purpose and Features: Software sound generator, featuring 4 voices, square waves

Name/Author: WRITER -- Pulfer (1969)
Language/Requirements: written in Assembler, memory size 2000, using Special Purpose Terminal
Purpose and Features: Used for writing music on screen in a simple and natural manner: notes, rests and commands available

Additional Comments

The NRC music system provided a means for composers to write their music into the computer in standard musical notation, or by the use of an organ-type keyboard. Many sorts of modifications and manipulations could then be made on the music. At any time during the process, the current music in memory could be played -- one voice at a time with hand-drawn or pre-set timbres, or four voices at a time with square-waves. The ability to hear the piece of music immediately after a modification is important.

Name

David Rosenboom

Private Address

Aesthetic Research Centre of Canada
P.O. Box 541
Maple, Ontario L0J 1E0

Address of Institution

York University (*cf.* entry for York)
Music Department

Type of Institution

Private

Principal Sources of Funding

University budget and research grants (see York University)

Areas of Activity

See York University

List of Works

See York University

Publications and Available Manuscripts

See York University

Public Presentation of Works

Live concerts, recordings and broadcasts. The Aesthetic Research Centre of Canada, P.O. Box 3044, Vancouver, B.C., is responsible for the exchange of much valuable information and recordings

Policy for Composers' Rights and Contracts

Broadcast Music Incorporated owns rights

HARDWARE

Computers and Digital Hardware

Interdata Model 74: 24K (16-bit)

Peripheral Devices

Data Storage

Paper tape reader/punch; audio tape storage

Input Devices

ADM-3 CRT terminal, MARSLAND ASR-33 type TTY

Output Devices
TTY

Sound Generation

Digital
DAC (48-channel, multiplexed and stored) in a Control Voltage Matrix system

Hybrid Systems
Large scale hybrid system with Control Voltage Matrices, Function Generators, Gating Matrix and sound control devices, much of it designed by Don Buchla and some designed by Rosenboom. This is a programmable general-purpose logic system included in our basic analog synthesis studios; it was assembled out of DEC components

Operating Systems
Interdata: BOSS operating system, TIDE, CLUB, BASIC, Fortran, Interactive Fortran, OS Assembler

PATCHR (music hardware driver and operating system written by myself)

SOFTWARE

Functioning Systems

Name/Author: MUSIC360
Purpose and Features: See York University entry

Name/Author: PATCHR – Rosenboom 1976
Language/Requirements: Interdata Assembler, BASIC, 24K, uses hybrid synthesis system Compositional procedures are specified using BASIC-like statements. The data is then handled by assembly language routines and transmitted to the sound generating hardware. This enable compositional procedures to be accessed in real time, in a stimulus response environment, by defining a musical stimulus or hardware event, such as touching a key, and assigning to it a response, sich as defining an instrument or calling a data generating routine to be applied in a musical parameter.

Name

Barry Truax

Address of Institution

Sonic Research Group
Dept. of Communication Studies
Simon Fraser University
Burnaby, B.C.
Canada V5A 1S6

Type of Institution

University

Principal Sources of Funding

University-supported equipment; other funding not needed so far

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Barry Truax	Physics, math, sonology	Director, programmer	Artistic, pedagogical, research	Full-time (with teaching)
Dik Bidwell	Electronics	Technician (analog studio)	Technical	Half-time

Principal Users

Computer system only:
1) Barry Truax (1973-)
2) Theo Goldberg (1975-)
3) Bruce Davis (1975-)
4) Jean Piché (1976-)
5) David Keeble (1977-)

Date of Inception of Studio and Computer Work

Studio - 1971; computer work - 1973

Areas of Activity

Environment sound recording and analysis; classical studio work; computer synthesis and composition

Type of Instruction Offered

Acoustic Communication (at undergraduate and M.A. levels)
Classical studio work and field recording
Introduction to Computer Sound Programs

Background of Computer Users

Composers (producing tape or live compositions) or students in Communications, Computer Science or Music

List of Works

1) *Sonic Landscape No. 3* (Truax 1975, revised 1977), for 4-track tape
2) *Trigon* (Truax 1974-75), for mezzo-soprano, alto flute, piano and 2-track tape
3) *Nautilus* (Truax 1976), for percussion and 4-track tape
4) *Orphée* (Theo Goldberg, 1975), for slides and 2-track tape
5) *Daedalus* (Goldberg, 1976-77), for slides, mezzo-soprano, harp, percussion and 2-track tape
6) *COMP 1101011* (Bruce Davis, 1976), for flute, oboe, percussion, tape
7) *Compres II (Crab Variation)* (Walter Boudreau, 1975), 4-track tape

Note: for other compositions realized with this system, see Institute of Sonology, Utrecht, Netherlands

Publications and Available Manuscripts

W. Buxton, *Manual for the POD programs*, Institute of Sonology, Utrecht, Netherlands, 1974 (revised 1976)

B. Truax, "The Computer Composition - Sound Synthesis Programs POD4, POD5 and POD6", *Sonological Reports*, No. 2. Institute of Sonology, Utrecht, 1973

B. Truax, "Some Programs for Real-Time Synthesis and Composition", *Interface*, Amsterdam. Swets & Zeitlinger, vol. 2, no. 2, 1973, pp. 159-162

B. Truax, "Computer Music in Canada", *Numus-West*. Seattle, no. 8, 1975, pp. 17-26

B. Truax, *The POD Programs at Simon Fraser University*, unpublished manuscript, Vancouver, August 1975

B. Truax, "A Communication Approach to Computer Sound Programs", *Journal of Music Theory, vol. 20, no. 2, 1976*

B. Truax, *The Inverse Relation between Generality and Strength in Computer Sound Programs*, unpublished paper, 1976

B. Truax, *Real-Time, Interactive Computer Music Systems*, unpublished paper, 1976

Public Presentation of Works

Concerts organized by the studio (4-channel mixed media events in Vancouver; special tape recitals at other centres)
Tape exchange
Disk (the three Truax works are expected to appear on a Melbourne disk this year)
Broadcast ("Music of Today", CBC-FM. program devoted to the Studio's computer work)

Policy for Exchange/Rental of Tapes and Related Materials

Tape exchange for private use
Tape rental for performance, broadcast, etc.
Computer program materials available free on request

Policy for Composers' Rights and Contracts

Composer retains all rights; studio keeps copy of tape for studio activities such as concerts

HARDWARE

Computers and Digital Hardware

HP-2116: 16K (16-bit)

Peripheral Devices

Data Storage

One fixed disk; one disk pack - 1.2 Mwords; one mag tape unit

Input Devices

CRT, teletype; paper tape; ADCs

Output Devices

Line printer; X-Y plotter; paper punch

Sound Generation

Digital

2 12-bit DACs; low-pass filters; programmable clock (output from accumulator or double buffered from mag tape @ 9KHz rate)

Hybrid Systems

None

Mixed Digital Systems

None

Other Peripheral Devices

Analog

Studio tape recorders transportable to computer:

SONY 854-4 1/4" quad
NAGRA IV-S 1/2 track stereo

Studio facilities:

Ampex 2- and 4-track tape decks
Tascam 12-4 mixer
Filters, etc.

Digital

None

Proposed Hardware Developments

1) During 1977, the H-P 2116 is expected to be replaced by a NOVA 3/D machine with similar characteristics, but faster mag tape unit and machine cycle time

2) It is planned to develop an interface of 1/3-oct. B&K real-time analyser

Access to Computer

Non-priority free access (mainly evening and weekends)

Availability of Technical Assistance

The programer-technician for the machine may be consulted re computer problems; the technician for the Sonic studio is available for studio problems

Operating Systems

Disk-oriented operating system (DOS) for H-P 2116

Turnaround/Response Time Characteristics

Interactive mini-computer system

SOFTWARE

Functioning Systems

Name/Author: POD6 -- Truax (1973-76)
Language/Requirements: Fortran program, also H-P assembler, uses 16K, CRT, line printer, plotter, PR/PT, D/A, disk
Purpose and Features: Interactive composition and real-time sound synthesis; features real-time monophonic FM synthesis with variable sampling rate (approx. 10K); composition based on statistical distributions mapping timbral "objects" onto syntactic fields
Availability/Documentation: user manual, program text

Name/Author: POD7 -- Truax (1976-77)
Language/Requirements: same as above, uses magtape
Purpose and Features: non-real-time synthesis; FM synthesis at fixed sampling rate (9K); half tape speed option; digital reverb option; envelope overlap mixing option; two-channel output with binaural time delays option; tunraround time: 5:1 to 10:1
Availability/Documentation: program text only

Name/Author: SCOR -- Truax (1975-76)
Language/Requirements: same as above
Purpose and Features: translates POD compositions into coded traditional notation; graphic output of event envelopes; outputs code for semitone pitch and metric notation from input frequency in Hz and durations in seconds; graphic output (envelopes, clefs, staves) suitable for scores
Availability/Documentation: program text only

Systems Under Development

None

Proposed Systems

POD5 Translation -- Truax (Utrecht 1972-73)
Language/Requirements: same as above
Purpose and Features: does the same as POD6; real-time fixed waveform synthesis with optional amplitude modulation; user waveform generation with compatability to POD6
Availability/Documentation: user manual for POD6

Additional Comments

Translations of POD6 for PDP-11 and Nova machines are in preparation; these should allow greater program exportability.

The Sonic Research Studio will support funding applications by composers wishing to visit for work periods.

The computer facility reported here will be integrated within a *proposed* interdisciplinary arts-and-technology project, called the Leonardo Project, in the near future. It is hoped that this project will expand the scope of this work to interactive graphics, workshops, visitors, etc.

Name

Structured Sound Synthesis Project (SSSP)

Address of Institution

W. Buxton
Computer Systems Research Group
Sandford Fleming Laboratories
University of Toronto
Toronto, Canada M5S 1A1

Type of Institution

University

Principal Sources of Funding

University and Canada Council Research Funds

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
K.C. Smith	Elec. engineering	Principal researcher, hardware development supervisor	Technical, digital design	Part-time
Les Mezei	Computer Science	Principal researcher, technical co-ordinator	Man-machine interface	Part-time
Ron Baecker	Computer Science	Principal researcher, computer languages, hardware	Computer Graphics applications and hardware	Part-time
G. Ciamaga	Music	Principal researcher	Pedagogical, artistic	Part-time
William Buxton	Music, Computer Science	Researcher and co-ordinator of SSSP	Pedagogical, artistic, technical	Full-time
D. Patrick	Music	Researcher	Artistic, pedagogical	Part-time
D. Jaeger	Music	Researcher	Artistic, pedagogical	Part-time

Principal Users

1) G. Ciamaga
2) N. Beecroft
3) D. Jaeger
4) D. Patrick
5) current graduate students

Date of Inception of Studio and Computer Work

Outperform – 1972
SSSP – January 1977

Areas of Activity

Composition; research into representations of musical data and processes; computer-assisted composition; sound synthesis; man-machine communication

Type of Instruction Offered

Part of graduate course in electronic music at the Faculty of Music, University of Toronto, is devoted to computer composition; also private tutorage on demand

Background of Computer Users

The user need not be a computer scientist; composers may use the system with a minimum knowledge of computers

List of Works

Piece for Bob (Beecroft 1975), for flute and tape
Fancye (Jaeger - Outperform), for pipe organ, computer-synthesized sounds and visuals
Numerous studies (Outperform) by Ciamaga, Jaeger, Pennycook, Patrick, Dusatko, Henninger, Tanner

Publications and Available Manuscripts

W. Buxton, *Manual for the POD programs*, Institute of Sonology, Utrecht, Netherlands, 1974 (revised 1976)

W. Buxton, "A Composer's Introduction to Computer Music", *Interface*, No. 6, 1977

G. Ciamaga, W. Buxton, "Current Facilitites at U of T for Computer Music", unpublished manuscript, SSSP, 1976

G. Fedorkow, W. Buxton, "A Computer Controlled Sound Distribution System for the Performance of Electro-Acoustic Music", unpublished manuscript, SSSP, 1977

D. Lester, D. Jaeger, *Manual for Outperform*, unpublished manuscript, University of Toronto, Department of Music

L. Mezei et al., *Research Goals of the SSSP*, unpublished manuscript, SSSP, 1976

Numerous technical memos and documents (listing available on request)

Public Presentation of Works

Isolated presentations of compositions using computer material; regular series of 7 concerts of tape music during the winter season

Policy for Exchange/Rental of Tapes and Related Materials

Material available on request provided consent given by composer

Policy for Composers' Rights and Contracts

Copyright material subject to conditions as stipulated by copyright organizations such as CAPAC and BMI

HARDWARE

Computers and Digital Hardware

PDP 11/40: 48K words (16-bit)
PDP 11/45: 96K words (16-bit)

Peripheral Devices

Data Storage

11/40: 2 RK05 disk cartridges; 2 mag tape drives; 2 floppy disks
11/45: 1 SI disk pack; 1 Diva disk pack; 1 mag tape drive

Input Devices

11/40: card reader; DECwriter; Summagraphics tablet; VT-11 display; video encoder; ADCs in DEC LPS
11/45: numerous terminals; Summagraphics tablet; Tektronix 4013 terminal; 3-Rivers refresh display (using HP 1310a vector drawing display); colour video display

Output Devices

11/40: ZETA plotter; line printer
11/45: Versatec printer/plotter; line printer; Calcomp 835 microfilm recorder

Sound Generation

Digital

11/40: 2 DACs (12-bit) on LPS

Mixed Digital Systems

11/45: digital synthesizer under development

Other Peripheral Devices

Analog

Krohn-Hite Filter model 3202; Revox tape recorder

Digital

See below

Proposed Hardware Developments

We are currently developing a d gital sound synthesizer which will interface to the UNIBUS of any PDP-11. Briefly, the device contains 16 specially designed digital oscillators, which are designed in such a way as to incorporate both the FM (Chowning) and the VOSIM (Kaegi, Tempelaars) models in hardware. The device provides high quality sound at a sampling rate of 50kHz, while maintaining a low data transfer rate from the processor to the synthesizer. The outputs of the oscillators can be routed (under program control) to one of four possible "channel distributors". These distributors function as a sub-master, and enable the generators connected to their inputs to be output at variable gain to the 16 output channels. Thus, high potential for spatialization in performance is possible.

The approach to the system has much in common with the GROOVE system; viz, composition is done in non-real time, but utilizing a highly interactive, graphics oriented facility. Performance then becomes analogous to conducting, where the user has real-time control over several parameters, via the graphics-oriented command language available to him.

Completion of the system is expected in June 1978. A basic prototype will be functional in the summer of 1977.

Access to Computer

11/40: has current user software. Access is good but must be paid for ($30/hr. peak times, $20/hr. off-hours)
11/45: system owned by research group (of which the music project is a part); unlimited access for development work, but until hardware for real-time synthesis is functional (fall 1977), digital tapes must be generated and converted on the 11/40.

Availability of Technical Assistance

Full time staff available for technical and operating problems; users either use existing package or do their own programming (assistance is freely available); users' ideas and requests are constantly reflected in ongoing software developments

Operating Systems

11/40: RT-11 operating system; single-user devoted; teletype or card-reader input
11/45: UNIX operating system - time sharing, currently handles up to 9 users at a time; interaction through either remote terminals or graphic input devices

Turnaround/Response Time Characteristics

11/40: OUTPERFORM programs -- short (30 sec) segments in real time, compositions typically in 20-40 times real time; POD (currently being implemented) -- truly interactive (functions in real time), but restricted to mono-linear strings
11/45: system under development will be real time. Typical response in doing interactive graphics while system is loaded with other users is circa 1-2 seconds

SOFTWARE

Functioning Systems

Name/Author: OUTPERFORM -- Jaeger, Lester (1972)
Language/Requirements: Fortran program, 20K, uses card reader, DAC (1 or 2)
Purpose and Features: MUSIC IV type program, but restricted to fixed-waveform output. Restrictions on sonic repertoire but reasonable turnaround
Availability/Documentation: from University of Toronto

Systems Under Development

POD -- Truax (1973)
Language/Requirements: Fortran, Assembler, TTY, DAC
Purpose and Features: Music composition, sound synthesis; features: interactive, real-time, FM, mono-linear strings
Availability/Documentation: Utrecht (Sonology)

Name/Author: SSSP -- Buxton
Language/Requirements: Written in "C"; graphics devices, digital synthesizer
Purpose and Features: Music composition, sound synthesis; interactive, graphics-oriented command language, mini-computer, real-time
Availability/Documentation: University of Toronto

Additional Comments

Our key concern is access, in both the physical and the mental sense. Thus, we are working on the development of a system which is small, affordable (when compared to existing alternatives), and where the musician need not become a technological expert in order to utilize the system in a non-trivial way. Thus, man-machine communication is a major part of our work. We are investigating representations for musical data and processes which facilitate such communication, especially through the medium of graphics-oriented human interface.

Name

University of Waterloo

Address of Institution

Department of Psychology
University of Waterloo
Waterloo, Ontario
Canada

Type of Institution

University

Principal Sources of Funding

Department of Psychology

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Annabel J. Cohen	Experimental psychology	Director	Music perception, cognition, creativity	Full-time faculty member
John Bradley	Computer science, music	Programmer	Composition	Part-time

Principal Users

1) Annabel J. Cohen
2) John Bradley
3) Students in the Dept. of Psychology, and in the integrated studies program at the University of Waterloo

Areas of Activity

Research in melodic perception (precise control of melodic information for study of melodic perception); composition (using MUSIC-11 as the basic program)

Type of Instruction Offered

Music Perception -- Psychology 651 (graduate course)
Music Perception -- Psychology 102 (undergraduate course)

List of Works

A piece is being prepared by John Bradley for fulfillment of the honours thesis requirement of the Faculty of Music at Wilfred Laurier University, Waterloo, Ontario

Publications and Available Manuscripts

None

Public Presentation of Works
None

HARDWARE

Computers and Digital Hardware
PDP 11/40: 48K

Peripheral Devices

Data Storage
2 RK05 disks, one 8-track mag tape drive

Input Devices
ADC (12-bit)

Output Devices
Hewlett-Packard X/Y plotter

Sound Generation

Digital
DEC DAC (2-channel, 12-bit)
DAC (2-channel, 8-bit) developed by the electronics shop in the Department of Psychology

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Revox A700 tape recorder
Kronhite filters
2 PSB speakers
12 Realistic minimus speakers

Digital
None

Proposed Hardware Developments
Three-Rivers Computer Company sample-and-hold unit

Access to Computer
Computer is heavily used by other experimenters in the Department

Operating Systems

RT-11

Turnaround/Response Time Characteristics

Using the MUSIC-11 program synthesis occurs within seconds of completion of programming

SOFTWARE

Functioning Systems

MUSIC-11 -- Barry Vercoe (1976)

Language/Requirements: Assembly code, 16K

Purpose and Features: Digital sound synthesis; features efficient transcription of the earlier MUSIC360 programs developed by Vercoe.

Systems Under Development

Service routines have been written at Waterloo in order to make use of MUSIC-11

Programs are under development for carrying out psychophysical, psychoacoustic, or psychomusical research and for compositional purposes.

Name

P. Clements

Address of Institution

Faculty of Music
University of Western Ontario
London, Ontario, Canada

Type of Institution

University

Principal Sources of Funding

University funds

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
P. Clements	Music	Director	Pedagogical, artistic, acoustical research	Extra-curricular

Principal Users

1) J. Walsh
2) W. Brackman (both graduate students)

Date of Inception of Studio and Computer Work

Electronic music studio running since 1967; computer studio just starting

Areas of Activity

Graduate course in computer-generated music to be offered in 1977-78

Background of Computer Users

Present users have extensive programming background; one is employed as a professional acoustical consultant

List of Works

None to date

Publications and Available Manuscripts

None

HARDWARE

Computers and Digital Hardware

PDP-10: 256K (36-bit)
PDP-11 for D/A conversion

Peripheral Devices

Data Storage
Disk, 9-track tape and DECtape

Input Devices
DEC LA-36 terminal

Output Devices
Printer, plotter, graphic terminal available

Sound Generation

Digital
2 DACs (12-bit) at PDP-11 (tapes transferred manually)

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
None

Digital
None

Proposed Hardware Developments
It has been proposed that a computer sound laboratory be established with the following hardware:
- PDP-11 minicomputer
- 16-bit ADC
- 2 16-bit DACs
- magnetic tape driive
- teletype and graphics terminals
- filters, amplifier, speakers
- audio tape recorder with 30 ips and/or noise-reduction system

Access to Computer
Computer is available at all times but more accessible during off-hours. Computing funds are generally unlimited.

Availability of Technical Assistance
Computing Centre maintains a staff for technical and programming assistance.

Operating Systems

Time-sharing and batch-processing systems

Turnaround/Response Time Characteristics

Response time is effectively instantaneous during time-sharing. Turnaround time for audio output is yet to be determined, but will likely be overnight, since the converters are presently shared with the plotting facility.

SOFTWARE

Functioning Systems

Name/Author: MUS10 -- Leland, Smith (1974)
Language/Requirements: Written in MACRO-10 and Fortran, memory size 6-10K, uses mag tape
Purpose and Features: Digital sound generation; integrated Orchestra and Score, Pass I, II and III
Availability/Documentation: Available from Stanford University

Systems Under Development

Name/Author: MUSIC V -- Mathews (1969)
Language/Requirements: Fortran, memory size 15-20K, uses mag tape
Purpose and Features: Digital sound generation; input format similar to MUS 10
Availability/Documentation: Available from Bell Labs

Name/Author: SCOR V -- Leland, Smith (1972)
Language/Requirements: Fortran, 15-20K
Purpose and Features: Preparation of string-formatted input for MUSIC V
Availability/Documentation: Available from Stanford University

Name/Author: MUSIC 4BF -- G. Winham (1972)
Language/Requirements: Fortran, 15-20K, uses mag tape
Purpose and Features: Digital sound generation; contains several unit generators not available in MUSIC V or MUS 10
Availability/Documentation: Available from Princeton University

Proposed Systems

Name/Author: SCORE -- Leland, Smith (1974)
Language/Requirements: Written in MACRO-10, memory size 6-10K
Purpose and Features: Preparation of string-formatted input for MUS-10; features parameter manipulation (motives, inversions, etc.)
Availability/Documentation: Available from Stanford University

Additional Comments

Working with the large computer is a compromise, and obviously the mini-computer self-contained system is the ultimate solution. "Unit-generator" oriented software is not the most intuitive for sound-generation, and needs a thorough re-examination.

Name

David Rosenboom

Address of Institution

Music Department
York University
4700 Keele Street
Downsview, Ont., Canada

Type of Institution

University

Principal Sources of Funding

University budget and research grants

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
David Rosenboom	Music, computer science, psychology	Director, teaching-research	Composition, research	Full-time
James Tenney	Music, computer science	Teaching, research	Composition, computer music, music theory	Full-time
William Stevens	Electronic engineering	Design and studio maintenance	Signal processing, performing, hybrid systems	Full-time
Michael Brook	Music, arts	Engineering, maintenance assistance	Live performing systems	Part-time

Principal Users

All of the above are principal users plus periodic guest composers and a large array of about 50 undergraduate and graduate students who are authorized users at any one time. The studio is constantly in use.

Date of Inception of Studio and Computer Work

June 1970 (founding of York University Electronic Media Studios)

Areas of Activity

Strong emphasis on live performance system, traditional tape composition, use of analog synthesizers, digital control mechanisms, computer aided composition, advanced acoustics research, psychophysical research in sound perception, biofeedback and the arts, neurological waveform analysis, computer-aided musical analysis, computer sound synthesis, hybrid microcomputer controlled systems

Type of Instruction Offered

1) Introduction to the History and Literature of Electronic Music (half-year)
2) Electronic Media Workshop I (studio course)
3) Electronic Media Workshop II (advanced composition)
4) Computers and Electronic Technology in the Arts (interdisciplinary)
5) Interdisciplinary Honours Porject and Seminar (advanced research)
6) Full Year Independent Study
7) Interdisciplinary Gradute (M.A.) Programme
8) Resources of a Music Department oriented around the study of contemporary music cultures of the world at both undergraduate and graduate levels

Background of Computer Users

Students are introduced to computer applications in music and related arts with almost no background. Advanced students with background are also given special places in studio work. We have both types and encourage both types.

List of Works

1) *Portable Gold and Philosophers' Stones* (1972), 18 minutes
2) *On Being Invisible*, Parts I, II, and III (1976-77), approx. 2 hours

The above two works use a computer for neurological signal analysis, pattern recognition applied to touch sensor signals, storage and retrieval of hybrid system "instrument" definitions in a stimulus-response environment, and generation of compositional procedural function data applied to sound control. Both are live performance works.

3) *How Much Better If Plymouth Rock had Landed on the Pilgrims*, Part I (1968), approx. 40 minutes. This is another live performance piece that uses real-time computer sound synthesis.

The only pieces listed are those in which the computer is used as an *integral* part of the process. Our work has tended to concentrate on live performance systems.

Publications and Available Manuscripts

Complete list available on request. Selected documents:

D. Rosenboom, "A Model for Detection and Analysis of Information Processing Modalitites of the Nervous System through and Adaptive, Interactive, Computerized, Electronic Music Environment", *Proceedings of the Second Annual Music Computation Conference*, Part 4, J. Beauchamp & J. Melby, eds., University of Illinois, 1975

D. Rosenboom, "Prolegomenon tto Extended Musical Interface with the Human Nervous System: An Outline Mandala of Instrumental, Electrocortical forms observable through Point Consciousness", in *Pieces: a Second Anthropology*, Michael Byron, ed., published by Michael Byron, Box 143, Maple, Ontario, Canada

D. Rosenboom (ed.), *Biofeedback and the Arts: Results of Early Experiments* (full length book), Aesthetic Research Centre, Vancouver, 1976 (second edition)

D. Rosenboom, *The Laboratory of Experimental Aesthetics at the Faculty of Fine Arts, York University*, Aesthetic Research Centre of Canada (A.R.C.) Publications, 1974

D. Rosenboom, *A Bibliography of Source Materials on Biofeedback and the Arts*, A.R.C. Publications, 1974

HARDWARE

Computers and Digital Hardware

PAR Correlation Function and Fourier Analysis Computer (dedicated processor)
IMSAI 8080, Microcomputer system (part of hybrid system): 16K (8-bit)

Systems also used but part of University Computing Centre:
IBM 370, large batch oriented system
HP 2000: 32K (16-bit)
DEC PDP-10, large time sharing system

Peripheral Devices

Data Storage

IBM disk and mag tape systems part of computing centre

DEC disk systems for PDP-10
HP mag tape system for HP2000

Input Devices

IBM card readers, CRT terminals; HARRIS printer-terminals for time-sharing; DEC terminals for PDP-10; ADCs on IMSAI hybrid system

Output Devices

IBM line printers; DECwriter

Sound Generation

Digital

DACs for use with MUSIC360 on IBM system; DACs for IMSAI hybrid system

Hybrid Systems

IMSAI 8080 is interfaced to computer controllable modules from *Buchla and Associates*, Berkeley, California.

Mixed Digital Systems

There is a programmable general purpose logic system included in our basic analog synthesis studios. It was assembled out of DEC components.

Other Peripheral Devices

Analog

All the facilities of two well equipped analog synthesis and recording studios, including SCULLY upe recorders, DOLBY noise reduction, mixing facilities and all standard sound processing modules.

Proposed Hardware Developments

We are in the process of converting much of the analog gear in our current studio systems into computer controlled hybrid systems. The most needed developments in this area are the input structures used and their interface to compositional languages that can manipulate hierarchical processes and in man-machine interface for better use of human gestural performing actions.

We are also looking into general purpose composing language structures for hybrid systems.

Access to Computer

All equipment resident in the Electronic Media Studios is available for scheduled use 24 hours a day. University Computing Centre facilities are available most of the time. The Music Department must apply each year for its share of the computer budget, as machine time is distributed around the university.

Availability of Technical Assistance

Good

Operating Systems

Large scale IBM batch-oriented setup.
Fortran, WATFOR, WATFIV, APL, BASIC, Snobol, Cobol, Algol, etc.

DEC system 10 APLSF

Turnaround/Response Time Characteristics

Generally quite fast

SOFTWARE

Functioning Systems

Name/Author: MUSIC360 – Vercoe
Language/Requirements: Fortran, assembler, uses DAC
Purpose and Features: Sound synthesis

Name/Author: PATCHR – Rosenboom 1976
Purpose and Features: See entry for Rosenboom, D.

Systems Under Development

A new general purpose live performance and composition language for hybrid systems in under development. This package will include borad based waveform analysis routines, compositional procedural routines, function generating routines, and utility hardware driving routines. All processes will be manipulable in strings and in assignment statements that execute musical procedures.

Name

York Interactive Music Project

Address of Institution

257 Winters College
York University
Downsview, Ontario, Canada

Type of Institution

University-based, individual faculty research enterprise

Principal Sources of Funding

National Research Council (technical support)
Provincial government Ministry of Education Research Grants
York University (support)

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Sterling Beckwith	Music, humanities	Director, principal investigator	Artistic, pedagogical, conceptual	Part-time
Michael Ross	Computer science	Systems programmer	Technical	Part-time
Peter Roosen-Runge	Computer science, linguistics	Advisor	Pedagogical, language design	Part-time
various student assistants	Music, psychology, education, etc.	Teaching Assistant	Pedagogical	Part-time

Date of Inception of Studio and Computer Work

June 1973

Areas of Activity

High-level language development and design; design of interactive systems and meterials for music learning and creativity; man-machine interaction and control of music output by children and other naïve users.

Type of Instruction Offered

Special tutorials as part of University or School courses, or as extra-time option for students involved.

Background of Computer Users

Most have no previous computer experience. Children (from age 10) are included.

List of Works

Many individual student works and work-in-progress. However, facility is not designed primarily for producing finished compositions, but rather to stimulate certain aspects of compositional thinking and general structural understanding. It has also been used to help teach music fundamentals.

Publications and Available Manuscripts

Sterling Beckwith, "Composing Computers for Kids -- A progress Report", *Canada Music Book/Les Cahiers Canadiens de Musique*, No. 9 (1974), p. 149ff.

Sterling Beckwith, "Talking Music With a Machine", *College Music Symposium*, Vol. 15 (Spring 1975), p. 94ff.

Sterling Beckwith, "The Well-Tempered Computer", *Music Education Journal*, March 1976

Sterling Beckwith, *The Interactive Music Project at York University: A Research Report.* Toronto, 1975, 300 pp. (Ontario Ministry of Education).

HARDWARE

Computers and Digital Hardware

DEC System 10

Peripheral Devices

Data Storage

Disk

Input Devices

CRT terminals; gestural rhythm inputter (own design); graphic sequencer (own design)

Output Devices

Line printer

Sound Generation

Digital

None

Hybrid Systems

Micro-synthesizer (Gnome)

Mixed Digital Systems

Music boxes (General Turtle)
Rhythm box (own design)

Other Peripheral Devices

Analog

None

Access to Computer

On-line time-sharing access to fairly large computer (PDP-10) is currently required.

SOFTWARE

Functioning Systems

A wide range of compatible systems oriented toward composition or notation, most conceived as "utilities", all of which are written in NRC version of BBN-LOGO. Documentation may be found in our fourth publication listed above.

Additional Comments

For more information consult
Barry Truax, *Computer Music in Canada*, NUMUS-WEST (Summer 1975) The system could be effectively used on a dedicated mini, but much of the development work done so far would not have been too easily accomplished under such conditions.

Name

Universidad de Chile

Address of Institution

José Vicente Asuar
Casilla 3583
Santiago de Chile

Type of Institution

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
José Vicente Asuar		Director		
Julio Zúñiga		Programmer		1970-71 project
Victor Rivera		Programmer		1972-73 project
Cristián Vergara		Composer		1972-73 project

Areas of Activity

Two projects were undertaken:
1970-71 *Proyecto FORMAS*. Design of a computer program to generate musical composition
1972-73: "Programmed control of analog sound devices by a digital computer"

Both were temporary projects undertaken by small groups of students directed by J.V. Asuar. A third project is being planned: "Design and construction of a musical instrument based on a microcomputer"

List of Works

FORMAS:
1) *FORMAS I* (Asuar, 1971)
2) *FORMAS II* (Asuar)
3) Music for piano and percussion (C. Vergara, J. Calabacero, E. Aránguiz, 1972)

CONTROL:
4) *El Computador Virtuoso* (teaching record)
5) Minor works by J.V. Asuar, V. Rivera and C. Vergara

Publications and Available Manuscripts

J.V. Asuar, "Música con Computadores", *Revista Musical Chilena*, No. 118 (April-June 1972)

Public Presentation of Works

FORMAS I performed in 1971 by the Chilean Symphony Orchestra
Musica para piano y percusiones performed in 1972

HARDWARE

Computers and Digital Hardware
FORMAS: IBM 360
Control: PDP-8: 4K

Peripheral Devices

Data Storage
IBM 360: disk and mag tape
PDP-8: no peripherals

Input Devices
TTY (paper tape)

Output Devices
TTY

Sound Generation

Digital
Two DACs (10-bit)

Name
Institute of Musicology

Address of Institution
Finn Egeland Hansen
Institute of Musicology
Universitetsparken 220
Arhus C, DK-8000, Denmark

Type of Institution
University

Principal Sources of Funding
University; Danish State Research Council

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Finn Egeland Hansen	Music	Director	Artistic, technical	Full-time
Finn Søberg Sørensen		Technician	Technical	Almost full-time
Ole Bromose Møller	Software	Systems programmer	Technical	Half-time
Mike Manthey	Software	Designer, programmer	Artistic, technical	Half-time

Date of Inception of Studio and Computer Work
Studio: 1967
Computer work: 1972

Areas of Activity
Sound analysis and synthesis in non-real time (the SIM system); real-time sound generation (the EGG synthesizer)

Type of Instruction Offered
Courses for students and composers

Background of Computer Users
It requires some knowledge of how a computer works to operate SIM. The EGG synthesizer in constructed to require no such knowledge.

List of Works
Synthesizer version of Per Nørgärds Canon (to be released on an LP record in 1977)

Publications and Available Manuscripts

Mike Manthey, "The EGG Synthesizer", *Electronic Music & Musical Acoustics*, No. 1 (1975)

Ole Bromose and Finn Egeland Hansen, "A Survey of the SIM System, a Computer System for Performing Acoustical Analysis and Synthesis", *Electronic Music & Musical Acoustics*, No. 1 (1975)

Kurt H. Andersen, "A Digital Sound Synthesizer Keyboard", *Electronic Music & Musical Acoustics*, No. 2 (1976)

Kurt H. Andersen, "A Digital Sound Generation Unit", *Electronic Music & Musical Acoustics*, No. 2 (1976)

Ole Bromose, *Simulering af en 200 UT* (unpublished)

Ole Bromose, *SIM-projektets status pr 1/9 1974* (unpublished)

Finn Egeland Hansen, "TI 960A minikomputeren på Musividenskabeligt Institut", *RECAU-74-39*, 1974

Thorkild Laursen and Erik Bak Kristensen, *Brugermanual til TI 960A SAL-cross-assembler*, DAIMI MD-8, April 1974

Ole Bromose, *Beskrivelse af programmet SIM*, 1.ed 1973, 2.ed 1975

Mike Manthey, *User Manual for the EGG Synthesizer*, 1976

Public Presentation of Works

A public concert with a presentation of the EGG synthesizer was planned for April 1977.

We are planning to release an LP record every year. The records and tapes released so far contain no computer music.

We have exchange arrangements with several institutions.

HARDWARE

Computers and Digital Hardware

TI 960A: 32K (16-bit)
PDP 11/10: 16K (16-bit), part of GT-42 system

Peripheral Devices

Data Storage

9-track mag tape station (RDL)

Input Devices

ADC (10-bit); paper tape reader (RC 2000); two ADM-1 terminals; two manual synthesizer keyboards; graphic input system (GT-42, DEC)

Output Devices

Line printer (CDC); plotter (Houston DP1); paper tape punch (Facit)

Mixed Digital Systems

Sound Generation Unit for the EGG Synthesizer

Note: Apart from the local system described above we have access to the central CDC 6400 system. The computations in the SIM system are run on this system.

Other Peripheral Devices

Analog

The standard analog first generation equipment for production of electronic music; standard analog measurement equipment.

Digital

Disk system for the TI 960A; digital sound mixing system.

Access to Computer

Remote CDC 6400: interactive batch system, standard rates, one-day turnaround (for SIM jobs). Local screens give access to the system.

Local TI960A: GT42B plus a PDP-11 forms the console for the system, which is primarily the EGG. Access via signup list.

Operating Systems

Simple-minded but fast message system (home-made); multi-tasking with FIFO and timer queues

Turnaround/Response Time Characteristics

80 usec to schedule a message

SOFTWARE

Functioning Systems

Name/Author: A/D – Møller
Language/Requirements: uses mag tape
Purpose and Features: Blocked analog to digital tape conversion

Name/Author: Cross assembler
Purpose and Features: Binary for TI960A, runs on CDC 6400, possibly useful to others
Availability/Documentation: In Danish

Name/Author: EGG synthesizer -- Manthey
Language/Requirements: In assembler, 24K
Purpose and Features: Real-time sound synthesis
Availability/Documentation: See publications

Name/Author: 200UT -- Møller
Language/Requirements: Assembler
Purpose and Features: Remote batch to CDC 6400

Name/Author: O=S -- Møller, Manthey
Language/Requirements: Assembler
Purpose and Features: Controlling operating system

Name/Author: SIM -- Møller
Language/Requirements: Pascal code, uses printer, plotter
Purpose and Features: Fourier analysis
Availability/Documentation: See publications

Systems Under Development

Minor improvements to EGG
Use of GT-42 graphics screen in A/D conversion process.

Additional Comments

Those interested in more complete information should contact Finn Egeland Hansen at the above address.

Name

Oy Yleisradio Ab Kokeilustudio (Finnish Broadcasting Corporation)

Address of Institution

Ratakatu 1 b A III
00120
Helsinki 12, Finland

Type of Institution

Radio

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jarmo Sermilä	Composition	Art Director	Artistic	Half-time
Pekka Sirén	Sound Engineering		Technical, artistic	Full-time
Jukka Ruohomäki	Computers, music	Programmer	Technical, artistic	Half-time
Antero Honkanen	Sound Engineering		Technical, artistic	Half-time
Åke Andersson	Sound Engineering		Technical, artistic	Half-time

Principal Users

Composers from Finland and abroad

Areas of Activity

Musical composition; development of a microprocessor based hybrid system for composition

Expectations of Computer Users

Guidance on computer technics is available, so expectations of composers are mainly musical

List of Works

1) *Vieraissa käynyt uni* (P. Sirén), quadrophonic
2) *Improvisation* (Sirén)
3) *Electro composition* (J. Sermilä)
4) *Satumaisema* (Marja Vesterinen)

All of the above are partially computer realized

Publications and Available Manuscripts

A publication on the equipment and policy of the studio will soon be available in English

Public Presentation of Works

Normally the studio will give two concerts a year; these concerts are also broadcast. A series of concerts was scheduled to be given in March 1977 throughout Finland, accompanied by a presentation with dials and tapes.

Policy for Exchange/Rental of Tapes and Related Materials
Tapes available free for exchange

Policy for Composers' Rights and Contracts
Upon completion every work is examined by a Yleisradio Music Department committee, which decides whether to buy the rights for repeated use on radio and TV, to buy the rights for one broadcast only, or not to buy any rights to the work. If the last, the composer retains full rights as well as a copy of the work. A new effort to sell the work to the radio may be made at a later date.

HARDWARE

Computers and Digital Hardware
DIS-6000, an Intel-8008 based microcomputer system developed in Finland in 1974. 6K (8-bit)

Peripheral Devices

Data Storage
Standard C-cassette (300 baud)

Input Devices
ADDS-880 console with limited graphical possibilities

Output Devices
None

Sound Generation

Digital
One DAC multiplexed to control 8 voltage-controlled devices (4 oscillators, 2 amplitude modulators or VCAs and 2 filters)

Hybrid Systems
See above

Mixed Digital Systems
None

Proposed Hardware Developments
Additional 4K memory for the DIS-6000
16 analog inputs

Access to Computer
As the microcomputer system is quite small it is generally used under the same conditions as the whole studio (see policy booklet)

Availability of Technical Assistance
Preliminary guidance is generally guaranteed

Operating Systems
DIrT2.0 (DIS Real-time operating system): can handle 8 simultaneous time-conditioned tasks, 8 input conditioned tasks, has a real-time clock

Turnaround/Response Time Characteristics
Immediate response time (30 milliseconds)

SOFTWARE

Functioning Systems

Name/Author: Discord 2.0 – E. Kurenniemi 1974
Language/Requirements: Intel 8008, own assembler code; 2K
Purpose and Features: This system is used by forming "nests" in the memory. Every nest can represent a certain musical event. These nests are then called in real-time by ASCII codes from terminal. Features direct setting of a control voltage, increments & decrements, setting of matrix connections
Availability/Documentation: Available

Systems Under Development

Kurenniemi & Ruohomäki 1976-77
Language/Requirements: 4K
Purpose and Features: Several text-editing possibilities - works with ASCII-coded characters. Sound devices are controlled by a certain language, which is to be written into the memory in ASCII form. The whole structure is similar to that in most microcomputer assembler. Direct setting, incrementing & decrementing of control voltages as well as jump, repeat n times and subroutines are all possible. The user can tune oscillators according to any scale
Availability/Documentation: Available

Proposed Systems

Name/Author: Kurenniemi & Ruohomäki 1977
Language/Requirements: 1.5K
Purpose and Features: Sequencer program, 1-16 channels simultaneously controlled by terminal or analog devices. The number of steps (i.e., length of a sequence) is limited only by the size of the memory
Availability/Documentation: Available

Name

Centre D'Etudes de Mathématique et Automatique Musicales

Address of Institution

Iannis Xenakis
17 Rue Victor Massé
75009 Paris, France

Type of Institution

Non-profit organization

Principal Sources of Funding

Gulbenkian Foundation (Lisbon); French Ministry of Cultural Affairs; Mme. M. Falabert

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Louis Leprince Ringuet	Science	Honorory president or CEMAMu	Artistic, scientific	Consultant
Iannis Xenakis	Music, architecture, civil engineering	President	Artistic, pedagogical, research	Full-time
Alain Profit	Engineering	Secretary-treasurer	Artistic, scientific	Consultant
Alain Bestougeff	Maître de conference	Member of executive committee	Artistic, scientific	Consultant
A. Aftier	Physics	Member of executive committee	Artistic, scientific	Consultant
Bernard Equer	Maître de recherches	Member of executive committee	Artistic, scientific	Consultant
François Génuys	Mathematics	Member of executive committee	Artistic, scientific	Consultant
G. Th. Guilbaud	Mathematics	Member of executive committee	Artistic, scientific	Consultant
Jean Lachaise	Maître de conference	Member of executive committee	Artistic, scientific	Consultant
René Schneider	Composition	Member of executive committee	Artistic	Consultant
Guy Medigue	Computer science, engineering	Assistant to Xenakis	Artistic, research, technical	Full-time
Cornelia Colyer	Music, computer science	Assistant	Artistic, research, technical	Full-time
Pierre de Bailliendcourt	Computer Science	Assistant	Artistic, technical, research	Full-time

Principal Users

1) Iannis Xenakis
2) Cornelia Colyer
3) Guy Medigue
4) Pierre de Bailliencourt
5) P. Barbaut
6) Frank Brown
7) Geneviève Klein
8) J. Thibault
9) R. Schneider
10) H. Besterjest
11) Patrick St. Jean
12) Bruce Rogers

Areas of Activity

Music composition; research; teaching; lectures; seminars

Expectations of Computer Users

1) To write instrumental music with aid of computer
2) To utilise D/A conversion system for sound synthesis
3) To provide the tools, using graphics on a mini-computer, for research, pedagogy and composition

List of Works

All works by Iannis Xenakis:

1) *ST-4*
2) *ST-10*
3) *ST-21*
4) *ST-48*
5) *Mikka*
6) *Amorsima-Morsima*
7) *Atrées*
8) *Eonta*
9) *Cendrés*

Also:

Polytope de Cluny: automated light/sound composition (600 electronic flashes, 3 2-watt lasers, and 7-track electronic music), Cluny Museum, Paris, 1972-74

Diatope: automated light/sound composition (1600 electronic flashes, 4 lasers, 12 loudspeakers). Commissioned by Georges Pompidou Centre, Paris. To be premièred November 1977.

Both of the above employ computer control of flash and laser events as well as sound localization. This is accomplished via a computer-generated digital magnetic tape.

Publications and Available Manuscripts

I. Xenakis, "Elements de Musique Stochastique", *Gravesaner Blätter*, Mainz, Nos. 11, 12, 18, 19, 20, 21, 22, 23, 26

I. Xenakis, "Musiques formelles", *La Revue Musicale*, Editions Richard-Masse, Paris 1963

I. Xenakis, *Musique-Architecture*. Editions Casterman, Paris 1971

I. Xenakis, *Formalized Music*. Indiana University Press, Bloomington 1971

Public Presentation of Works

1) Records of Xenakis' music

2) Frequent concerts of above works
3) Polytope de Cluny: public presentation 4-5 times daily, 6 days per week
4) Diatope: daily for minimum 12 months in Paris. Diatope is in a special shell which is dismountable and transportable. Further presentations to come: Bonn, BAD, 1979; London....

Policy for Exchange/Rental of Tapes and Related Materials
Composers are entitled to preserve own copyright.

HARDWARE

Computers and Digital Hardware
Free standing D/A conversion system: 16-bit DAC with 9-track Ampex drive
Solar 16-65 amplifier: 48K, 16-bit words
Restricted use of IBM 360 at University of Paris

All peripherals information is for the Solar 16-65

Peripheral Devices

Data Storage
Disk; 9-track tape

Input Devices
Card reader; CRT, teletype; graphics tablet; ADC (12-bit)

Output Devices
Hard copy device

Sound Generation

Digital
DAC (16-bit) -- for the mini-computer, different from the free-standing system

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Revox tape recorder

Access to Computer
On agreement (negotiable)

Availability of Technical Assistance
Casual assistance for programming and operating

Operating Systems
Solar system: graphics oriented, fully interactive

SOFTWARE

Functioning Systems

Name/Author: ST -- Xenakis
Language/Requirements: Fortran IV
Purpose and Features: Music composition; utilizes stochastic techniques
Availability/Documentation: Yes

Name/Author: Polytope -- Xenakis, Colyer
Language/Requirements: Fortran IV
Purpose and Features: Programation of Polytope composition

Name/Author: Diatope -- Xenakis, Colyer
Language/Requirements: Fortran IV
Purpose and Features: Programation of Diatope composition

Name/Author: UPIC-A -- Xenakis, Medigue
Language/Requirements: Assembly language
Purpose and Features: Pedagogy of music and elementary mathematics; research in psycho-acoustics and composition. On-line system enabling general user to hear (in real-time) result of designed and/or devised sounds and structures and other transformations according to user's score

Systems Under Development

Name/Author: UPIC-B
Purpose and Features: Extension of UPIC-A: greater memory size; increased speed; A/D input

Proposed Systems

Name/Author: UPIC-C
Purpose and Features: Improvements to UPIC-B

Additional Comments

See also entry for France: IRIA

Name

Institut National de L'Audiovisuel

Address of Institution

Département de Recherches et Création Musicales
Insitut National de l'Audiovisuel
Maison de Radio-France
116 av. Pdt Kennedy
GRM/INA piece 3533
75016 Paris, France

Type of Institution

Electroacoustic studio

Principal Sources of Funding

Radio and television dues

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jean-François Allouis	Computer science, electronics	Technical director	Music, real-time synthesis	Full-time
Bernard Durr	Electronics	Researcher, composer	Sound synthesis, musical research	Full-time
Benedict Mailliard	Computer science, mathematics	Researcher	Music, mathematical research	Half-time
Pierre-Alain Jafrenou	Computer science, mathematics	Researcher	Music, mathematical research	One-third time
Denis Valette	Electronics	Researcher, technician	Electronics, acoustics	Full-time

Principal Users

Members of the GRM; invited composers; students from the CSV of Paris

Date of Inception of Studio and Computer Work

1974

Areas of Activity

Musical composition; technological and psychoacoustic research; teaching; radio

Type of Instruction Offered

Course in electroacoustic composition:
Conservatoire de Paris, 14, rue de Madrid, 75008 Paris

Expectations of Computer Users

Real-time and delayed-time sound synthesis
Manipulation of sounds
Interactive composition systems

List of Works

1) *Mutation* (J.C. Risset)
2) *Cristal* (F. Bayle, 1977)
3) A large collection of concrete and/or electronic works on tape

Publications and Available Manuscripts

"Recherche/Musique" notes, no. 3, *Synthetiseur/Ordinateurs*

Journal Report from the Festival du Son (1976-77)

Public Presentation of Works

Concerts; radio broadcasts (Radio-France); GRM/INA records; animations

HARDWARE

Computers and Digital Hardware

IBM 370

Sound Generation

Digital

Syter 2 -- experimental real-time multiprocesser system (16-bit words)

Hybrid Systems

Syter 1 -- microcomputer controlling a sound spatialization system

Mixed Digital Systems

None

Other Peripheral Devices

Analog

Analog synthesizer studio (116 C) containing diverse voltage control equipment
"Classical" studios for radio production and teaching

Digital

None

Proposed Hardware Developments

Bus controlled recording and diffusion of 16 channels of signal - April 1977
16-track studio 116A (Studer) - July 1977
PDP 11/70 (128K core, 100M on disk) - December 1977

Additional Comments

Up to 1977 all work requiring computer facilities was done at the Computation Centre of French radio and television (GIRATEV). Due to difficulties with this arrangement, GRM/INA has decided to acquire its own system, to be devoted entirely to musical information systems, which will be implemented by the end of 1977.

Name

Institut de Recherche et de Coordination Acoustique/Musique

Address of Institution

I.R.C.A.M.
31, rue Saint Merri,
75004 Paris, France

Type of Institution

Research institution (part of the Centre National d'Art et de Culture Georges Pompidou)

Principal Sources of Funding

French Government

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jean-Claude Risset	Music, sciences	Director, computer department	Music, psychoacoustics	Full-time
James Lawson	Sciences	Systems programmer	Real-time systems	Full-time
Brian Harvey		Systems programmer	Graphic systems, pedagogical	Full-time
John Gardner		Systems programmer	MUSIC V	Full-time
Peppino di Giugno	Elec. engineering	Electronics Department engineer	Digital synthesizer construction	Full-time

Date of Inception of Studio and Computer Work

September 1975

Areas of Activity

Sound synthesis and analysis; psychoacoustics; man-machine communication; sound and musical structure description languages

Type of Instruction Offered

Courses to be organized in the future (Département Pédagogique, care of Michel Decoust)

List of Works

None

Publications and Available Manuscripts

None yet

Public Presentation of Works

Concerts, workshops, occasional radio broadcast; exchanges planned for the future

Policy for Exchange/Rental of Tapes and Related Materials

Under study

Policy for Composers' Rights and Contracts
Under study

HARDWARE

Computers and Digital Hardware
PDP-11: 64K (36-bit)
PDP-10

Peripheral Devices

Data Storage
Disks, mag tape

Input Devices
Interactive terminals, ADC, potentiometers and switches; graphics terminal for PDP-11

Output Devices
Line printer, Versatec plotter

Sound Generation

Digital
DAC (4-channel)

Hybrid Systems
None

Mixed Digital Systems
Digital synthesizer constructed by Di Giugno: 256 oscillators in real-time, controlled by PDP-11

Other Peripheral Devices

Analog
Tape recorders

Digital
Under development

Proposed Hardware Developments
Increase in number of peripherals; electroacoustic equipment

Access to Computer
Owned computer (maintenance cost only)

Availability of Technical Assistance
Available

Operating Systems
Time-sharing (and mini-computer)

Turnaround/Response Time Characteristics
Depending on number of users, system overloads quickly due to low memory capacity.

SOFTWARE

Functioning Systems

Name/Author: MUSIC V – Mathews (Bell Labs 1967)
Language/Requirements: 30K, uses disks
Purpose and Features: Direct sound synthesis; assembles "modules virtuels reentrants"
Availability/Documentation: Available

Name/Author: MUSIC 10 -- Chowning, Moorer (Stanford University)
Language/Requirements: 30K, uses disks
Purpose and Features: Direct synthesis

Name/Author: NEWMUS S
Purpose and Features: Analysis
Availability/Documentation: Available

Name/Author: MUSICA -- De Poli (Padova)
Purpose and Features: Language for input

Systems Under Development

Name/Author: New version of MUSIC V -- Gardner (1976)
Purpose and Features: New features available
Availability/Documentation: Under preparation

Name/Author: Input language for synthesis programs -- Bennett

Name/Author: Program to manipulate sounds for psychoacoustic tests – Wessel

Name/Author: Program for using digital synthesizer with other peripherals

Proposed Systems

Real-time systems for handling sound synthesis and controlling external devices

Name
Pierre Barbaud

Private Address
6, avenue Marcel Doret
75016 Paris, France

Address of Institution
Institut de Recherche en Informatique et Automatique (I.R.I.A.)
B. P. 5
78 Rocquencourt, France

Principal Sources of Funding
Contract renewable annually

Staff
Collaborators: Frank Brown, Geneviève Klein

Areas of Activity
Computerized composition and synthesis

Type of Instruction Offered
I.R.I.A. course, "Informatique et Musique"

List of Works
1) *Terra Ignote Ubi Sunt Leones*
2) *Ars Recte Computandi I*
3) *Innumerae Voces Segetis Ahenae*
4) *Hypatia*
5) *Musica Barbarorum*
6) *Ars Recte Computandi II*
7) *Lumpenmusik*
8) *Tubicen Temulentus*
9) *Le Grand Prisme*

All of the above entirely computer generated.

Publications and Available Manuscripts

Material for I.R.I.A. course

Frank Brown's Ph.D. thesis

Pierre Barbaud, *Ludus Margaritis Vitreis*

Public Presentation of Works
Concerts; films; audio-visual presentations

Policy for Composers' Rights and Contracts
Tapes registered with SACEM

HARDWARE

Computers and Digital Hardware
Iris 80
Honeywell Bull 6000

Peripheral Devices

Data Storage
Mag tape

Input Devices
Card reader

Output Devices
Line printer

Sound Generation

Digital
Using DAC at studios of CEMAMu

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
None

Proposed Hardware Developments
Construction of a stereo DAC

Turnaround/Response Time Characteristics
Composition and execution in real-time

Name

U.E.R. de Luminy

Address of Institution

Information et Acoustique Musicale
U.E.R. de Luminy
70, rue Leon Lachamp
13288 Marseille Cedex 2
France

Type of Institution

University (and National Research Centre)

Principal Sources of Funding

French Government

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jean-Claude Risset	Music, sciences	Director	Music, research	Part-time
Françoise Nayroles	Mathematics	Research technician		Full-time
Daniel Arfib	Physics, Eng. Science	Researcher	Research	Full-time
Jean-Etienne Marie	Music, broadcasting	Resident composer		Half-time

Principal Users

1) F. Nayroles
2) D. Arfib
3) J.-E. Marie

Date of Inception of Studio and Computer Work

May 1975

Areas of Activity

Research into sound synthesis and perception; musical composition

Type of Instruction Offered

Occasional instruction

List of Works

1) *Dialogues* (J.C. Risset), four instruments + computer sound
2) Computer-produced sounds for an opera in process of completion (Barry Conyngham)
3) Stochastic composition produced by means of computer (Denis Lorrain)

Publications and Available Manuscripts

M.V. Mathews, F.R. Moore & J.C. Risset, Computers and Future Music, *Science*, January 25, 1974 (vol. 183 pp. 263-268)

G. Charbonneau, J.C.Risset, *Différences entre oreille droite et oreille gauche pour la perception de la hauteur des sons*, C.R. Acad. Sc. Paris, Serie D, no. 281 (July 21, 1975), pp. 163-166

Public Presentation of Works
Concerts, occasional radio presentations; possibility of exchanges

Policy for Exchange/Rental of Tapes and Related Materials
Depends on individual case

Policy for Composers' Rights and Contracts
Depends on individual case

HARDWARE

Computers and Digital Hardware
Télémécanique T1600: 32K (16-bit)

Peripheral Devices

Data Storage
Disks

Input Devices
Alphanumeric terminal

Output Devices
Line printer

Sound Generation

Digital
DAC (4-channel)

Hybrid Systems
None

Mixed Digital Systems
Planned

Other Peripheral Devices

Analog
Tape recorder

Digital
None

Proposed Hardware Developments
Implementation of real-time computer-controlled mixing; A/D conversion; mixed digital systems and input peripherals

Access to Computer
Computer owned

Availability of Technical Assistance
Available

Operating Systems
Mini-computer

Turnaround/Response Time Characteristics
Depends on the program

SOFTWARE

Functioning Systems

Name/Author: MUSIC V – Mathews (1967)
Language/Requirements: 64K, uses disk
Purpose and Features: Direct sound synthesis; assembles virtual reentrant modules
Availability/Documentation: Available

Name/Author: Pedagogic programs for stochastic composition (related to MUSIC V) – Arfib (1971-75)

Systems Under Development

Specialized programs for new synthesis processes; sound processing

Name

Groupe Art et Informatique de Vincennes

Address of Institution

Université de Paris III
Route de la Tourelle
75571 Paris Cedex 12, France

Type of Institution

University

Principal Sources of Funding

University teaching and research funds

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jacques Arveiller	Music, computer science, medicine	Instructor, researcher, composer	Pedagogic, composition	Part-time
Marc Battier	Music, computer science	Same	Same	Part-time
Gilbert Dalmasso	Same	Same	Same	Part-time
Giuseppe G. Englert	Same	Same	Same	Part-time
Patrick Greussay	Music, computer science, linguistics	Same	Same	Full-time
Didier Roncin	Music, computer science, electronics	Researcher, composer, hardware technician	Composition, execution, hardware	Part-time

Principal Users

The above; also students

Date of Inception of Studio and Computer Work

1969

Areas of Activity

Computer-assisted musical composition
Computer-assisted musical analysis
Direct and hybrid sound synthesis
Other computer-aided artistic activities (non-musical)

Type of Instruction Offered

Numerous courses are given by the Departments of Computer Science and Music of the university, notably:
Artificial Intelligence (P. Greussay)
Electronic Music (M. Battier, G.G.Englert)
Computer Music (J. Arveiller)

List of Works

1) *Paire de Lacs* (Arveiller)
2) *Re-Cosa Materiale* (Battier)
3) *Dépilostére* (Dalmasso)
4) *Boîte Echo-logique* (Dalmasso)
5) *The Mohawk Evening Song* (Englert)
6) *Fragola* (Englert)
7) *Eclipse* (Greussay)
8) *Les Nuages de Magellan* (Greussay)
9) *Fab* (Roncin)
10) *Dole* (Roncin) etc.

Publications and Available Manuscripts

Members of the group have written several texts about computer music.

The group also publishes a periodical, *ARTINFO/MUSINFO*, devoted to computer-related artistic activities, particularly those in the field of music. The articles and programs in this publication are written by members of the group and students.

Documentation on the software developed and used by the group can be found in the various *Rapports Techniques du Département d'Informatique de l'Université Paris VIII*

Public Presentation of Works

Live musical concerts (with on-site equipment); production of tapes sent for presentation in concert; seminars, expositions, etc.; radio and television presentation

Policy for Exchange/Rental of Tapes and Related Materials

Our policy is to encourage exchange of material as much as possible. Thus we do not rent, but will lend requested tapes and related materials.

Policy for Composers' Rights and Contracts

Some of the works and composers are covered by SACEM.

HARDWARE

Computers and Digital Hardware

Télémécanique T1600: 32K (8-bit)
"Ordoprocesseur" linked to a PDP-10: huge memory

Numerous mini-computers:
INTEL 8008: 16K (8-bit)
INTEL 8080: 16K (8-bit)
ZILOG: 16K (8-bit)
etc.

Peripheral Devices

Data Storage

Disks, mag tape, etc.

Input Devices

Card readers; paper tape readers; teletypes; direct input from piano-type keyboard

Output Devices

Two line printers; one plotter

Sound Generation

Digital
Not yet

Hybrid Systems
Numerous hybrid systems in operation

Mixed Digital Systems
Under development

Other Peripheral Devices

Analog
Synthesizers; tape recorders; filters; colour television screen controlled entirely by mini-computers

Proposed Hardware Developments
Construction of hardware designed specifically for music is going well.

Construction of two digital synthesizers is under way.

Access to Computer
Varies depending on the computer in question; access is generally free

Availability of Technical Assistance
Assistance is easily obtained from the members of the group (all experienced programmers), the instructors and the technicians of the department.

Operating Systems
Varies depending on the computer being used

SOFTWARE

Functioning Systems

Name/Author: STUCK/STOCK -- Arveiller 1973
Language/Requirements: Fortran code, uses line printer
Purpose and Features: Writes pieces for keyboard
Availability/Documentation: Yes

Name/Author: ZIZIK 1 -- Audoi e 1976
Language/Requirements: Fort n, uses plotter
Purpose and Features: Plottin of graphical musical score
Availability/Documentation: Y s

Name/Author: ICOSA REICOSA -- Battier 1976
Language/Requirements: INTELgreu, uses DAC
Purpose and Features: Hybrid synthesis
Availability/Documentation: Yes

Name/Author: KRWTH -- Chailloux
Language/Requirements: CAB, uses DAC
Purpose and Features: Digital synthesis
Availability/Documentation: Yes

Name/Author: GSYSE -- Dalmasso 1976

Language/Requirements: LISP, uses printer
Purpose and Features: Formalised musical composition
Availability/Documentation: Yes

Name/Author: FRAGOLA -- Englert 1976
Language/Requirements: INTELgreu, uses DAC
Purpose and Features: Hybrid synthesis
Availability/Documentation: Yes

Name/Author: MUSICREAD -- Greussay 1974
Language/Requirements: CONNIVER, LISP, uses printer
Purpose and Features: Compositional data handling
Availability/Documentation: Yes

Name/Author: QUADRI-SEQUENCER -- Greussay 1977
Language/Requirements: INTELgreu, uses DAC
Purpose and Features: Hybrid synthesis
Availability/Documentation: Yes

Name/Author: DOLE -- Roncin 1976
Language/Requirements: INTELgreu, uses DAC
Purpose and Features: Hybrid synthesis
Availability/Documentation: Yes

Additional Comments

The Université de Paris VIII offers the rare opportunity of high-priority access to its computer system to artists.

Name

The City University

Address of Institution

Computer Music Unit
Centre for Arts and Related Studies
The City University
St. John St.
London EC1V 4PB, England

Type of Institution

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Stanley Haynes	Music	Research fellow in computer sound synthesis	Composition, system design, teaching	Full-time
David Jenkins	B.Sc., MIEE, CEng	Head of Arts Centre	Administrative, pedagogical	Full-time
Malcolm Troup	D.Phil, FGSM, Arct.	Head of Music	Coordination; teaching, composition	Full-time

Principal Users

1) Stanley Haynes (full-time)
2) Kevin Jones (full-time)
3) Odaline Martinez (occasional)
4) Jonathan Harvey (occasional)

Date of Inception of Studio and Computer Work

October 1976

Areas of Activity

Establishment of Music V computer sound synthesis program

Type of Instruction Offered

Undergraduate courses on computer music; facilities for postgraduate research in areas relating to computer music and synthesis

List of Works

1) *Pyramids - Prisms* (S. Haynes 1977), piano and computer synthesized tape
2) *Macricisum* (K. Jones 1977), computer synthesized tape

Publications and Available Manuscripts

Papers:
Stanley Haynes, "Computer Sound Synthesis in the U.K." (1976)
Stanley Haynes, "Computer Sound Synthesis" (1974)
Kevin J. Jones, "Macrisisum" (1977, report)

Public Presentation of Works

Concerts and broadcasts

Policy for Exchange/Rental of Tapes and Related Materials
Too early to specify

HARDWARE

Computers and Digital Hardware
ICL 1905E twin: 128K, 24-bit words

Peripheral Devices

Data Storage
Mag tape, exchangeable disks

Input Devices
Paper tape; card readers; VDU; teletypes

Output Devices
Line printers; Calcomp plotter; paper tape; card punch

Sound Generation

Digital
Stereo DACs

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Stereo and 8-track tape recorders; monitoring system

Digital
Digitizing piano keyboard

Proposed Hardware Developments
The establishment of an interactive system for computer-controlled digital synthesis with A/D and D/A facilities for quadrophonic sound (Di Giugno, IRCAM, Paris)

Access to Computer
Access free at present. Possible change to bodies commissioning composers.

Availability of Technical Assistance
Stanley Haynes and Kevin Jones are available to advise musicians. More general advice is available from the University's Computer Advisory Service.

Operating Systems
MAXIMOP multi-access system

Turnaround/Response Time Characteristics
Variable response time according to number of users

SOFTWARE

Functioning Systems

Name/Author: Music V – Mathews (1968), modified by Haynes (1975)
Language/Requirements: Fortran, PLAN (assembler), 90K, disk, VDU, L/P, C/R
Purpose and Features: Digital synthesis of sound via DACs
Availability/Documentation: Mathews, "The Technology of Computer Music", MIT 1969

Systems Under Development

Name/Author: Music V mod – Gardner (IRCAM, Paris)
Language/Requirements: Fortran, Macro 10, PLAN
Purpose and Features: As above
Availability/Documentation: IRCAM Music V manual

Proposed Systems

Name/Author: Digital mixing program
Language/Requirements: PLAN, devices as above
Purpose and Features: Mixing of digital sound files

Name/Author: On-line conversion
Language/Requirements: Same as above

Additional Comments

We have found in our research that on-line systems, where the musician/acoustician can verify his results by ear fairly immediately and flexibly, are very important in enabling rapid progress to be made on a composition or piece of research.

Name

Peter D. Manning

Address of Institution

Department of Music
Durham University
Palace Green
Durham DH1 3RL
England

Type of Institution

University

Principal Sources of Funding

University of Durham

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Peter David Manning	Music	Director	Artistic, pedagogical	Half-time
(changing staff)	Electronics	Technician	Technical	Half-time
Dr. Frederic Tibbals	Computing	Occasional advice	Technical, pedagogical	Advisory

Principal Users

1) Peter D. Manning (1976-)
2) David Lumsdaine (1976-)

Date of Inception of Studio and Computer Work

January 1977

Areas of Activity

Initially - direct synthesis
Later - computer control of analog/digital sound generation

On completion of direct synthesis operating system -- facilities for the production of high quality computer-generated sound information

Type of Instruction Offered

None formulated yet (project too new)

Background of Computer Users

Musical

List of Works

None yet

Publications and Available Manuscripts

None

Policy for Composers' Rights and Contracts
Studio safeguards all users' interests

HARDWARE

Computers and Digital Hardware
IBM 360/67: 1M (32-bit)
IBM 370/185: virtual memory, effective size about 4M
(these computers located at Newcastle-upon-Tyne)

PDP 11/34: 64K words (16-bit)
PDP 11/20: 16K words (16-bit) (standalone for conversion work; the other three form a linked system)

Peripheral Devices

Data Storage
PDP 11/34 computing system connected directly to IBM 370/185 and 360/67 for direct transfer of output data onto PDP-11 disk units; disks transferred to adjacent PDP 11/20 for standalone conversion

Input Devices
IBM 2741 communications terminals; V.D.U. interactive terminals; fast card reader; input also possible direct from PDP 11/34 (input graphics to be added)

Output Devices
Calcomp plotters; IBM fast line printer

Sound Generation

Digital
DAC (2-channel, 16-bit) under construction

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Full analog studio facility (not located at computing installation) offering full mixing, filtering and recording - up to 8-track (as of Oct 1977); a stereo recorder will be located at the PDP 11/20, and suitable low pass filters will be provided between the DACs and the recorder

Digital
None

Proposed Hardware Developments
D/A conversion system (see above)
Other projects under consideration

Access to Computer
Terminal access 10:00-19:00 Monday-Friday; there are enough terminals that maximum wait for terminal is one hour (they can also be booked ahead of time)
Batch access (cards) 9:00-22:00 Monday-Friday, 9:00-13:00 Saturday
If user attached to University Music Department cost is nominal within allocation limits

Availability of Technical Assistance

If registered at the University, no charge for advice from all staff including full advisory service of the University of Durham Computing Unit

Operating Systems

Two modes possible (both services run more or less continually):

OS Batch Processing only (on 360/67)

MTS Time sharing (multipurpose) - batch, terminal, etc.

Turnaround/Response Time Characteristics

OS - Normal jobs 6-12 hour turnaround

MTS - immediate from terminals; batch: 4 hours to overnight

SOFTWARE

Functioning Systems

None

Systems Under Development

MUSIC360 -- Barry Vercoe (1975)

Language/Requirements: Fortran and 360 Assembler programs, also MUSIC360 orchestra score language; 150K bytes; directly connected to PDP 11/34

Purpose and Features: direct synthesis for musical composition and pedagogical investigations wtih a view to hardware/software research and development

Availability/Documentation: from M.I.T.

Additional Comments

This project is so new that many details are still very sketchy; nevertheless this is the first attempt in Europe (other than Padova, Italy) to run MUSIC360, and the first to run it under MTS, the highly sophisticated Michigan Terminal System. It is anticipated that composers will be able to specify and test their orchestral and score instructions interactively, with final generation and conversion taking perhaps a few hours to complete.

The 360-370 system at Newcastle-upon-Tyne is owned 40% by Durham University and shared with other universities. Other universities have rented lines and hope to run MUSIC360 from there also. The analog studio has been very active since 1970, and the use of direct synthesis is seen as an integral part of Durham's facilities in electronic music. It is also hoped to encourage development in other computer-based musical research using standard input-output facilities.

Name

University of East Anglia

Address of Institution

Denis Smalley
Electronic and Recording Studio
University of East Anglia
Norwich NR4 7TJ, England

Type of Institution

University

Principal Sources of Funding

Government financing via the University budget

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Denis Smalley	Music, composition, electro-acoustic music	Musical director	Composition, pedagogy	Full-time
Tryggvi Tryggvason	Sound engineering	Technical Director	Sound recording, computer development	Full-time
Michael Lewis	Electronics engineering	Maintenance, technical design	Technical	Full-time

Principal Users

1) Denis Smalley
2) Tryggvi Tryggvason
3) Visiting composers
4) Teaching

Areas of Activity

Electronic composition; sound recording (preparation of master tapes, etc.)

Computer not yet in use

Type of Instruction Offered

Courses in composition and sound recording

HARDWARE

Computers and Digital Hardware

Computer Systems Inc. System 2100: 24K (16-bit)

Proposed Hardware Developments

Research still being undertaken, this being additional to normal teaching, sound recording and compositional acitivities. We intend to use the "central" mini-computer to control micro-computer digital oscillators. This project is dependent on the success of the grant application in preparation at present.

In addition we shall be setting up a digital-analog-hybrid system involving the mini-computer and the Synthi 100. The system envisaged will be real-time, interactive, and user-dedicated, totally at the service of the electronic and recording studio.

Name

Electronic Music Studios (EMS)

Address of Institution

The Priory
Great Milton
Oxford, England

Type of Institution

Private (to be associated with Oxford University Faculty of Music in the near future)

Principal Sources of Funding

Electronic Music Studios (London) Ltd.

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Peter Zinovieff	Geology	Director	Artistic, technical	Half-time
Alan Sutcliffe	Mathematics	Programming	Artistic, technical	Half-time
Peter Eastty	Electronics	Hardware	Technical	Half-time
Robin Wood	Music	Studio Technician	Technical	Full-time

Principal Users

1) Own staff
2) Harrison Birtwistle
3) Hans Werner Henze
4) Tristram Cary

Date of Inception of Studio and Computer Work

Studio: 1963
First computer: 1967

Areas of Activity

Composition, commercial music, studio development, product development; digital voice processing, program development

Type of Instruction Offered

Special courses for composers

List of Works

Partial list:
(All realized using computer system and studio)

1) *Lollipop for Papa*, variations on Haydn Theme (P. Zinovieff)
2) *January Tensions* (P. Zinovieff)
3) *Pieces* (T. Cary)
4) *Bubbles* (R. Grainer)
5) *Tesseraek* (J. Connolly)
6) *ZASP* (A. Sutcliffe, P. Zinovieff)

7) Violin Concerto - electronic track (H.W. Henze)
8) *Chronometer* (H. Birtwistle)
9) *Glass Music* (H.W. Henze)
10) *Tristan* - electronic track (H.W. Henze)

Publications and Available Manuscripts

None

Public Presentation of Works
Several concerts at Royal Festival Hall and Queen Elizabeth Hall, London; many broadcasts; records produced

Policy for Exchange/Rental of Tapes and Related Materials
No arrangements

Policy for Composers' Rights and Contracts
On an individual basis

HARDWARE

Computers and Digital Hardware
PDP-8/E: 28K (12-bit)
PDP-8/L: 8K

Peripheral Devices

Data Storage
One RK05 exchangable disk; two DECtape units

Input Devices
Paper tape readers; DECwriter; Vista VDU and keyboard; programmable music keyboard; digitizer (Graphpen); TV camera; light pen

Output Devices
DECwriter; Graphpen plotter

Sound Generation

Digital
300 DACs

Hybrid Systems
Synthi 100; Vocoder

Mixed Digital Systems
192 digital oscillators

Other Peripheral Devices

Analog
Two 4-track TEAC tape recorders; one 4-track Ampex; one 16-track Scully; filters; radio; 16-channel mixer

Access to Computer
The computers are not used separately from the rest of the studio. Arrangements for use are made on an individual basis

Availability of Technical Assistance

All composers work with assistance in both programming and studio operation

Operating Systems

DEC OS/8 operating system
EMS MUSYS music compiler
EMS Vocom operating software
EMS PROC processing programs

Turnaround/Response Time Characteristics

The system can be run in real-time with simultaneous analysis and synthesis of sound; more compex processes can be run in non-real time, with a typical turnaround of 5 minutes

Additional Comments

The main emphasis in the studio is the control of very fast digital hardware for both analysis and synthesis of sound. Attention has also been paid to means of inputting information (via keyboards and music keyboards, digitizer, TV camera, light pen, etc.)

Name

Electronic Music Studio (ELMUS)

Address of Institution

Hellenic Association for Contemporary Music
8 Patroou Street
Athens 118, Greece

Type of Institution

Private studio (at the disposal of all composers in Greece)

Principal Sources of Funding

Greek government and membership dues; foreign foundations

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Stephanos Vassiliadis	Music, electronic music	Director	Electronic music, education, theatre, conducting	Part-time
Manolis Tzekakis	Architecture, acoustics	Advisor	Acoustics research/applications, electroacoustics	
Achilles Anghelidis	Electronics engineering	Advisor, installations and maintenance	Electronics, electroacoustics	Part-time
Charalambos Kornaros (and two assistants)	Electroacoustics	Maintenance and repairs	Electroacoustics	Part-time
Dimitris Hadjivassilakos	Unskilled	Clerk (security and contacts)		Full-time

Some of the supervisors of ELMUS (from HACM) also contribute a lot of time towards the system, as do some of the music students working at the studio

Principal Users

About 40 composers and students

Date of Inception of Studio and Computer Work

Preliminary studio - 1967
First "Sequencer 256" - 1971
First "Synthi 100" synthesizer - 1975

Areas of Activity

Seminars; composition of electronic music; listening to tapes or records, with previous introductory talks and subsequent discussion; international exchanges; otherm musical activities

Type of Instruction Offered

General seminars on acoustics, electroacoustics, use of equipment; seminars on various musical topics

List of Works

Some 150 compositions of electronic music have been produced so far by Greek composers, many of which have made use of small synthesizers as sound sources (usually the VCS3 by EMS of London), but a few using the recently installed "Synthi 100"; thus the only real computer music by a Greek composer is the group of works by Iannis Xenakis (Paris, 1956-62) using an IBM 7090 computer (ST-4, ST-10, ST-49, Atrees, Morsima-Amorsima), as well as some later works by the same composer that made partial use of a computer.

Publications and Available Manuscripts

A mimeographed instruction booklet, *Regulations for the use of the Electronic Music Studio* (in Greek), 1976, by ELMUS of HACM

Scores involving electronic music by Greek composers: a large collection of scores for electronic music by Anestis Logothetis (blueprints). Other scores for electronic music have not been published, but many scores are available for music for instruments and/or voices plus tape. Also *Parastasis* by Nikos Mamangakis (Gerig Verlag) for tape, flutes and voice. Studies on the use of computers in composition are not available.

Public Presentation of Works

Concerts; seminars, lectures and public discussions; Festival of Contemporary Music (Hellenic Week of Contemporary Music) biennially, with special emphasis on electronic music; special presentations of electronic music; records; exchange of tapes with electronic music.

Policy for Exchange/Rental of Tapes and Related Materials

No charge for exchange, except for tapes handled by music publishers (where the usual rental is payable)
Records - the usual copyright restrictions

HARDWARE

Computers and Digital Hardware

Synthi 100 - large synthesizer by EMS of London, including a small digital sequencer with 256 bytes of memory

Peripheral Devices

None

Other Peripheral Devices

Analog

Clavier (of Synthi 100, works in conjunction with sequencer); 5 Revox stereo tape recorders, one TEAC 4-track tape recorder, one 8-track ICAM tape recorder; mixing console, patchboard, amplifiers, loudspeakers, etc.

Proposed Hardware Developments

Beyond minor improvements to existing hardware, the next stage in the development of the studio will be an independent computer system, allowing for connection with the Synthi 100 and other existing hardware. Several such systems are under consideration.

Additional Comments

The existing facility scarcely provides what is expected from a true computer system. Still, it is useful in (a) globally changing a sequence of sounds; (b) editing (changing isolated notes or groups of notes at will); (c) other simple transformations

It is considered imperative to acquire a true computer system, with a number of peripheral devices that could operate both independently and in conjunction with the existing equipment.

Name

Josef Tal

Private Address

3 Deborah Hanevia Street
Jerusalem 95103, Israel

Address of Institution

Hebrew University
Jerusalem, Israel

Type of Institution

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Josef Tal	Electronic music	Director		
Jaacov Sailes	Electronic engineering	Maintenance		Full-time

Principal Users

1) Composers
2) Musicology students

Areas of Activity

Composition and pedagogical activities; no computer work yet

List of Works

No computer works

Additional Comments

In progress is a research project for:
Electronic Notation for Electronic Music

We are contemplating the uses of a computer in our project

Name

Istituto di Calcolo Automatico del Consiglio Nazionale delle Ricerche

Address of Institution

Pietro Grossi, CNUCE
via S. Maria, 36
56100 Pisa, Italy

Principal Sources of Funding

Consoglio Nazionale delle Ricerche (CNR)

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Pietro Grossi	Music, computer science	Director	Teaching, integral automation	Part-time
Mario Milano	Music, physics	Researcher	Sound synthesis	Full-time (CNR)
Leonello Tarabella	Computer science	Programmer	Operating systems	Full-time (CNR)
Silvio Farese	Computer science	Analyst	Operating systems	Full-time (CNR)
Tommaso Bolognesi	Physics	Programmer	Formal analysis	Full-time

Date of Inception of Studio and Computer Work

September 1969

Areas of Activity

Research into and realization of programs for use in teaching and of programs for the automation of creative and executive processes; preparation of musical archives stored in digital code and of programs dealing with these archives.

Type of Instruction Offered

From 1970 to 1975 two one-semester courses per year were taught at CNUCE. In 1974 a course on computer music with a direct terminal line to the centre at Pisa was taught at the Conservatorio di Musica di Firenze.

List of Works

All compositions realized and executed entirely by computer

1) *Combinatoria* (P. Grossi)
2) *Polifonia* (Grossi)
3) *Monodia* (Grossi)
4) *Virtuosità* (Grossi)
5) *Algotirmi* (Grossi)
6) *Octofonia* (Milani)

Publications and Available Manuscripts

Baruzzi, Grossi, Milani, *Compendio dell'attività svolta dal 1969 al 1975* Ed. CNR

L. Tarabella, *Applicazione delle Catene di Markov nell'ambiti della composizione automatica.*

Ed. CNR

M. Milano, *N-tone systems and symmetrical series.* Ed. CNR

P. Grossi, Sommi, *DCMP* (digital computer musical program) *versione per il sistema 360/67 IBM.* Ed. CNR

P. Grossi, *Modalità operative del TAUMUS, software di gestione del terminale audio TAU2.* Ed. CNR

P. Grossi, "Musica in tempo reale", *Futuribili,* No. 34, May 1971

P. Grossi, "Computer and Music", *International Review of the Aesthetics and Sociology of Music,* Vol. IV, No. 1, 1973

P. Grossi, "Elettronica e informatica nel mondo dei suoni", *Città & Regione,* Vol. I, No. 4, 1975

P. Grossi, Documentation of activity prior to 1972

P. Grossi, Documentation of activity 1973-75

M. Milani, Busico, *Forme d'onda e timbri: distinguibilità e criteri de scelta.* Ed. CNR

Public Presentation of Works

Demonstrations since 1970 in many cities in Italy and at CEMAMu in France. For all demonstrations remote terminal connection to the computer was used. Italian radio and television have covered research at Pisa.

HARDWARE

Computers and Digital Hardware

IBM 370/168: 1M, 32-bit words
IBM 1800: 32K, 16-bit words
IBM system 7: 24K, 16-bit words

Peripheral Devices

Data Storage
Disk packs, mag tape

Input Devices
Terminals, punch tape

Output Devices
Printers

Sound Generation

Digital
Three DACs

Hybrid Systems
Audio terminal TAU2 designed and built at the Istituto di Elaborazione dell'Informazione, CNR, Pisa

Mixed Digital Systems
None

Proposed Hardware Developments
Acquisition of a minicomputer with intelligent terminal and self-sufficient system

Access to Computer
All computers at the Istituto di Pisa are available at all times

Operating Systems
The 370/168 operates in time-sharing mode, making it possible to implement DCMP and TAUMUS at the same time. All programs run in real time. The system 7 is used for DCMP and the IBM 1800 for the program PLAY1800

SOFTWARE

Functioning Systems

Name/Author: DCMP – Grossi, Paoli, Sommi
Language/Requirements: Fortran IV, assembler, virtual size 1M
Purpose and Features: Production of digital music; highly flexible interactive system with facilities for storing music
Availability/Documentation: Yes

Name/Author: DCMP for graphics terminal -- Milani
Language/Requirements: Same as above
Purpose and Features: Same as above; for graphics terminal
Availability/Documentation: Yes

Name/Author: TAUMUS -- Grossi, Paoli, Sommi
Language/Requirements: Fortran IV, assembler, 2M virtual, TAU2 terminal
Purpose and Features: Conversion of digital data into sound on the audio terminal TAU2; 12 voices grouped into 3 channels of 4 voices each; library sotrage capacity of about 20 million sounds
Availability/Documentation: Yes

Name/Author: PLAY1800
Language/Requirements: .....Fortran IV, assembler, DACs
Purpose and Features: Synthesis of waveforms; used in the study of the timbre of sounds
Availability/Documentation: Yes

Name
Walter Branchi

Private Address
Passeggiata di Ripetta, 11
00186 Roma, Italy

Address of Institution
Laboratorio Sperimentale per la Musica Elettronica
Conservatorio "G. Rossini"
Piazza Olivieri 5 Pesaro
Italy

Type of Institution
Conservatory of Music

Principal Sources of Funding
Italian Goverment

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Walter Branchi	Music	Director	Artistic, pedagogical	Full-time
Guido Baggiani	Music	Composer	Artistic	Half-time
Giorgio Nottoli	Music, technical work	Composer	Artistic, technical	Half-time
Vito Asta	Technical work	Engineer	Technical	Half-time

Principal Users
1) John Heineman
2) Fausto Razzi
3) Walter Branchi
4) Guido Baggiani
5) Giogio Nottoli

Date of Inception of Studio and Computer Work
Studio - November 1974
Computer - scheduled for spring 1977

Areas of Activity
Musical research; music production; instruction

Type of Instruction Offered
One triennial course in electronic music

Expectations of Computer Users
Research in the field of sound perception and study of the relationship between the subjective dimensions and the physical properties of sound

List of Works
None

Publications and Available Manuscripts

W. Branchi, Partendo della tecnica delle forme d'ona, *Rivista Musicale Italiana*, No. 3, 1976

W. Branchi, *Tecnologia della Musica Elettronica*, Lerici Ed., Roma, 1976

Public Presentation of Works
Concerts: Italy, France, Germany
Radio broadcasts: Italy, France Germany
Conferences: Italy, France, Great Britain

Policy for Exchange/Rental of Tapes and Related Materials
All materials available free except for cost of tape and copying

Policy for Composers' Rights and Contracts
The Laboratorio retains ownership of master copy of tapes; composer's rights reserved

HARDWARE

Computers and Digital Hardware
PDP 11/34: 32K words (16-bit)

Peripheral Devices

Data Storage
2 DECpack RK05 disks (2.4M)

Input Devices
VT-52 video terminals; teletype

Output Devices
Teletype (10 chars./sec.)

Sound Generation

Digital
4 DACs under construction by the University of Naples

Hybrid Systems
Function generators; modulators; speed variation (1-, 2- and 4-track Ampex tape recorder)

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Generators, modulators, filters, tape recorders, synthesizer

Digital
None

Access to Computer
The computer will be the property of the Conservatorio Rossini

Name
Teresa Rampazzi

Private Address
Riv. S. Benedetto 31
Padova, Italy

Address of Institution
Conservatorio di Musica "Pollini"
Via Eremitani, 6
35100 Padova, Italy

Conservatorio di Musica "G. Verdi"
Milano, Italy

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Teresa Rampazzi	Electronic music, computer music	Director	Composition, experimental music	Full-time

Date of Inception of Studio and Computer Work
1965

Areas of Activity
"Gruppo NPS" formed in 1965
Instruction in Electronic Music Composition

Type of Instruction Offered
Instruction to students of the Conservatorio Pollini

List of Works
Two compositions

Publications and Available Manuscripts

Unpublished articles and manuscripts

Public Presentation of Works
Italian radio and television broadcasts

HARDWARE

Computers and Digital Hardware
IBM S/370-158: 2 Mbytes (8-bit)
IBM S/7: 16K (16-bit)
Data General NOVA 1200: 32K words (16-bit)

Peripheral Devices

Data Storage
S/370 -4 tape unit (9-track), 12 disks IBM 3330
S/7 -2 disks
NOVA -1 disk, 1 tape unit, 2 cassettes

Input Devices
S/370 -alphanumeric terminals, card reader
S/7 -teletype, Channel Attachment with S/370, ADC, light pen
NOVA -teletype, ADC, display, card reader, 2 cassettes, line attachment with S/370

Output Devices
S/370 -printers, terminals, plotters, Calcomp 565-925/1036 plotters
S/7 -teletype
NOVA -printer, teletype

Sound Generation

Digital
S/7 -4 DACs
NOVA -4 DACs

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
2 Revox A77, 1 Uher 4000, 1 Teac 3340 tape recorders
8 filters

Access to Computer
Access from 8 a.m. to 8 p.m. Monday-Friday; 8 a.m. to 1 p.m. Saturday; rates fixed by the board of directors

Availability of Technical Assistance
Daily ordinary assistance; research staff

Operating Systems
Multiprogramming; time-sharing; TSO

Turnaround/Response Time Characteristics
20-minute turnaround for batch applications

SOFTWARE

Functioning Systems

Name/Author: MUSICA -- De Poli 1972
Language/Requirements: PL/1, 80K
Purpose and Features: Musical texts transcription
Availability/Documentation: Yes

Name/Author: MUSIC4BF -- Howe 1973
Language/Requirements: Fortran, Assembler
Purpose and Features: Synthesis
Availability/Documentation: Yes

Name/Author: MUSIC360 -- Vercoe 1975
Language/Requirements: Fortran, Assembler
Purpose and Features: Synthesis
Availability/Documentation: Yes

Name/Author: MUSIC5 -- Mathews 1970
Language/Requirements: Fortran, Assembler
Purpose and Features: Synthesis
Availability/Documentation: Yes

Name/Author: Notae -- De Poli 1974
Language/Requirements: PL/1
Purpose and Features: MUSICA-MUSIC4, MUSIC360 interface
Availability/Documentation: Yes

Name/Author: CELLE -- Vidolin 1976
Language/Requirements: PL/1
Purpose and Features: Rhythmic structures processing
Availability/Documentation: Yes

Name/Author: ICMS -- Tisato 1976
Language/Requirements: PL/1, Assembler
Purpose and Features: Interactive real-time synthesis
Availability/Documentation: Yes

Name/Author: ORGANUM1 -- Tisato 1974
Language/Requirements: PL/1
Purpose and Features: Synthesis
Availability/Documentation: Yes

Name/Author: LPC -- Mian, Offelli 1975
Language/Requirements: Fortran
Purpose and Features: Linear predictive coding analysis/synthesis
Availability/Documentation: Yes

Name/Author: ASEQ -- Mian, Offelli 1973
Language/Requirements: Assembler
Purpose and Features: Digital Signal Processing Package (S/7 standalone)
Availability/Documentation: Yes

Name/Author: FILTER -- Morganitini 1975
Language/Requirements: Fortran
Purpose and Features: Digital filter design
Availability/Documentation: Yes

Name/Author: TRANSM -- Tisato 1974
Language/Requirements: PL/1, Assembler
Purpose and Features: Digital samples I/O
Availability/Documentation: Yes

Systems Under Development

Name/Author: ANAMUS -- Tisato, Cortellazzo
Language/Requirements: PL/1, Assembler
Purpose and Features: Musical sound analysis

Proposed Systems

Name/Author: EMUS -- De Poli, Vidolin
Language/Requirements: PL/1
Purpose and Features: Musical structures processing

Name
Institute of Sonology

Address of Institution
Instituut voor Sonologie
Plompetorengracht 14-16
Utrecht, Netherlands

Type of Institution
University

Principal Sources of Funding
Government

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
G.M. Koenig	Music	Lecturer	Artistic	Full-time
J. Scherpenisse	Electronics	Hardware	Technical	Full-time
S.Tempelaars	Physics	Lecturer, researcher	Physical research	Full-time
F. Weiland	Music	Lecturer	Artistic	Full-time
P. Berg	Music	Lecturer	Pedagogical, artistic	Half-time
W. Kaegi	Music, phonology	Lecturer, researcher		Full-time

Principal Users
1) O.E. Laske (1973-75)
2) B. Truax (1973)
3) W. Buxton (1975)
4) W. Matthews (1976)
5) P. Berg (1974-75)
6) V. Radovanovic (1976)

Date of Inception of Studio and Computer Work
Electronic studio - 1960
Computer facility - 1971

Areas of Activity
Production of electronic music; development of studio equipment; research into sound and structure in music; education; electronic music concerts

Type of Instruction Offered
Studies in Sonology (annual course), comprising signal processing, electronic music, computer languages, logic, exercises in sound synthesis and structure description

Background of Computer Users
Musical training, understanding of algorithmic processes

List of Works

1) *Reportage* (Berg 1975), 2 tracks, 11'50"
2) *Merriweather's Guide to Plants and People* (Berg 1975), 2 tracks, 7'08"
3) *Six Loaves to Feed A Family of Five for a Week* (Berg 1974), 2 tracks, 10'30"
4) *For Dance* (Buxton 1975), 4 tracks, 12'05"
5) *Project 1 - Version 1* (Koenig 1966), instrumental ensemble
6) *Project 1 - Version 3* (Koenig 1967), instrumental ensemble
7) *Uebung fuer Klavier* (Koenig 1970), piano
8) *Structure IV* (Laske 1973), 4 tracks, 17'35"
9) *Structure V* (Laske 1974), 4 tracks, 17'40"
10) *Structure VIII* (Laske 1975), 4 tracks, 19'30"
11) *Field Guide* (Matthews 1976), 2 tracks, 9'00"
12) *Diora Sarabanda II* (Matthews 1976), 4 tracks, 14'00"
13) *Gilgamesh Tape VII (The Journey)* (Truax 1973), 4 tracks, 14'00"

Publications and Available Manuscripts

Paul Berg, *ASP Report*, May 1975 (manuscript)

Paul Berg, *PILE - A Description of the Language*, December 1976 (manuscript)

W. Buxton, *A Manual for POD6*, 1975 (manuscript)

G.M. Koenig, "Computer-Verwendung in Kompositionsprozessen", in: Dibelius, *Musik auf der Flucht vor sich selbst*, Munchen 1969

G.M. Koenig PROJECT 1, *Electronic Music Reports* (EMR) 1, Swets & Zeitlinger, Amsterdam 1970

G.M. Koenig, PROJECT 2, A Programme for Musical Composition, *Electronic Music Reports 3*, Swets & Zeitlinger, Amsterdam 1970

G.M. Koenig, "The Use of Computer Programmes in Creating Music", in: *Music and Technology*, La Revue Musicale, Paris 1970

G.M. Koenig, Programmed Music: Personal Experience and Work, in: *Seminario di Studi e Richerche sul Linguaggio Musicale*, Padova 1975

W. Matthews, *FMS User's Manual*, December 1976 (manuscript)

W. Kaegi & S. Tempelaars, *VOSIM - A New Sound Synthesis System* (submitted for publication in AES journal)

S. Tempelaars, *The VOSIM Oscillator*, Computer Music Conference Paper, MIT 1976

B. Truax, The Computer Composition - Sound Synthesis Programs POD4, POD5 & POD6, *Sonological Report no. 2* (reprint 1975)

Public Presentation of Works

Local concerts; tapes for broadcast, concerts for educational purposes, educational broadcasts; co-operation with museums and cultural centres

Policy for Exchange/Rental of Tapes and Related Materials

Hiring fee for rental of tapes; no fee if for educational purposes

Policy for Composers' Rights and Contracts

The Institute always keeps documentary copies. Composer can choose between two contracts: one releases him of all obligations, the other reserves the Institute some rights with respect to tape exchange (for five years)

HARDWARE

Computers and Digital Hardware
PDP 15/20 (extended): 24K words (18-bit)

Peripheral Devices

Data Storage
Two fixed-head disks; two DECtape units

Input Devices
Teletype, paper-tape reader, ADCs

Output Devices
Matrix printer

Sound Generation

Digital
8 DACs (12-bit)

Hybrid Systems
DC connecting lines with an analog studio for driving analog hardware by the computer

Mixed Digital Systems
Six computer-controlled digital oscillators of various types

Other Peripheral Devices

Analog
One stereo tape recorder; two Krohnhite filters; one dbx compander; one Tektronix oscilloscope; one XY recorder

Digital
Two variable real-time clocks; one hardware random-number generator

Proposed Hardware Developments
Fourier synthesizer
TV screen text display
Digitally-controlled attenuator

Access to Computer
Access time dependent on proposed project and work situation; no costs

Availability of Technical Assistance
No continuous assistance, but staff always prepared to help with programming or operating

Operating Systems
Disk-oriented, single-user operating system

Turnaround/Response Time Characteristics
Programs are conversational and interactive

SOFTWARE

Functioning Systems

Name/Author: ASP – Berg (1975)
Language/Requirements: Program written in MACRO-15; DAC; variable clock; hardware random generator
Purpose and Features: Automatic sound production in real-time
Availability/Documentation: Listing, program description

Name/Author: PILE -- Berg (1976)
Language/Requirements: MACRO-15 program
Purpose and Features: Compilation of programs written in PILE, a language for sound synthesis
Availability/Documentation: Listing, language description

Name/Author: FMS – Matthews (1976)
Language/Requirements: MACRO-15 program; FM generators, variable clock
Purpose and Features: Control of frequency modulation generators
Availability/Documentation: Listing, user manual

Name/Author: POD5 -- Truax (1973-76)
Language/Requirements: MACRO-15 and Fortran; DAC; filter; real-time clock
Purpose and Features: Production of mono-linear sound strings using fixed waveforms
Availability/Documentation: User manual

Name/Author: POD6 -- Truax (1973-76)
Language/Requirements: MACRO-15 and Fortran; devices as for POD5
Purpose and Features: Same as POD5 with frequency modulation
Availability/Documentation: User manual

Name/Author: VOSIM -- Tempelaars (1975)
Language/Requirements: MACRO-15 and Fortran; digital oscillator
Purpose and Features: Production of musical and linguistic signs; basic model: trains of sine-squared pulses
Availability/Documentation: Listing

Name/Author: PR1 -- Koenig (1964-66)
Language/Requirements: Fortran program
Purpose and Features: Composition of structure models
Availability/Documentation: Listing

Systems Under Development

Name/Author: ROLCOL, WAVEX AMCOL -- Lennox (1976)
Language/Requirements: MAC O-15, uses DAC, oscillator
Purpose and Features: Compc ition of electronic music with sound built up from simple waveforms.

Name/Author: PR2 – Koenig (1976)
Language/Requirements: Fortran, MACRO-15, uses DAC, digital oscillator
Purpose and Features: Composition of structure models (new edition of PR1), featuring interactive programs, turning out score, sound and graphs

Name/Author: SSP – Koenig (1975)
Language/Requirements: MACRO-15
Purpose and Features: Sound production in real-time based on the distribution of amplitudes in time

Name

University of Canterbury

Address of Institution

Department of Electrical Engineering
University of Canterbury
Christchurch, New Zealand

Type of Institution

University

Principal Sources of Funding

New Zealand university grants committee

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Prof. R. H. T. Bates	Elec. engineering	Research co-ordinator	Technical, pedagogical	One-eighth time
W. K. Kennedy	Elec. engineering	Technical director of research	Technical, pedagogical	One-eighth time
W. H. Tucker	Elec. engineering	System co-ordinator	Technical	Two-thirds time
M. R. Lamb	Music, mathematics	Research	Technical, artistic	Full-time
Susan D. Frykberg	Music	Research assistant	Artistic, technical	Full-time
R. J. Howarth	Music, Elec. engineering	Master's student	Technical	Full-time
R. D. Vaughan	Elec. engineering	Master's student	Technical	Full-time

Principal Users

1) Those listed above
2) Undergraduate E.E. students on projects
3) Music School staff members helping with research
4) Music students acting as guinea pigs

Date of Inception of Studio and Computer Work

March 1972

Areas of Activity

Research into computerized musician aids: teaching machines, music typesetting, musicological studies, compositional aids

The long term goal is to develop hardware and software suitable for musicians to generate artistically satisfactory performances (of new or old compositions) using electronic sound-producing apparatus which is under computer control.

Type of Instruction Offered
None

Expectations of Computer Users
The work so far has been purely of a research nature, and mostly technical, since the primary concern has been one of building a powerful, versatile system

List of Works
Susan D. Frykberg has generated some experimental, unpublished compositions.

Publications and Available Manuscripts

W. H. Tucker, M. M. R. Lamb, R. J. Howarth, R. D. Vaughan, W. K. Kennedy, Susan D. Frykberg & R. H. T. Bates, *Computerized Musicianship Aids*, presented at New Zealand National Electronics Conference (NELCON), Wellington (August 1975)

Some half-dozen papers are in preparation covering the Department's artistic and technical achievements (i.e., the initial stage of building up the system technically is being finished, and several of the research students are completing their studies and writing them up).

Public Presentation of Works
Lecture-demontrations of the system to interested groups (e.g., Royal Society of New Zealand, Canterbury Graduates in Music, Australasian composers at the 1976 "Sonic Circus", school groups, general public at University "open days")

HARDWARE

Computers and Digital Hardware
EAI 590 (hybrid computer): 16K words (16-bit)

Peripheral Devices

Data Storage
Disk, mag tape, paper tape

Input Devices
DECwriter, paper tape reader, ADCs, binary data interface

Output Devices
Line printer, storage oscilloscope, hard copy unit

Sound Generation

Digital
DAC

Hybrid Systems
Multi-voice electronic organ playable either as a conventional organ with a conventional keyboard, or as a super-synthesizer under computer control.

Mixed Digital Systems
See under *Digital* below

Other Peripheral Devices

Analog
Transducers (especially for real-time pitch detection systems currently under development

Digital

Waveshape and envelope specifier, vibrato and tremelo generation.

Proposed Hardware Developments

1) Extension of number of voices for the organ
2) Use of microprocessors to allow parts of the system to function independently of the computer.

Access to Computer

On-line computing system; time booked on first-come, first-served basis (with a maximum allowable time per booking). No cost for approved projects. The music system uses 3 to 4 hours per day.

Availability of Technical Assistance

The system is available only to persons taking part in or assisting with the research activities

Operating Systems

The system is, of course, dependant on the special hardware that has been developed, but the major effort has been directed towards development of appropriate software for the system.

Turnaround/Response Time Characteristics

Single-user system

Additional Comments

This system is concerned solely with interactive uses of the computer. Computers can generate sounds, but they cannot compose "music". However, they should be able to be of enormous help to composers in all sorts of sophisticated ways.

Name
University of Singapore

Address of Institution
Department of Music
University of Singapore
Singapore 10

Type of Institution
University

Principal Sources of Funding
Government of Singapore

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Bernard Tan	Physics, music	Acting head	Acoustics, composition, electronic music	Full-time

Areas of Activity
Music instruction

HARDWARE

Computers and Digital Hardware
IBM 1130: 16K (University computer)

Proposed Hardware Developments
Development of a music system on above computer

Additional Comments

We have done very little actual work on computer or electronic music

Name

Stiftelsen Elektronmusikstudion

Address of Institution

Kungsgatan 8
11143 Stockholm, Sweden

Type of Institution

Independent foundation

Principal Sources of Funding

Government

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Lars-Gunnar Bodin	Composition	Director	Artistic	Part-time
Tamas Ungvary	Instrumental, conducting, composition	Studio assistant (teaching, producing)	Artistic, pedagogical	Half-time
Miklos Maros	Composition	Studio assistant	Artistic, pedagogical	Half-time
Per-Olov Strömberg	University	Engineer	Technical	Full-time
Göran Svensson	University	Engineer	Technical	Full-time

Principal Users

1) Knut Wiggen (1969-76)
2) Thorkell Sigurbjörnsson (1970-71)
3) Leo Nilson (1970-71)
4) Eberhard Eyser (1970-75)
5) Miklos Maros (1971-)
6) Mikel Hinton (1972-)
7) Peter Lyne (1972-)
8) Tamas Ungvary (1972-)
9) Gottfried Gräsbeck (1973-75)

Date of Inception of Studio and Computer Work

1970

Areas of Activity

Courses (individual and in groups); lectures; production of works

Type of Instruction Offered

Courses range from elementary level to Fortran user courses

List of Works

Computer-realized pieces:
1) *Resa* (K. Wiggen)
2) *Sommarmorgen* (Wiggen)

3) *La Valse* (E. Eyser)
4) *Seul* (T. Ungvary)
5) *Incrementum* (Ungvary)
6) *Un Portrait* (Ungvary)
7) *Basic Barrier* (Ungvary), only partly computer-realized
8) *Traum des Einsamen* (Ungvary), partly computer-realized
9) *Mozgások* (M. Maros)
10) *Ostinato* (Maros)
11) *Viarp I* (L. Nilson)
12) *Viarp II* (Nilson)
13) *Fipur* (T. Sigurbjörnsson)
14) *Kejsarens nya slipd*
15) *3 Pieces* (J. Throvier)
16) Unititled (P. Lyne)

Public Presentation of Works
Mainly concerts and broadcasts

Policy for Composers' Rights and Contracts
Composers own all rights to their work

HARDWARE

Computers and Digital Hardware
PDP 15/40: 48K (18-bit)

Peripheral Devices

Data Storage
Disk, mag tape

Input Devices
Paper tape; terminals (TTY, CRT); DECtape (4)

Output Devices
Line printer

Sound Generation

Digital
None

Hybrid Systems
24 Audio frequency generators; noise generator; 2 third octave filter bank; 4 reverb units; 3 ring modulators; 2 ampl. modulators; 4 output channels

Mixed Digital Systems
One digital tone generator capable of frequency modulation

Other Peripheral Devices

Analog
Tape recorders (1-, 2- and 4-channel); a complete analog studio

Digital
Two mag tape units (off-line)

Proposed Hardware Developments

1) Frequency modulators for the existing 24 generators
2) Bank of 16 digital oscillators capable of frequency modulation
These should be in use in 1978

Access to Computer
Unlimited access; no cost to research users

Availability of Technical Assistance
Some programming assistance; operating and technical assistance available

Operating Systems
XVM/DOS disk operating system

SOFTWARE

Functioning Systems

Name/Author: XVMEMS (1970-77), EMSDEV (1970-75), SYNTAL (Slawson), COTEST (Ungvary)
Language/Requirements: Macro-15, Fortran
Purpose and Features: To write magnetic tapes with EMS's studio information which can be played either on EMS's own tape transports or through the PDP-15. EMSDEV permits program control of all addressable functions.
Availability/Documentation: COTEST available with persmission of author. User's guide.

Systems Under Development
XVMEMS, EMSDEV and COTEST are under continuous development

Additional Comments

Many of the users have their own small software packages for very different purposes, or slightly changed versions of XVMEMS. XVMEMS provides the possibility to link the users' own Fortran machines to the standard software.

Name
Curtis Abbott

Private Address
311 Glenmont
Solana Beach, California 92075

Address of Institution
B-027
University of California
San Diego, La Jolla, California 92093

Principal Sources of Funding
Private

Date of Inception of Studio and Computer Work
Development started August 1976

Areas of Activity
Development of software for interactive synthesis, processing of concrete materials and support for partially, interactively automated compositional activity. Also development of hardware to support the above.

The software developed here is expected to be used by the Center for Music Experiment at UCSD.

List of Works
1) MV1: *Muffled Voices* (analog synthesizer and studio techniques)
2) MV2: *Son of Muffled Voices* (same)

Publications and Available Manuscripts

None

Public Presentation of Works
No formal, regularly scheduled events or arrangements. Information is disseminated through occasional concerts, radio broadcasts and personal contacts.

Policy for Exchange/Rental of Tapes and Related Materials
Would be glad to exchange materials

HARDWARE

Computers and Digital Hardware
Cal Data 100 (PDP-11/40 emulator): 64K words (16-bit)

Peripheral Devices

Data Storage
Dual RK05 disk, Linctape

Input Devices
Diablo 1620 typewriter terminal; Tektronix 4014 graphics scope; high-speed ADC (12-bit, with sample/hold and selectable pre-filters); DMA type interface

Output Devices
Line printer; plotter (for artistic -- drawing -- purposes)

Sound Generation

Digital
High-speed DAC (12-bit, four selectable post-filters at 10K, 20K, 30K, 40K); DMA type interface

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Pioneer tape deck; preamp; power amplifier (both stereo and homemade); speakers; filters

Access to Computer
Access by arrangement; no cost

Availability of Technical Assistance
Available on an informal basis

Operating Systems
UNIX (a multi-user, diskbased operating system deloped at Bell Labs)

Turnaround/Response Time Characteristics
The system is interactive and response is generally very fast. Batch type operation can also be initiated from the keyboard with slower response. A priority system is available (say for running long jobs) but is not much used

SOFTWARE

Functioning Systems

Name/Author: invokator – Abbott
Language/Requirements: Written in C, uses 8K
Purpose and Features: The invokation section of a music synthesis/processing language implemented as an interpreter which consists of data (buffers, variables, structures), arithmetic expressions on data and primitives (which perform operations such as D/A and A/D conversion, read/write data files, filtering, fft, scaling, visual display, etc.) and macros which allow building the above into more complex abilities (e.g. specialized mixing operations, etc.). Features: may be run interactively or in batch mode; able to mark times in data files interactively (during the playing of a file)
Availability/Documentation: January 1977

Name/Author: macro-editor
Language/Requirements: C; 3K
Purpose and Features: Editor to facilitate the development of collections of macros for use by invokator

Systems Under Development

Name/Author: invokator (further development)
Purpose and Features: Development of further capabilities for invokator; currently only the skeleton of the language is operational

Name/Author: score-editor
Language/Requirements: C
Purpose and Features: Editor/compiler to accept structural information and data; will output commands to the invokator
Availability/Documentation: May 1977

Additional Comments

The computer here is owned by Harold Cohen, who is an artist interested in "freehand" drawing by computer. I am his assistant, and so the project described here is on my own time. Although the project is on a small scale, it should be a useful facility once fully operational will demonstrate the feasibility of digital systems for ppor institutions and rich individuals. Also, since the PDP-11 is a popular computer, and UNIX is becoming a popular operating system (for good reason), I have hopes that the work done here will be of use to others.

Somewhat more far-off projects include special purpose digital synthesis hardware and a variety of input control mechanisms.

Name

P. Howard Patrick

Address of Institution

Dept. of Music
The American University
Washington, D.C. 20016

Type of Institution

University

Principal Sources of Funding

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
P. Howard Patrick	Music	Director	Pedagogical, artistic, technical	One-third time

Principal Users

Students

Date of Inception of Studio and Computer Work

September 1973

Areas of Activity

Computer sound-synthesis; computer assisted analysis of music; computer-assisted translation of music Braille

Type of Instruction Offered

1) Computer sound-synthesis
2) Computer-assisted analysis of music

Background of Computer Users

Prerequisite: two years of music theory

List of Works

1) *Reflections* (1972) realized at Princeton
2) *Suspensions* (1973) realized at Princeton
3) *Gwladoi* (1976) realized at American University
4) *Movement* (in progress) realized at American University

Publications and Available Manuscripts

Patrick, P. Howard and Rosalind E. Patrick, "Computers and Music Braille", *Braille Automation Newsletter*, Warwick Research Center for the Blind (August 1976)

Patrick, P. Howard and Patricia Friedman, "Computer-Printing of Braille Music using the IML-MIR System", *Computers and the Humanities*, May 1975 (Vol. 9, pp. 115-121)

Patrick, P. Howard, "A Computer Study of a Suspension-Formation in the Masses of Josquin Desprez", *Computers and the Humanities*, September 1974 (Vol. 8, pp. 321-331)

Patrick, P. Howard, "Composer, Computer and the Audience", *Composer*, Spring 1970 (No. 35, pp. 1-3)

IML-MIR (Intermediary Musical Language - Music Information Retrieval) *Users' Manual*. Written

by T. Hall, P.H. Patrick and J. Selleck

Public Presentation of Works
On-campus concerts

HARDWARE

Computers and Digital Hardware
IBM 370-145: 750K bytes (actually more because of VM)

Peripheral Devices

Data Storage
Disk, mag tape

Input Devices
Card readers

Output Devices
Line printer

Sound Generation

Digital
DAC at the Johns Hopkins University, Applied Physics Lab

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Filters and tape recorders on site at D/A conversion facilities

Proposed Hardware Developments
Would like to have own D/A facilities on campus, but this seems unlikely

Access to Computer
No limitations -- considered as ordinary research/classroom use

Availability of Technical Assistance
Computer Center Clinicians for JCL problems

Operating Systems
Batch system

Turnaround/Response Time Characteristics
Sound synthesis (MUSIC4BF) -- when CPU time greater than 30 minutes run only on weekends; usual turnaround time one day. Visit D/A facilities every 3 weeks

Computer-assisted analysis/translation of Braille (IML-MIR system) -- most runs take approximately 3 minutes CPU time (turnaround time 2 hours)

SOFTWARE

Functioning Systems

Name/Author: Music4BF -- H.S. Howe
Language/Requirements: Fortran code, 250K bytes
Purpose and Features: Computer-synthesis of sound
Availability/Documentation: Described in *Electronic Music Synthesis* by Howe

Name/Author: IML-MIR
Language/Requirements: Fortran code, 150K (IML), 200K (MIR)
Purpose and Features: Translation of IML language to a machine-usable data base; retrieval of information for analysis of music
Availability/Documentation: User's Manual

Systems Under Development

Name/Author: IML-MIR Braille system -- P.H. Patrick
Language/Requirements: Fortran code, 250K
Purpose and Features: Generation of music Braille from coded music
Availability/Documentation: Document in preparation

Name

Dems L. Baggi, Ph.D.

Private Address

25-1/2 Felix St.
Brooklyn, NY 11217

Areas of Activity

Artificial intelligence applied to problems of composition and tonal classical harmony; programming digital filters for sound generation

Type of Instruction Offered

Previously taught the course "Electronic Music Composition" at the Polytechnic Institute of New York, while an assistant professor there. Stress was on software applied to composition, although various projects emerged

List of Works

1) *Prelude to the Afternoon of a Faun* (C. Debussy), played by digital filter, work still in progress (at Bell Labs, Murray Hill, N.J.)
2) Speech synthesis with digital filters (Directed by Max Mathews, Bell Labs)

Publications and Available Manuscripts

D.L. Baggi, "Realization of the Unfigured Bass by Digital Computer", Ph.D. thesis, University of California, Berkeley, 1974 (publ. by University Microfilms, Ann Arbor, Michigan)

This thesis describes a system of programs, mostly in Lisp, which accepts as input a bass without figures, in any signature (temp 2/2), constructs the harmony, constructs the uppper voices, and edits a complete score with a CalComp plotter. Examples borrowed from real harmony tests were given to the programs, which simulate a student of harmony.

Public Presentation of Works

Computer Science Conference, Detroit, February 12, 1974:
"Automatic Realization of a Bass without Figures: a Computer System to Study Classical Harmony"

Similar lectures given at: University of California, Berkeley; University of Pennsylvania, Philadelphia; City University of New York, Staten Island, NY; University of Southern California, Los Angeles; Columbia University, New York; Polytechnical Institute of New York

HARDWARE

Computers and Digital Hardware

CDC 6400: 140K (60-bit) (at Berkeley)
PDP 11/20: 32K words (16-bit)

Sound Generation

Digital

Digital filter and DAC

SOFTWARE

Functioning Systems

Name/Author: BACH (Bass Comp. Harm.) -- Baggi 1974

Language/Requirements: Lisp, fortran code; 120K, uses CalComp plotter
Purpose and Features: Realizes an unfigured bass and produces the score of the piece in four part harmony with that bass; features routines for score editing
Availability/Documentation: Ph.D. thesis

Systems Under Development

Name/Author: D.Baggi 1975
Language/Requirements: 64K
Purpose and Features: Plays "Prelude of the Afternoon of a Faun" thorough a digital filter; high-level language for writing scores; the software drives a digital filter

Proposed Systems

An Automatic machine to compose pieces in four part harmony. From a keyboard one selects a progression, key, etc. It is played in real-time and stored. No more than 30 progressions, properly interfaced, should be needed to reproduce the structure of any tonal piece.

Name
Bell Laboratories

Address of Institution
Joseph P. Olive
Bell laboratories
Murray Hill, New Jersey 07974

Type of Institution
Industrial laboratory

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Max V. Mathews	Engineering	Director	Artistic, technical	Part-time
Joseph Olive	Physics, Composition	Member of technical staff	Artistic, technical	Part-time
Emanual R. Ghent	Composition	Resident visitor	Artistic, technical	Part-time

Date of Inception of Studio and Computer Work
1957

Areas of Activity
Computer music: all digital, analog digital, hybrid

List of Works
By E.R. Ghent:
1) *Phosphons*
2) *Lustrum*
3) *Innerness*
4) *Dualities*
5) *Computer Brass*
6) *E c.*

By J.P. Olive:
1) *Studies #4, #5, #6*
2) *Mar-ri-ia-a for computer*
3) *Voice, soprano & chamber ensemble*
4) *Study #7 for tape and cello*

Other compositions realized at Murray Hill:
1) *In the Silver Scale* (Guttman 1957), 0'15" long
2) *Pitch Variations* (Guttman 1958), 1'00"
3) *Study I* (M. Mathews 1959), 0'20"
4) *Stochatta* (Pierce 1959), 0'36"
5) *Beat Canon* (Pierce 1959), 0'48"
6) *May Carol I* (Mathews 1960), 0'38"
7) *Three Against Four/May Carol II* (Mathews 1960), 1'04"
8) *Numerology/Study II* (Mathews 1960), 2'30"
9) *Long Periods* (Guttman & Mathews 1960), 3'40"
10) *Variations in timbre and attack* (Pierce 1961), 1'18"

11) *Study No. 1* (Lewin 1961), 1'36"
12) *The Second Law/Study III* (Mathews 1961), 3'22"
13) *Joy to the World* -- after Handel (Mathews 1961), 1'09"
14) *Study No. 2* (Lewin 1961), 3'10"
15) *Frère Jacques* -- traditional round (Mathews 1961), 0'37"
16) *Five Against Seven -- random canon* (Pierce 1961), 1'02"
17) *Fantasia* -- after Orlando Gibbons (Franks 1961), 2'46"
18) *Melodie* (Pierce), 1'01"
19) *Molto Amoroso* (Pierce 1961), 0'56"
20) *Theme and Variations* (Speeth 1961), 1'11"
21) *Noise Study* (Tenney 1961), 4'14"
22) *Bicycle Built for Two* -- after Dacre (Mathews 1962), 1'42"
23) *Five Stochastics Studies* (Tenney 1962), 10'
24) *Entrance/Exit Music* -- for George Brecht (Tenney 1962), 10'
25) *Stochastic Quartet* (Tenney 1963), 4'
26) *Sea Sounds* (Pierce 1963), 1'50"
27) *Dialogue* (Tenney 1963), 4'
28) *Radiopiece* (Tenney 1963), 2'
29) *Compusition No. 2* (Strang 1963), 2'
30) *Ergodos I* (Tenney 1963), 10'-18', can also be performed together with *String Complement* or *Responses*
31) *Compusition No. 3* (Strang 1963), 2'30", music for the IBM 7090
32) *Phases* (Tenney 1963), 12'
33) *Masquerades* (Mathews 1963), 2'42"
34) *Pergolesi Development* (Mathews 1964), 2'10"
35) *Cyclic Study* -- and Exercise (Mathews 1964), 2'08"
36) *Ergodos II* (Tenney 1964), maximum 18'
37) *Substitution Study* (Mathews 1964), 3'20"
38) *Slider* (Mathews 1965), 6'20"
39) *Composition* (Risset 1965), 0'28"
40) *Happy Birthday* -- arrangement (Mathews 1965), 1'25"
41) *Eight-Tone Canon* (Pierce 1966), 4'
42) *Canon for New Scale* (Pierce 1966), 6'
43) *International Lullaby* (Fujimura & Mathews 1966), 2'30"
44) *Swansong* (Mathews 1966), 10'
45) Computer Suite from *Little Boy* (Risset 1968), 12'

Publications and Available Manuscripts

M.V. Mathews, "An Acoustic Compiler for Music and Psycholgical Stimuli", *BSTJ*, Vol. XI, No. 3, May 1961, pp. 677-694

M.V. Mathews and N. Guttman, "Generation of Music by a Digital Computer", *Proceedings* of the Third International Congress on Acoustics, Stuttgart, 1959

M.V. Mathews, J.R. Pierce and N. Guttman, "Musical Sounds from Digital Computers", *Gravesaner Blätter*, Vol. VI, 1962. Dutch pp. 109-118, English pp. 119-125

M.V. Mathews, "The Digital Computer as a Musical Instrument", *Science*, Vol. 142, No. 3592, pp. 553-557, Nov. 1, 1963

J.R. Pierce, M.V. Mathews and J.C. Risset, "Further Experiments on the Use of the Computer in Connection with Music", *Gravesaner Blätter*, No. 27/28, Nov. 1965. German, pp. 85-91, English, pp. 92-97

M.V. Mathews, "A Graphical Languages for Composing and Playing Sounds and Music", Preprint No. 477, 31st Audio Engineering Soc. Convention, New York, October 1966

M.V. Mathews and L. Rosler, "Graphical Language for the Scores of Computer-Generated Sounds", *Perspectives of New Music*, Vol. 6, No. 2, Spring-Summer 1968, pp. 92-118. Also in *Music By Computers*, H. Von Foerster and J.W. Beauchamp (Eds.), pp. 84-114, Wiley (1969)

J.J. Chang and M.V. Mathews, "Score Drawing Program", Preprint No. 506, 32nd Audio Engineering

Soc. Convention, Los Angeles, April 1967

J.C. Risset and M.V. Mathews, "Analysis of Musical Instrument Tones", *Physics Today*, Vol. 22, No. 2, February 1969, pp. 23-30

M.V. Mathews, *The Technology of Computer Music*, Cambridge: The MIT Press (1969)

M.V. Mathews and F.R. Moore, "GROOVE—A Program to Compose, Store and Edit Functions of Time", in *Communication of the ACM*, Vol. 13, No. 12, December 1970, pp. 715-721

M.V. Mathews, "Computer Composers -- Comments and Case Histories", in *Techne, Vol. 1, No. 2, Noovember 6, 1970, pp. 10-11*

M.V. Mathews, "The Electronic Sound Studio of the 1970's", for meeting of "Music and Technology: the composer in the technological era", Stockholm, Sweden, June 8-12, 1970, sponsored by UNESCO. *Music and Tech.*, Proceedings of Stockholm Meeting, pp. 129-141 (Paris: La Revue Musicale, UNESCO 1971)

J. Kohut and M.V. Mathews, "Study of Motion of a Bowed Violin String", in *JASA*, Vol. 49, No. 2 (part 2), pp. 532-537, Feb. 1971

M.V. Mathews, "The Computer as a Musical Instrument", in *Computer Decisions*, February 1972, pp. 22-25

J.C. Risset and M.V. Mathews, "Computer-Synthesized Sounds and Tone Quality Studies", in *Proceedings of the 7th International Congress on Acoustics, Budapest 1971*, Vol. 1, Sec. E, AKADEMIAI KIADO, Budapest 1971, pp. 261-264

M.V. Mathews and J. Kohut, "Electronic Simulation of Violin Resonances", in *JASA*, Vol. 53, No. 6. pp. 1620-1626, 1973

M.V. Mathews, F.R. Moore and J.C. Risset, "Computers and Future Music", *Science*, Vol. 183, January 25, 1974, pp. 263-268

Also: two Decca records
"Music from Mathematics" DL79103
"Voice of the Computer" DL710810

Public Presentation of Works
Concerts, broadcasts, disks, lectures

HARDWARE

Computers and Digital Hardware
DDP 224: 32K words (24-bit)

Peripheral Devices

Data Storage
Disk, mag tape

Input Devices
Card reader; terminal; ADC; tablet; knobs and keyboard

Output Devices
Line printer; hard copy plotter; X-Y display; Memoscope

Sound Generation

Digital
DAC

Hybrid Systems
Computer-driven analog hardware

Mixed Digital Systems
Computer-driven digital hardware

Other Peripheral Devices

Analog
Analog sound synthesizer; tape recorder; computer communication with continuous knobs and a tablet

Digital
Speech synthesizer; filter network

Proposed Hardware Developments
All digital real-time music synthesizer

Access to Computer
Night use; no cost

Availability of Technical Assistance
None

Operating Systems
All of: time sharing; batch; on-line (real-time)

SOFTWARE

Functioning Systems

Name/Author: MUSIC V -- Mathews 1958
Language/Requirements: Fortran and assembler code, uses 32K, requires DAC, tape drive
Purpose and Features: Generation of music; entirely digital
Availability/Documentation: Book (Mathews 1969)

Name/Author: GROOVE -- Mathews, Moore 1969
Language/Requirements: Fortran, assembler; 32K, analog synthesizer, knobs, tablets, keyboard
Purpose and Features: Generation of music; real-time hybrid
Availability/Documentation: Article in ACPL

Name/Author: SYNLOG -- Olive, Nakatang 1971
Language/Requirements: Fortran, assembler; 32K
Purpose and Features: Generation of speech and song
Availability/Documentation: Not public

Name

Willard Van De Bogart

Private Address

Admiral Hotel Room #62
608 O'Farrell Street
San Francisco, California 94109

Address of Institution

Department of World Studies
San Francisco Art Institute
800 Chestnut Street
San Francsisco, California 94133

Type of Institution

Private sound studio in San Rafael, Calif.

Principal Sources of Funding

Concerts and teaching

Areas of Activity

Presently storing pre-composed patterns and amplifying them at specific times in the composition

Type of Instruction Offered

How to alter the speed of played back sound patterns with real-time patches

List of Works

All compositions are partly computer-generated:
1) *Composition for Space* (1973)
2) *4 Variations for Organ, Tape and Synthesizer* (1973)
3) *City Scape*, (1973), for organ, synthesizer, tape, flute, violin, harmonica
4) *Scoring for Peace* (1975)
5) *Celestial Fugue* (1975)

Publications and Available Manuscripts

"A 4th Dimension Theory of Electronic Music Composition" (definitive manuscript)

"Harmonic Neurons", *World Union*, Pondicherry, India, Vol. XVI #4, April 1976

Public Presentation of Works

The majority of presentations have been in the form of public concerts. The latest of these concerts occurred on November 3, 1976 for the Esalen Institute in San Francisco. The title was "Concert for the New Age". The storage unit was used in a partial way with the real-time performance.

The rest of the presentations are done by tape over local radio stations.

Policy for Exchange/Rental of Tapes and Related Materials

All exchanges and rentals can take place after a personal exchange of ideas has been established with the inquiring composer

HARDWARE

Computers and Digital Hardware

Digital Sequencer: 256 stored events (5-bit binary form)

Proposed Hardware Developments

Presently under construction is a new touch-sensitive keyboard which is connected to an electric tone generator. A connected memory unit is then interfaced to enable any pre-composed score to be re-integreated into the live performance. Voice modulation designed to trigger certain cord changes with pitch change of voice varying pitches then are co-ordinated to pre-determine chord changes and played back on a real-time basis. Portable terminals to me are the most practical way to perform on a real-time basis. I personally do very many live concerts and by having pre-determined programs in selected programs I can dial in my programs by telephone and have them presented at the concert site.

Additional Comments

My system at the moment is not as sophisticated as the larger computer music systems. I have been composing with the synthesizer for over five years and am now very interested in the interactive capabilities on a real-time basis with the computer in a live concert situation. My limited Digital Sequencer has afforded me the opportunity to develop some ideas I would like to explore further. The portable real-time computer music synthesis is my next addition. I would very much like to gain more knowledge in this area.

Name
Reginald D. Boudinot, Ph.D.

Private Address
8424 Richmond Hwy #89
Alexandria, Virginia 22309

Address of Institution
12816 Pinecrest Road
Herndon, Virginia 22070

Principal Sources of Funding
Personal

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Reginald D. Boudinot	Music composition	Designer, composer	Time-series synthesis	Part-time
Dorothy E. Boudinot	Computer Programming	Programmer	Technical	Part-time

Date of Inception of Studio and Computer Work
March 1976

Areas of Activity
Time-series synthesis

Type of Instruction Offered
None

List of Works
All works realized wholly by computer:
1) *Randu*, single channel analog tape
2) *Symphony in Octal*, stereo analog tape
3) *Biorhythms*, mono analog tape
4) *Concerto* for Altair, dual channel tape
5) *Sonic Collage 1976* (1976), dual analog tape

Publications and Available Manuscripts

R.D. Boudinot, "On Source", *Byte Magazine*, May 1976

Public Presentation of Works
Tapes of works have been submitted to numerous computer music workshops and concerts

Policy for Exchange/Rental of Tapes and Related Materials
Tapes of all works available for nominal duplication fee

Policy for Composers' Rights and Contracts
All right retained; licenses negotiable subject to current standard practices

HARDWARE

Computers and Digital Hardware
MITS Altair 8800: 25K (8-bit)
Processor Technology SOL: 14K (8-bit)

Processor Technology SOL: 6K (8-bit)

Peripheral Devices

Data Storage
PerTec floppy disk system
MITS 88-ACR cassette interface
2 1200-baud cassette interfaces

Input Devices
3 CRTs; ADC (8-bit), 2uS settle time

Output Devices
UNIVAC DCT 500 printer/terminal

Sound Generation

Digital
2 mono DACs (8-bit); 1 stereo DAC (each channel 8-bit)

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
2-channel tape recorder (reel-to-reel, 7")
2 cassette tape recorders (1-channel and 2-channel)

Access to Computer
Computer time available week-days by remote interactive or in-studio use. Charges are $10/hour and dedicated computer is provided

Availability of Technical Assistance
Technical assistance available on Time and Materials (T&M) basis. Documentation available for systems programs, high-level languages and applications programs. Check for current pricing.

Operating Systems
The operating system is MONITOR2 (International Data Systems, Inc., P.O. Box 593001AMF, Miami, Florida 33159). It is interactive and supports local and remote access via local or dial-up ASCII terminals at speed of 110 to 9600 baud.

Turnaround/Response Time Characteristics
Turnaround time is immediate (interactive system); both real-time and multipass applications are being used

SOFTWARE

Functioning Systems

Name/Author: MUS8 – Boudinot 8/76
Language/Requirements: Basic, assembler; 16K, uses cassette
Purpose and Features: Music synthesis; features instrument definitions and several expanded subroutines
Availability/Documentation: Yes

Name/Author: ANMUSIC -- Boudinot 7/76
Language/Requirements: Assembler code, 12K
Purpose and Features: Music synthesis; features instrument definitions and basic interface language (generates 5-bit digital code only)
Availability/Documentation: Yes

Additional Comments

The computer system is privately owned. It consists of three separate computers interfaced to each other. Current areas of endeavour include development of methods for distribution of processing so that more complex functions may be "played" in real-time. One computer is oriented to be the software development facility. The two SOL computers have PROM programs which include down-line loading functions allowing programs to be loaded from the Altair and executed in the other machines. Basic is available on all three machines but the Altair has the mass storage disk.

Name

Brigham Young University

Address of Institution

BYU Computer Music Project
Computer Science Department
Brigham Young University
222 TMCB
Provo, Utah 84602

Type of Institution

University

Principal Sources of Funding

University and principal users' donations

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Alan C. Ashton	Computer science, some music	Co-director	Pedagogical, technical	Part-time
Robert F. Bennion	Elec. engineering, computer science	Co-director, technical administrator	Technical	Half-time

Principal Users

Students throughout the day

Date of Inception of Studio and Computer Work

1969

Areas of Activity

Automatic performance of linearly encoded musical scores via electronic organs, pipe organs, and digitally controlled sound generators; creation of computer tools for music education

Type of Instruction Offered

Computer Science special projects
Computer Science 501 course, "Music and Computers"

Background of Computer Users

Varies from none to much depending on project of interest

Public Presentation of Works

Automatically performed electronic organ and pipe organ concerts have been given

HARDWARE

Computers and Digital Hardware

PDP-8: 4K (12-bit)
PDP-11: 28K (16-bit)
NOVA 2/4: 16K (16-bit)

for auxiliary functions:
DEC-10: 256K (36-bit)

Peripheral Devices

Data Storage
Disk; diskettes; DECtape; paper tape

Input Devices
Card readers; terminals; organ manual keyboard; lap practice keyboard; light pen; graphics stylus; auxiliary computers

Output Devices
Line printers; teletypes; plotter; typewriter

Sound Generation

Digital
Digitally encoded stored waveforms read out to a DAC

Hybrid Systems
Electronic organ; off-site pipe organ (in California)

Mixed Digital Systems
Computer driven digital tone generators

Other Peripheral Devices

Analog
Tape recorders; graphics display processor and screen

Digital
Indicator lamps for organ keyboard

Proposed Hardware Developments
Use of large scale integrated circuit techniques to construct computer driven music tool for use in music education.

Simple digitally controlled sound generators capable of various timbres, alterable under computer control.

Micro-computer controlled and monitored organ keyboard for the encoding and entry of musiscal information into a computer.

Access to Computer
Immediate and continual access through the dedicated PDP-8 computer; use of other computers on a priority sign-up basis

Availability of Technical Assistance
Consultation and direction from project leaders and participating students in an informal atmosphere

Operating Systems
Private operating system of own design on PDP-8; timesharing, conversational access to other computers

Turnaround/Response Time Characteristics
Immediate response and turnaround

SOFTWARE

Functioning Systems

Name/Author: Solfege -- Thompson, Bennion, Ashton (1970-76)
Language/Requirements: Data-General Assembly code, <8K, uses CRT & digital tone oscillators
Purpose and Features: Teaches sight singing with the aid of audio & visual response; user controlled; program randomly selects exercises within global parameter settings

Name/Author: Music Interpreter -- Ashton, Bennion, Cannon (1971-76)
Language/Requirements: PDP-8 and Nova Assembly code, <4K, uses CRT graphics system organ
Purpose and Features: Automatic performance of linearly encoded music; allows ascell, deacells, cresc, decresc & orchestration markings. Uses delta-list event-scheduling algorithm

Name/Author: CHORDS -- Tom Thurston
Language/Requirements: Basic-like language, 8K, uses CRT digital tone generators, graphics
Purpose and Features: Teaching of chord recognition; user directed

Name/Author: Entry -- Hal Shearer
Language/Requirements: PDP-8 & PDP-11 Assembly, 8K, uses stylus for input
Purpose and Features: Writing input for musical material; allows user to point to note positions on a staff

Systems Under Development

Name/Author: Music Education Computer Music System -- Thurston, Ashton, Bennion
Language/Requirements: Nova Basic and Assembly code

Name/Author: Lap Keyboard Entry -- Paul Roper
Language/Requirements: Hardware

Proposed Systems

Music-Education Stations

Name

University of California (Irvine)

Address of Institution

Prof. James R. Meehan
Dept. of Information and Computer Science
University of California
Irvine, California 92717

Type of Institution

University

Type of Instruction Offered

Graduate seminar: Computer Models of Music Theory

Background of Computer Users

Students in the course and working on the project:
- programming experience in LISP
- some experience in music performance

Additional Comments

My research interest in Computer Music is in building a model of composition by using tonal music theory. That is, I am interested in understanding and representing what a musician *knows* who has been trained in traditional music theory, and producing programs which will compose by using that knowledge. The work is consciously analogous to current research, here and elsewhere, in Natural Language Processing, where the emphasis has changed from grammar and syntax to meaning and real-world knowledge. Just as most NLP systems are not yet concerned with recognition and production of speech, using text for input and output, I am not yet concerned with signal processing and hardware. To put it another way, I am less concerned with a musician's eyes and ears than with his mind. Where are the *conceptual* structures that guide his listening and composing?

Name

University of California at Los Angeles

Address of Institution

Dr. Frederick Lesemann, Director
Electronic Music Studio
School of Performing Arts
University of Southern California
University Park
Los Angeles, Califfornia 90007

Although we have an extensive analog studio we do not at present have any computer music. Ask us again in fall 1978.

Name
Dr. Justus Matthews

Private Address
245 Harvard Lane
Seal Beach, California 90740

Address of Institution
Department of Music
California State University
Long Beach, California 90840

Type of Institution
University

Principal Sources of Funding
University

Date of Inception of Studio and Computer Work
January 1971

Areas of Activity
Programming, digital synthesis of music

Type of Instruction Offered
None in this area; we offer a course in analog electronic music, which covers briefly some areas of computer music composition

List of Works
The following were all realized entirely by computer:
1) *Hdoryut* (1971), for sixteen solo instruments
2) *MUS15/1-35/S.EED* (1973), for mag tape, 35 pieces
3) *Crystals* (1974), for mag tape and slides
4) *Bionic Music* (1976), for mag tape

Publications and Available Manuscripts

List available on request

Public Presentation of Works
Numerous concert performances

HARDWARE

Computers and Digital Hardware
I have used the CDC-6400, PDP 15/40 and Interdata (Buchla) systems. Memory sizes vary with each system.

Peripheral Devices

Data Storage
Mag tapes, cassettes

Input Devices
TTYs, ADCs, batch card readers

Output Devices
Line printers

Sound Generation

Digital
DACs

Hybrid Systems
I have mainly depended on these: the system at EMS in Stockholm, Sweden and the Buchla system in Oslo, Norway

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Tape recorders, filters

Digital
Paper tape readers

Proposed Hardware Developments
None due to cuts in state expenditure

Name
Carnegie Mellon University

Address of Institution
Paul E. Dworak
Carnegie-Mellon University
Schenley Park
Pittsburgh, Pennsylvania 15213

Type of Institution
University

Principal Sources of Funding
Internal and Carnegie Corporation

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Paul Dworak	Music	Director, design and administration	Composition and theoretical research	Half-time
Alice C. Parker	Elec. engineering	Design consultant	Computer architecture, interfaces	5%

Principal Users
System is still under construction

Date of Inception of Studio and Computer Work
Design: September 1973
Construction: September 1976

Areas of Activity
Design of an interface for polyphonic sound generation which allows construction of timbres in real time. Design of microprocessor control devices, digital hardware oscillators, and D/A conversion facility.

Applications will include composition and timbre recognition research.

Type of Instruction Offered
Introductory studio course for composition majors. Advanced research projects for music and electrical engineering students

Publications and Available Manuscripts

Paul E. Dworak and Alice C. Parker, "An Input Interface for a Real-time Digital Sound Generation System", Third Annual Computer Architecture Symposium

Paul E. Dworak and Alice C. Parker, "An Input Interface for the Real-time Control of Musical Parameters", First International Conference on Computer Music, MIT, Boston

Paul E. Dworak, Alice C. Parker and Richard Blum, "The Design and Implementation of a Real-Time Sound Generation System", Fourth Annual Computer Architecture Symposium

Public Presentation of Works
None at present

HARDWARE

Computers and Digital Hardware
PDP 11/40: 16K (16-bit)
Intel WF-3000: 40K words (16-bit)

Peripheral Devices

Data Storage
Disk

Input Devices
Optically controlled keyboard interface

Output Devices
None

Sound Generation

Digital
DAC (16-bit); also, related filters, reveberation system, etc.

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
4-channel tape deck (not yet available)

Digital
Digital filters planned for future acquisition

Proposed Hardware Developments
Digital filters; also, redefinition of the interface parameters to allow FM

Access to Computer
Only users are music composition students and electrical engineering research students. Plans will be made for other users at a later date

Availability of Technical Assistance
Programming, operating and technical assistance readily available. Principally undergraduate and graduate Electrical engineering students

Operating Systems
Score input, editing, and score recall programs only

Turnaround/Response Time Characteristics
Real-time

Additional Comments

The system employs optical techniques for data generation and transmission. An optically controlled keyboard generates data on the phase, amplitude and envelopes of harmonic or non-harmonic partials of waveforms. This implies (correctly) that additive synthesis is employed in this system. The keyboard interface is polyphonic and provides sufficiently concise information to permit real-time sound generation.

Name
Case Western Reserve University

Address of Institution
Robin B. Lake
Biometry
University Hospitals
Cleveland, Ohio 44106

Type of Institution
University medical school

Principal Sources of Funding
Largely unfunded. Some use of private research equipment. Institutional post-doctoral fellowship for one individual

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Robin B. Lake	Biomedical Engineering	Concierge, consultant, organizer	Technical aspects of signal synthesis and analysis	Casual, consultative
Ralph Cherubini	Music	Composer, programmer, teacher	Artistic, technical	Full-time
Craig Bourne	Electronic music	Composer, programmer	Artistic, technical; aspects of cycle generation	One-quarter time

Date of Inception of Studio and Computer Work
1970

Areas of Activity
Sound synthesis; signal analyses; aleatoric composition; composition in transform domains

Type of Instruction Offered
One course in computer music. Master's program in Computer Applications in the Health Sciences

Background of Computer Users
Musically knowledgeable, or programmers, or composers

List of Works
1) *Small Changes* (Cherubini), wholly computer-generated
2) Work in progress (Bourne), partly computer-generated

Publications and Available Manuscripts

Orthogonal Waveforms and Sound Synthesis

Public Presentation of Works
Concerts

Policy for Exchange/Rental of Tapes and Related Materials
No policy exists

HARDWARE

Computers and Digital Hardware
1. PDP 11/45: 124K (16-bit)
2. PDP 11/45: 48K (16-bit)
3. PDP 11/20: 24K (16-bit)

Peripheral Devices

Data Storage
1. 50 Mbyte disk; mag tape drive
2. 50 Mbyte disk; 2 2.5 Mbyte disks
3. None

Input Devices
1. Card reader; digitizing tablet; 8 terminals; graphic display
2. Card reader; CRT; ADC; graphic display
3. Teletype

Output Devices
1. Line printer; Calcomp plotter; graphics display with hard copy
2. Line printer; Calcomp plotter; graphics display with hard copy
3. None

Sound Generation

Digital
2. DAC

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Bandpass filter
Tape recorders (14-track FM and Dolby cassette)

Digital
Vocal synthesizer

Proposed Hardware Developments
Microprocessor-based systems

Access to Computer
1. $5/hour connect time; $25/hour CPU time
2. $22.50/hour
3. No charge

Availability of Technical Assistance
Extensive Laboratory staff to consult on technical questions

Operating Systems

1. UNIX time-sharing system
2. DOS/BATCH and standalone
3. Paper tape

Turnaround/Response Time Characteristics

1. Interactive, very fast response
2. Interactive, good response
3. Slow

SOFTWARE

Functioning Systems

We maintain a *complete* library of signal (sound) synthesis, analysis, and display programs. Usual language is Fortran-IV or PDP-11 MACRO assembler

Name/Author: Lake
Language/Requirements: MACRO, 4K, uses AA-11
Purpose and Features: Sound synthesis driver for DAC; high-seed, scope display
Availability/Documentation: On request

Name/Author: Cherubini
Language/Requirements: Fortran, 28K, uses Tek 4015 and card reader
Purpose and Features: Sound synthesis in spectral domain; features interactive graphics, randomizing on request
Availability/Documentation: On request

Systems Under Development

Name/Author: Bourne
Language/Requirements: C (UNIX)
Purpose and Features: Cyclic generation
Availability/Documentation: On request

Additional Comments

UNIX has superb software tools for information (sound) synthesis and transformation

Name

Center for Music Experiment

Address of Institution

Pauline Oliveros, Director
Center for Music Experiment Q-037
University of California at San Diego
La Jolla, California 92093

Type of Institution

University

Principal Sources of Funding

Rockefeller Foundation, Ford Foundation, university funding

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Pauline Oliveros	Music composition	Director	Electronic music, mixed media	50%
Robert Gross (Fellow)	Engineering, music	Head, Technical Dept.	Electronic music, instrument design, composition	100%
Bruce Leibig (Fellow)	Programming, music	Head, Software Development	Electronic music, instrument design	62%
Bruce Rittenbach	Electronics, music	Electronics technician	Electronic music, instrument design	62%
John Celona	Composition	Computer facility instruction recordist	Composition	10%
Chris Chafe	Graduate student	Software development		27%
David Jones	Composition	Assistant to director	Composition, electronic music, speech research	16%
George Ritscher	Electronics maintenance		Electronic Music	20%
Roger Marsh	Musical composition		Music theatre, contemporary music	20%

Also: additional staff in related fields (administration, video, lighting, dance, instrumental music, etc.)

Date of Inception of Studio and Computer Work

Center opened September 1972
Computer purchased October 1973

Areas of Activity

Studio for Extended performance
Studio for Technical Research
Colloquium
Documentary/Archive

Type of Instruction Offered

No formal courses. Instruction given to faculty, staff, and visiting researchers in current available computer composition programs, programming, and use of the facility

List of Works

1) *Timbral Orchestral* - John Celona
2) *Micro-Macro* - John Celona
3) *My Blue Sky in Southern California* - Joji Yuasa
4) *Piece Coeliaque Madreparienne* - Jean-Charles François
5) *Inner Voices* - John Celona
6) *Two Hundred Billion* - John Celona
7) *La Jolla Good Friday: I* - Thorkell Sigurbjörnsson
8) *La Jolla Good Friday: II* - Thorkell Sigurbjörnsson
9) *HYB. III* - Robert Shallenberg
10) *Galaxy* - Russell Lieblich

Publications and Available Manuscripts

Robert Gross, *A Compositionally Oriented Sound System*

Edwin L. Harkins, *A Programmable Rhythm Sequencer*

Robert Gross and Linda Vickerman, *Preliminary Remarks on Extended Vocal Capabilities with the Artificial Larynx*

Bruce Rittenbach, *Aspects of Computer Music System Design*

Roger Reynolds, *Exploration in Sound Space Manipulation*

Edward Kobrin and Jefferey Mack, *The Hybrid II: A Real-Time Composing/Performing Computer Synthesis System*

Hybrid IV: User's Manual, Revision: Edward Kobrin; Revision 1; Roger Reynolds, John Celona; Revision 2: Bruce Rittenbach

Robert Erickson, *LOOPS, An Informal Timbre Experiment*

Bruce Leibig, *A User's Guide to Music V*

Robert Gross, Bruce Leibig, Jeff Goldstein, *Timbre Tuning System* (Revision: Robert Gross, Ralph Hawkins)

CME Reports - Year-end report printed annually for foundations and universities. Available to those interested in the Center's activities as well

Pauline Oliveros, "On Sonic Meditation", *Painted Bride Quarterly*, Winter 1976 issue

Public Presentation of Works

Fellow Presentations: Quarterly presentations of current research efforts of Fellows, faculty and visitors

Colloquium Presentations: Held every Friday at 2pm for informal presentations of graduate student and faculty research, as well as outside visitors doing work of interest to CME

Broadcasts: Of composition by CME visitors, Fellows, and faculty. Video broadcasts have been viewed also, including computer generated soundtracks

Conferences: Two or three held yearly. Previous conferences have included: Music Criticism, Psychoacoustics, Computer Programming in Music, Psychoacoustics and Perception.
The Second Annual Computer Music Conference is scheduled for October 1977

Aspects of Craft: A continuing series of seminars given by professionals in music and the arts

Policy for Exchange/Rental of Tapes and Related Materials

The Center maintains an archive for storage of materials generated by visitors and composers involved with CME. Additionally materials from other sources are continually being solicited. Dubs of tape holdings are available for a small fee, as well as copies of printed materials. Future plans for the Archive include storage of other materials such as video and film. We intend to actively collect ethnic materials on a worldwide basis.

Policy for Composers' Rights and Contracts

All tapes submitted to the file are accompanied by a Composer's Release Form that protects the composer against commercial use of their pieces, but allows CME to use materials for educational purposes.

HARDWARE

Computers and Digital Hardware

PDP 11/20: 28K (16-bit)

Peripheral Devices

Data Storage

2 RK05 disk drives

Input Devices

High-speed punch reader; VT55 graphics terminal; LA30 Decwriter

Sound Generation

Digital

2 Datel DACs (16-bit)
4 DACs (10-bit)
10 DACs (8-bit)

Hybrid Systems

6 VCOs; 8 VCAs; 4 VCFs; 4 envelope generators (all connected to the 16 DACs)

Mixed Digital Systems

None

Other Peripheral Devices

Analog

2 Ampex 440 tape recorders; Sony 850 (4-channel); DBX 154 (4-channel); Nakamichi 500 (cassette)

Digital

Interface to drive HYBRID system

Proposed Hardware Developments

A high-speed digital signal processing unit is being constructed to perform Additive Synthesis, Chowning FM and Digital Filtering in real-time.

The unit is microprogrammable under control of the PDP 11/20 to allow for maximum flexibility. Eventually 4 or 8 units will be built and interconnected through high-speed microprocessors. This system was designed to provide a real-time complex sound output controlled by the relatively slow PDP-11.

Access to Computer

Computer is available 24 hours. About two-thirds of the time it is used by researchers/technicians. The rest of the time is used by composers. The computer is presently used about 12-16 hours per day.

Availability of Technical Assistance

Programming assistance limited to one half-time systems programmer with some volunteers supplying another 10-15 hours a week; technical assistance available on a limited basis

Operating Systems

RT-11 operating system
Mini UNIX operating system (scheduled to be operational May 1977)

Turnaround/Response Time Characteristics

Digital synthesis system - computer takes up to 4-1/2 minutes to generate one second of sound

Hybrid real-time system

SOFTWARE

Functioning Systems

Name/Author: Timbre Tuning -- Leibig 1975
Language/Requirements: Macro 11 code, 12K
Purpose and Features: Digital sound synthesis using Chowning FM
Availability/Documentation: Not available in present version

Name/Author: Hybrid -- E. Kobrin, J. Mack
Language/Requirements: Macro 11, 8K, requires paper tape
Purpose and Features: Real-time control of analog synthesizer; has macro capability
Availability/Documentation: Requires extensive hardware, program available

Name/Author: Nobas – B. Leibig 1975
Language/Requirements: Fortran, 12K
Purpose and Features: Generation of bank limited noise; additive synthesis
Availability/Documentation: Program available

Systems Under Development

Name/Author: Rhythm -- D. Gregory
Language/Requirements: Algol, mag tape
Purpose and Features: Generates a file containing durations from a rhythm language for producing complex rhythms; durations must then be entered into Timbre Tuning; can generate rhythms beyond the capabilities of standard notation

Proposed Systems

Purpose and Features: Compositionally oriented language including Rhythm for use with real-time digital synthesiser under development

Additional Comments

Our aim is to develop compositionally oriented, accessible computer music systems. We do not believe it is possible for any one system to serve the needs of any significant group of composers or that engineers can develop a usable system without considering a compositional system first. Ideally we would like a number of systems to serve the needs of a limited number of composers. At present the task seems impossible because of the lack of skilled manpower.

Additionally, we are developing a program to index and cross-reference archive materials. Eventually we would like to connect with databases from other archives.

Name

College of Charleston, South Carolina

Private Address

David W. Maves
31 Society Street
Charleston, SC 29401

Address of Institution

Fine Arts Dept.
College of Charleston
Charleston, SC

Type of Institution

College

Principal Sources of Funding

College of Charleston

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
David Maves	Music	Director	Teaching, artistic	Part-time

No-one else yet (studio will not be operational for two years or so)

HARDWARE

Computers and Digital Hardware

IBM 370 available (5 Mbytes)

Proposed Hardware Developments

As much as money becomes available for -- will be a long slow process

Name

Dexter G. Morrill

Address of Institution

Colgate University
Hamilton, New York 13346

Type of Institution

University

Principal Sources of Funding

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Dexter Morrill	Composition	Director	Composition, brass tone synthesis	Half-time

Other members of the computer centre are not directly attached to the studio

Principal Users

1) Morrill (Director)
2) Students (12 per year)
3) Guest composers

Date of Inception of Studio and Computer Work

1973

Areas of Activity

1) Musical composition - production studio
2) Music research - tone synthesis and audio localization experiments
3) Undergraduate student course work

Type of Instruction Offered

1) Music-University Studies 320 (Computer Generated Music)
2) Independent Studies
3) Introduction to Electronic Music (analog equipment only)

List of Works

1) *Chowning* (Morrill 1973), tape
2) *A Flourish of Trumpets and Drums* (Morrill 1974), tape
3) *Studies for Trumpet and Computer* (Morrill 1974), tape
4) *If Carrillons Crew Wings* (Bruce Pennycock 1975), tape
5) *Silver Screens* (Roger Meyers 1975), tape
6) *Timbre Wheels* (Morrill 1976), tape
7) *Time Into Pieces for Piano and Computer* (Wesley Fuller 1976), piano and tape

Publications and Available Manuscripts

Dexter Morrill, "An Undergraduate Course for an Interactive Computer System", *Fifth Conference on Computers in the Undergraduate Curricula*, June 1974

Dexter Morrill, *Colgate Computer Music Studio Manual*

Dexter Morrill, "Towards a Computer Trumpet Design", manuscript accepted for publication in the *Audio Engineering Society Journal*

Dexter Morrill, "Trumpet Algorithms for Computer Composition", accepted for publication in

Composition by Computers, H. Lincoln, ed., and the *Computer Music Journal*, and *Creative Computing Magazine*

Public Presentation of Works
Annual concert of new music at Colgate University

ROTATIONS program of Computer Generated Music. Presentations for galleries and unusual spaces offered throughout the United States by Dexter Morrill since May 1976. This program includes music by Morrill, John Chowning, Bruce Pennycook and Tracy Petersen

Policy for Exchange/Rental of Tapes and Related Materials
Most of our tapes are available through the Colgate Studio

Dexter Morrill's *Studies for Trumpet & Computer* is recorded on Golden Crest Records

HARDWARE

Computers and Digital Hardware
PDP-10: 96K, 36-bit words

Peripheral Devices

Data Storage
Two RPO-2 Memorex disk drives; mag tape drive

Input Devices
25 CRT terminals

Output Devices
Line printer

Sound Generation

Digital
DAC (12-bit, 4-channel), designed and built by Joseph Zingheim (maximum sampling rate of 62500 samples/second)

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Moog synthesizer
2 Revox A77 tape recorders
2 Ampex AG350 tape recorders
1 TEAC Tascam 3 mixer
1 Fairchild Reverberation Unit
2 MC2550 Stereo Amps - McIntosh
4 KLH 5 Speakers

Access to Computer
Free access for students, faculty and guests; studio is generally restricted to one active user at a time

Availability of Technical Assistance
Computer centre staff of four are available for programming assistance; student programmers are hired for various tasks

Operating Systems
Timesharing and a single user monitor for the music system

Turnaround/Response Time Characteristics
Our interaction is quite fast at most times for sections under a minute in length. We operate in batch mode for large music jobs when a work nears completion.

Name

Columbia University

Address of Institution

Charles Dodge
Music Department
Columbia University
New York, NY 10027

Type of Institution

University

Principal Sources of Funding

Columbia Music Department; the Columbia Electronic Music Center

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Charles Dodge	Music	Project Co-ordinator	Music composition	Full-time
Richard Garland	Physics	Programming, hardware	Technical	One-eighth time
Virgil de Carvalho	Engineering	Hardware	Technical	Small

Principal Users

1) Charles Dodge (1970-)
2) Maurice Wright (1973-)
3) Jeffrey Hall (1973-)
4) Darius Clynes (1973-)
5) John Peter Lund (1975-)
6) Paul Betjeman (1972-74), affiliated as a consultant
7) H.S. Howe (occasional use of DACs)

Areas of Activity

Computer music

Type of Instruction Offered

A two-semester graduate course in computer sound synthesis and related issues

Background of Computer Users

Background of most is training in music composition at the graduate level. The expectation is to use the computer as a sound synthesis medium to realize tapes of their compositions.

List of Works

1) *Earth's Magnetic Field* (Dodge)
2) *Extensions for Trumpet and Tape* (Dodge)
3) *The Story of Our Lives* (Dodge)
4) *In Celebration* (Dodge)
5) *Palinode for Computer and Orchestra* (Dodge)
6) *Cantata* (Wright), partly computer-realized
7) *Hocket* (Hall)

8) *Clausula* (Hall)
9) *I Am Not A Computer* (Clynes), partly computer-realized

Publications and Available Manuscripts

Charles Dodge, "Synthesizing Speech", *The Music Journal*, Vol. XXXIV, No. 2, February 1976

Charles Dodge, "The Structure of *In Celebration* and Considerations in Its Computer Performance" (manuscript)

Public Presentation of Works

Public concerts are given from time to time, usually in association with the Columbia-Princeton Electronic Music Center. Six of Charles Dodge's works are available on recording (on the Nonesuch and CRI labels). Interviews for radio and TV take place with increasing frequency, as do lectures and concerts outside New York

HARDWARE

Computers and Digital Hardware

IBM 360/91: 1.6M, 8-bit bytes
IBM 360/44: 128K

Peripheral Devices

Data Storage

Disk and tape storage used on both systems

Input Devices

Model 91: card reader and terminals
Model 44: card reader and teletype

Output Devices

Model 91: Line printer and plotter
Model 44: Line printer

Sound Generation

Digital

IBM 1827 D/A conversion system on the model 44 (4-channel)

Hybrid Systems

None

Mixed Digital Systems

None 4-channel tape recorder; low pass filters, etc.

Proposed Hardware Developments

We would like to own our own computer facility which would include D/A and A/D conversion in an interactive environment

Access to Computer

Access to the model 91 is limited only by its very great use by students, faculty and administration. The model 44 is located 20 miles from campus; tape may be sent there to be converted or brought personally for same-day service. For longer periods of running (such as for working on speech synthesis) music jobs are restricted to nights and weekends

Availability of Technical Assistance

The usual University computer centre personnel

Operating Systems

Model 91: batch runs, submitted via terminals
Model 44: runs in batch mode, but used interactively from the operator's console at night and on weekends

Turnaround/Response Time Characteristics

Model 91: turnaround is overnight or same day
Model 44: 2 or 3 day service if tapes are sent for conversion. Use for synthetic speech (interactively) requires about 40 seconds waiting for each second of speech

SOFTWARE

Functioning Systems

Name/Author: MUSIC360 -- Barry Vercoe 1970
Language/Requirements: Fortran, Assembler code, 130K
Purpose and Features: General-purpose sound synthesis language; high speed computation on IBM 360
Availability/Documentation: Available from author

Name/Author: Speech Synthesis by Analysis system -- Winham, Steiglitz, Gorland, Eskin & Dodge 1974
Language/Requirements: Fortran, Assembler, 100K; tape and card input; tape and printer output
Purpose and Features: Analyses recorded speech and allows the user to alter the attributes of the speed before synthesis; provides a command language for doing speech synthesis by analysis or "cross-synthesis"
Availability/Documentation: Available from author

Additional Comments

We feel very strongly that the slow turnaround between programming a musical passage and hearing it is inhibiting our musical development. We need a computer music system which will enable several computer music users to work on their compositions simultaneously, each being able to interact with the sonic output of the computer while he works.

Name

Bregman Electronic Music Studio

Address of Institution

Dartmouth College
P.O. Box 746
Hanover, New Hampshire 03755

Type of Institution

University

Principal Sources of Funding

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jon Appleton	Music	Director	Artistic, pedagogical	Full-time
Malcolm Goldstein	Music	Instructor, concerts	Artistic, pedagogical	Part-time
Sydney Alonso	Elec. engineering	Hardware	Technical, design	Part-time
Cameron Jones	Elec. engineering	Programmer	Technical	Part-time
J. Des Coombes	Engineering	Technical supervisor	Technical	Part-time

Principal Users

1) Jon Appleton (1968-76)
2) Lauren Levey (1974-77)
3) Malcolm Goldstein (1976-)
4) Christian Wolff
5) William Brunson
6) Russell Pinkston

Date of Inception of Studio and Computer Work

1967

Areas of Activity

Composition; instruction; research dealing with the creation of new synthesis equipment using computers

Type of Instruction Offered

Regular instruction for students enrolled in Dartmouth College. Occasional special summer institutes for composers.

Background of Computer Users

Musical background is all that is required.

List of Works

1) *Zoetrope* (Appleton)

2) *Georgeanna's Farewell* (Appleton)
3) *The Sydsing Camklang* (Appleton)
4) *Bilder* (Bodin)
5) *Emergence* (Pinkston)
6) *Tapestry* (Brunson)
7) *Witch* (Haines)

Publications and Available Manuscripts

Sydney Alonso, Jon Appleton & Cameron Jones, "A Special Purpose Digital System for Musical Instruction, Composition and Performance", in: *Computers and the Humanities*, No. 10 (1976), pp. 209-215

Jon Appleton, "Problems of Designing a Composer's Language for Digital Synthesis"

Paul Tobias, "*Klang* Language for Digital Synthesis"

Peter Nye, "*Sing* Language for Digital Synthesis"

Cameron Jones, "*Teach* Language for Instruction in Music (CAI)"

Public Presentation of Works

Concerts, tapes for broadcast, exchanges with other studios, and the following phonograph recordings:

Electronic Music from the First International Competition (Turnabout Records)
Electronic Music from the Second and Third Dartmouth Competitions (Turnabout Records)
The World Music Theater of Jon Appleton (Folkways Records)
The Dartmouth Digital Synthesizer (Folkways Records)

Policy for Exchange/Rental of Tapes and Related Materials

Tapes of works produced in the studio are available for concerts and broadcasts with permission of the composer.

Policy for Composers' Rights and Contracts

On an individual basis, studio has no interest in works produced there.

HARDWARE

Computers and Digital Hardware

Data General Nova III: 32K (16-bit)

Peripheral Devices

Data Storage

Diablo 21 moving head disk: 2.5 megabytes
Linc-tape

Input Devices

CRT terminals; digital keyboard

Output Devices

LA33 Hard copy terminal

Sound Generation

Digital

Special purpose digital synthesizer (64-channel) manufactured by New England Digital Corporation, Norwich, Vermont

Hybrid Systems
None

Mixed Digital Systems
See above

Other Peripheral Devices

Analog
Conventional "tape studio" with four 2-track tape recorders, two 4-track tape recorders, mixer, filters, reverberation equipment, Moog III system, auxiliary modifying devices.

Proposed Hardware Developments
Development of portable, performing, dedicated digital system in co-operation with the Thayer School of Engineering and the New England Digital Corporation, Norwich, Vermont.

Access to Computer
Use of the digital system usually up to four hours per day for each composer. Due to the time-sharing nature of the system this means as many as twenty-four composers can be regularly accomodated on the system. No charge for use of system, but composers must purchase their own tapes.

Availability of Technical Assistance
Technical assistance available; programming assistance for invited composers

Operating Systems
Time-sharing operating system for dedicated mini-computer.

Turnaround/Response Time Characteristics
5 seconds

SOFTWARE

Functioning Systems

Name/Author: PLAY -- Jones & Appleton
Language/Requirements: XPL code
Purpose and Features: Teaching composition

Name/Author: SING -- Jones, Appleton, Nye, Tobias
Language/Requirements: XPL
Purpose and Features: Musical composition; easy to use

Name/Author: TEACH -- Jones
Language/Requirements: XPL
Purpose and Features: Teaching music theory; features conventional CAI

Additional Comments

In general the system is a dedicated music system designed for composers without previous experience with digital systems. The available languages are self-explanatory and there is a course on instruction on the system itself to provide beginners with the minimal skills required to use the system.

Name
Shiang-tai Tuan

Private Address
906 Clarendon St.
Durham, N.C. 27705

Address of Institution
Computation Center
Duke University
Durham, N.C. 27706

Type of Institution
University

Principal Sources of Funding
University Educational Computational Fund

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Shiang-tai Tuan	Physics, computer science	Only person in project	Artistic, analytical, pedagogical	Part-time

Areas of Activity
Teaching class ("Experimental Music" including composition with the aid of the computer); preparing a textbook

Type of Instruction Offered
Experimental Music: one semester "Electronic Music Lab", one semester "Computer Music"

Publications and Available Manuscripts

1) *Evenings Work* (done in whole with computer)

Public Presentation of Works
In preparation: a text book for MUSIC360

Policy for Exchange/Rental of Tapes and Related Materials
Lecture Demonstrations

HARDWARE

Computers and Digital Hardware
IBM 370-165: 500 Kbytes normally available (1500K by special arrangement)

Peripheral Devices

Data Storage
3330 disks available
Own and can rent 9-track and 7-track tapes

Input Devices
Card readers, CRT terminal, teletypes available

Output Devices
Line printer, plotter, hard copy slow-spaced terminal

Sound Generation

Digital
DAC available (through collaboration)

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Moog synthesizer; tape recorders; some other electronic circuitry

Access to Computer
Available at all times
Cost: approx. $4/minute depending on run

Availability of Technical Assistance
Full support of Computation Center

Operating Systems
IBM 370-165 OS MVT 21.6 with HASP 3.0 with TSO

Turnaround/Response Time Characteristics
Turnaround time: 1 minute to hours depending on run and queue at time

SOFTWARE

Functioning Systems

Name/Author: MUSIC360 – Barry Vercoe
Language/Requirements: Assembler, Fortran code; runs with card reader, line printer, mag tapes, DAC
Purpose and Features: Composition and education; helping blind musicians
Availability/Documentation: Author's manual; text in preparation

Name

Florida Atlantic University

Private Address

Dr. David Basson
Research, Inc.
P.O. Box 164
Deerfield Beach, Florida 33441

Address of Institution

Florida Atlantic University
Boca Raton, Florida

Type of Institution

University

Principal Sources of Funding

University; Research, Inc.

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Dr. David Basson	Engineering	Programmer	Pedagogical, artistic, technical	20%
Dr. Daniel Callahan	Music	Professor of Music	Pedagogical, artistic	5%
Dr. Eugene Crabb	Music	Chairman of Music Dept.	Artistic	1%
Les Brown	Music	Piano teacher, composer	Artistic	As required
Bernard Nivort	Music	Saxaphone player	Artistic	As required

Date of Inception of Studio and Computer Work

September 1976

Areas of Activity

Music theory; performance; computer generated composition

Engineering background is being combined with musical talent to develop musical composition computer programs capable of producing varied and musically interesting pieces at high speed and low cost. The computer acts as an aid to the human composer and generates 15 lines of music for every one line the human devises. Great flexibility is provided to achieve variations in harmonic richness or tonal colour in the generated melodies. Note sequences and timing are produced.

Type of Instruction Offered

Directed independent study; Music Composition; Computer Music

List of Works

1) *God*
2) *Love*

3) *Yesterday, Today and Tomorrow*
4) *Power*
5) *Power*
6) *Wealth*
7) *Desire*
8) *Fame*
9) *Success*
10) *Time*
11) *Space*
All of the above are partly computer generated

Publications and Available Manuscripts

None currently available: to be written in the near future

Public Presentation of Works
Concert: Unitarian Church, Boca Raton, Florida, April 23, 1977

Policy for Exchange/Rental of Tapes and Related Materials
Computer deck available - $200 per copy

Policy for Composers' Rights and Contracts
Not established

Policy for Composers' Rights and Contracts
Univac 1106: 60K partition memory

Peripheral Devices

Data Storage
Not presently in use

Input Devices
Card reader, terminal

Output Devices
Line printer

Sound Generation

Digital
All sound generation is currently by means of conventional instruments based on computer generated scores

Other Peripheral Devices

Analog
Tape recorder; electronic synthesizer

Proposed Hardware Developments
An IBM 370 is currently being accessed through the University Computer Center. It is currently restricted to handling financial data but may become available for music work in the future.

Access to Computer
Computer owned by University

Availability of Technical Assistance
Very limited

Operating Systems

Both batch and time-sharing systems

Turnaround/Response Time Characteristics

Response time good; card input turnaround time - 1 hour

SOFTWARE

Functioning Systems

Name/Author: Basson 1976
Language/Requirements: Fortran code, 60K
Purpose and Features: Composition of songs and piano pieces; expandable to orchestral works, etc. Generates notes and timing
Availability/Documentation: Available; documentation being developed

Systems Under Development

Name/Author: Basson 1976
Language/Requirements: Fortran, 60K
Purpose and Features: Composition of orchestral work; generates orchestration based on instrument data, etc.
Availability/Documentation: 1977

Proposed Systems

Name/Author: Basson 1977
Language/Requirements: Fortran, 60K
Purpose and Features: Composition of ballet scores, operas, musical comedies, and other works of commercial and artistic value
Availability/Documentation: 1977+

Additional Comments

The art of musical composition has much to gain from computerized systems. Many elaborate schemes can be implemented with the aid of the high speed digital computer. Experimentation with complex methods of development is now possible with little expenditure of time and money.

Much work remains to be done before the public, critics, music publishers and producers are convinced of the value of this new method of artistic expression.

However, many professional musicians are coming to know and understand engineering, mathematical and scientific methods based on computer programs.

Let us hope that this recent marriage of modern technology with the ancient art of musical writings will bear worthwhile fruit and hasten the day of greater mutual understanding between men and nations.

Name
Alan Glasser

Address of Institution
Alan Glasser
Bell laboratories (1A117)
6 Corporate Place
Piscataway, New Jersey 08854

Date of Inception of Studio and Computer Work
Computer sound generation work: June 1971 (at Polytechnic Institute of Broklyn, N.Y.)
Joined Bell Labs: May 1973

Areas of Activity
Real-time generation of sound by computer; languages for the direction of computer production of sound

List of Works
Computersonic (1973)

HARDWARE

Computers and Digital Hardware
PDP-11 (all models): varying memory capacities

Operating Systems
UNIX time-sharing system

Turnaround/Response Time Characteristics
Excellent

SOFTWARE

Functioning Systems

Systems Under Development
(Glasser)
Language/Requirements: written in C
Purpose and Features: Musician oriented (i.e., subset of human-oriented) language for specifying computer generated sound; will probably be a family of languages: at one end one that transcribes conventional music, and at the other one which affords the composer all the power of the computer (sequences, dependencies, etc.)

Name
Jeff Goldstein

Private Address
161 Lower Terrace
San Francisco, Calif. 94114

Type of Institution
Private

Principal Sources of Funding
Private

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jeff Goldstein	Music, computer science	Principal investigator	Design, performance, research	Full-time

Date of Inception of Studio and Computer Work
January 1976

Areas of Activity
Development of a real-time, portable digital music system

Policy for Exchange/Rental of Tapes and Related Materials
Open to any avenues for exchange of music and information

HARDWARE

Computers and Digital Hardware
Zilog/80 based system: 16K (8-bit)

Peripheral Devices

Data Storage
Not purchased yet

Input Devices
Multiplexed ADC; video terminal

Output Devices
None

Sound Generation

Digital
None

Hybrid Systems
None

Mixed Digital Systems
Additive synthesis and FM digital processor receiving instructions via the Zilog/80 system

Other Peripheral Devices

Analog
Amplifiers, recorders, speakers

Proposed Hardware Developments
Construction of suitable input devices for performance; a second version of the additive synthesis processor

Turnaround/Response Time Characteristics
This is presently a single-user system with real-time capability. None of the software is transferable to other systems, although schematic information will become available through publications and expanding number of users.

Additional Comments

This research was begun in order to bring about a portable, digital music system optimized for performance situations. Multiple processors handle the functions of monitoring external events, analysing these events, interpreting these analyses in the context of the present, transforming these interpretations into a stream of sound specifications, and synthesizing the sounds themselves

The large quantities of fundamentally different kinds of information that must pass through the music system make it necessary to divide tasks among distinct processes.

Name

University of Illinois

Address of Institution

James Beauchamp
Music Building
University of Illinois
Urbana, Illinois 61801

Type of Institution

University

Principal Sources of Funding

Departmental and University Research Board

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
James Beauchamp	Elec. engineering	Director of hybrid project	Hybrid computer design, timbre analysis	
John Melby	Music composition	Director, computer music project	Music composition	
Scott Wyatt	Music composition	Supervisor, experimental music studios	Music composition	Half-time
Herbert Brün	Music composition	Director, CAC music project	Music composition	

Date of Inception of Studio and Computer Work

1958

Areas of Activity

Computer music composition (Hiller), 1958-68
Tone Analysis Program (beauchamp), 1966-present
Music 5 (Beauchamp), 1970-present
MUSIC360 & Music 4BF (Melby), 1974-present

Type of Instruction Offered

Music 309 Electronic Music Techniques
Music 448 Computer Music
Music 456 Advanced Computer Music

Background of Computer Users

Broad training in composition and short-term training in use of computer

List of Works

Works below realized in part with computer are for computer and voice or instruments
1) *Sonoriferous Loops* (H. Brün 1964), part
2) *Non Sequitur VI* (Brün 1966), part
3) *Infrandibles* (Brün 1968), part
4) *Dust* (Brün 1976), whole

5) *More Dust* (Brün 1977), whole
6) *Two Stevens Songs* (J. Melby 1975), part
7) *Zonnorites* (Melby 1974), part
8) *of quiet desperation* (Melby 1975), whole
9) *Martial Cadenza* (B. Abers 1976), part
10) *Vee-spoek-en Good.droon* (D.J. Murray 1977), whole
11) *Underfallen Leaves* (B. Gaburo), part
12) *Transparencies* (Melby), part a

Publications and Available Manuscripts

J. Beauchamp, "A Computer System for Time-Variant Harmonic Analysis and Synthesis of Musical Tones", *Music by Computers*, Wiley, 1969

James Beauchamp, "Time-Variant Spectra of Violin Tones", *JASA* No. 56, 1974, pp. 995-1004

James Beauchamp, "Analysis and Synthesis of Comet Tones Using Nonlinear Interharmonic Relationships", JAES No. 13, 1975, pp. 778-795

James Beauchamp, K. Pohlmann and L. Chapman, "The T.I.980A Comuter-Controlled Synthesizer", *Proceedings of the Second Music Computation Conference*, part 3, University of Illinois (1976)

Public Presentation of Works
Several electronic music concerts at the University of Illinois

Policy for Exchange/Rental of Tapes and Related Materials
Contact should be made with the individual composers

HARDWARE

Computers and Digital Hardware
IBM 360/75 (at digital computer lab)
Cyber 175 (at digital computer lab)
TI 980A (in music building)
PDP 11/45 (at Center for Advanced Computation)

In the music building are also located PLATO terminals linked to the CDC-Cyber system. The IBM and Cyber computers have all the usual peripherals but no DAC or ADCs. The PDP 11/45 has a 40kHz tape-to-DAC channel.

The TI 980A system has an 8K processor, thermal teleprinter, dual cassette drive, dual 1" tape drive, PLATO terminal and analog/digital synthesizer. There are also three analog studios containing tape recorders, synthesizers, filters, etc.

Proposed Hardware Developments
Expansion of 980A synthesizer to include more voices (presently there are 4) and increased timbral complexity.

Addition of a DAC system (2-channel) to Cyber 175 via a DEC 11/40 port.

Access to Computer
Access times good and costs reasonable

Availability of Technical Assistance
Some consulting available

Turnaround/Response Time Characteristics
IBM 360/175: 5 minutes to several hours turnaround
TI 980A: immediate

SOFTWARE

Functioning Systems

Name/Author: TONEAN — Beauchamp 1973
Language/Requirements: Fortran IV, 75K, uses tape, plotter
Purpose and Features: Performs harmonic spectral analysis of sound and plots data. Resynthesize tones
Availability/Documentation: Yes

Name
Center for Electronic and Computer Music

Address of Institution
School of Music
Indiana University
Bloomington, Indiana

Type of Institution
University

Principal Sources of Funding
Indiana University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Dr. John Nagosky	Music theory, acoustics	Director	Acoustic research	Half-time
Thomas Wood	Elec. engineering, applied music	Associate director	Instruction, technical operation and development	Half-time
John Eaton	Music, composition	Instructor	Composition, instruction	Part-time
Donald Byrd	Music composition, computer science	Programmer	Composition, musical notation	Volunteer
Gary Levenberg	Music, computer science	Programmer, hardware developer	Music and light composition	Same
George Cohn	Computer science	Same	Sound synthesis	Same
Bruce Rogers	Music composition, computer science	Same	Music and light composition	Same

Principal Users
1) Donald Byrd (1971-)
2) George Cohn (1971-)
3) Gary Levenberg (1971-)
4) Bruce Rogers (1971-76)
5) Lots of students

Date of Inception of Studio and Computer Work
Studio: 1968
Computer: 1970

Areas of Activity
Instruction, composition, research

Type of Instruction Offered

Basic courses in the history, literature and usage of electronic music and the equipment associated with this medium of musical composition. A Master of Music degree is offered to those who wish to concentrate in this area.

Background of Computer Users

General knowledge of computer programming, particularly Fortran systems. Users are expected to understand principles of analog sampling and thus the process involved both programmatic and hardware-wise in the creation of music via digital synthesis.

List of Works

Compositions realized entirely by computer marked W; those only partly marked P:

1) *Cirrus Circles* I & II (W, Gary Levenberg)
2) *Golden Study #2* (P, Levenberg)
3) *Corona* (W, Bruce Rogers)
4) *Tenso* (P, Rogers)
5) *STP Sequences* (W, George Cohn)
6) *Reflects* (W, Cohn)
7) *3 Pieces for 3 Winds* (P, Byrd)

Publications and Available Manuscripts

Donald Byrd, "A System for Music Printing by Computer", *Computers and the Humanities* 8,. (1974)

Donald Byrd, "An Integrated Computer Music Software System", *Computer Music Journal* 1,2 (August 1977)

Bruce Rogers, "A User's Manual for the Stochastic Music Program" (unpublished, 1972)

Thomas Wood, "A High-Speed Digital-to-Analog Conversion System for Digital Music Synthesis", Audio Engineering Society preprint no. 1121 (D-1) (1976)

Public Presentation of Works

We have had two concerts of computer-composed and computer-synthesized music, in October 1974 and February 1976.

HARDWARE

Computers and Digital Hardware

Cincinnati Milacron CIP/2100: 8K words (16-bit)
CDC 6600 (University Computing Center): 96K (60-bit)

All equipment listed below is for the CIP/2100

Peripheral Devices

Data Storage

One Ampex TM-16 150ips 9-track tape drive

Input Devices

ASR-33 teletype

Sound Generation

Digital

Two Datel DACs (16-bit)

Hybrid Systems
Soleil laser performance system

Mixed Digital Systems
A large, microprocessor-controlled analog instrument for real-time, polyphonic performance was slated for delivery in late 1977

Other Peripheral Devices

Analog
Ampex 2-, 4- and 8-track tape recorders; 12x4 mixer; dbx noise reduction equipment; 2 EMT reverberation units; Moog and Synket synthesizers; smoothing filter; etc.

Proposed Hardware Developments
High-speed, A/D conversion of analog signals
More digital control equipment for analog sources

Access to Computer
Available cost-free for all associated with the University

Availability of Technical Assistance
All current users offer informal assistance

Operating Systems
On CIP/2100, Teletype Operating System for D/A conversion of tapes generated on the CDC 6600

SOFTWARE

Functioning Systems

Name/Author: STOCHOS – I. Xenakis
Language/Requirements: Fortran, 43K
Purpose and Features: Composing program. Assumes memory is preset to 0.
Availability/Documentation: Available

Name/Author: JANUS 2.2
Language/Requirements: Fortran, 42K
Purpose and Features: General composing program-to-SMUT interface; does graphic scores
Purpose and Features: Same

Name/Author: SMUT 2.0 -- D. Byrd
Language/Requirements: Fortran, 60K
Purpose and Features: Polyphonic music printing program
Availability/Documentation: Available

Name/Author: MUSTRAN II -- J. Wenker
Language/Requirements: Fortran, assembler, 106K
Purpose and Features: Music input language translator
Availability/Documentation: Available

Name/Author: MUSTRAN library -- J. Wenker
Language/Requirements: Fortran, assembler, 45-126K
Purpose and Features: Five analysis and two utility programs
Availability/Documentation: Available

Name/Author: MUSIC5 – M.V. Mathews
Language/Requirements: Fortran, assembler, 50K
Purpose and Features: Sound synthesis program
Availability/Documentation: Available

Name/Author: WAVER 1.1
Language/Requirements: Fortran, assembler, 25K
Purpose and Features: Printer plotting utility for sound synthesis programs
Availability/Documentation: Available

Name/Author: SMIRK 2.0
Language/Requirements: Fortran, 45K
Purpose and Features: MUSTRAN-to-SMUT interface
Availability/Documentation: Available

Name/Author: Gross lib. -- Dorothy Gross
Language/Requirements: Snobol4
Purpose and Features: 3 translation and 5 analysis programs
Availability/Documentation: Available

Name/Author: MUSC 1.3A -- D. Byrd
Language/Requirements: Algol-60, 41K
Purpose and Features: 12-tone composing program
Availability/Documentation: Available

Name/Author: PRFORM
Language/Requirements: Fortran, 40K
Purpose and Features: MUSTRAN-to-MUSIC5 interface
Availability/Documentation: Available

Name/Author: STOKES -- C. Stokes
Language/Requirements: Snobol4, 70K
Purpose and Features: Set theoretical analysis program
Availability/Documentation: Available

Name/Author: Hunter lib. -- B. Hunter
Language/Requirements: Fortran
Purpose and Features: A white mensural notation program
Availability/Documentation: Available

Name/Author: SOUND -- G. Cohn
Language/Requirements: Pascal, assembler, 40K
Purpose and Features: Sound synthesis panguage compiler
Availability/Documentation: Available

Additional Comments

We are proud of our software development for both light and sound synthesis as well as conventional music notation transcription, analysis, and composition. The center exists primarily as a service center to all types of interests in electronic music. The digital work has been highly influenced by Iannis Xenakis. John Eaton has been a strong influence in the use of electronic synthesizers (analog and digital-control of analog) as real-time instruments. Likewise, Dr. Gary Wittlich (IU School of Music - Theory Department) is actively involved in musical analysis by computer systems which consists of equipment outside the Center for Electronic and Computer Music.

Name
Edward G. Kobrin

Private Address
1135 W. Vine
Stockton, California 95203

Type of Institution
Private (a few frineds)

Principal Sources of Funding
Grants

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
E. Kobrin	Composition, farming	Director	Composition, hardware	Spare time
N. Kopp	Technical, farming	Systems programmer	Software, technical	Spare time
T. Chen	Surgery	Applications programmer	Hardware	Spare time

Date of Inception of Studio and Computer Work
August 1977

Areas of Activity
Digital sound synthesis; control of analog synthesis; sound analysis programs

List of Works
Untitled composition nos. 1-27 for the HYBRID V computer system (Kobrin, 1975-77)

Publications and Available Manuscripts

Hybrid V User's Manual, Center for Music Experiment, La Jolla, California

Kobrin: Computer in Performance, Lingua Press (6417 La Jolla Scenic Drive, La Jolla, Ca. 92037)

Hybrid II Computer System DECUS Proceedings, Fall 1972

Assorted scores for performances available from E. Kobrin

Public Presentation of Works
Available for lectures on control systems in general.

Policy for Exchange/Rental of Tapes and Related Materials
Would be most happy to exchange tapes and/or programs

HARDWARE

Computers and Digital Hardware
PDP 11/34: 65 Kbytes (16-bit words)
LSI-11: 8 Kbytes (16-bit words)

Peripheral Devices

Data Storage
One RK05 disk (2.4M); two RX01 floppy disk units (256K each)

Input Devices
ASR-33 TTY; Infoton CRT display

Output Devices
LA180 line printer

Sound Generation

Digital
16 DACs (12 8-bit, 4 10-bit)

Hybrid Systems
Hybrid interface to DACs

Mixed Digital Systems
"4B"-type digital synthesizer under contruction

Other Peripheral Devices

Analog
Sony tape recorders; testing equipment

Proposed Hardware Developments
Completion of digital sound synthesizer for real-time, interactive sound performance by January 1978

Access to Computer
The system is not generally open to the public. If, however, an individual wishes to undertake a project which would benefit the group as a whole, this person should contact Ed Kobrin. Some arrangements could then be worked out.

Availability of Technical Assistance
Assistance on all levels could be supplied initially; everyone on the system should achieve independence early

Operating Systems
RT-11 operating system

Turnaround/Response Time Characteristics
Immediate turnaround

SOFTWARE

Functioning Systems

Name/Author: HYBRID II – J. Mack
Language/Requirements: PAL-8 code, 12K, paper tape
Purpose and Features: Sound control of 8 analog devices on a PDP-8
Availability/Documentation: Available with doc.

Name/Author: HYBRID V -- J. Mack
Language/Requirements: Macro-11, 16K, uses CRT, cassette, piano-type keyboard
Purpose and Features: Sound control of 16 analog devices on a PDP 11/10
Availability/Documentation: Available with doc.

Name/Author: 4B -- E. Kobrin
Language/Requirements: Macro-11, 32K, uses CRT, disks, piano kbd.
Purpose and Features: Digital synthesis, with 64 osc FM, and envelopes; real-time interaction with the inst. for performance
Availability/Documentation: Not available

Name

Otto E. Laske

Private Address

c/o School of Music
University of Illinois
Urbana, Illinois 61801

Type of Institution

All information here concerns my work at the Institute of Sonology, Utrecht, The Netherlands, 1970-75. This information concerns only my own work, and the results having accrued from it, up to 1976.

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Otto E. Laske	Composition, musicology, cognitive psychology	Teaching of Theory and Composition; research	Psycho-musicology, computer-aided musical instruction, development of musical cognition	Full-time

Areas of Activity

1) Computer-sound composition
2) Instrument/vocal composition
3) Studies in compositional problem solving
4) Methodology of cognitive musicology
5) Studies in musical learning and development

Type of Instruction Offered

1) Introduction to computer-aided score writing (1971-72)
2) Seminar: Computer Programs as Models of the Structure of Compositional Processes (1971-72)
3) The empirical investigation of compositional processes by way of protocol analysis (1972-73)
4) Practical introduction to computer-aided sound synthesis, using Truax's POD (1973-74)
5) Orchestration of computer-synthesized score structures, taught with G.M. Koenig (1974-75)
6) Introduction to problems of a General Music Problem Solver (1974-75)

For instruction at University of Illinois, see that section

List of Works

All compositions computer-realized:
1) *Structure IV* (1973), for four channels, 17'35"
2) *Structure V* (1974), for four channels, 17'40"
3) *Structure VIII* (1975), for four channels, 19'30"
4) *Structure IX* (1975), for four channels, 16'45"

Publications and Available Manuscripts

O.E. Laske, "Introduction to a Generative Theory of Music", *Sonological Reports 1(B)*, Institute of Sonology, Utrecht, The Netherlands, 1975 (reprint of two separate monographs dating from 1972 and 1973)

O.E. Laske, "Toward a Musical Intelligence System: OBSERVER", *Numus West*, No. 4, Mercer Island, Washington. 1973, pp. 11-16

O.E. Laske, "Toward a Center for Musical Intelligence Studies", *Numus West*, No. 5, 1974, pp. 44-46

O.E. Laske, "The Information Processing Approach to Musical Cognition", *Interface*, Amsterdam: Swets & Zeitlinger, vol. 3, no. 2, pp.109-136, 1974

O.E. Laske, "Toward a Theory of Musical Cognition", *Interface*, vol. 4, no. 2, pp. 147-208, 1975

O.E. Laske, "Toward a Theory of Musical Instruction", *In Theory Only*, Ann Arbor, Michigan: School of Music, University of Michigan, vol. 2, nos. 3-4, pp. 43-66, 1976; reprint: *Psychology of Music*, London, 1977

O.E. Laske, "On the Use of Human Beings in Computer Music: An Information Processing Approach to Computer Music Systems", unpublished manuscript, 1976, 35 pages

O.E. Laske, "Toward a Theory of User Interfaces for Computer Music Systems", Conference Paper, *First International Conference on Computer Music*, Boston, October 1976 (Proceedings published 1977)

O.E. Laske, *Music, Memory and Thought: Explorations in Cognitive Musicology*, Ann Arbor, Michigan: Xerox University Microfilms International, 1977, monograph

O.E. Laske, "Musical Semantics: A Procedural Point of View", unpublished manuscript concerning a Music Understanding System, 1973, 90 pp.

O.E. Laske, "A Conceptual Task Analysis of Monolinear Composition", unpublished manuscript, 1976, 200 pp.

Name

Experimental Music Studio - M.I.T.

Address of Institution

Room 26-311
Massachusetts Institutue of Technology
Cambridge, Massachusetts 02139

Type of Institution

M.I.T.

Principal Sources of Funding

Institute Resources; National Science Foundation; IBM; DEC

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Barry Vercoe	Music	Director	Composition, teaching	Half-time
Carl Howe	Computer science, music	System manager	Technical, pedagogical	Full-time
Roger Hale	Computer science	Programmer, technical instructor	Technical, research	Full-time
Dean Wallraff	Classics	Programmer, technical instructor	Technical, artistic	Two-thirds time
Steven Haflich	Music, computer science	Programmer	Technical, artistic, research	One-fifth time

Date of Inception of Studio and Computer Work

1971

Areas of Activity

Music production and performance; development of direct-synthesis software for this purpose; export and maintenance of software for use in the field (e.g. over 40 installations of our MUSIC360 and MUSIC-11 systems around the world); hosting senior composers; teaching students; relating to other MIT research.

Type of Instruction Offered

Fall: *Electronic Music Literature and Techniques.* Survey from Paris and Cologne to the present, with emphasis on the growth of digital methods. Introduction to MUSIC360, MUSIC-11 and the MIT studio; studio techniques; synthesis projects using the facility.

Spring: *Electronic Music Composition.* A senior-level composition course fostering works for synthesized sounds, with or without live instruments. Unlimited studio time. Students expected to produce a major work, staged in public, by the end of term

Background of Computer Users

For the fall course: one full year of college-level music, including ear-training and perception, plus a one-semester study of musical acoustics (or 3 terms of Physics)

For the spring course: the fall course is one prerequisite. Additionally, students must have had two full years of Writing and Analysis (or the equivalent in Theory and Composition)

No background in computers is required. Composers communicate with the MIT system in natural

musical modes (keyboards, tactile devices, scope displays of standard music notation, etc.) The interactive system is sufficiently intuitive to musicians.

List of Works

The MUSIC360 system has been repsonsible for over 150 compositions to date at the 40 installations currently active. About 20 of these are now commercially recorded (see "Computer Music 1976" catalogue). MIT continues to do D/A conversions for many MUSIC360 facilities.

The more recent MUSIC-11 system has produced about 20 works to date. Those of the MIT home installation include:
1) *Synapse for Viola and Computer* (Barry Vercoe 1976)
2) *In Memoriam Patris* (Richard Hoffman 1976), CRI
3) *Eden Among Us* (Martin Ferren 1976)
4) *Dance* (Dean Wallraff 1976)
5) *Contrapunctus I* (Wallraff 1977)
6) *Spheres of Influence* (Alva Couch 1977)

Publications and Available Manuscripts

MUSIC360 - Reference Manual (MIT Studio, soon MIT Press)

B. Vercoe, "The MUSIC360 Language for Digital Sound Synthesis", *Proceedings 6*, American Society of University Composers, 1971

"Man-Computer Interaction in Creative Applications", paper read at Music Computetion Conference II, Univ. of Illinois, 1975

MUSIC-11: *Installation guide* and *User's Reference Manual* (in preparation)

Public Presentation of Works

Concerts:

1. February 1976, Studio Inaugural Concert as part of National Conference, American Society of Univerisity Composers. All-electronic, inclusing Vercoe's *Synapse for Viola and Computer* (première). Audience c. 1200.

2. October 1976, 4 concerts, given jointly by the First International Conference on Computer Music (MIT) and the 1976 I.S.C.M. World Music Days International Festival. Eighteen computer works, including 9 by MUSIC360 and 3 by MUSIC-11. Audience 500-1200.

3. Two concerts per year by MIT Chamber Players, featuring contemporary works for electronic sounds and chamber ensemble (Barry Vercoe, conductor).

Policy for Exchange/Rental of Tapes and Related Materials

MUSIC360 system distributed freely
MUSIC-11 system distributed on rental

Policy for Composers' Rights and Contracts

Composers retain all rights to their compositions

HARDWARE

Computers and Digital Hardware

IBM 370/168: 2M, 32-bit words (at Central Campus)
PDP 11/50: 80K, 16-bit words (Studio, exclusive)
IMLAC PD5-4 Display Computer: 8K, 16-bit words (Studio, exclusive)
PDP 11/40: 48K, 16-bit words (Studio, shared)

The IBM 370 is used for MUSIC360; the other three for MUSIC-11. All hardware information below is for studio-exclusive computers.

Peripheral Devices

Data Storage
2 RK05 disk drives (1.2M); 1 Diva disk drive (30M); TU-10 tape drive (9-track, 800 bpi)

Input Devices
3 VT-52 video terminals; IMLAC PD5-4 display terminal; 2 touch/velocity sensitive organ keyboards; ADC (16-bit)

Output Devices
Versatec electrostatic plotter

Sound Generation

Digital
4-channel floating-point DAC, giving a 90 dB signal/noise window over 150 dB dynamic range. Maximum rate 120 KC

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
DBX noise reduction unit; Scully and Otari tape recorders; Klipschorn speakers

Proposed Hardware Developments
None disclosed

Access to Computer
Both studio computers used continuously. Composition students, visiting composers and staff have unlimited access. Beginning students only under supervision.

Availability of Technical Assistance
Unlimited

Operating Systems
UNIX PDP-11 time-sharing, with priority scheduling for real-time programs, D/A conversion, etc. All software is interactive and on-line.

Standalone DOS for high-rate multi-channel conversion

Turnaround/Response Time Characteristics
Response time good for up to three active composers at once

SOFTWARE

Functioning Systems

Name/Author: MUSIC360 -- Vercoe (1969)
Language/Requirements: Fortran, assembler, 120 Kbytes, disk, tape
Purpose and Features: Complete digital sound synthesis on IBM 360 or 370. Full complement, including speed ()10 times Fortran), 4x4 digital mixing, selectable output format
Availability/Documentation: Available free with user manual

Name/Author: MUSIC-11 floating point -- Vercoe (1973)
Language/Requirements: Macro-II, 16 Kwords, disk DAC
Purpose and Features: Complete digital synthesis system for PDP 11/45 and up. Fast new orchestra translator. High-speed sound generation, using many new techniques of control- and audio-signal processing. Interactive on most PDP-11 operating systems
Availability/Documentation: Lease

Name/Author: MUSIC-11 fixed point -- Vercoe (1975)
Language/Requirements: Same as above
Purpose and Features: Complete digital synthesis system for PDP 11/-05, /10, /35, /40. Same features as above
Availability/Documentation: Lease

Systems Under Development

Name/Author: NEDIT -- Haflich, Wallraff (1975+)
Language/Requirements: Macro-11
Purpose and Features: Graphic-oriented creation of musical scores for digital realization by MUSIC-11. Tactile organ keyboard input; immediate display in standard notation; interactive editing and playback (real-time); hard copy of score, parts

Name/Author: OEDIT -- Steiger, Hale (1975+)
Language/Requirements: AMBL, Macro-11
Purpose and Features: Graphic-oriented editing of signal-processing networks that define instruments, orchestras for MUSIC-11. Tablet-based input; menu-selection of symbols (oscillator/filter); elastic network display; immediate audio feedback

Name

Speech Group - Massachusetts Institute of Technology

Private Address

Gregory M. Gargarian
807 Sommerville Ave. #3
Somerville, Massachusetts 02143

Address of Institution

Speech Group
attn. W. Henke 36-525
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Type of Institution

University

Principal Sources of Funding

Personal

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Gregory M. Gargarian	Music	Independent researcher	Music composition and education	Half-time
William Henke	Elec. engineering	Instructor, research associate	Software design, psychoacoustics, speech	Full-time

Areas of Activity

Design of an interactive language for time signal processing, and implementation of translators for the language

Type of Instruction Offered

Introductory subject in time signal processing called "Computer Aided Sound Sculpting"

Background of Computer Users

Musicians using MITSYN need not have any computer background

List of Works

Computer for Six Strings (1974), composition for 4 violins, electric guitar and electric bass

Publications and Available Manuscripts

Manual for MISTYN (available from MIT RLE document room, Cambridge, Mass. for about $4)

Public Presentation of Works

Mostly presented as accompaniment for dance

Policy for Exchange/Rental of Tapes and Related Materials

At this early stage in our research, we are not equipped to formally submit tapes and materials, although we welcome correspondence with other groups and will make reports (tapes, etc.) on our work in progress available on request

Policy for Composers' Rights and Contracts
None of Gargarian's work under contract or copyrighted (yet)

HARDWARE

Computers and Digital Hardware
PDP-9: 24K, 18-bit words -- this was the original host for the MITSYN system, which depends little on what computer it is run on.

Peripheral Devices

Data Storage
Disks, tapes (both analog and digital)

Input Devices
ADC; tablet, knobs, buttons, switches; alphanumeric keyboards

Output Devices
Printer; graphics hard copy device (for block diagrams, data analyses, etc.)

Sound Generation

Digital
DAC (2-channel)

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Tape recorders; filters; spectrum analyses

Proposed Hardware Developments
A small and cheap system which will support the MITSYN language/notation and include more real-time actions than in the present implementation.

SOFTWARE

Functioning Systems

Name/Author: MITSYN -- Henke 1976
Purpose and Features: High level interactive dialogue type language/notation for time signal processing; highly graphical, easy for musicians no learn without knowledge of computers
Availability/Documentation: MITSYN manual

Name/Author: Translator/interpreter for MITSYN -- Henke 1976
Purpose and Features: Translates and interprets

Additional Comments

The MITSYN language, designed by William Henke, offers easy translation from traditional music notation by way of its own graphic notation. It is flexible enough for theory that emerge directly from the principles of sound -- and, of course, the opportunity to act out new theory to evaluate its interest to composers. Putting aside concerns in the area of music theory and focussing in terms of pure sonics, MITSYN is very accessible and offers detailed and dynamic control in both subtractive and additive computer sound synthesis.

Name
University of Michigan

Address of Institution
Computer & Communication Sciences Dept.
2076 Frieze Building
University of Michigan
Ann Arbor, Michigan 48109

Type of Institution
University

Principal Sources of Funding
National endowment for the humanities

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Martin Piszczalski	Psychology and Computer Engineering	Systems analysis and programming	Scientific analysis	Full-time
Dr. Bernard Galler	Computer Science	Project Director	Theoretical	One-eighth time
Robert Scott	Mathematics	Mathematics and signal analysis	Technical	Non-specific

Date of Inception of Studio and Computer Work
July 1976

Areas of Activity
Automatic transcription of musical sounds into common music notation

Type of Instruction Offered
None

Publications and Available Manuscripts

Automatic music notation translation from sound via 3-dimensional harmonic analysis (1975)
-- available through Computer and Communication Sciences Department, University of Michigan

HARDWARE

Computers and Digital Hardware
Amdahl 470: 4 Mbytes, 32-bit words
Hewlett-Packard MX21: 16K, 16 bit words

Peripheral Devices

Data Storage
Amdahl: three disk drives; nine mag tape drives
H-P: one disk drive; one mag tape drive

Input Devices
Amdahl: card readers, terminals
H-P: paper tape reader; ADC (10 bit); Tektronix terminals

Output Devices
Amdahl: line printer; Calcomp plotter
H-P: line printer; X-Y plotter

Sound Generation

Digital
One DAC (7-bit)

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Function generators; filters

Proposed Hardware Developments
None

Access to Computer
For MTS, costs available through the University of Michigan Computing Center. The Hewlett-Packard costs $4-$8/hour; access varies

Availability of Technical Assistance
Technical assistance to others is not included within the project's activities

Operating Systems
Amdahl computer is in a large-scale, time shared system using MTS; the Hewlett-Packard is in a mini-computer system

Turnaround/Response Time Characteristics
Response and turnaround time vary on MTS but are generally good. The H-P's characteristics are typical for a scientifically-based mini-system.

SOFTWARE

Functioning Systems

Name/Author: MUSIC 4BF -- Hubert, Howe (1975)
Language/Requirements: Fortran, IBM370 asembler, uses 10K, standard devices
Purpose and Features: Generates synthesized sound samples
Availability/Documentation: See *Electronic Music Synthesis* by Howe

Name/Author: PLL -- Robert (1976)
Language/Requirements: Fortran, uses 2K, standard devices
Purpose and Features: Tracks simple frequencies; features a simple phase-lock loop program
Availability/Documentation: not currently documented

Name/Author: MUSE -- Ress (1976)

Language/Requirements: Fortran, uses standard devices and plotter
Purpose and Features: Plotting and editing common music notation; features interactive CMN editor
Availability/Documentation: 5 pages of documentation

Systems Under Development

Name/Author: A/D Convert -- Piszczalski
Language/Requirements: Assembler program, 16K, uses A/D disk, magtape
Purpose and Features: Converting musical sounds to digital samples

Proposed Systems

In planning stage: digital spectrograph display, fundamental frequency detection, mapping acoustically-generated data into music notations, symbols, and interfacing to music notation display program

Name
John L. Clough

Address of Institution
Laboratory for Music and Technology
University of Michigan
Ann Arbor, Michigan 48109

Type of Institution
University

Principal Sources of Funding
University of Michigan

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
John L. Clough	Music	Director	Arts, technology	Varying
Byrom Tate	Music	Assistant, programmer	Composition	One-quarter time

Date of Inception of Studio and Computer Work
Studio presently being set up (August 1977)

Areas of Activity
Laboratory is intended to serve a broad range of musical interests: composition, musicology, theory, music education

Type of Instruction Offered
1) Introduction to Computer-Based Musical Studies
2) Computer Sound Generation

Publications and Available Manuscripts

Various papers (1969-73) by John Clough covering previous work at Oberlin College

HARDWARE

Computers and Digital Hardware
DEC LSI-11: 16K (16-bit)

Peripheral Devices

Data Storage
None

Input Devices
ADM-3A terminal

Output Devices
None

Sound Generation

Digital
None

Hybrid Systems
ARP 2600 Synthesizer

Mixed Digital Systems
None

Other Peripheral Devices

Analog
None

SOFTWARE

Functioning Systems

Name/Author: ARPCON -- B. Tate, S. Choy
Language/Requirements: PDP-11 Assembler, 8K
Purpose and Features: Drives analog synthesizer
Availability/Documentation: Forthcoming

Name
Mid-Atlantic Modern Music Institute

Address of Institution
5201 Governor Printz Blvd.
Wilmington, Delaware 19809

Type of Institution
Music Institute

Principal Sources of Funding
Grants, donations, private funding

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Dana Smith	Audio engineering	Co-director	Artistic, technical	Half-time
Joseph Pinzarrone	Music	Co-director	Artistic, technical	Half-time
Thomas Noggle	Design engineering	Consultant	Technical	Variable
Elven T. Riley	Programming	Consultant	Technical	Variable
Edward Kobrin	Music	Consultant	Artistic, technical	Variable

Principal Users
1) Dana Smith
2) Joseph Pinzarrone
3) Thomas Noggle

Date of Inception of Studio and Computer Work
October 1976

Areas of Activity
Real-time performance instruments with computer control; computer-controlled electronic music studio facility; construction of instruments to be interfaced to studio system

Type of Instruction Offered
None

Expectations of Computer Users
The composers and media artists have imaginative ideas in performance and studio composition with the aid of computers

List of Works
Digest available by contacting the Institute

Publications and Available Manuscripts

MAMMI Hardware; MAMMI Software; MAMMALIA; *Creative Computing*, January 1977; *Personal Computer*, March-April 1977

Public Presentation of Works
Monthly informal evenings of new and electronic music in Delaware; touring theatre pieces by Pinzarrone, Smith, Loewen and others presented nationally; radio show, Jerry Hunt (Dallas, Texas)

Policy for Exchange/Rental of Tapes and Related Materials
Available on request

Policy for Composers' Rights and Contracts
Available on request

HARDWARE

Computers and Digital Hardware
1) PDP 11/10: 8K words (16-bit)
2) Special purpose 1802 and 8080 microprocessor systems

Peripheral Devices

Data Storage
Mag tape

Input Devices
Two silent terminals (TTY compatible)

Sound Generation

Digital
20 DACs and extensive original analog studio

Hybrid Systems
PDP 11/10 driven hybrid system in 8K of core

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Two 4-track tape recorders; three 2-track tape recorders; 20 VCOs; 20 VCAs; assorted filters, phase shifters, Dolby units, limiters, microphones, speakers, analog matrices, etc.

Digital
High-speed paper tape, DECwriter; general purpose interfaces to drive computers in or out of house; electronic movement sensing costumes for performance

Proposed Hardware Developments
Intelligent (microprocessor designed) performance devices -- dance costumes, keyboards, painting machines (funicular pantographs); random access audio edit system; interfaces to the control of theatrical systems, i.e. theatre lighting, etc. extended analog in multiplication and addition; programmable counters for D/A conversion; digital replacement for analog components; video graphics display and control

Access to Computer
In-house computing; night and day access; only cost is upkeep

Availability of Technical Assistance
Lease line linkage to several systems; in-house technicians; network of programmers and engineers in several states of the U.S.

Operating Systems

P.I.E. 4.1 to 4.62 in house operating system, originally designed; keyboard terminal with tape storage

Turnaround/Response Time Characteristics

Turnaround time: instantaneous
Reponse time: 900 ns.

SOFTWARE

Functioning Systems

Name/Author: P.I.E. 4.62 – Riley (1975)
Language/Requirements: Machine code, uses 5.5K, hybrid system
Purpose and Features: Control of analog and pattern recognition of movement; features performance correlations over wide range

Systems Under Development

Name/Author: DANCE -- Pinzarrone
Language/Requirements: Fortran code
Purpose and Features: Interepretation of movement; with graphic display

Name/Author: QUAUDIO -- Smith
Language/Requirements: C1802 code (2K)
Purpose and Features: Automatic patching and fading; with interfaceability to program control

Proposed Systems

PANT -- Smith & Pinzarrone
Language/Requirements: "Focal"; uses painting machine
Purpose and Features: Performance control of funicular pantographs (very large: 20x40 feet)

Additional Comments

Studies at the Institute have led the users to suspect that all computer systems, large or small, may be in fact visitors from other worlds. In establishing communication with them, it is found that they are sensitive, aesthete beings, capable of transcendant realities, who have been set about freeing into the world.

Name

Digital Sound Synthesis Studio

Address of Institution

John E. Rogers
Music Department
Paul Arts Center
University of New Hampshire
Durham, N.H. 03824

Type of Institution

University

Principal Sources of Funding

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
John E. Rogers	Music	Director, systems programmer	Artistic, technical, pedagogical	Whatever it takes
Joseph Zingheim	Elec. engineering	Builder of AD/DA systems, consultant	Technical	Consultant
Ernest Nichols	Elec. engineering	Designer and troubleshooter of AD/DA systems	Technical	Consultant
Richard Shofield	Computer science	Systems programmer (for Computer Center)	Technical	Consultant

Principal Users

1) John E. Rogers
2) Phillip Batstone
3) about 15 undergraduate students

Areas of Activity

Computer sound synthesis; computer sound analysis; electronic music composition; teaching of electronic music

Type of Instruction Offered

1) A general course in electronic music, about one-third of which is devoted to computer work

2) Electronic music composition (usually all computer)

Background of Computer Users

1st level users (beginners) -- must know: (a) how to operate time shared computer system; (b) how to use an on-line editor; (c) how to "code" music
2nd level users (after one course) -- must know: (a) Fortran; (b) MONITOR; (c) principles of instrument design and D/A operation
3rd level user (expert) -- must know: (a) Assembler language; (b) A/D operation; (c) various more complicated support programs

List of Works

The following are all computer synthesized:
1) Various short computer pieces (Rogers 1966-76)
2) *Canonic Structures* (Rogers 1973)
3) *Computer Fantasy* (Rogers 1975)
4) *Variants* (Rogers 1975-76)
5) *Rotational Arrays* (Rogers 1966-76)
6) *Experiments in Jazz* (Rogers 1975-76)
7) *Combinatorial Identities* (Robert Taylor)
8) *Duo* (Michael Annicchiarico)
9) Many short student works

Publications and Available Manuscripts

John E. Rogers, "The Uses of Digital Computers in Electronic Music Generation", in *The Development and Practice of Electronic Music*, ed. J. Appleton & R. Perera (Prentice-Hall)

Various articles on "set structures" which used computer to generate the sets have appeared in *Perspectives of New Music* and the *ASUC Journal*

An instrumental version of *Rotational Arrays* is available from the Bowdoin College Music Press, Brunswick, Maine

Public Presentation of Works

Tape exchange
Concerts

Policy for Exchange/Rental of Tapes and Related Materials

Will send a tape on request

HARDWARE

Computers and Digital Hardware

DEC KL10: 1M, 36-bit words
Varian 620L (not discussed below): 32K, 16-bit words

Peripheral Devices

Data Storage

Arge disks; 9- and 7- track tapes; DECtapes; paper tape

Input Devices

TTY (up to 9600 baud); card reader; paper tape; DECtape; mag tape; ADC (4-channel, 12-bit)

Output Devices

Line printers; Calcomp plotters; TTYs;

Sound Generation

Digital

4-channel, 12-bit DAC (data rate at present limited to 50K samples/second total: mono 50K, stereo 25K, quad 12.5K)

Hybrid Systems

Not presently in use

Mixed Digital Systems

Not presently in use

Other Peripheral Devices

Analog
Teac and Sony 1/4-inch 4-track tape recorders; Revox A77 stereo tape recorder

Proposed Hardware Developments
1) Addition of sample and hold circuits to D/A to provide deglitching (3-Rivers Computer Corp.)
2) Purchase of higher quiality output-input analog filters
3) Possible upgrade to more bits or "floating-point" DAC/ADC

Access to Computer
Computer accessible 22-24 hours/day; only one user of music system at any one time (ADC/DAC not multiplexed between users)

Availability of Technical Assistance
We do it mostly ourselves; DEC support can help sometimes if you pinpoint the problem for them

Operating Systems
Time-sharing and batch (most music users use time-sharing); tty-oriented (screen type)

Turnaround/Response Time Characteristics
1) Short test jobs -- quick turnaround (1-2 minutes for 10 second test)
2) Long jobs -- slow turnaround (impossible if system loaded with 80 users)
3) DAC and ADC under normal time-sharing -- very quick response under most conditions

SOFTWARE

Functioning Systems

Name/Author: MUSIC4BF -- Howe (modified by Rogers for DEC KL10)
Language/Requirements: Fortran, MACRO code
Purpose and Features: Synthesis
Availability/Documentation: Incomplete

Name/Author: MUS 10 -- David Poole (1966)
Language/Requirements: FAIL, Fortran
Purpose and Features: Synthesis (Stanford University sound synthesis package)
Availability/Documentation: Incomplete

Name/Author: "SPEECH" -- Steiglitz & Winham, Princeton 1970 (modified by Rogers)
Language/Requirements: Fortran, MACRO
Purpose and Features: Analysis of speech and other "real" sounds; synthesis based on analysis

Additional Comments

We have recently converted from an IBM 360/50 system using Barry Vercoe's MUSIC360 to a DEC KL10. This has caused about 1-1/2 years to be devoted to systems work. We are now doing music regularly again.

Name
Joel Chadabe

Address of Institution
Music Department
State University of New York
Albany, New York 12222

Type of Institution
University

Principal Sources of Funding
Grants; university budget

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Joel Chadabe	Music	Director	Artistic	Full-time
Phil Edelstein	Arts, technology	Programmer	Artistic, technical	Half-time
Roger Meyers	Music	Programmer	Music	Full-time
Tom DeWitt	Art	Guest	Video	Full-time

Date of Inception of Studio and Computer Work
Analog studio: 1966
Computer arrived: 1975

Type of Instruction Offered
Basic lecture course in the literature, the philosophy and the various technologies of electronic music

Seminars in studio practice and composition, as well as technical matters

List of Works
1) *Settings for Spirituals* (Chadabe 1977), voice, computer and analog
2) *Melanzane* (G. Englert 1977), computer and analog

Public Presentation of Works
Concerts, disks

HARDWARE

Computers and Digital Hardware
PDP 11/10: 8K words (16-bit)

Peripheral Devices

Data Storage
Cassette

Input Devices
Terminals, ADCs

Output Devices
Terminal

Sound Generation

Digital
DACs

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Several tape recorders; a great deal of analog synthesis equipment

Operating Systems
The system is geared for real-time operation only

SOFTWARE

Functioning Systems

Name/Author: RTMS1 -- Chadabe, Meyers
Language/Requirements: Assembly language, 6K
Purpose and Features: Generates control signals; features real-time interaction with complex process
Availability/Documentation: Contact authors

Name/Author: SCIPS -- Chadabe, Meyers
Language/Requirements: Assembly language, 1K, uses ADC, DAC
Purpose and Features: Processing of sounds, modular
Availability/Documentation: Contact authors

Name

State University of New York at Buffalo

Address of Institution

Experimental Music Studio
State University of New York
Buffalo, New York 14214

Type of Institution

University

Principal Sources of Funding

University operating budget; some SLEE endowment money; N.S.F. grants in the past

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Lejaren Hiller	Science, music	Director	Artistic, technical, pedagogical	Variable part-time
John Morley	Computer science, electrical engineering	Graduate research assistant	Technical	Half-time
Christos Hatzis	Music	Graduate teaching assistant	Artistic, pedagogical	Half-time

There is a regular turnover of graduate assistants as they acquire various advanced degrees; also, the number of assistants required varies. Maintenance work is done by the Department of Music electronics technician. This is one of several responsibilities he has.

Principal Users

1) Lejaren Hiller
2) Research Fellows in Center of Creative and Performing Arts
3) Graduate students in composition
4) Other students
5) Other members of faculty
6) Outsiders, e.g. theater sound technicians (occasional)

Date of Inception of Studio and Computer Work

1968

Areas of Activity

Standard electronic music studio; computer composition; computer sound synthesis and analysis

Type of Instruction Offered

(1) Three undergraduate courses in basic electronic music -- one for composition and theory majors, one for music education students, and one concentrating on computer sound synthesis (MUSIC 5, etc.)
(2) One year (2 semester course) for graduate students on "Music and Technology" -- a more sophisticated approach
(3) Individual instruction to advanced students as needed

Background of Computer Users

If composers: competence in more traditional composition craft and/or electronic music
If theorists: competence in advanced analysis and appropriate analytical tools (e.g., statistics)
If science or engineering majors: sufficient knowledge of music to avoid naïve approach

List of Works

1) *String Quartet No. 4 (Illiac Suite)* (1957, with L. Isaacson), composed with computer
2) *Computer Cantata* (1963, with R. Baker)
3) *An Avalanche for Pitchman, Prima Donna, Player Piano, Percussionist and Prerecorded Playback* (1968), player piano roll composed with computer and realized on Calcomp plotter
4) *Hpschd for 1-7 Harpsichords and 1-51 Tapes* (1968, with J. Cage), tapes realized by D/A conversion
5) *Algorithms I for 9-10 Instruments and Tape* (1968, with R. Kumra)
6) *Algorithms II for 9-10 Instruments and Tape* (1972)
7) *Computer Music for Percussion and Tape* (1968, with G.A. O'Connor)
8) *A Preview of Coming Attractions for Symphony Orchestra* (1973)
9) *Electronic Sonata for Four-Channel Tape* (1976), tapes partly prepared with DAC
10) *Midnight Carnival for an Urban Environment* (1976), partly prepared with DAC
11) *Persiflage for Flute, Oboe and Percussion* (1977), composed with computer
12) *Algorithms III for 9 Instruments and Tape* (in progress), like *Algorithms I & II*

Publications and Available Manuscripts

Scores of above compositions published

L. Hiller & L. Isaacson, *Experimental Music*, McGraw-Hill, New York, 1959

Numerous (over 35) articles published and in process of publication, on computer music and on electronic music. Also technical reports, unpublished manuscripts, etc.

Public Presentation of Works

All compositions listed above have had public concert presentation (excepting *Algorithms III*, which is still in progress). Most have been broadcast and recorded on disks and tapes

Policy for Exchange/Rental of Tapes and Related Materials

Publishers handle published music. Other items can be obtained from L. Hiller. Technical reports from SUNYAB available in limited supply.

HARDWARE

Computers and Digital Hardware

Cyber 173: 133K (60-bit)
PDP-8: 4K (12-bit)

The Cyber 173 is for the whole university; the PDP-8 is owned by the Department of Music. All details below are for PDP-8 unless stated otherwise.

Peripheral Devices

Data Storage
Disk (256K), mag tape

Input Devices
TTY, other terminals

Output Devices
TTY; Calcomp plotter on Cyber 173

Sound Generation

Digital
DAC (3-chanel), 20K

Hybrid Systems
Moog synthesis VCOs can be operated directly by PDP-8

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Complete electronic music studio directly interwired to PDP-8, with tape recorders (4-channel), filters, test equipment, etc.

Proposed Hardware Developments
1) Hardwire floating-point arithmetic for PDP-8 of our own design to speed up computations in progress like MUSIC 5
2) As soon as new music building is approved by N.Y. State Legislature, we will have capital funds for new equipment which will involve a complete new computer system starting with a computer like a recent model PDP-11, peripherals including multiplexed A/D, D/A, graphics terminal and complete new electronic music-tape studio. The present equipment will be retained on secondary system. Present plans aim for occupation in 1981.

Access to Computer
PDP-8 owned, so available freely at no cost to users
Reasonable access to Cyber 173 available for faculty research

Availability of Technical Assistance
Not normally available except for basic instruction on how to use the equipment. Students are expected to take the available courses. Some help is available depending on how busy assistants are.

Operating Systems
PDP-8 telexed to Cyber 173 (time-shared). MUSIC 5 program run on Cyber 173 delivers digital tape output for off-line conversion to sound (which is often more convenient, because conversion can then be carried out at any time of day)

Turnaround/Response Time Characteristics
Cyber 173 batch turnaround veries from minutes to one week, depending on program duration and user load. PDP-8 is dedicated and thus response time limited only by computation capabilities

SOFTWARE

Functioning Systems

Name/Author: MUSIC 7 -- Hiller et al.
Language/Requirements: Fortran, Compass, 55K
Purpose and Features: D/A sound synthesis; modified version of basic package by M.V. Mathews. Many more generators. Sends digital tape directly to PDP-8
Availability/Documentation: Doc. incomplete; listings available

Name/Author: MUSIC 5 -- Hiller, Morley
Language/Requirements: PDP-8 Assembler, 30K
Purpose and Features: D/A sound synthesis; A/D real sound processing (on PDP-8)

Name/Author: MUSICOM -- Hiller
Language/Requirements: Fortran, Compass, 130K
Purpose and Features: Composition; constantly being expanded. Output can go to printer, Calcomp music notation program or MUSIC 7
Availability/Documentation: Doc. incomplete

Name/Author: Analysis programs – Hiller
Language/Requirements: PDP-8 Assembler, Fortran
Language/Requirements: Acoustic analysis and special research (Fourier transforms, vibration analysis, etc.) Uses ADCs
Availability/Documentation: Some published papers

Name
Bill O'Brien

Private Address
Route 2
Pilot Point, Texas 76258

Type of Institution
Private

Areas of Activity
Writing score for a "MUSIC360" digital synthesizer

List of Works
Computer-generated works:
1) *Rusty Calliope*
2) *Enunciation of the Beast* (in progress)

Public Presentation of Works
None

HARDWARE

Computers and Digital Hardware
IBM 370: this computer, which has the MUSIC360 program, is located in North Carolina and being used from Texas by mail with the help of a friend

Access to Computer
No support funds available that the user knows of

Turnaround/Response Time Characteristics
Turnaround for generating a tape playable on a home tape recorder is about one week

SOFTWARE

Functioning Systems

Name/Author: MUSIC360 -- Barry Vercoe
Purpose and Features: Generation of digital tape or orchestral and score output Barry Vercoe at MIT

Name

Thomas L. Blum

Private Address

189 Duncan St.
Columbus, Ohio 43202

Address of Institution

Electronic Music Studio
Lord Hall
Ohio State University
Columbus, Ohio 43210

Type of Institution

University (other work done with radio: WOSU-FM, NPR, OSU Telecommunications Bldg.)

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Thomas L. Blum	Music, electronics	Primarily independent work		
Thomas Whitney	Physics, Computer Science	Advisor, programmer; instructs course		

Date of Inception of Studio and Computer Work

1973 (at Buchla studios at California Institute of the Arts)

Areas of Activity

Current projects:
1) implementation of MUSIC V using IBM 370 and PDP-9 computers
2) development of a program for music composition using probability theory, statistics, etc.
3) a set of 13 radio programs on New Music (brief, elementary programs dealing mostly with music of the last 20-25 years)

Type of Instruction Offered

Ohio State U. offers a "personalized study program" in which I have created a curriculum for my major which is based on my plans to implement MUSIC V and research the possibility of computer sound synthesis using existing facilities at the University. I have studied a variety of programming courses with science applications and have conducted "independent studies" in digital sound synthesis and composition using the analog sound studios.

List of Works

1) *Dihedra* (1974), computer-structured using Probability Theory; score realized at the EMS at California Institute of the Arts
2) *Maincomp.F4* (1976), electro-acoustic, OSU, in progress (computer-generated structure)
3) Several electro-acoustic compositions not utilising computer techniques

Publications and Available Manuscripts

Documentation available for (1) above

New Music: Interpretations of Modern Sound (set of 13 fifteen-minute radio essays)

Public Presentation of Works

Six concerts (both live and tape performances) since 1972
Rada series mentioned above

Mark Drebnis, graduate student at OSU, will be presenting *Audiolight*, a computer-controlled light and sound interactive environment

Policy for Exchange/Rental of Tapes and Related Materials

Please contact me for arrangements on tape rentals, exchanges, etc. I would like to start an exchange system for concerts and radio programs

Policy for Composers' Rights and Contracts

All work listed above is under copyright

HARDWARE

Computers and Digital Hardware

Data General Nova (mini): approx. 20K
IBM 370: class=A, 126K, 32-bit words
DEC-10
PDP-9

Peripheral Devices

Data Storage

IBM disk stores MUSIC V source program for sound synthesis; IBM mag tape stores sample points for input to D/A's; DEC-10 disk stores *Maincomp.F4*-composing subprograms

Input Devices

IBM: card reader input to MUSIC V
PDP-9: tape input to DACs

Output Devices

IBM: line printers
DEC-10: line printer, teletype
PDP-9: sound generation via D/A's

Sound Generation

Digital

DACs at the PDP-9

Hybrid Systems

Dr. Thomas Wells (director of the Electronic Music Studio at OSU) is attempting to purchase a computer for sound synthesis and control of analog equipment.

Mixed Digital Systems

None

Other Peripheral Devices

Analog

Assorted test equipment at the EMS, discrete instruments, sequencers: Moog Synthesizer, tape recorders, mixers

Proposed Hardware Developments

I am just beginning to think about the construction of music systems on the hardware level. Now that computer equipment is becoming "affordable" in terms of the space and money requirements, I see the possibilities of constructing a personal/public studio for digital sound synthesis. Details may materialize in the future. (I would be open to the idea of a coöperative studio.)

Most of the computer sound synthesis installations that I know of are intimately connected to a

university. I see a need for the promotion and financial backing of public studios, with analog as well as digital equipment. I do not like the situation in which an Art is strictly an appendage to a university. It would be nice if all Art and Technology projects could get outside of the college institution even occasionally.

Access to Computer

Computer funds supplied by the University (approx. $200/quarter total use)

Availability of Technical Assistance

OSU offers free programming consultation services for the PDP-9.
DEC operators are helpful.
Instruction & Research Computing Center (IRCC) offers free consultation to all IBM 370 users at OSU.

Operating Systems

IBM: batch
DEC-10 and PDP-9: time-sharing, TTY access

Turnaround/Response Time Characteristics

Turnaround time 5 to 20 minutes on IBM 370; 1 to 10 seconds on the DEC

SOFTWARE

Functioning Systems

Name/Author: Dihedra -- T.L Blum
Language/Requirements: BASIC, uses punch tape
Purpose and Features: Provides a formalized plan (score) for the electro-acoustic composition *Dihedra* (uses the concepts from General Systems Theory and Probability Theory for the construction of stochastic music forms
Availability/Documentation: Documentation available for mailing costs

Systems Under Development

Name/Author: Maincomp.F4
Language/Requirements: Fortran (takes 40 disk blocks)
Purpose and Features: Provides a more general program for designing formal structures for compositions; uses statistical distributions and pseudo-random number generators
Availability/Documentation: Incomplete

Proposed Systems

Name/Author: Maincomp.F4 extended
Purpose and Features: I would eventually like to set up Maincomp.F4 for sound synthesis and the macro-structuring of that sounding output

Additional Comments

In working with computers in music, the question becomes, "How much does the computer affect the musical thought?" I find that there is a continuous spectrum of effects. Some would say that the musical thought is totally subordinate to the computer/computational task. Others might say that the computer is strictly a tool which is mastered and functions *for* the user. This fine state is achieved only when all software and hardware are operating exactly as the composer of the thought desired.

I am working between these poles. My programs are in an incomplete state at this time. So, naturally I cannot feel as if the computer and the musical thought are functioning as one. But that is, in one way, the overall goal: to produce the program with which I can interact freely to transform my musical thoughts into their sounding forms.

Name
Penn State University

Address of Institution
Center for Research in Electronic Music
Music Building
Penn State University
University Park, Pennsylvania 16802

Type of Institution
University

Principal Sources of Funding
University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Robert W. Baisley	Music	Director	Administrative	Varying
R. Wilkins	Electronics	Technician	Technical	Full-time

Principal Users
1) B. Fenner
2) B. Trinkley
3) K. Klouser

Date of Inception of Studio and Computer Work
Studio: 1968
Computer: 1975

Areas of Activity
Development of a hybrid system for real-time music performance in a concert situation

Type of Instruction Offered
Composition in Electronic Music

List of Works
No works have been realized with the computer as yet

Publications and Available Manuscripts

None

Public Presentation of Works
Concerts of electronic music (no computer music yet)

HARDWARE

Computers and Digital Hardware
XLO 3300: 8K, 8-bit words

Peripheral Devices

Data Storage
None

Input Devices
TTY; high-speed tape

Output Devices
TTY

Sound Generation

Digital
DAC

Hybrid Systems
Computer -> DAC -> Synthesizer

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Moog III c
Tape recorders: 2 Scully 4-track, 2 Scully 2-track, et al.

Proposed Hardware Developments
Computer program is too new and budgets are too low to predict at this time

Access to Computer
Not available for general use; no cost for use by researchers; free access with studio

Operating Systems
Mini-computer

Turnaround/Response Time Characteristics
Real-time

SOFTWARE

Functioning Systems

Name/Author: Music I -- P. Warme
Language/Requirements: Machine code, 0.75K
Purpose and Features: Provides control voltages for synthesizer - 1 voltage and a trigger only; usable in real-time performance
Availability/Documentation: No

Systems Under Development

Name/Author: Music II -- P. Warme, B. Fenner
Language/Requirements: Machine code, 1K
Purpose and Features: Will provide five voltages and one trigger

Additional Comments

Principal thrust is toward portability and real-time use in concert as well as multi-track taping in the studio

Name

Jeffrey Lederer

Address of Institution

Project Solo
Department of Computer Science
University of Pittsburgh
Pittsburgh, Pennsylvania 15260

Type of Institution

University, "Educational Uses of Computers" research project

Principal Sources of Funding

National Science Foundation

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Dr. T. Dwyer	Mathematics	Director	Technical, artistic	Half-time
Jeffrey Lederer	Computer Science	Programmer	Technical	Full-time
James Berman	Mathematics	Transcriber	Artistic	Half-time

Principal Users

1) James Berman
2) Jeffrey Lederer

Date of Inception of Studio and Computer Work

January 1976

Areas of Activity

We have a computer driven pipe organ. Compositions are created in a special notation language, compiled and then performed. Currently, we are just transcribing and performing existing music.

Type of Instruction Offered

None

Background of Computer Users

The system does not require a previous knowledge of programming. The user must understand the basic abilities and limits of a pipe organ. Our users' experience with computers ranges from novices to mid-level programmers. They have found the system to be direct and clear. The only disappointment is the non-real time nature of the system.

List of Works

None so far

Publications and Available Manuscripts

J.H. Lederer, *Organ Music Language Manual.* Dept. of Computer Science, University of Pittsburgh, November 1976

J.H. Lederer, *Performance System User's Manual.* Dept. of Computer Science, September 1976

J.H. Lederer, "An Inexpensive Computer Driven Pipe Organ System". *Proceedings of the First International Computer Music Conference,* MIT Press, Boston, Mass.

J.H. Lederer, "A Computer Driven Pipe Organ", *Proceedings of the ACM Computer Science Conference*, Anahcim, California, February 1976

J.H. Lederer, *Music Language Graphics Editor User's Manual.* Dept. of Computer Science, June 1976

Public Presentation of Works
There is an audio tape available that demonstrates the system. It has been played at a number of lectures.

Policy for Exchange/Rental of Tapes and Related Materials
The above tape is available for brief loan periods. A copy can be obtained if a blank tape and return postage are sent to Jeffrey Lederer.

HARDWARE

Computers and Digital Hardware
PDP 11/40: 28 Kwords (16-bit)
Intellec 8/model 80: 8K, 8-bit words
Altair 8800B (with 2-80 processor): 64K, 8-bit words

Peripheral Devices

Data Storage
Cartridge disk; diskettes

Input Devices
Plasma display terminals; hard copy terminals

Output Devices
Hard copy terminals

Sound Generation

Digital
None

Hybrid Systems
Computer driven pipe organ

Mixed Digital Systems
None

Other Peripheral Devices

Analog
None

Proposed Hardware Developments
Currently, we have the PDP-11 upline loading the Intellec. The Intellec drives the pipe organ. We are in the process of converting the entire system to run on the Altair microcomputer. In addition, we plan to add a harpsichord to the system.

Access to Computer
The PDP-11 (on which the compositions are created) is available for composers 80% of the time during working hours; the Intellec is dedicated to the pipe organ and always available

Availability of Technical Assistance
The author of the software is available during the day to lend assistance to the users. There are also users' manuals to aid the composers.

Operating Systems

On the PDP 11/40 we are running RSTS, a small time-sharing system. The microcomputers are running real-time operating systems of our own design.

Turnaround/Response Time Characteristics

A typical composition (15 minutes of performance) takes about a day to input. This can be compiled in under 20 minutes. After compilation it can be performed immediately (assuming the pipe organ is available)

SOFTWARE

Functioning Systems

Name/Author: MUSCOM -- Lederer 11/76
Language/Requirements: Basic Plus code, 20K words
Purpose and Features: Compiles scores written in Organ Music Language; outputs a listing file and an object file
Availability/Documentation: Yes

Name/Author: MULAG -- Lederer 6/76
Language/Requirements: Basic Plus, 20K
Purpose and Features: Creates scores in Organ Music Language; uses a plasma display terminal
Availability/Documentation: Yes

Name/Author: MUSIC -- Lederer 6/76
Language/Requirements: Basic Plus & 8080 Assembly language; 20K words + 400 bytes
Purpose and Features: Performs previously compiled scores on the pipe organ; loosely couples the two computers together
Availability/Documentation: Yes

Proposed Systems

Name/Author: MUSIC2
Language/Requirements: Z-80 Assembly language, 100K bytes
Purpose and Features: To combine the above systems for real-time performance through direct interpretation of Organ Music Language files; will be able to play small segments of scores without compiling an entire piece
Availability/Documentation: No

Additional Comments

The system has been running since February 1976. The music notation language is still evolving, but it has remained upward compatible. The graphic music editor, which runs on a PLATO type terminal, has made the inputting of scores very easy. Because of job swapping, we were unable to drive the pipe organ from the time-sharing system. This problem was corrected by using a microcomputer to buffer the object files. As we gained more experience with micros, we realized that we could eliminate the need for the time-sharing system. Our next system will drive the pipe organ directly from files stored on a micro's diskettes.

Name

University of Pittsburgh

Address of Institution

Electronic Music Studio
Music Department
University of Pittsburgh
Pittsburgh, Pennsylvania 15260

Type of Institution

University

Principal Sources of Funding

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Robert Morris	Composition, ethnomusicology	Director of studio	Artistic	Half-time
Wayne Slawson	Composition, psychoacoustics, math	Director of computer music project	Artistic, technical	Half-time

Principal Users

About 30 composers, both students and faculty

Date of Inception of Studio and Computer Work

Studio: 1968
Computer work: 1972

Areas of Activity

Production of tape music and computer music

Type of Instruction Offered

Course in electronic music; private study in computer music

Background of Computer Users

Students have no background in computers, for the most part, but they get some while working on the system

List of Works

poor flesh and trees, poor stars and stones (W. Slawson), realized in tape studio

Publications and Available Manuscripts

Wayne Slawson, *SYNTAL II: A Computer Synthesizer Revisited*, in mimeoform

Public Presentation of Works

About five concerts of tape music per year in Pittsburgh; tapes are available for presentation elsewhere

Policy for Composers' Rights and Contracts

Depends on individual case

HARDWARE

Computers and Digital Hardware
PDP-10: 2 Mwords (36-bit). This system is shared with the rest of the University.

Peripheral Devices

Data Storage
Large disks

Input Devices
Card readers, terminals

Output Devices
Printers

Sound Generation

Digital
DAC

Hybrid Systems
None

Mixed Digital Systems
None

Proposed Hardware Developments
We plan to use a microcomputer facility to control the electronic music studio

Access to Computer
Cost is paid through University overhead

Availability of Technical Assistance
Available both in the Music Department and from Computer Centre personnel

Operating Systems
An adaptation of the standard DEC PDP-10 operating system: time-sharing

Turnaround/Response Time Characteristics
Fast

SOFTWARE

Functioning Systems

Name/Author: SYNTA L-II – Slawson (1977)
Language/Requirements: Fortran, 16K, DAC
Purpose and Features: Specification of music; features nested macros, nested repeats, user defined macros, long-term envelope generation for selected parameters
Availability/Documentation: From author

Name

Godfrey Winham Laboratory, Princeton University

Address of Institution

Department of Music
Princeton University
Princeton, New Jersey 08540

Type of Institution

University

Principal Sources of Funding

University

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Mark Zuckerman	Music	Co-director, systems programmer	Musical, technical, research, teaching	Part-time
Kenneth Steiglitz	Elec. engineering	Co-director	Technical, research, teaching	Part-time

Date of Inception of Studio and Computer Work

Studio: 1970
Computer work: 1963

Areas of Activity

Computer sound synthesis and analysis; speech synthesis and analysis; electronic music; music information retrieval systems; computer music autography

Type of Instruction Offered

MUSIC 523 - Introduction to Electronic Music
MUSIC 524 - Composition for Digital Computer
Inidividual instruction

Background of Computer Users

The majority of the lab users are from the Music Department. The average Music Departmental has had no computing experience prior to his involvement with the lab, and wants to learn just enough about computing to realize a piece of music

List of Works

1) *Croup Variation II* (B. Boretz 1973), realized with MUSIC360
2) *3 Pieces for Computer* (F. Brickle 1974), MUSIC360 and 4BF
3) *Variosa* (Brickle 1975), 4BF
4) *Flute Suite* (Brickle 1976), 4BF
5) *Romanze* (Brickle 1976), 4BF
6) *Bete Noire* (Brickle 1976), 4BF
7) *Bonnylee* (R. Cann 1972), MUSIC360
8) *Ampersand* (Cann 1973), MUSIC360
9) *Maentwrog* (Cann 1976), 4BF
10) *Maud* (M. Dellario 1976), 4BF
11) *Changes* (C. Dodge 1969), 4BF
12) *Earth's Magnetic Field* (Dodge 1970), 4BF
13) *Aspects of 3 Tetrachords* (E. Graebner), MUSIC360 and 4BF

14) *P-Vibes* (J. Gressel 1972), MUSIC360 and 4BF
15) *Exercycles* (Gressel 1973), MUSIC360
16) *Points in Time* (Gressel 1974), MUSIC360
17) *Unwinding* (Gressel 1976), MUSIC360
18) *Convergence* (E. Haimo 1974), MUSIC360
19) *Time Points* (J. Harvey), MUSIC360
20) *Computer Variations* (H.S. Howe 1967-68), 4BF
21) *Mild und Leise* (P. Lansky 1973-74), MUSIC360
22) *Artifice* (Lansky 1975-76), 4BF
23) *Antiphon* (R. Meckstroth 1973), MUSIC360
24) *Forandre* (J. Melby), MUSIC360 and 4BF
25) *91 Plus 5* (Melby 1970-71), MUSIC360
26) *Valedictory* (Melby 1973), MUSIC360
27) *Suspensions* (P.H. Patrick 1973), MUSIC360
28) *Quartets in Pairs* (J.K. Randall 1964), MUSIC4
29) *Mudgett* (Randall 1965), 4B
30) *Lyric Variations* (Randall 1968), 4B
31) *Quartersines* (Randall 1969), 4BF
32) *Music for Eakins* (Randall 1974), MUSIC360
33) *Templum* (H. Tann 1976), MUSIC360
34) *Polyvalence* (D. Thome 1972), MUSIC360
35) *January Variations* (Thome 1973), MUSIC360
36) *Los Nombres* (Thome 1974), MUSIC360
37) *Digressions* (B. Vercoe 1968), MUSIC360
38) *Synthesism* (Vercoe 1970), MUSIC360
39) *Miniature* (G. Warfield 1966), 4B
40) *Work in Progress* (G. Winham 1970), 4B

Publications and Available Manuscripts

Godfrey Winham and Kenneth Steiglitz, "Input Generators for Digital Sound Synthesis", in the *Journal of the Acoustical Society of America*, February 1970

Kenneth Steiglitz, Godfrey Winham and John Petsinger, "Pitch Extraction by Trigonometric Curve Fitting", in *IEEE Transactions on Acoustics, Speech, and Signal Processing*, June 1975

Leah Siegel, Kenneth Steiglitz and Mark Zuckerman, "The Design of Markov Chains for Waveform Generation", delivered at IEEE EASCON, Washington, D.C., October 1975. Appeared in the *Proceedings*, 1976. To appear in *IEEE Transactions*, 1977

Mark Zuckerman and Kenneth Steiglitz, "Using Circulant Markov Chains to Generate Waveforms for Music", delivered at Music Computation Conference II, University of Illinois at Urbana-Champaign, November 1975. To appear in the *Proceedings*, 1976

Richard Cann, Paul Lansky, Kenneth Steiglitz and Mark Zuckerman, "Practical Considerations in the Application of Linear Prediction to Music Synthesis", delivered at Music Computation Conference III, M.I.T., October 1976. To appear in the *Proceedings*, 1977

Public Presentation of Works

Concerts, broadcasts, disks, exchanges

Policy for Exchange/Rental of Tapes and Related Materials

We will send to anyone sending us a tape and adequate instructions a copy of any programs to which we have exclusive rights. Exchange of audio tapes and pieces can be arranged by contacting the composer(s) involved

Policy for Composers' Rights and Contracts

Protection of composers' rights and contracts is the composers' responsibility

HARDWARE

Computers and Digital Hardware

IBM 360/91: 2M, 8-bit words
IBM 370/158: 2M, 8-bit words
(The above are for general Princeton University use)

HP 2116C: 16K, 16-bit words
HP 2100A: 32K, 16-bit words
(The above are in the Winham Lab)

The 2116 has a dual DMA channel; the 2100 has hardware multiply and divide and firmware floating point

Peripheral Devices

Data Storage

800 CPI, NRZI tape; transport speed 75 ips.; 9-track
1600 CPI, PE tape; transport speed 75 ips.; 9-track

Input Devices

ASCII keyboards; ASR33 TTY; ADC (12-bit); X-Y encoder (7-bit); photo-reader (300 cps)

Output Devices

Dot-matrix printer; ASR33 TTY (8-level punch); flat-bed X-Y plotter

Sound Generation

Digital

2 DACs (16-bit)

Hybrid Systems

None

Mixed Digital Systems

None

Other Peripheral Devices

Analog

2-track tape and amplifiers; speakers, headphones; 4 sample and hold filters; 4 smothing filters (2 14kHz, 2 7kHz)

Digital

X-Y CRT display (8-bit resolution)

Access to Computer

Students and visitors may receive computer budgets for the University machines. Access to the Winham Lab is limited, but anyone with a digital tape in the proper format may have his tape D/A converted at no charge.

Availability of Technical Assistance

Faculty members of the Music Department are available for help, and there is a programming clinic in the University Computer Center.

Operating Systems

IBM 360/91 - LASP-OS/360 (batch)
IBM 370/158 - VM/370 (time sharing)
Winham Lab - ZTS: interactive single-user tape operating system

Turnaround/Response Time Characteristics
IBM systems: turnaround 1-24 hours
Winham Lab: turnaround immediate

SOFTWARE

Functioning Systems

Name/Author: MUSIC4B -- G. Winham, T. Robison, H. S. Howe, M. Zuckerman (1964-74)
Language/Requirements: Fortran code
Purpose and Features: General-purpose sound synthesis
Availability/Documentation: Documentation published

Name/Author: Speech synthesis -- K. Steiglitz, G. Winham, M. Zuckerman, R. Cann (1970-76)
Language/Requirements: Fortran code
Purpose and Features: Speech analysis and synthesis using linear production
Availability/Documentation: Documentation published

Name/Author: DAD -- K. Steiglitz, G. Winham, M. Zuckerman (1970-74)
Language/Requirements: HP assembler code, uses 8K (16-bit), requires mag tape drive
Purpose and Features: D/A and A/D conversion program on HP 2116, for use with MUSIC4B, MUSIC4BF and MUSIC360
Availability/Documentation: Documentation published

Name/Author: MOM -- G. Winham, M. Zuckerman (1972-74)
Language/Requirements: Fortran, HP assembler, uses 24K (16-bit), requires 2 tape drives
Purpose and Features: Fast-turnaround, general-purpose sound synthesis on HP 2100 and HP 2116
Availability/Documentation: Documentation published

Name

Queens College Electronic Music Studio

Address of Institution

Department of Music
Queens College
Flushing, New York 11367

Type of Institution

Queens College of the City University of New York

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Hubert S. Howe, Jr.	Music	Director	Artistic, administrative	Part-time

Principal Users

1) College faculty
2) Graduate students
3) Undergraduate students

Date of Inception of Studio and Computer Work

Studio: 1968
Computer acquired: 1969

Areas of Activity

Composition, sound synthesis

Type of Instruction Offered

Fundamentals of Tape Studio Composition
Computer Synthesis of Electronic Music
tutorials in composition (on graduate level)

Background of Computer Users

B.A. in Music or equivalent. No previous experience with computers assumed. Students are generally enrolled in M.A. program at Queens College or Ph.D. program at the City University of New York

List of Works

All works below realized entirely with computer facility; all by H. S. Howe, Jr.

1) *Interchanges* (1970-71)
2) *Macro-Structures* (1971)
3) *Freeze* (1972)
4) *Three Studies in Timbre* (1970-73)
5) *Canons* (1974)

Public Presentation of Works
Annual concert
An occasional broadcast prepared for radio station WNYC

Policy for Exchange/Rental of Tapes and Related Materials
Tapes of works available from American Composers' Alliance, 170 W. 74th Street, New York, New York 10023.

HARDWARE

Computers and Digital Hardware
IBM 370/168: 2 Mbytes
Xerox Sigma-7: 131K words

(These are general College and University facilities available to users of the Electronic Music Studio. D/A conversion available on the Sigma-7 only.)

Peripheral Devices

Data Storage
IBM 370: 12 tapes, 16 model 3330 disks
Sigma-7: 3 800-BPI tapes, 4 disks

Input Devices
Both systems take card or terminal input. In general, Sigma-7 is run from cards, and the 370 from terminals

Output Devices
IBM 370: 3 line printers Sigma-7: 1 line printer, 2 plotters

Sound Generation

Digital
Sigma-7: DACs (stereo)

Hybrid Systems
None

Mixed Digital Systems
None

Proposed Hardware Developments
Implementation of D/A conversion in quad

Access to Computer
Reasonable amounts of computer time provided free to students and faculty

Availability of Technical Assistance
Programming assistance available but usually worthless
Technical staff for computer facilities very good

Operating Systems
Time-sharing and batch processing available on both systems

Turnaround/Response Time Characteristics
Response time excellent. Turnaround time can be immediate, but more costly to run jobs during the day. Deferred priority jobs run late at night; all jobs under 20 minutes on IBM 370 run in no more than one day

SOFTWARE

Functioning Systems

Name/Author: MUSIC7 – Howe
Language/Requirements: Metasymbol, Fortran IV code, 42K
Purpose and Features: Music synthesis; features a programming language for design of instruments
Availability/Documentation: Available free; documentation in manual

Name/Author: MUSIC4BF – Howe
Language/Requirements: Fortran IV, 100K
Purpose and Features: Same
Availability/Documentation: In book

Name/Author: MUSIC360 – B. Vercoe
Language/Requirements: 360 Assembler, Fortran IV, 130K
Purpose and Features: Same as above
Availability/Documentation: Available from IBM; documentation in manual

Additional Comments

This questionnaire does not fit the format of our installations very well. The computer facilities are independent of the Queens College Electronic Music Studio, although most users use the studio for splicing and editing. The studio is a conventional synthesizer studio with no computer equipment.

Name

Dr. Gary M. Rader

Private Address

617 W. 24th,
Spokane, Washington 99203

Address of Institution

Computer Science Department
University of Ife
Ile-Ife, Nigeria (temporary)

Type of Institution

University

Principal Sources of Funding

None

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Dr. G.M. Rader	Computer Science	Sole investigator	Formalization via computer of artistic creative processes	Part-time

Date of Inception of Studio and Computer Work

Work on computer-composed music: 1972

Areas of Activity

Computer composition of traditional styles of music; currently work focuses mainly on techniques of composing simple traditional melodies by computer

Type of Instruction Offered

None

Background of Computer Users

Ranges from none to any amount of musical training with the ability to perceive the various aspects of music as formal patterns. The ability to change parameters and constrain the music to be generated intelligently depends on this capability. A user who knows nothing would use the system set as it is (and would obtain reasonable music but would have no control over it).

List of Works

Rounds 1-27. Composed wholly by computer.

Two 2-part keyboard inventions with higher level patterns similar to Bach's 2-part inventions in C major, and two other simple two-part pieces in sonata form. These four pieces were computer-composed in that the composer determined the higher-level patterns which were to appear in the pieces but the actual notes were determined by the computer system

Publications and Available Manuscripts

"An algorithm for the Automatic Composition of Simple forms of Music Based on a Variation of Formal Grammars", Moore School Rep. 73-09, University of Pennsylvania

"A Method for Composing Simple Traditional Music by Computer", *Communications of the ACM,* November 1974

"The Formal Composition of Music", Department of Computer Science *Technical Report 77-1,* University of Ife, Ile-Ife, Nigeria, 1977

Policy for Exchange/Rental of Tapes and Related Materials
Academic conferences and colloquiums

Policy for Composers' Rights and Contracts
None

HARDWARE

Computers and Digital Hardware
System is written in APL and has run on several computers -- IBM 360 and 370 series, and Univac Spectra 7090

Output Devices
APL terminal

Operating Systems
Runs under APL

Turnaround/Response Time Characteristics
On Spectra 7090, a 2-part keyboard invention similar to Bach's 2-part invention in C major took about 750 seconds running in a time-shared environment.

On IBM 360/50, a 9-measure, 4/4 meter, 3-part round took about 5 seconds (again running in a time-shared environment)

SOFTWARE

Functioning Systems

Name/Author: Round Composing System -- Rader (1973)
Language/Requirements: APL program, uses 40K
Purpose and Features: Generates musical rounds; user can indicate the number of parts he wants, the length of the round, meter (3/4, 4/4 or 6/8), and set various weights and switches. Output is pseudo-musical score.

Systems Under Development

Name/Author: MUSCOMP -- Rader (1974)
Language/Requirements: APL program, uses 60K
Purpose and Features: Generates entire pieces of music, including the higher level organization of the piece; allows experimentation with various formal theories of music composition. The system can be used as it is with initial settings, or these can be changed by the user by specifying various higher level aspects and changing weights and switches. Output is pseudo-musical score. Range possible is 4 octaves chromatic

Proposed Systems

Name/Author: Rader
Language/Requirements: APL program, uses 60K
Purpose and Features: Extension of MUSCOMP to allow user to input words and obtain songs using these words; the program will also accept information about the words such as which are more important, which rhyme, etc.

Additional Comments

The composer's work and systems are aimed at understanding and duplicating the processes by which non-contemporary styles of music are composed. The goals are a system which is interactive and easy to use and requires no special knowledge about computers or computer terminology, whose output is ordinary musical score, whose pieces can be controlled to any degree desired,

and which composes music that sounds good to the average layman. Thus, the aim is a general system which allows a user to work within it and develop styles of music of his own interest with a minimum of attention paid to non-interesting computer details.

Name
Jef Raskin

Private Address
P. O. Box 511
Brisbane, California 94005

Type of Institution
Private

Principal Sources of Funding
Private

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jef Raskin	Music, computer science	Director	Artistic, technical	Part-time
Doug Wyatt	Music, computer science	Musician, programmer	Artistic, technical	Part-time

Date of Inception of Studio and Computer Work
First computer music produced by Raskin in 1971

Areas of Activity
Computer music production; the present system is for personal use

Type of Instruction Offered
Private lessons on computer music

List of Works
1) *Piece of Beasts*, realized by voices and instruments
2) *Jack and the Beanstalk*, for voices and instruments
(both of these realized partly with computer)

Public Presentation of Works
The two works mentioned have been performed a number of times in concert

HARDWARE

Computers and Digital Hardware
Polymorphic Systems model 88: 44K, 8-bit words

Peripheral Devices

Data Storage
Mag tape (cassette)

Input Devices
CRT terminal; mag tape; paper tape; keyboards

Output Devices
Line printer; plotter

Sound Generation

Digital
Own build of DAC

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Tape recorders, etc.

Access to Computer
The system cost about $2000; no maintenance costs since owned

Availability of Technical Assistance
None necessary

Operating Systems
Our own

Turnaround/Response Time Characteristics
Immediate response time

SOFTWARE

Functioning Systems
In the mid 1960's I wrote a number of programs for computer music typography. They were very successful but the publishers approached were not interested.

Additional Comments

Having used large, expensive computers for many years we find the small, cheap, fast microcomputers the way to go.

We are also using the microcomputer to interface our pipe organ keyboard to the pipes.

Name

Curtis B. Roads

Private Address

Box 853
Del Mar, Calif. 92014

Address of Institution

Employed at the Center for Music Experiment
University of California, San Diego at La Jolla

Date of Inception of Studio and Computer Work

October 1972

Areas of Activity

Composition (score-generating programs)
Synthesis (sound-generating) programs

List of Works

1) *3-S*, for string textures (1972), partly with computer
2) *Colligation 1*, electro-acoustic realization (1973), computer generated score
3) *Colligation 2*, electro-acoustic realization (1974), computer generated score
4) (prototype), composition program model, (computerized) granular synthesis (1975)
5) *D type*, realization in progress (1976), computer-generated score

Publications and Available Manuscripts

Author's manuscripts:

1) "Documenta: *MC-2* program" (1974), 46 pages and chart
2) "An aesthetics of algorithmic music" (1974), 19 pages
3) "On Formalization" - a philosophical survey of formalization with implications for composition (1975-76), 50 pages
4) "A Systems Approach to Composition and Decomposition", documentation and explanation of the *Procsessing* composition program (1976), 80 pages, with figures

Public Presentation of Works

1) Occasional concerts of electro-acoustic tape compositions
2) Monthly concert broadcasts over KPBS-FM (Public Broadcasting System) "Sound Sculpture Gallery" program

Policy for Exchange/Rental of Tapes and Related Materials

Tapes available for cost and postage

Policy for Composers' Rights and Contracts

Performance fee waived for non-profit concert or broadcast
Scaled performance fee if admission charged
All compositions are copyrighted and ASCAP licensed

HARDWARE

Computers and Digital Hardware

See Center for Music Experiment (at La Jolla, CA)

SOFTWARE

Functioning Systems

Name/Author: MC-1
Language/Requirements: Nova Basic code, 12K (16-bit)
Purpose and Features: Score-generation; stochastic value generation with feedback and analysis, which produces ergodically-developing output
Availability/Documentation: Paper tape, written papers

Name/Author: MC-2
Language/Requirements: Nova Basic, uses 12K
Purpose and Features: same as above

Name/Author: autoklang
Language/Requirements: Burroughs B6700 Algol, uses 64K (48-bit)
Purpose and Features: Sound synthesis, generates 3000 NOT records/minute of sound which serve as input file to pass1 of B6700 MUSIC V; features automated granular (Gabor) synthesis of sound, produces masses of sound grains according to simple composer's input instructions
Availability/Documentation: On punch cards; paper written about the program

Name/Author: Process/ing
Language/Requirements: Burroughs B6700 Algol, 64K (48-bit)
Purpose and Features: 26 musical variables represented by an optimized stochastic automaton interact to produce score data. Several levels of analysis change the networks of interaction. A separate translation routine tranlates the system data into values suitable as input for a synthesis program
Availability/Documentation: On punch cards; paper written about the program

Systems Under Development

Name/Author:
Language/Requirements: Bell Labs UNIX yacc, C, uses 32K (16-bit) and disks
Purpose and Features: Front-end processor consisting of an interactive language for the construction of algorithms (synthesis) and a corresponding interpreter and library of compositional procedures. Produces data which functions as an input file to CME sound synthesis systems, in particular Timbre Training System (TTS) by B. Leidig. Features ineractive, modular library of compositional procedures. Reduces the otherwise necessary specification of large amounts of microstructure of sounds for synthesis

Name/Author:
Language/Requirements: yacc, C, uses 32K and disks
Purpose and Features: Specification of experimental musical grammars and their realization. Compiles high level structure statements down into terminals which are symbols for a catalog of comput-synthesized sounds. Features easily modifiable grammar and sound catalog
Availability/Documentation: Not yet

Name
John Snell

Private Address
531 Benvenue
Los Altos, Calif. 94022

Type of Institution
Private

Principal Sources of Funding
Outside work (as an electronics engineer)

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
John Snell	Electronics, music, programming	Engineer, programmer, composer	Artistic, technical	Half-time
Ken Jenkins	Electronics	Design engineer, artist	Artistic, technical, metaphysics	Half-time
Dean Cutler	Kinetic light art	Technician, artist	Artistic, technical, metaphysics	Half-time

Principal Users
1) John Snell
2) Ken Jenkins
3) Dean Cutler
4) Glenda Walen

Date of Inception of Studio and Computer Work
Computer work: 1967
Studio work (analog music): 1969
Computer music instrument design: 1970
Computer music on a PDP-10: 1973

Areas of Activity
Design of real-time hardware for synthesis of timbre by Fourier-like methods, FM methods, as well as circuits for real-time solution of equations like those suggested by Andy Moorer and Mark Lebrun for timbre synthesis; design of real-time controllers with high sensitivity to position and movement of musician's hands as well as applied pressure; composition

Type of Instruction Offered
I edit the *Computer Music journal* which contains useful information for teaching a course on computer music.

List of Works
1) *Sea to Sky* (realized in part with analog processor)
2) piece in progress for computer, flute and piano
3) Handel's *Water-Music*- "Air" (digital computer)
4) *Yantra,* a colour video kinetic abstract art and music piece realized for the most part on analog processors by Ken Jenkins, Dean Cutler, John Snell, Bob Orban, Iasos and Jeff Chandler.

Publications and Available Manuscripts

Snell, John, "Computer Music Bibliography", Dr. Dobb's *Journal of Computer Calisthenics & Orthodontia*, Vol. 1, No. 7, August 1976
Snell, John, "Analog and Digital Electronic Music Instrument Design 1971" (unpublished)

I will publish several articles this year in *Computer Music Journal*. The first will describe digital circuits used for real time timbre synthesis. Another will describe the design of a real-time controller of computer music instruments. It is a surface which detects the positions of many fingers (or other objects): to the left or right movement, forward or backward movement, and pressure.

Public Presentation of Works

Sea to Sky has been played in several tape concerts and has been broadcast on the radio.

Yantra was played many times in an art museum in San Francisco called Capricorn Assunder in an exhibition called *Video October* (1976)

HARDWARE

Computers and Digital Hardware

6800 microcomputer: 9K, 8/16-bit words

Processor being constructed: home built from AM2900 series low power Schottkey 4-bit microprocessor slices (16-24 bit accumulators or general purpose registers): 8K

Peripheral Devices

Data Storage

6 platter hard disk drive Singer Friden Division 9311 (similar to IBM 2311 disk drive); 15 disk packs (6 platters each) 2311-type hard disks

Input Devices

Homemade video terminal (high-speed); I will soon add several real-time music instrument controllers. One is a traditional organ type keyboard with sensitivity to depth of key depression (from which key velocity can be determined — velocity is rate of change of key position). Pressure-sensitive pads will also be used to control amplitude envelopes, frequency envelopes, index of modulation for FM synthesis, etc. A three-dimensional polyphonic surface plane is also under contruction.

Sound Generation

Digital

12-bit DAC, will soon be replaced by 16-bit DAC

Hybrid Systems

Sample and hold device on output of DAC; also a low pass filter on the output of the sample and hold

Mixed Digital Systems

Digital oscillator which will produce 256 ultra low distortion sine waves. I will soon add a very high speed mutiplier (16x16 bit -> 16-bit product in less than 20ns) plus digital filters to my real-time computer music instrument. The above digital oscillator will also produce many of the Chowning type FM instruments.

Other Peripheral Devices

Analog

Reel-to-reel 1-inch videotape recorder (colour) IVC 870
Reel-to-reel audio tape recorders: Sony 366, Sony 353D
Cassette colour video recorder JVC 6100
Cassette audio recorder Advent
Marantz 4240 receiver, quadraphonic amplifier

4 loudspeakers Advent (largest)
Delay line/phase shifter
Video cameras and related image-processing equipment
Two oscilloscopes; power supplies; function generaotrs
Digital voltmeter; other test equipment

Access to Computer
Own equipment so no computer time cost

Availability of Technical Assistance
Technical assistance in personal equipment given back and forth between many friends

Operating Systems
The AM2900 processor is microprogrammed for highest speed of operation, and a language specifically tailored for music synthesis will be developed in microcode.

The 6800 processor may be programmed in Basic or assembly language. A monitor for examining memory, writing to memory, burning PROMs, assembling and disassembling code is in ROM memory.

Turnaround/Response Time Characteristics
The AM2900 processor is much faster than human response time. It is capable of outputting a sound sample to the DAC every 5us for a quadraphonic sound system. The 6800 system is slower and may respond anywhere from less than a msec. to under a minute, depending on the task.

SOFTWARE

Functioning Systems

Name/Author: Tom Pitman (1976)
Language/Requirements: 6800 Basic, 2K
Purpose and Features: Mathematics, non real-time uses such as sheet music analysis

Name/Author: Snell (1976)
Language/Requirements: 6800 Monitor, assembler, disassembler; 2K, uses PROM burner
Purpose and Features: Burn PROM memory, examine and deposit all memory and peripheral devices

Proposed Systems

Name/Author: AM2900 microcode for 24-bit processor
Language/Requirements: using 16-bit DAC
Purpose and Features: Real-time synthesis of music; timbre synthesis by: sine summation, FM (Chowning type) solution of equations by Moorer & Lebrun

Name/Author: Music composition programs
Language/Requirements: Basic code
Purpose and Features: Would generate control information for digital oscillators and other special-purpose hardware instead of sound samples

Name/Author: Sheet music analysis program
Language/Requirements: Basic

Additional Comments

The AM2900 processor will control digital oscillators, digital filters, multipliers, and other special purpose high-speed hardware for real-time generation of sound samples to be fed to the DAC.

The 6800 processor will be used as an interpreter of input controller information. It will also be used for composition. Several real-time controllers will be constructed including an organ-like keyboard, pressure pads, and a surface which will be sensitive to the position (X and Y co-

ordinates) and pressure of all fingers touching the surface. Left/right movement may control frequency. Forward/backward movement may control some aspect of timbre (such as index of modulation for Chowning type FM synthesis or filtering) or the amplitude of each note. Pressure may control amplitude envelope and/or the index of modulation envelope (for FM synthesis) for each note on each finger (being a polyphonic device). Alternately it could be used as a Fourier series controller. Each finger of several people would control one sine component. Left/right movement would control frequency; pressure would control amplitude and frequency envelopes for each note; forward/backward movement could control phase or period jitter or some other parameter. The surface could be used as a special location positioner and mover of many sounds (one for each finger) - pressure might be used to control reverberation. Doppler shifting could be determined from the speed of movement of each finger. The surface will be a programmable controller. Control information will be stored on the disk at the same time that it is controlling the sound generation hardware (oscillators, filters, etc.). The disk pack may be used like a multitrack analog tape recorder for playing back earlier recorded information while it is recording new control information. Thus you may build up a sound while playing along with yourself. You may control one parameter at a time while the disk plays the other parameters along with you.

Name
Jerry Hunt

Private Address
5815 Swiss Avenue
Dallas, Texas 75214

Address of Institution
SMU
Hillcrest Avenue
BRFM Division
Dallas 75275

Type of Institution
Private (at SMU until January 1977)

Principal Sources of Funding
University, Rockefeller Foundation

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Jerry Hunt	Music	Composer, technical director	Development, composition	Full-time
David Dowe	Art, graphics, video	Director, composer	Development, composition	Full-time
Gordon Hoffman	Elec. engineering	System development	System development	Part-time
Phillip Hughes	Systems analysis	Software development	Software development	Part-time

Principal Users
1) Jerry Hunt
2) David Dowe
3) Gordon Hoffman
4) Phillip Hughes
5) about 15 students per year

Date of Inception of Studio and Computer Work
1971

Areas of Activity
Video-audio synthesis systems performance and real-time oriented work; interactive performance processors, etc. (all since 1974)

List of Works
Procession (videotape) -- part computer control of analog video system

Haramand Plane -- performance work version (1974) using hybrid system; another version under development (1976) using F-S based special purpose processor

Public Presentation of Works
Real-time interactive works -- performance

Video broadcasts in various formats and versions

Videotapes and recordings available from Elec Arts Intermix (New York) and Ocean Records (Cali-

fornia)

Policy for Exchange/Rental of Tapes and Related Materials
Exchange or loan -- direct from centre address
Rental and sale -- see above recording companies

Policy for Composers' Rights and Contracts
Depends on particular case

HARDWARE

Computers and Digital Hardware
PDP 11/35: 32 Kwords (16-bit) (system use through February 1977)

Peripheral Devices

Data Storage
RK11 cassette disk

Input Devices
VT52 video terminal

Sound Generation

Digital
DAC

Hybrid Systems
Hybrid system in use

Other Peripheral Devices

Analog
Two centre-designed analog music systems with interfaces
Two buchla systems (medium size configurations)
Various special purpose music systems
Two video systems, direct, "scanconvert" graphic, and raster transform components analog with interfaces

Digital
Two A/D - D/A systems with RAM and control (12b/12K) designed at the centre
Two special systems for control: real-time performance applications

Proposed Hardware Developments
Completion of conversion facility for television image processing and generation under consideration and three agencies (December 1976)

"F-8" based special purpose real-time sound system under development through private corporate support

Expansion and upgrading of performance characteristics of hybrid system

Additional Comments

We feel in looking over some of this that the direction and applications of much of our work could not be and is not anticipated by the organization of your questions. I hope that some useful documentation of our work can be determined by this rather rapid run-through of your forms. One aspect of your study might in some way approach my feeling that the recent developments in the technical support for electronic work are having a profound effect upon the social and financial structures surrounding so-called digital and analog systems for artists. Our own interests have been almost entirely directed toward diversified special purpose systems optimized for specific and (hopefully eventually) easily altered process configurations.

Name

Center for Computer Research in Music and Acoustics

Address of Institution

Artificial Intelligence Laboratory
Stanford University
Stanford, California 94305

Type of Institution

University

Principal Sources of Funding

University; National Science Foundation; National Endowment for the Arts

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
John Chowning	Music	Research, instruction	Synthesis, computer simulation of music, composition	Full-time
John M. Grey	Music, psychology	Research, instruction	Psychoacoustic research, composition	Full-time
F. Richard Moore	Music, elec. engineering	Research, instruction	Real-time synthesis, composition	Full-time
James A. Moorer	Math, engineering, music, computer science	Research, instruction	Digital signal processing, composition	Full-time
Loren Rush	Music	Research, instruction	Digital processing, composition	Full-time
Leland C. Smith	Music, computer science	Research, instruction	Musical score production, composition	Full-time

Principal Users

Staff, visiting composers, students

Date of Inception of Studio and Computer Work

CCRMA founded in 1975

Areas of Activity

Major research objectives: digital recording, editing and processing (Rush); digital signal processing (Moorer); psychoacoustic research (Grey); advanced synthesis techniques (Chowning, Grey, Moorer); automatic production of musical manuscripts (Smith)

Type of Instruction Offered

Computer Music Seminar: offered during three-quarters of the year, open to graduate and advanced undergraduate students; enrolment limited to 15 due to restricted computer time. This introductory course to computer applications in music is divided into several streams including sound-synthesis techniques, signal processing, psychoacoustics and programming.

Summer Workshop in Computer Music: special six-week course covering basic programming, fundamentals of acoustics and psychoacoustics, and simple production of compositions. 16-20 students per summer (including a number from abroad)

Advanced graduate students work directly with the staff on research projects

Background of Computer Users

For the Computer Music Seminar students are assumed to have competence in music composition or a related field such as psychology or engineering. The Summer Workshops are for musicians and scientists from outside the University

List of Works

1) *Sabelithe* (Chowning 1972), computer-generated quadrophonic tape
2) *Turenas* (Chowning 1972), computer-generated quadrophonic tape
3) *Rhythmicana* (Cowell/Smith 1971), for orchestra and computer-generated stereo tape
4) *Loops* (Erickson/Grey 1974), computer-generated stereo tape
5) *A Little Travelling Music* (Rush 1974), for amplified piano and quad tape
6) *Song and Dance* (Rush 1975), for orchestra and quad tape
7) *Machines of Loving Grace* (Smith 1970), for bassoon, narrator and computer-generated tape
8) *Rhapsody for Flute and Computer* (Smith 1971), for flute and computer-generated stereo tape

Publications and Available Manuscripts

CCRMA publications:

J.M. Chowning, J.M. Grey, J.A. Moorer, L. Rush, *Computer Simulation of Music Instrument Tones in Reverberant Environments*, STAN-M-1, 99pp, 1974

J.M. Grey, *An Exploration of Musical Timbre*. STAN-M-2, 133pp, 1975

J.A. Moorer, *On the Segmentation and Analysis of Continuous Musical Sound by Digital Computer*. STAN-M-3, 165pp, 1975

J.A. Moorer, *On the Loudness of Time-Variant Tones*. STAN-M-4, 18pp, 1975

J.A. Moorer, *The Synthesis of Complex Audio Spectra by Means of Discrete Summation Formulae*. STAN-M-5, 23pp, 1975

PAPERS PUBLISHED

J.M. Chowning, "The Simulation of Moving Sound Sources", *JAES* 2-6, 1971

J.M. Chowning, "The Synthesis of Complex Audio Spectra by Means of Frequency Modulation", *JAES* 21, 526-534, 1973

J.A. Moorer, "The Optimum Comb Method of Pitch Period Analysis of Continuous Digitized Speech", *IEEE Trans. on Acoustics, Speech and Signal Processing*, Vol. ASSP-22, #5, October 1974, pp330-338

J.A. Moorer, "The Use of the Phase Vocorder in Computer Music Applications", Audio Engineering Society *Preprint no. 1146 (E-1)*

J.A. Moorer, "The Synthesis of Complex Audio Spectra by Means of Discrete Summation Formulae", *JAES* Vol 24, #9, Novermber 1976, pp717-727

L.C. Smith, "Score, A Musician's Approach to Computer Music", *JAES* January 1972

L.C. Smith, "Editing and Printing Music by Computer", *Journal of Music Theory*, Fall, 1973

L.C. Smith, "Henry Cowell's 'Rhythmicana'", *Yearbook for American Research*, 1973

PAPERS ACCEPTED FOR PUBLICATION

J.A. Moorer, "Signal Processing Aspects of Computer Music - A Survey". Invited paper, accepted for publication in the *Proceedings* of the IEEE, sceduled for July 1977

J.M. Grey, J.A. Moorer, "A Perceptual Evaluation of Synthetic Music Instrument Tones", *JASA*

J.M. Grey, " multidimensional Perceptual Scaling of Musical Timbres", *JASA*, May 1977

PAPERS IN PREPARATION

J.M. Grey, J.W. Gordon, "Perceptual Effects of Spectral Modifications on Musical Timbres", for *JASA*

J.M. Grey, "Perceptual Continuity of Interpolations Between Musical Timbres", for *JASA*

J.M. Grey, "Multidimensional Scaling of Interpolated Music Instrument Tones", for *JASA*

G. Loy, *Reference Manual and Tutorial for the Systems Concepts Digital Synthesizer*, STAN-M-6, 95pp, 1977

F.R. Moore, *Real Time Interactive Computer Music Synthesis*, STAN-M-7, 1977

J.A. Moorer, L. Rush, G. Loy, "All-Digital Sound Recording", for *JAES*

L. Rush, J.A. Moorer, "Editing, Mixing and Processing Digitized Audio Waveforms", for *JAES*

L. Rush, J.M. Grey, "Relating Digital Techniques: Analysis, Synthesis and Processing of Recorded Sound".

Public Presentation of Works

Throughout the academic year, CCRMA gives a monthly demonstration which is open to the public, but not widely publicized. The average attendance is around 50 people.

All of the CCRMA compositions listed above have been performed many times both in the Unites States and abroad.

HARDWARE

Computers and Digital Hardware

PDP-10

SOFTWARE

Functioning Systems

Name/Author: MUSIC 10 -- Chowning, Moorer
Language/Requirements: 30K, uses disks
Purpose and Features: Direct synthesis

Additional Comments

Much work is done in coöperation with IRCAM, Paris, France.

Contact CCRMA directly for specifics on hardware, software and other details.

Name
Diane Thome

Address of Institution
School of Music
University of Washington
Seattle, Washington 98105

Date of Inception of Studio and Computer Work
Computer work begun at Princeton: 1970

Areas of Activity
Computer composition

List of Works
1) *Los Nombres* (1974), for piano, percussion, computer-synthesized tape
2) *January Variations* (1973), computer-synthesized tape
3) *Polyvalence* (1972), for computer and six players (flute, clarinet, piano, violin-viola, cello, percussion
4) Eleven non-computer realized compositions

Public Presentation of Works
Concerts

HARDWARE

Computers and Digital Hardware
I have used the IBM Model 360/91 at Princeton University, running Barry Vercoe's MUSIC360 program

Name
University of Tulsa

Address of Institution
University of Tulsa
600 S. College
Tulsa, Oklahoma 74104

Type of Institution
University

Principal Sources of Funding
University of Tulsa

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
James H. Justice	Mathematics	Director	Artistic, technical (analysis & synthesis techniques)	One-quarter time
Wm. E. McKee	Music	Director	Artistic (composition)	One-eighth time
D.G. Gaither	Music	Technical Co-ordinator (organization, composition)	Artistic, technical	One-eighth time
Bing Vassaur	Music, mathematics	Programming consultant	Artistic, technical	Occasional

Principal Users
1) J.H. Justice
2) Wm. E. McKee
3) D.G. Gaither
4) Students

Date of Inception of Studio and Computer Work
1972

Areas of Activity
Research in analysis and synthesis techniques; some work in music theory; composition

Type of Instruction Offered
Course entitled "Music by Computer" taught each spring semester; numerous lectures and seminars to interested groups

List of Works
1) *Study I* (McKee), for computer, piano, trumpet, French horn
2) *Drums and Bells* (as above)
3) *Baraba* (Gaither), computer alone
4) *Images in the Seaward Wind* (Gaither, Justice), computer alone

Publications and Available Manuscripts

J.H. Justice, "Recursive Filtering in Music Computation", *Proceedings*, Music Computation Conference II, University of Illinois

J.H. Justice, "Analytic Signal Processing by Music Computation", *Proceedings*, First International Music Conference. MIT

J.H. Justice, Bing Vassaur, "An Amplitude Control Scheme for Computer Generated Music", submitted to Acoustic Society of America

Public Presentation of Works
Numerous speaking engagements; radio and television interviews; TV documentary produced in 1976

HARDWARE

Computers and Digital Hardware
Xerox Sigma VI: 128K, 32-bit words
Interdata Model 70: 64K, 32-bit words

Peripheral Devices

Data Storage
Private disk; mag tape

Input Devices
Card reader; Hazeltine 1200 CRT terminal

Output Devices
Line printer; Calcomp plotter

Sound Generation

Digital
DAC (8-bit)

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
TEAC 2- and 4-channel tape decks; SAE Amplifiers, equalizer; Altec speakers

Proposed Hardware Developments
Graphic CRT terminal with graphic tablet; ADC

Access to Computer
Available from midnight to 7:00 a.m.; cost underwritten by University

Availability of Technical Assistance
Operating and technical assistance available; no programming assistance

Operating Systems
Time-sharing on Sigma VI, sign-up on mini-computer (user for conversion only)

Turnaround/Response Time Characteristics
Overnight turnaround 4 days/week

SOFTWARE

Functioning Systems

Name/Author: SYMPFONICS -- Vassaur (1972)
Language/Requirements: Fortran, machine languages; uses disk, tape
Purpose and Features: Complete generation and organization of sound; research oriented, features coding system easy for musicians
Availability/Documentation: None

Proposed Systems

Name/Author: Music 7 -- H. Howe

Name
University of Utah

Address of Institution
Computer Science Department
Merrill Engineering Building 3160
University of Utah
Salt Lake City, Utah 84112

Type of Institution
University

Principal Sources of Funding
Private and institutional

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Ercolino Ferretti	Music, engineering	Director	Art, technology	Full-time

Principal Users
Director and students

Date of Inception of Studio and Computer Work
1953

Areas of Activity
"Analysis by Synthesis" and "Synthesis by Rule"

Type of Instruction Offered
CS 565 Computer Music Seminar
Analysis of musical sounds

Background of Computer Users
Most students are engineering or computer science majors with an interest in music.

Publications and Available Manuscripts

E. Ferretti, "The Computer as a Tool for the Creative Musician". *Computers for the Humanities? A Record of the Conference Sponsored by Yale University,* January 22-23, 1965 (Yale University Press, New Haven 1965, pp. 107-112)

E. Ferretti, "Some Research Notes on Music with the Computer", *American Society of University Composers, Proceedings of the First Annual Conference,* April 1966 (1968, pp. 38-41)

S. Boll, E. Ferretti and T. Petersen, "Improving Synthetic Speech Quality using Binaural Reverberation". *IEEE International Conference on Acoustics, Speech and Signal Processing,* April 12, 1976, Philadelphia.

HARDWARE

Computers and Digital Hardware
PDP-10: 128K, 36-bit words

Peripheral Devices

Data Storage
Disk, mag tape, DECtape

Input Devices
Tektronix 4010 Display terminal; ADC

Output Devices
Teletype

Sound Generation

Digital
DACs

Proposed Hardware Developments
32-bit floating-point microprocessors; standardization of Interfacing Modules for I/O; multiport memory

SOFTWARE

Functioning Systems

Name/Author: Computer Music III – Ferretti
Language/Requirements: Fortran, PDP-10 Macro code, uses 30K, tapes, DACs, display terminal
Purpose and Features: Research and development for understanding and synthesizing live sounds and music; very flexible interactive capabilities, especially for analysis by synthesis

Name
Virginia Commonwealth University

Private Address
Dr. Loran F. Carrier
1208 Laburnam Ave.
Richmond, Virginia 23227

Address of Institution
Virginia Commonwealth University
919 W. Franklin St.
Richmond, Virginia 23284

Type of Institution
University

Principal Sources of Funding
State, grants, self

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
L. F. Carrier	Electronic music composition, programming	Director, teacher, composer	Artistic, some technical	Full-time

Date of Inception of Studio and Computer Work
1973

Areas of Activity
1) Electronic music synthesis
2) Acoustics
3) Digital applications

Type of Instruction Offered
1) Introduction to Electronic Music
2) Advanced Control Systems (some digital)
3) Projects in Electronic Music (some digital)

Background of Computer Users
Little or none

List of Works
None to date

Publications and Available Manuscripts

None to date

Public Presentation of Works
Many public concerts of compositions
One record (privately issued)

HARDWARE

Computers and Digital Hardware
IBM 370-145: very large capacity
IMSAI 8080: 1 Mbyte, 8-bit words

Peripheral Devices

Data Storage
Cassette; mag tape; floppy disk

Input Devices
ADCs; one CRT terminal

Output Devices
Teletype

Sound Generation

Digital
DAC

Hybrid Systems
None

Mixed Digital Systems
Digital synthesizer under development, using SERGE synthesizer

Other Peripheral Devices

Analog
16x16 switching matrix
Viking Studio 90
Teac 3340 4-channel tape recorder

Digital
Honeywell Model 1000
Paper tape (REMCO)

Proposed Hardware Developments
Development of a microprocessor based mixed-digital system: the principal components will include a microprocessor with digital cassette backup memory. The microprocessor will provide switching and control information to a digital synthesizer whose output will be fed in turn to the DAC. In addition, information will be input to the microprocessor via an ADC.

Access to Computer
Up to the user

Availability of Technical Assistance
Very little

Operating Systems
Micro-computer, disk terminal; it is hoped to tie in a piano-like keyboard later

Turnaround/Response Time Characteristics
Fairly good; some delay because of need to check data and repeating of patterns

SOFTWARE

Functioning Systems

Systems Under Development

Name/Author: DOC -- Carrier
Language/Requirements: Fortran code, uses 20K
Purpose and Features: Fourier analysis
Availability/Documentation: None yet

Proposed Systems
Development of a reliable program that will act as an operator system for control purposes

Name
Xerox Research Center

Address of Institution
Xerox Research Center
3333 Coyote Hill Road
Palo Alto, California 94304

Type of Institution
Private corporation

Principal Sources of Funding
Internal corporate funds

Staff

NAME	BACKGROUND	RESPONSIBILITIES	AREAS OF PERSONAL INTEREST	TIME COMMITMENT
Alan C. Kay		Director		
E.B. Kaehler	Computer science	Systems design, programming	Technical	Occasional
W. Chris Jeffers	Music	Applications design, programming	Artistic, pedagogical	Occasional

Areas of Activity
Sound generation from waveform sampling (1973)
Sound generation from FM synthesis (1975)

List of Works
None of consequence

Publications and Available Manuscripts

A.C. Kay & Adele Goldberg, *Personal Dynamic Media*, Xerox Palo Alto Research Center, 1976. Published in *Computer*, Vol. 10, No. 3, March 1977

S.E. Saunders, "Improved FM Audio Synthesis", *Computer Music*, Vol. 1, No. 1., February 1977

A.C. Kay, "Microelectronics and the Personal Computer", *Scientific American*, September 1977

HARDWARE

Computers and Digital Hardware
Various: 64K (16-bit)

Peripheral Devices

Data Storage
Disk

Input Devices
Alphanumeric keyboard; CRT pointer ("mouse"); organ console

Sound Generation

Digital
Yes

Hybrid Systems
None

Mixed Digital Systems
None

Other Peripheral Devices

Analog
Filter and conventional amplification

Access to Computer
Computer usually available

Availability of Technical Assistance
Limited

Operating Systems
Mini system

Turnaround/Response Time Characteristics
In real-time: 12 voices waveform-sampled or 6 voices FM generated

SOFTWARE

Functioning Systems

Name/Author: TWANG -- Kaehler 1975
Language/Requirements: Smalltalk, 64K
Purpose and Features: For editing "scores" in "piano-roll" notation in real-time; also entering and editing FM timbre envelopes

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This comprehensive alphabetical index of persons named in this document covers all staff, students, composers or authors listed for a given installation. Authors of programs used but not developed at a given location are not listed for that location. References are to sections in this document.

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APPENDIX

The following are respondents to the questionnaire who are not currently active in Computer Music but expressed interest in the field and in this publication.

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Studio Musique Electronique
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