Computer Art For Theatrical Performance.

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INTRODUCTION

This paper deals with a specialised form of artificial
intelligence namely Computer Art and the author's view
that more attention should be paid to the creative use
of computers in the arts, not only in order to simulate
and study human intelligence but, perhaps more import-
antly, to widen the scope of artistic creativity.

In particular the paper is concerned with the author's
own work on computer programs producing output intended
for performance by dancers, singers and actors.   Although
to some extent, the end results of the programs are experi-
mental and tentative they are conceived as serious but entertain-
ing theatrical works.   They have been performed both 'live'
and on film on a number of occasions with varying degrees
of success, but always with enthusiastic interest on the part
of both performers and spectators.

BASIC FEATURES OF THE PROGRAMS

Differing greatly in content and form and having end results
as unlike as dances, choral works, theatrical sword fights,
short plays and even custard-pie routines the programs
described exhibit four fundamental features which are
common to all.

The features are:-

1.   A 'vocabulary'

2.   A 'grammar'

3.   A 'presentation'

4.   A 'selector'

It is instructive to examine these in detail and draw conclusions on the way in which, given the features, further programs could be developed.

1.   Vocabulary : this is the particular set of basic 'data' elements used by and manipulated in the program and having a meaning in the context of the work.

These elements might be words or phrases, as in the case of poetry and drama programs; individual balletic movements, as in the dance programs; combinations of movements, as in the sword fighting programs; or musical notes, chords or phrases as in a choral work on which the author is at present working (January 1970).

2.   Grammar : these are the rules which regulate the allowable or desirable combinations of vocabulary. They will, for example, in a dance program prevent physically impossible or dangerous moves arising. In the described programs the rules are held either in numerical form representing stochastic logical trees or as multiple AND/OR Boolean statements.

It is in the use of the numerical form, with its
ease of modification, that a potential learning
model is perhaps available. With this, the
artist could instruct the computer in a conver-
sational way by updating the tree-structure to
suit his own particular grammar developed from
earlier output. In this way rules need not be
explicit but could be derived from interaction
with the computer and one of the dance programs
is being re-written to allow such choreographer/
machine interaction.

Built in to each program as part of the grammar
is a stopping-rule which determines the point at
which the work is considered to be complete.

3.   Presentation : this is the form of output.
Depending on the context of the program, the
output is in musical notation, ballet notation, or
typewritten scripts of instructions or text. Not
surprisingly the form of final presentation to a
greater or lesser extent determines the nature
of the program. This is particularly so in the
case of presentations for dance where the use
of different types of instructions to the dancers
(generally one of the established movements nota-
tions) demands different approaches to the
program : very different forms of dance, of
course, arise from these distinctions.

4.   Selector : when a computer is used entirely to
replace the creative process of the artist, it is
necessary to substitute for the artist's intuition
some device capable of being programmed.   In
most of the programs dealt with here, the
substitute for intuition is a pseudo-random number
routine which is called into play to sample from
empirical distributions.   This sampling produces
numbers which either generate paths through the
logical rule trees or act as guides through the
Boolean AND/OR instructions.

It is in this area of work that the greatest
controversy is normally engendered.   Few
people with whom the author has discussed the
matter regard the use of randomness as a
legitimate substitute for intuition and yet none
have been able to suggest a suitable programm-
able alternative.

It must, of course be realised that, whilst
randomness is used in the selection process,
the final effect is rarely random in any accepted
sense.   Indeed, depending on the degree of
control exercised by the grammar, one finds
that the patterns produced are quite recognis-
able as patterns albeit often strange and unfami-
liar.

In order to investigate other substitutes for
intuition, one version of the ballet program uses
the musical interval of the accompanying music
to generate numbers for the path but, surpris-

ingly, the resulting dances do not seem to exhibit more 'form' than those arising from the random generation of numbers.

In contrast to the selector for the other programs, that for the choral work is entirely deterministic, that is to say, the grammatical rules for prescribing harmony, melody, rhythm and distribution of voices are such that, given the starting or finishing condition, an entire section of the work follows logically and inevitably without the need for any stochastic selector.

THE PROGRAMS

1. Dance Program:

This is, in fact, a group of related programs called PATH, BEAT and DANS; PATH having a number of different versions.

The basic premise of the work is that any balletic movement can be considered as being made up of what might be called 'elements' or perhaps 'elemental movements' which, in general, are independent of one another but which can occur together. Such elements may be anything from, for example, a slight but definite movement of the arm or hand to a particular ballet jump, step or position. Those independent movements of different parts of the body which take place simultaneously in time can then be combined in accordance with the

grammatical rules to form a 'frame', similar to
a frame in a motion picture.

(1)   Vocabulary : whilst further breakdown is
possible, it was thought sufficient to limit
description of the elemental movements to those
of each arm and hand (18 movements each),
both legs and feet (50 movements in all) and
body and head (7 movements in all). In
addition 12 directions of movements where
included. The items of vocabulary can be
amended or augmented with comparative ease.

(2)   Grammar : on a probability distribution basis,
the grammar determines which movement follows
which. Some movements can follow others with
a high probability, some with low or zero
probability and, as the choice of one movement
depends only on the choice of the previous one,
the effect of the grammar is to establish between
consecutive elements, a Markoff process.
There is a different set of rules for each of the
four sets of elemental movements and over 100,000
different combinations of these can be generated
for each frame. Both the vocabulary and the
grammar are utilised in the PATH program
which is written in BASIC.
The number of frames required is determined
by the stopping-rule applied to the numerical

form of the accompanying music via the program BEAT.

(3)   Presentation : the output of PATH is a matrix of numbers giving the chosen elements built up into frames indicating the positions and actions of the arms, hands, legs, feet, body and head together with a direction of movement.
The program BEAT also written in BASIC, determines the rhythmic arrangement of these frames in relation to the music and both outputs can then either be transcribed by hand into a dance notation or used as input for the DANS program.
DANS, written in FORTRAN, translates the numbers by even more elemental breakdowns and dictionary searches into instructions for a digital plotter giving a final output as a computer drawn score in Benesh dance notation which is familiar to many British and European dancers.
As DANS is not, at the moment, as easily modified to suit changes in vocabulary or grammar as the dance generation program, hand transcription of Benesh notation is the general rule.

(4)   Selector : numerical interpretation of musical intervals or pseudo-random number generator sampling empirical distributions.

2. Sword Fighting Program:

This program, called FIGHT and written in TELCOMP, takes movements and groups of movements derived from a fight director's instructions and combines them to form a theatrical sword fight for two actors.

In addition there are instructions to cover the stage placing of the players and the actions of the winning actor after the kill.

(1) Vocabulary : movements, groups of movements and instructions such as "Thrust", "Parry and Thrust", "Cut to", "left side", "right side" and so on.

(2) Grammar : a series of AND/OR instructions which are designed to allow free flowing movements but, at the same time preventing impossible or dangerous play.

Basically, the grammar allows the computer to choose for each antagonist in turn:

(i) an attack

(ii) a direction of aim, followed by

(iii) a defence

Within this framework the vocabulary can be varied considerably but, to avoid too stereotyped activity and to introduce an element of surprise, not all attacks are defended.

The stopping-rule arises (1) when a kill is chosen by the selector during the fight or (2) after a given number of moves when the kill is then automatically chosen.

(3)   Presentation : typewritten scripts of instructions.

(4)   Selector : pseudo-random number generator sampling from empirical distributions.

3. Custard Pie Routine:

This program, called CPR and written in TELCOMP, composes a custard pie fight for two actors.

(1)   Vocabulary : movements, groups of movements, actions and reactions associated with custard pie fights.

(2)   Grammar : a series of AND/OR instructions which allow the setting up of various patterns. The basic pattern is divided into five stages which are (i) action, (ii) reaction, (iii) follow through, (iv) reply and (v) close and each of these stages can develop along a number of different lines.

The stopping-rule comes into play after a given number of repeats of the pattern and terminates the action with a suitable flourish.

(3)   Presentation : typewritten scripts of instructions.

(4)   Selector : pseudo-random number generator
sampling from uniform distributions.

4. Conversation:

This program called PINTER and written in
BASIC composes sets of conversations with a
framework laid down by the program structure.

(1)   Vocabulary : everyday phrases and words.

(2)   Grammar : rules for combining the phrases
and substituting words together with sequencing
instructions.

(3)   Presentation : typewritten scripts.

(4)   Selector : pseudo-random number generator
sampling empirical distributions.

PROBLEMS AND CONCLUSIONS.

From the examples and descriptions given it will be realised
that, essentially, what is being done here is the creation of
patterns which have some meaning within their context.   This,
indeed seems to be the aim of computer art in all its aspects.
However, due mainly to the nature of the selectors and
grammars employed, the program described are aimed at
exploring patterns which do not readily arise in non-machine
art.   Artists, like all of us although not perhaps to the same

degree, are products of their training and tend to follow paths down which their previous experience leads them. Computer art opens up new paths and creates new relationships. Strangely, it is in these new relationships that one of the author's problems lies: the very unfamiliarity of the patterns give the performers special difficulties not encountered in other works. These are particularly evident in the computer ballets where the dancers have some difficulty in learning and remembering the sequences of movements presented.

The choreographers, dancers and actors with whom the author has co-operated uniformly find that working with these programs helps them not only to explore new avenues of expression but also to investigate the make up of their own style.

Indeed, it is the author's view that it is possible to define an artist's style by means of the stochastic logical tree approach used in some of the programs. That is to say, style can be defined as the probability of one particular element of a work following another and programs are being developed to analytically examine this hypothesis.

It is clear from the literature (in fact, the lack of it), that study of artistic creativity as a branch of artifical intelligence has been neglected and it is hoped that the work outlined here will do something to stimulate work in this area.

REFERENCES.

BENESH, R. and J. Introduction to Benesh Movement
                    Notation, London 1955

CAUSLEY, M. Benesh Movement Notation, Max Parrish,
                    London 1967

HUTCHINSON, A. Labanotation. Theatre Arts,
New York, 1954

PRESTON-DUNLOP, V. A Notation System for Recording
Observable Motion.
Int.J.Man-Machine Studies (1969)1,
361-386.

ESHKOL, N., WACHMANN,A., Movement Notation.
Israel Music Institute,
Tel Aviv 1968.

HARRIES, J.G., Shapes of Movement. Movement Notation
Society, Tel Aviv 1969.

HOBBS, W. The Technique of Stage Fight. Studio Vista,
London 1967

FREEMAN, J., BUTCHER, H.J., AND CHRISTIE,T.
Creativity : A Selective Review of
Research.
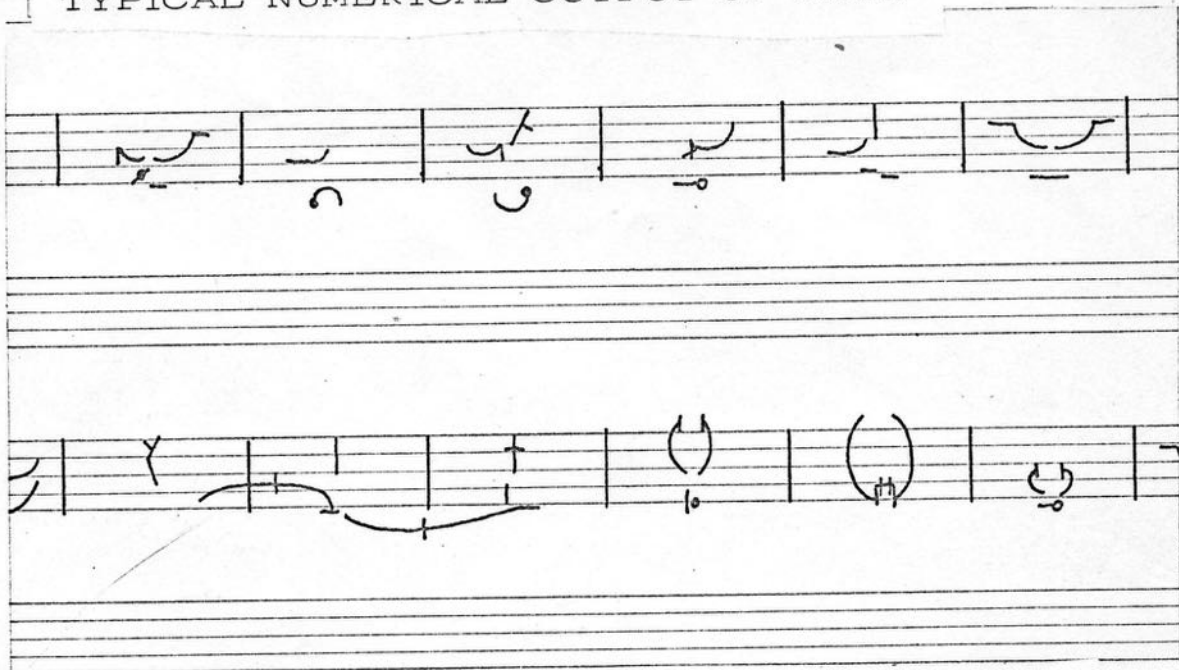Society for Research into Higher
Education, London 1968.

COURANTE:2

NO	LEGS	R ARM	L ARM	BODY	DIRECTION
0	3	3	3	3	2
1	5	0	4	0	0
2	9	0	1	0	0
3	23	0	0	0	1
4	24	4	0	4	0
5	31	0	2	0	0
6	10	0	7	0	0
7	25	0	8	0	6
8	28	0	0	0	0
9	7	1	0	0	0
10	5	0	1	0	5
11	1	0	2	2	0
12	2	5	0	0	0
13	3	0	0	1	0
14	9	4	7	6	4
15	34	1	0	0	0
16	0	0	8	0	9

TYPICAL NUMERICAL OUTPUT OF PATH

EXCERPT FROM SCORE IN BENESH NOTATION

## COMPUTER GENERATION OF DANCE WITH BENESH NOTATION

Like music, the notation is designed to be written
on a five-line stave: the top line representing the
line of the top of the head of a standing figure and
the bottom line, the line of the feet. The other
lines then naturally fall into place as the line
of the knees, the line of the waist and the line of
the shoulders. The dancer is viewed from behind
and the movement and position of the straight limbs
is shown by the position on the stave code marks
representing their extremities.

If we imagine the stave drawn life-size on a wall
which the dancer faces with, say, arms outstretched
sideways, we can see that, by marking the position
of the hands and feet on the wall, we will have
achieved a visual record of his body position.

In order to represent the position of limbs when
they are in front of or behind the plane of the body,
code symbols are necessary and three basic signs are:

——————   Level with the body

| In front of the body

•   Behind the body

With these signs and the staves it is possible to
show all the positions of the straight limbs but
further symbols are necessary for bent limbs and
movement pathways as the limbs move from one position
to another.
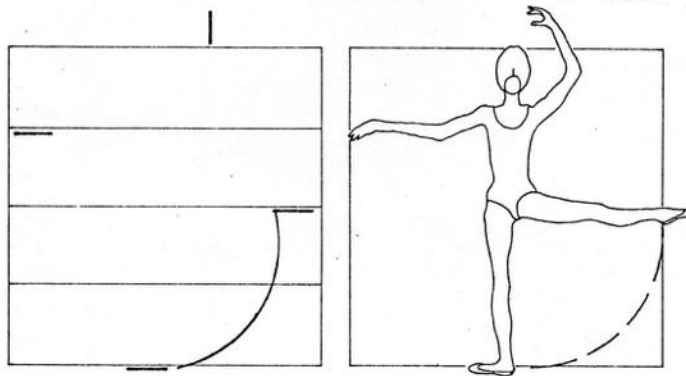
The notation is written across the stave from left
to right to show the movement in time and, in general
only limbs which actually move are shown. Spatial
movement of the dancer is shown by flat curves (rather
like legato phrase lines in music) which connect one
record of the position of the feet to the next.

BRIEF DESCRIPTION OF NOTATION

COMPUTER CUSTARD PIE ROUTINE   2

ACTOR: 1
     TAKES UP PIE
ACTOR: 2
     LOOKS AMUSED
ACTOR: 1
     PRESSES PIE INTO OPPONENTS FACE
ACTOR: 2
     WIPES OFF WITH LITTLE FLICKS OF THE HAND
ACTOR: 1
     IS CONVULSED WITH LAUGHTER

ACTOR: 2
     TAKES UP PIE
ACTOR: 1
     WAITS WITH RESIGNATION
ACTOR: 2
     PRESSES PIE INTO OPPONENTS FACE
ACTOR: 1
     WIPES OFF
ACTOR: 2
     SMILES

ACTOR: 1
     CAREFULLY CHOOSES PIE
ACTOR: 2
     LOOKS AMUSED
ACTOR: 1
     PRESSES PIE INTO OPPONENTS FACE
ACTOR: 2
     WIPES OFF
ACTOR: 1
     SMILES

ACTOR: 2
     TAKES UP PIE
ACTOR: 1
     LOOKS PUZZLED
ACTOR: 2
     PRESSES PIE ONTO OPPONENT'S
     STOMACH
     AND SLOWLY SMEARS
ACTOR: 1
     SHOWS DISGUST AND WIPES OFF
ACTOR: 2
     IS CONVULSED WITH LAUGHTER

EXCERPT FROM OUTPUT OF CPR

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ACTOR: 2
--------
YES NOT FAR FROM THE SNUFF FACTORY

ACTOR: 1
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NEAR THE GASWORKS ?

ACTOR: 2
--------
YES, BUT MUCH TOO COLD FOR ME
POOR SURROUNDINGS

ACTOR: 1
--------
AND YOUR GRANDFATHER ?

ACTOR: 2
--------
A CHARMING PERSON; SO REFRESHING SO BEAUTIFUL
BUT FAILING I FEAR

ACTOR: 1
--------
THE KARATE LESSONS DIDN'T HELP THEN ?

ACTOR: 2
--------
YEARS OF STUDY WASTED

ACTOR: 1
--------
AH.
DO YOU STILL HAVE YOUR OLD MINI ?

ACTOR: 2
--------
TOTAL LOSS
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EXCERPT FROM OUTPUT OF PINTER