COMPUTER ARTS SOCIETY
BRITISH COMPUTER SOCIETY SPECIALIST GROUP

COMPUTERS IN THE ARTS CONFERENCE/EVENT/EXHIBITION EDINBURGH 27-31 AUGUST 1973

A number of new computer-choreographed dances are being presented at the Eventibition organised by the Computer Arts Society from 27th August 1973 to 31st August 1973 at Edinburgh.

The dances, choreographed by a GE265 and John Lansdown include one based on the Japanese Noh play. This is for four dancers, percussion and narrator who declaims the 'story' in mock computer-written Japanese.

A suite of dances, embedded in the idea of Machine-Man-Society Interaction, the theme of the Eventibition, has been composed in which the computer presents the dancers with a script showing peaks of movements only. The dancers follow the instructions of the script but create their own movements to link one peak to another.

Another dance, using a similar program, is for three dancers and narrator and uses peak movements from a Victorian Book (published 1892) by Professor Edward B Warman called 'Gestures and Attitudes'. This book, using the long-forgotton, Delsarte System illustrated gestures appropriate to such things as 'Defiance', 'Remorse', 'Shame', 'Tender Rejection' and other Victorian necessities.

The dances will be performed on the evening of 27th, 28th and 29th August and 1st September 1973 by, Mobile, a group of professional dancers from the Place, London.

The performances will take place at the Reid Concert Hall, Edinburgh University.

John Lansdown 50-51 Russell Square
Edinburgh Conference London WC1 B4JX

COMPUTER ARTS SOCIETY
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COMPUTERS IN THE ARTS CONFERENCE/EVENT/EXHIBITION EDINBURGH 27-31 AUGUST 1973

The Computer Arts Society, the Scottish Arts Council and Edinburgh University are holding an International Conference/ Event/Exhibition on Computers in the Arts with the theme INTERACT Machine: Man: Society in Edinburgh during the week commencing 27 August 1973.

The Conference

The Conference will be held in the Appleton Tower of Edinburgh University and each session will be devoted to a particular approach in the uses of computers in the arts under chairmen who are experienced in those fields. These chairmen include Manfred Mohr, Lambert Meertens, Leo Geurts, Knut Wiggen and Frieder Nake. About twenty-five papers on all aspects of computer art will be presented in seven separate sessions.

The Conference is restricted to registered delegates only and presents a unique opportunity for those interested in the latest developments in computer art to meet and discuss their problems, approaches and achievements.

The Eventibition

Associated with the Conference but open to the general public will be a five-day event and exhibition of creative computer works. The emphasis will be on live events in music, dance, theatre, poetry, film and robotics and a number of exciting new works are being created specifically for the event. There will also be a continuous display of computer graphics.

A preliminary list of exhibits and compositions include those by John Whitney (US), John Lifton (UK), Peter Zinovieff (UK), Greta Monach (Holland), Alexandre Vitkine (France), Edward Ihnatowicz (UK), Steve Willats (UK), Jacques Palumbo (Canada), U and D Trustedt (Germany), Pietro Grossi (Italy) and Analivia Cordeiro (Brazil).

The Exhibition will take place in the Appleton Tower whilst the dance, music, theatrical and poetry Events will be held in the nearby Reid Concert Hall on the evenings of 27, 28, 29 August 1973.

The Events culminate in a final performance on the evening of Saturday 1 September 1973.

Potential delegates and visitors are asked to note that INTERACT takes place during the Edinburgh Festival so that early bookings are advisable.

Papers to be presented at the Conference include the following:-

Stroud Cornock (UK)	Art and Cognition
Ernest Edmonds (UK)	Interfaces for Human Interaction
A Jebb, C B Besant and S A Hayward (UK)	Man-Machine Interaction and the Creative Process
Jerry Hunt (USA)	An Adaptive Controller System for Interactive Composition
R J Howarth (UK)	Colour Mapping by Computer
John Whitney (USA)	A Humanist Counterforce: Computer Motion Graphics in Art and Music
Artemis Smith (USA)	A Cybernetic Model of Conscious Behaviour
T H O'Beirne (UK)	How to Tune and Play a Computer
John Lifton (UK)	Electronic System for the Production of Music from the Internal Processes of Plants
Otto Laske (HOLLAND)	Foundation of a Generative Theory of Music
Jef Raskin (USA)	A Guide to FLOW
Pietro Grossi (ITALY)	On Computer Music
Analivia Cordeiro and Silvio M Zanchetti (BRAZIL)	A Language for the Dance
Stanley Haynes and Alasdair Rawsthorne (UK)	A Version of Music V In use at University of Southampton
John Lansdown (UK) and Pat Friedman (USA)	Procedures for Artists
George Mallen (UK)	Art Technology and Communal Authority
Alan Sutcliffe (UK)	Wherever Next
Roger Saunders (UK)	Technical Artists or Artistic Technicians?

John Lansdown
Edinburgh Conference

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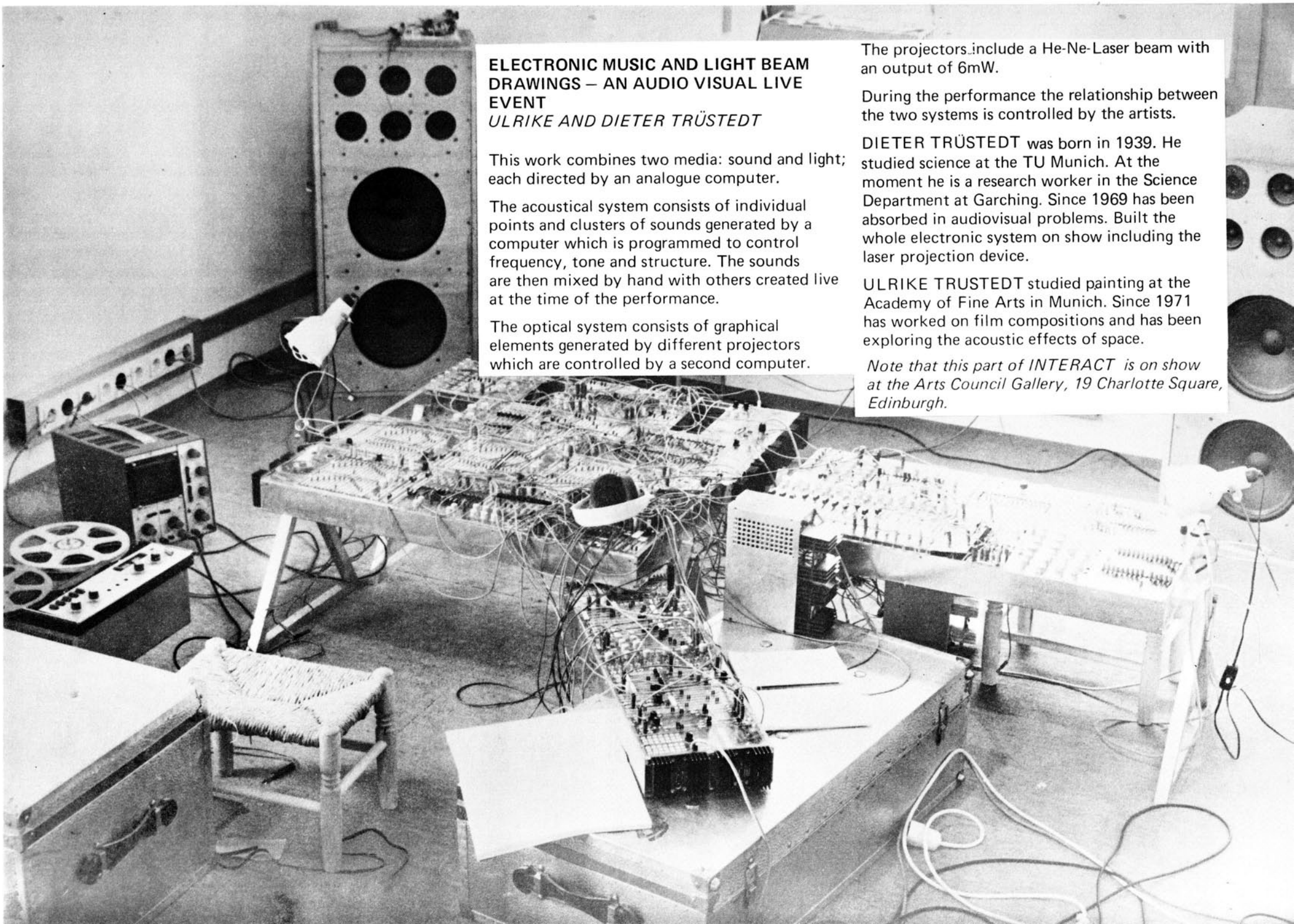
London WC1 B4JX



ELECTRONIC MUSIC AND LIGHT BEAM DRAWINGS – AN AUDIO VISUAL LIVE EVENT

ULRIKE AND DIETER TRÜSTEDT

This work combines two media: sound and light; each directed by an analogue computer.

The acoustical system consists of individual points and clusters of sounds generated by a computer which is programmed to control frequency, tone and structure. The sounds are then mixed by hand with others created live at the time of the performance.

The optical system consists of graphical elements generated by different projectors which are controlled by a second computer.

The projectors include a He-Ne-Laser beam with an output of 6mW.

During the performance the relationship between the two systems is controlled by the artists.

DIETER TRÜSTEDT was born in 1939. He studied science at the TU Munich. At the moment he is a research worker in the Science Department at Garching. Since 1969 has been absorbed in audiovisual problems. Built the whole electronic system on show including the laser projection device.

ULRIKE TRUSTEDT studied painting at the Academy of Fine Arts in Munich. Since 1971 has worked on film compositions and has been exploring the acoustic effects of space.

Note that this part of INTERACT is on show at the Arts Council Gallery, 19 Charlotte Square, Edinburgh.

GRAPHICS
CENTRO DE ARTE Y COMUNICACION

These graphics, by a number of artists who work at the Centro in Buenos Aires, include some which illustrate the rarer figurative aspects of computer art. Under its director, Jorge Glusberg, CAYC is one of the most active centres in the world for the creative use of computers and other technology.

GRAPHICS
CHARLES AND DOROTHY MATTOX

The graphics displayed can be considered not only as works in their own right but also as sketches for items of sculpture. The works were produced using the DART1 system of David Caulkins.

CHARLES MATTOX is Professor of Sculpture at the University of New Mexico at Alberquerque. He is the American éditor of LEONARDO, the journal of art and science and he is well-known for his kinetic and sound-making sculptures of striking and simple design.

DOROTHY MATTOX, his wife, collaborated with Charles on some of the works. Both have recently taken up ballooning.

GRAPHICS
DAVID CAULKINS

The four four works shown are impressive examples of the use of DART1, a general graphics system for artists designed by Caulkins and which runs on the Univac 1108 and a Calcomp 663 plotter.

DAVID CAULKINS is at the Jacobi Computation Centre in Los Angeles. He describes himself as more of a tool-builder than a tool-user.

COMPUTERSTRUCTURES
PETER STRUYCKEN

These diagrams, not meant as art works in themselves, are included in the exhibition to illustrate Struycken's approach to computer art. This approach is given a more detailed exposition in his two films, Image Programme I-72 and II-72 which are also on show at INTERACT. Struycken uses a computer in all his current work and has a close collaboration with A. Tempelaars of the Electronic Music Studio in Utrecht who does the programming. A large quantity of output is generated from these programs indicating possible designs. From this Struycken chooses what he wants, possibly modifying it and then produces the final design by hand.

It should be noted that he does not use purely random selection but has considerable recourse to a logical ordering. 'The aim is to determine accurately the visual significance of each visual medium.... The arbitrary use of time, form, colour and material must therefore be replaced by directed use. The choice must be made at the commencement of production'.

PETER STRUYCKEN was born in 1939 and lives in Arnhem, Holland, working at the Academy of Arts. He is also engaged on a research project for the University of Utrecht to investigate how data can be visualised, especially in mathematics, physics and chemistry.

GRAPHIC
ALAN SUTCLIFFE

The graphic shown is a version, in two directions, of Alan Sutcliffe's line division algorithm. This operates by successively halving intervals on a line using a counting rule which skips alternate intervals. Simple, logical but visually interesting algorithms such as this are rare and are the concern of those who wish to exploit the procedural potential of computers in art.

ALAN SUTCLIFFE founded the Computer Arts Society in 1968 and has been its Chairman since its inception. He is not a prolific artist (this is one of his very few graphics) and is better known for his music and behavioural compositions an example of which, PEOPLE PIECE, is being presented at the INTERACT performances.

INTERACT
MACHINE:MAN:SOCIETY

GRAPHICS
MANFRED MOHR

Accepting that creative work is an algorithm which represents a human behavior in a given situation, it is natural to ask: how is such an algorithm built up, and which precise mathematical laws could be extracted for later use in different circumstances? If one is now curious enough to look for his own aesthetical parameters, he is ready to engage in an interesting line of research. These considerations led me to use the computer as a **PARTNER** in my work.

The first step in that direction was an extended analysis of my own paintings and drawings from the last ten years. It resulted in a surprisingly large amount of regularities, determined of course by my particular aesthetical sense, through which I was able to establish a number of basic elements that amounted to a rudimentary syntax. After representing these basic constructions through a mathematical formalism, and setting them up in an abstract combinatorial framework, I was in a position to realise all possible representations of my algorithms.

Since the most important point in applying a computer to solve aesthetical problems is the MATERIALGERECHTE * use of this instrument, the research therefore should assume that old techniques of drawing and imagination are not to be imposed on the machine (although this would be possible), but should develop a priori a vocabulary which integrates the computer into the aesthetic system.

Computer graphics in general are conditioned by four basic premises:

1. A **PRECISE** idea of an aesthetical problem.
2. The need to break this idea into parts which could be reassembled as a program.
3. A steady control of the computing process to take full advantage of the **MACHINE — HUMAN** dialogue.
4. The need for the logic of the events to become perceptible.

The logic built into a program makes it possible to create a nearly infinite number of new situations. This is very important since the creation of a form is limited a priori by its author's characteristics, of which he may be consious or unconsious. It means that the exploration of a new idea leads sooner or later to a repetition which can be avoided by resorting to a computer once the basic parameters have been formulated. As it is possible to conceive the logic of a construction but not all its consequences it is nearly an imperative to rely on a computer to show this large variety of possibilities; a procedure which may lead to different and perhaps more interesting answers, lying of course outside of normal behavior but not outside of the imposed logic.

At this point a new problem appears: how to choose what is to be kept and what is to be rejected?

My aesthetic criteria were determined by a decision not to create **single** forms but sets of forms. The basic parameters are the relationships between the forms and no aesthetical value is associated to particular forms. Within this context it is possible to ignore the former "good" and "bad", and aesthetical decisions can be based on WERTFREIE ** procedures, where the totality represents a "quality of a quantity". The fundamental consequence of this attitude is, that after a period of tests, modifications of the logic, and parameter exchanges, all possible results of a program have to be rigorously accepted as final answers.

Computer graphics is a young and new way of aesthetical communication; it integrates human thinking, mechanical handling, logic, new possibilities of drawing, and incorruptible precision of drawing — a new DUKTUS! ***

The concentration which is necessary to establish a logic (writing a program — that means to give a definition of all instructions that have to be done in the machine) will reflect itself in the result as a clear construction which could be understood by everybody and there will be less and less mystical barriers behind which the artist can hide himself.

Manfred Mohr

* MATERIALGERECHT, German for: working or using a material only in the way which is basic to the material.

** WERTFREI, German for: decisions, where the knowledge is neither based nor conditioned by any values.

*** DUKTUS, Lat., German for: "handwriting". Individual peculiarity of the drawing material.

Manfred Mohr, born 1938, lives in Paris. Since 1958, has studied at the art and applied art school in Pforzheim; private music studies, two years as jazz musician — tenor saxophone, clarinet. Since 1963, works with black and white graphics, mathematics, programming. Since 1969, computer techniques. 1971 exhibition and demonstration in the Musée d'Art Moderne, Paris.

FIVE GRAPHIC WORKS
JACQUES PALUMBO

All my works are based on a matrix of numbers. Each column of the matrix corresponds to a numeration in a certain base. Therefore, if I take a row, each number will be equivalent to all the others in the same row, each being the same number written in a different base.

1	1	1	1
2	2	2	10
3	3	10	11
4	10	11	101
10	11	12	110

4 (to base 5) = 10 (to base 4) = 11 (to base 3) = 101 (to base 2)

To each numerical sign, a graphic symbol is assigned.

The works that constitute my contribution to this exhibition have been made with PAL 2, a program written in FORTRAN by Serge Poulard of the University of Montreal according to constraints and rules which I deduced from my previous work which was done in the same vein, but manually.

When I was working by hand, it took a lot of time from the initial idea to the completed drawing. I had to spend many hours to be able to see the resulting work.

Using the computer allows me to make new works visible in *real time*. I only have to order the cards of the program in a certain fashion, add a few or withdraw a few and I am able, by running the deck of PAL 2, to obtain almost instantly a visible output on an electrostatic point printer connected to the computer (Versatec).

JACQUES PALUMBO was born in 1939 at Philippeville and now lives in Montreal.

Recent exhibitions include: Pluriel 71, Museum of Quebec, 1971; Midland Group Postal Exhibition, Nottingham, Grande-Bretagne 1972; International Exhibition of Photography, Royal Photographic Society, London 1972 Coventry 1973 et Leigh 1973; Sound as Visual/Visual as Sound, Galerie Vehicule, Montreal 1973; French Window, Paris 1973; Xerox Exhibition, Galerie SC, Zagreb 1973; Program, Random, System, coll. H. J. Elzold, Museum Mönchengladbach, Allemagne 1973.

HARMUT POHL was born in 1943; studied mathematics, philosophy and biology. Scientific employee at the Data Centre of the University of Cologne. Special interests computer graphics and computer contracts.

FIVE GRAPHIC WORKS
WADE SHAW

The 16" x 16" prints were produced by enlarging hardcopy from an SD 4020 plotter. The magnetic tapes for the SD4020 were produced using a program written by the author for a PDP15 with a VT15 graphic display and spark-pen drawing tablet. The program produces matrix transformations of hand drawings input to the machine using the pen.

WADE SHAW, an American citizen, is employed by the Science Research Council's Atlas Laboratory at Chilton, Berkshire.

Working with Stan Vanderbeek in 1971, Wade produced the computer animated film "Ad Infinitum"

GRAPHIC WORKS
H POHL
M LINDER

All the graphics shown were produced at the Data Centre of the University of Cologne. They are results partly of a computer arts competition and partly of the initative of the Data Centre collaborators and were produced on a Seimens 4004/55G computer and a Calcomp 565 plotter.

The plotter operates in incremental mode and can produce only mono-coloured graphics. The size of the graphics is limited by the breadth of the plotter (10.9 ins) but the length is variable. All the programs were written in FORTRAN.

For the realization of their ideas and the production of the graphics, most of the workers at the University are just a few elementary forms such as rectangles, triangles, circles and lines.

The effect of the graphics is realized by a structural composition with the aid of these fundamental forms.

The alternating structure is produced for example by distributing light and dark levels, by perspective composition, by central points or reflection.

Since, during the drawing, the pen breadth cannot be changed, the different breadth of lines must be simulated by drawing several times.

The structure which is produced by the computer program, can be changed by procedure to give to the structure interest and to remove too obvious a character. By this means, elements of structure are neglected or changed according to certain probabilities, but there is also the possibility that elements are added which are not planned by the structural composition.

In this way the picture gets a certain dynamic and vivacity and the impression of being too inflexible is avoided.

SOUND AND VISUAL POETRY

NOTES ON THE AUTOMATERGA

GRETA MONACH

The poems displayed in the Edinburgh Computer Art Exhibition are purely abstract verse: they use essentially non-semantic words, which were selected mainly by acoustic criteria.

The title "automatergon", which the poems have in common, is not really a title, but rather a general indication: the word is derived from the Greek αυτοματος (= moving of its own accord; "automatic": the automatic element in this case being the computer) and εργον (= work: of. the Latin word "opus" used in music). The word also hints at the Greek το αυτοματον (= chance) and thereby points to an important aspect of the constructive process used.

Writing poetry might be described as: manipulating *words.*

For each separate poem, the poet makes a selection from all conceivable words — the result of this selection from all conceivable words — the result of this selection may be defined as the *material* for this specific poem — and puts these words in a certain *order.* Poetry being a composite (auditive and visual) art, the selecting and ordering processes are governed both by visual and auditive criteria.

Each word is characterized by its own specific *sound* and its own *form* (= representation in writing). In addition to these characteristics, it may have a fixed meaning in a fixed language; but this is not essential to poetry. Indeed, I am convinced that the semantic category is — and has always been — the poet's excuse rather than his motivation. This conviction has led me to compose a type of poetry from which semantics have been "abstracted". When I speak about relations between words, I do not mean semantic relations, but exclusively auditive and visual ones.

The *material* for each of the "automaterga" consists of a set of inter-related words (e.g. one-syllable words ending in P and using only short vowels, see Automatergon 72–4). These words are grouped into categories (subsets) of more closely related words (e.g. again in Automatergon 72–4: the words with the vowel A and final consonant P, but beginning with different consonants; or, the words beginning with KR- and still ending in P, but with different vowels in between).

Auditive conception and orthography are largely based on the sound and spelling of the Dutch language, in which there is a strong correlation between sounds and their written representation. Thus, any visual connections between words are closely coupled with auditive ones.

While the selection and grouping of words was performed without the aid of the computer (categories of words form part of the input data for the programme), the latter is wholly responsible for the spatial distribution (the ordering) of the words.

The programme sets up a grid of variable size. In the output, only the borderline of this grid are visible.

Words are allowed to spread in chains through the compartments of this grid. Each chain uses words of one category only. Starting in an aleatorically selected compartment, the chain develops step by step, a random selection determining the direction of each step. Important variables in the programme are: the *size* of the chains and the *density* of words in each grid; both these variables are defined by limit values.

A simple permutation programme determines the colour of each category of words. Colours are used in order to elucidate the structure of the poems: the chaining and the distribution of the words over the page.

Because of the use of a 2-dimensional grid, relations between words become active in 2 dimensions, which means in many directions. Thus, the poems are multi-interpretable, interpretations varying with the wanderings of the eye over the page.

The tape-recorded readings represent a few of the countless interpreting possibilities, at the same time giving to those who are not acquainted with the Dutch language and orthography an impression of the sounds as represented by the written words.

GRETA MONACH lives in Culemborg, Holland

MUTATIS MUTANDIS
COMPOSITIONS FOR INTERPRETERS
HERBERT BRUN

MUTATIS MUTANDIS are not to be treated as scores, as some symbolic representation in a new notation, as sets of instructions which, if obeyed, would lead a performer to 'execute' the shapes, symbols and configurations, as they follow one another, according to his reading habit, on the page. I have written and shall continue to write such scores; but with MUTATIS MUTANDIS I intend to present a different kind of challenge.

Here the Interpreter is invited to begin by contemplating a graphic as traces left by a process which moved a pen in various directions across the plane.

This process has been composed by the composer. The pen, thus, moved according to a programmed structure: rules, constraints, commands.

The Interpreter, now, is to construct, by thought and imagination *his* version of a structure that might leave the traces which the graphic displays.

The Interpreter is not asked to reconstruct my computer program, the structured process that actually generated the graphics. Rather he is asked to construct the structured process by which *he* would like to have generated the graphics.

Finally he should compose a working model of this structure, (a score?), in and for the medium of his choice: sound, movement, language, film, and so on and perform it.

The Interpreter is not asked to improvise.

The Interpreter is not asked to improvise.

He is asked to compose.

POLYPLOT
HERBERT BRUN

These six photographs are copies of originals 30 in x 65 in drawn by plotter and were made in the Spring of 1973.

It is not known whether they are to be taken as a subset of MUTATIS MUTANDIS or whether they have a different functional proposition.

NINE COMPUTER SCORES
HERBERT BRUN

The nine drawings illustrated are copies of original plotter drawings and are musical scores for performance. They were played as piano works by John Tilbury at EVENT ONE in London 1969 and one of them, GRAPHIC 328-1, is to be performed in various media at the INTERACT Concerts.

HERBERT BRUN, born 1918 in Berlin studied in Israel at the Jerusalem Conservatory of Music and with Stefan Wolpe and Frank Pelleg. Further studies included work at Columbia University, NY.
From 1955-61 he conducted research concerning electro-acoustics and electronic sound production to explore their possibilities in the field of musical composition in Paris, Cologne and Munich. In addition to his activities as a composer he gave numerous lectures and seminars particularly emphasising the function of music in society. In 1963 he went to the School of Music of the University of Illinois as Research Associate, primarily to do research on the significance of computer systems for the composition of music and is presently an Associate Professor of Music there. For the 1969-70 academic year he was Distinguished Visiting Professor in the College of the Arts at Ohio State University.

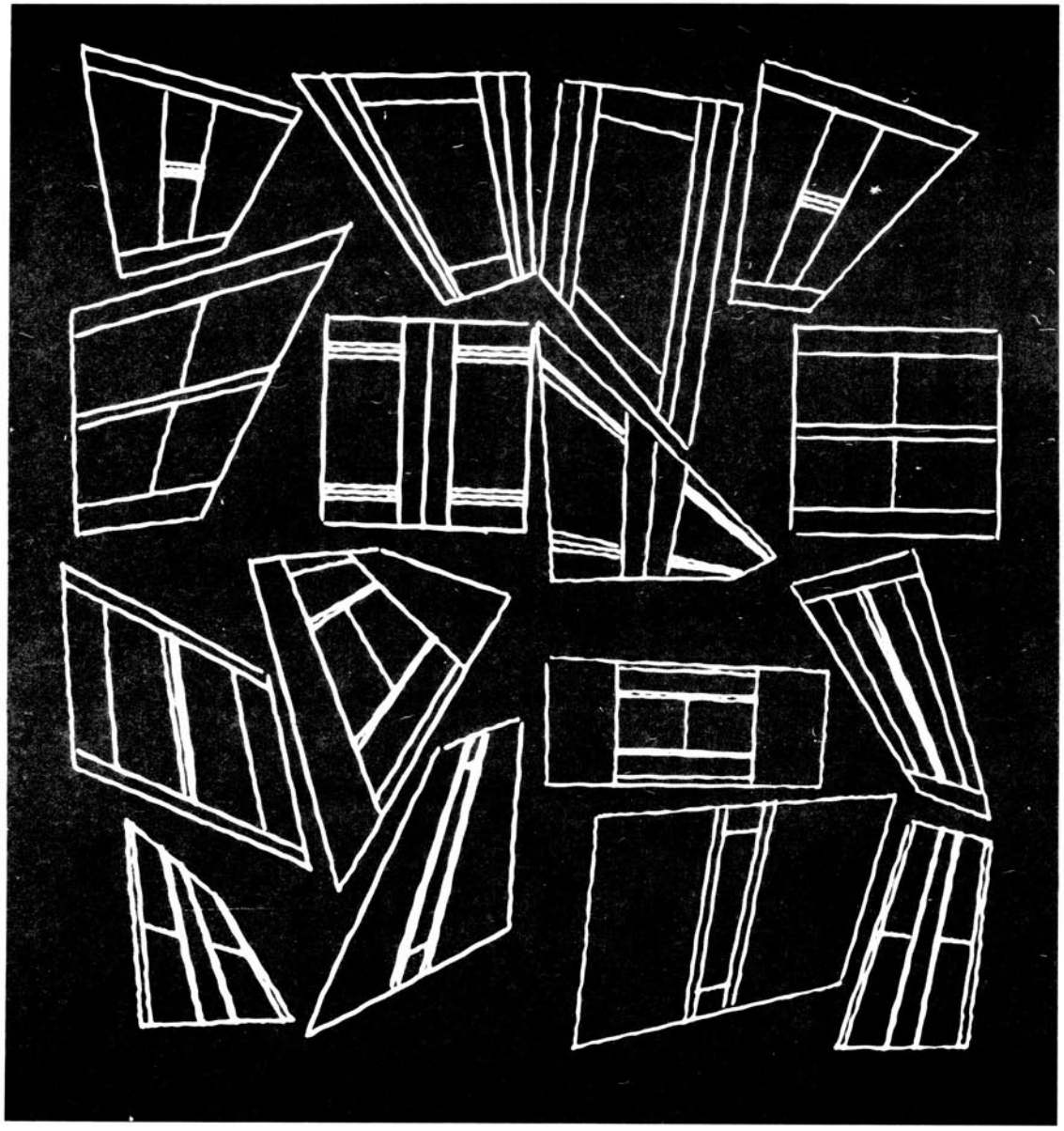
He is the author of many publications and compositions.

INTERACT
MACHINE:MAN:SOCIETY

GRAPHICS
MANUEL BARBADILLO

A single square module has 16 forms, based on rotation, mirror image and inversion (black for white). A square element of four such modules can be formed in over 4000 ways from a single module. Barbadillo has been interested in permutation of forms where there is a large degree of symmetry, unlike many other artists who have used random arrangements of a module. Having designed a module, he uses the computer to print out many different arrangements of it before selecting the one to paint by hand. A typical computer output and silk screen print is shown.

MANUEL BARBADILLO was born in 1929 in Spain and now lives in Malaga. For the past few years he has been working on modular paintings, exploring the many possibilities of a few basic modules. He spent 1969 working with the programmer, Lorenzo Soto and others at the University of Madrid Computer Centre.



Miljenko Horvat

GRAPHICS
MILJENKO HORVAT

The original images were created, drawn and manipulated on the digigraphic screen of a CDC 1700 by means of a conversational program by Serge Poulard. Photographs of these images were taken and transferred to a silk screen and a very limited edition of serigraphic prints were made.

MILJENKO HORVAT was born in 1935 in Yugoslavia and now lives in Montreal, Canada. He is a graduate architect and has exhibited his art works in many shows in Canada and Europe.

GRAPHIC
MAUGHAM S MASON

This work was created by an analogue computer controlling an X-Y plotter. Mason first visualises the pattern he wants and then designs the circuit arrangement that will produce it. He has created many such Moire patterns and other works with striking visual effects.

MAUGHAM MASON lives in Saratoga, California.

INTERACT
MACHINE:MAN:SOCIETY

GREEN MUSIC
ELECTRONIC SYSTEM FOR THE PRODUCTION OF MUSIC FROM THE INTERNAL PROCESSES OF PLANTS

JOHN LIFTON

This project is for the first of a series of works exploring the production of music from processes of growth and change in the natural world. In 'Green Music' the electrical signals in plants are picked up by electrodes and, after processing by an analogue computing and storage system, are fed to a sound synthesiser. The processing includes a small self-organising learning net, and it is believed that this is the first work of art to make use of such a system. Computer simulation has been undertaken to verify the design proposals for this learning net.

A grant from the Arts Council of Great Britain for £600 has been received towards a total budget of £1225.

Future use of the system is intended in investigating the production of music from crystal growth, meteorological instruments, bio-feedback and radio astronomy.

Description of the System

The surface membranes of plant cells have a small electrical potential with respect to the cell interiors due to the chemistry of the cells' activity. As the cell surfaces are in contact through the plant, this leads to the production of small currents through the plant. Recent research indicates that these currents play an important part in coordinating the growth and general metabolic activity of plants. With modern instrumentation techniques, these small voltages can be picked up from electrodes and amplified to a level where computing techniques can be applied.

Six plants are used, in an environmental chamber. In the first stage of processing, correlation between the signals from them separates their response to environmental changes (temperature, humidity, soil chemistry, air movement, light/dark cycle) from their response to internal activity. In the second processing stage, this information is built up in storage by a learning system/memory modelled on a multiple threshold neuron model. This stores up the information over a period of time so that the relationship of the plants' current activity to their previous activity may be used to control the synthesiser. This produces an ongoing structural coherence in the music.

The synthesiser will have both rhythm and tone generation; the rhythmic base being built up from the learnt activity of the plants over a period of time, and the tone generation being controlled by the plants' current activity. A type of fugue in which different plants produce different melodic lines, overlaid on an increasingly complex rhythmic base, will build up from silence each time the processing is switched on. When the learning ability of the processor approaches maximum, the unit will automatically cancel what it has learnt and start again. Each variation produced in this way will be different, but related to the inherent 'theme' designed into the processing and the synthesiser. The music will be produced in stereo.

The signals picked up by the electrodes on the plants are very small and at a high impedance, so low-noise instrumentation amps will be placed close to the plants. The plants are put in a partly controlled environment consisting of a transparent housing with some regulation of temperature and humidity to ensure the exhibition climate is not harmful.

The first processing section contains buffer amps to receive the input signals and low-pass filters to remove any high frequency noise. Differentiation and subtraction are used to compare the rate of change of signals. These correlations are then weighted towards significant rather than coincident response. Switching allows signals from any stage of this processing to be selected as output.

The second processing unit is a small self-organising learning net. This is used from a desire for the plants to control the sound output as directly as possible, rather than imposing too much preconceived analysis of the means of storage. The net is based on a threshold cell model (closer to a 'Perceptron' than McCulloch-Pitts or universal logic type) with pairs of inputs. Each pair has an 'excite/inhibit' relationship and separate threshold. This design has stemmed from computer simulations using random and part-random connectedness; following Kauffman (M.I.T.) and Alexsander (Univ. of Kent).

Cost studies have shown that for a small net, hybrid rather than digital design is best. (A digital system using a microprocessor is comparable in cost but construction would take too long.) Operational amplifiers handle all linear functions, and threshold storage uses comparators, 8 bit counters and D/A converters with antilog response. This follows results from simulation that fast initial learning rate, decreasing as the threshold rises, counteracts saturation of thresholds and thereby maintains high discrimination between related cells in the net. The net outputs may be selected experimentally.

The rhythm section of the synthesiser consists of a ring counter that can pulse a set of decaying oscillators via a diode matrix. Matrix connections and the clock speed of the counter are controlled by the learning net. Tone generation is by three sets of voltage

controlled sinewave oscillators. Each set is controlled by a single voltage and harmonic intervals between them are preset. Voltage controlled amplifiers on the outputs allow the harmonic structure to be controlled by first processor. Rhythm and tone are mixed to produce a stereo output of 30W per channel.

All units are designed for enclosed 19" subracks, with provision for later expansion. Digital circuitry is TTL, and most analogue circuitry uses 741Cs.

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The detailed way in which the electrical signals in plants affect growth and change and metabolic activity is still unknown, but a number of recent experiments show electro-chemical reactions in plant cells very similar to those of neurons, and regular cyclic variations in the electrical field of whole plants.

Important research in this area has been carried out by – Dainty (Univ. of Edinburgh); Hope and Walker (Commonwealth Scientific and Industrial Research Organisation, Australia); Scott (Univ. of Tasmania); Schrank (Univ. of Texas; and Hertz (Univ. of Lund, Sweden).

Other recent research (particularly by Clive Backster, Backster Inst. of Lie Detection, N.Y.) has indicated that plants exhibit a behavioural response to people and other organisms around them. Although this work is not generally credited, it is being followed up by (supposedly) around 60 research organisations in various countries, but too recently for information to yet be available. However, there is slightly better evidence that plants respond directly to sound, and this possible feedback connection could obviously affect 'Green Music' and will be investigated.

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3. GENERAL
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JOHN LIFTON, born Northwood, Middlesex, 1944. M.A. in architecture, University College London, 1966.

His work has been shown in–
"Cybernetic Serendipity", Exhibition, Institute of Contemporary Arts, London, 1968; and subsequently at the Corcoran Gallery, Washington D.C, and the Palace of Arts and Science, San Francisco, 1969.
'Event 1', inaugural exhibition of the Computer Arts Society, Royal College of Art, London, 1969.
'Summer Solstice Festival', Univ. of East Anglia, 1969.
I.C.A. Foyer, London, 1970.
'IBM International Conference Exhibition', Amsterdam, 1970.
Gallery, London New Arts Lab., London, 1970.
"Cybervironment", Birmingham, 1970.
'Happenings and Fluxus Retrospective', Kunstver Kunstverein, Cologne, 1970–1971 (collaboration with Carolee Schneemann).

He performs regularly as a member of the experimental music group, 'Naked Software', and in 1972 was technical coordinator and recording engineer for ICES '72, a festival of new music and arts, in which over 400 artists and musicians from all over the world appeared.