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A COMPUTER PROGRAM FOR ISOLATING GROUPS OF DRAMATIC MASKS OF THE HELLENISTIC AND ROMAN PERIODS

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The objective of the program was socio-literary but the procedure used was the essentially archaeological one of matching sets of artefacts/attributes. We give here, not the results, which are still being analysed, but a critique of the interface between archaeologist and programmer, in the hope that this may be of use to other researchers who intend to use a computer. The program was designed and written by Enn Männik, programmer, using the computing facilities of the Faculty of Architecture and Building, NSW Institute of Technology, which were generously made available through the good offices of Neville Quarry, Head of School, and Ken Madden, Coordinator of Contextual Studies, to whom thanks are due. The project was supervised by J.R. Green, Associate Professor of Archaeology, University of Sydney, in connection with the revision of the text of T.B.L. Webster's *Monuments Illustrating New Comedy* (London 1969), to be published by the Institute of Classical Studies, University of London.

Project

The original aim of the project was to test the hypothesis that the dramatic masks which are shown together on various Greek and Roman artefacts could be correlated into groups which might correspond to the cast-lists of known plays. In this instance we were interested in masks of the 'New Comedy' repertory, a dramatic style which was popular throughout the Classical world from about 500 BC to about 300 AD. It is essentially a comedy of manners, revolving around a boy-meets-girl theme, with a fair amount of secondary intrigue, as in the works of Menander, Terence, and Plautus. All actors were masked, which of course enables a relatively small cast to portray many characters. A mask list given by Pollux (2nd century AD, from a 3rd or 2nd century BC original) describes 42 types of masks for New Comedy, 4 of old men, 11 of young men, 7 of slaves, 3 of old women, and 14 of young women.

We used as basis for our project Webster's *Monuments Illustrating New Comedy* (MNC) in which he had listed about 1800 artefacts (monuments) which have representations of masks. Of these we were interested only in the 190 or so which show more than one mask type. We decided to use a computer, partly because of the bulk of the material, and partly because Webster had devised a descriptive scheme which we felt would eliminate a lot of preparatory work. His scheme consists of a letter for provenance, a letter for artefact-type, and an artefact number, e.g. DM2 = Delos mosaic 2, IT26 = North and Central Italian terracotta 26, etc. No code for chronology is given, as much of the dating is insecure; instead Webster gave a range of possible dates. For each artefact he listed the masks present, which he had numbered

FIGURE 1 Flowchart of input program

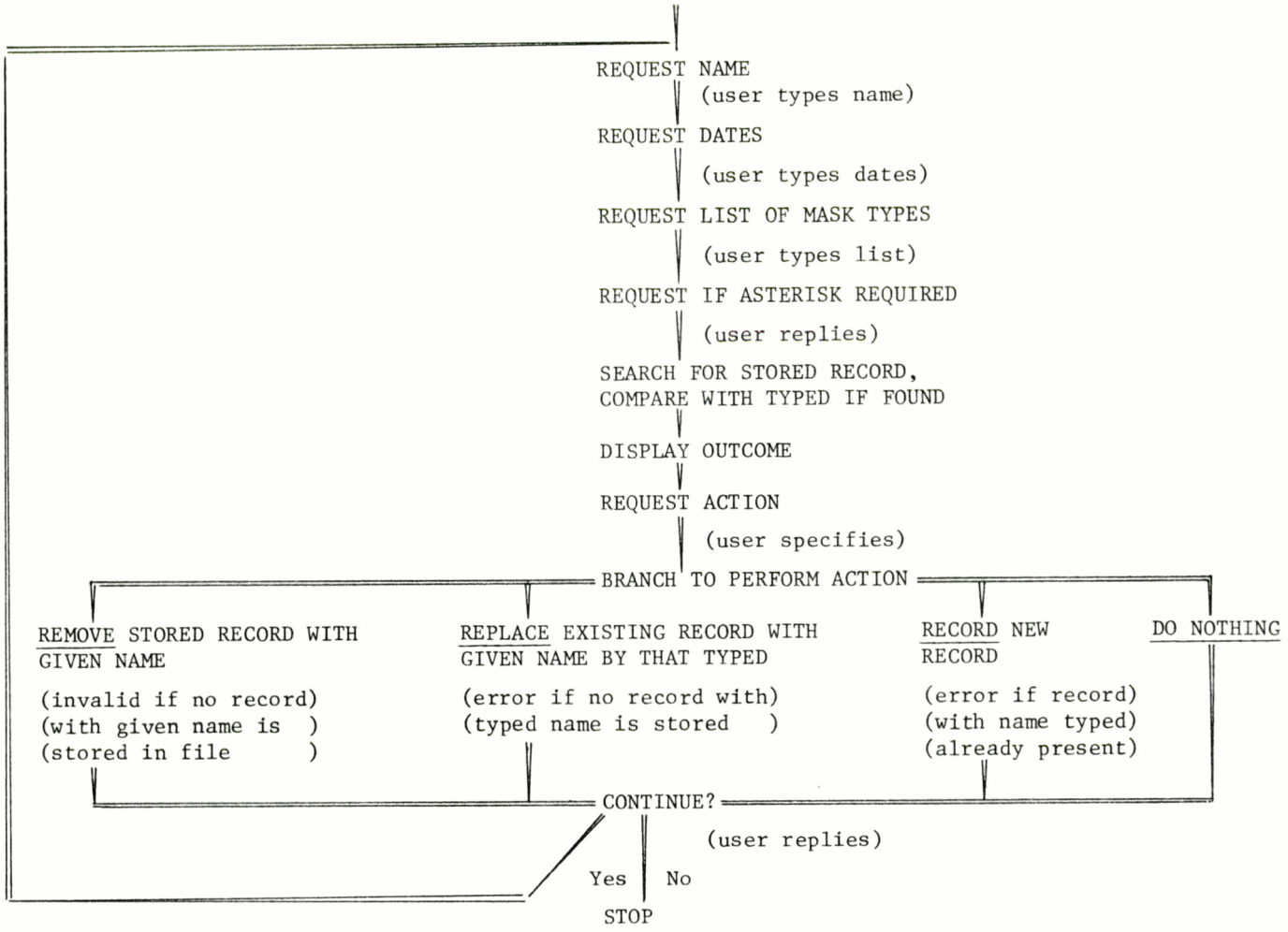

FIGURE 2 Flowchart of output program

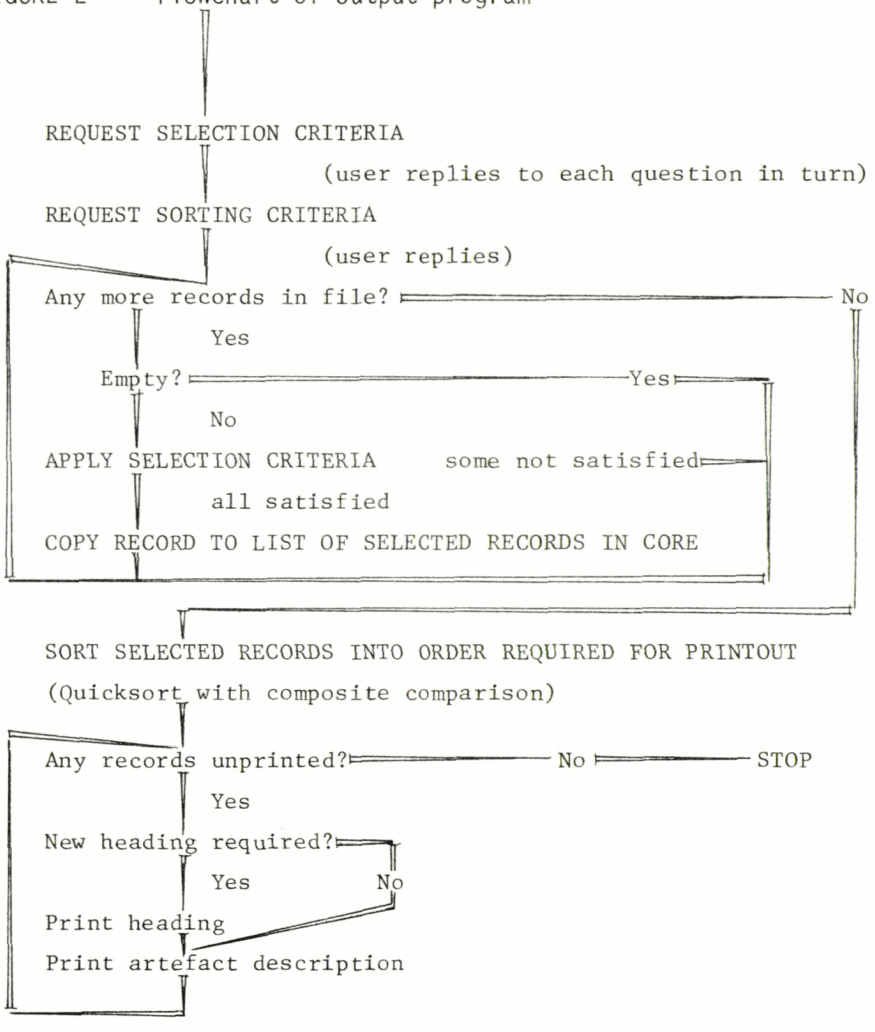

FIGURE 3 Combinations of masks which include mask type 38. Note: YM912 and YM922 are subdivisions of Webster's YM2, mosaics from the House of Menander, the subdivision being indicated by the prefix 9. ST51 is formed of individual terracottas from one tomb (Webster's ST51, ST52, ST53), the grouping being indicated by an asterisk.

```
.R MO
SELECT GEOGRAPHICAL AREAS INCLUDED
  1    INCLUDE, 8    OMIT
ABCDEFGIJKMNPSTUXYZ
11111111111111111111

SELECT USES/MATERIALS INCLUDED
  1    INCLUDE, 8    OMIT
ABCGJLMPSTV
11111111111

SELECT TIME RANGE
  START THEN FINISH
-1500,1500

SELECT MASK TYPES (ONE OF WHICH MUST BE PRESENT
00000000011111111112222222222333333333344444444
12345678901234567890123456789012345678901234567
00000000000000000000000000000000000000000000000

TYPE SORT CRITERIA (5 IN ORDER, SEP. BY COMMAS)
0    NULL
1    GEOG AREA
2    USE OR MATL
3    TIME PERIOD
4    MASK TYPES
4,1,2,0,0

     7 CASES

     3 25 38                    YM 912            300 AD -  300 AD

    12 34 38                    ST  51      *    1000 AD - 1000 AD

    16 27 38                    IM   9           200 AD -  300 AD
                                IT  80           200 AD -  200 AD

    25 25 38 38
                                UJ  25          1000 AD - 1000 AD

    27 38                       NP  38             0 AD -  100 AD

    29 33 38                    YM 922           300 AD -  300 AD

STOP --
```

in sequence according to the Pollux list, from 3 to 44 (Pollux 1 and 2 are now New Comedy). We hoped to obtain from the computer simply an easily legible list of artefacts showing which combinations of masks, if any, occurred sufficiently consistently for us to assess their significance in terms of play identification. The programmer pointed out, however, that we were under-using the computer and thus limiting our own possibilities of interpretation. Accordingly, he built in a number of options for sorting the material, which he describes below, and these proved eventually to be more useful than those we had originally asked for.

A preliminary analysis of the results, which Ken Sheedy discusses in the Conclusions, indicates that the problem of play identification is not to be solved in the way we had approached it. A more valuable result, archaeologically speaking, has been the isolation of a 'normal' combination of mask types against which other combinations may be tested. Another interesting aspect of using the computer was that feeding in the data revealed certain deficiencies in the original classification: in a number of cases masks were either not securely identified or not identifiable at all (for these a category 'Undetermined' had to be created).

Program functions

The task to be accomplished by the program was primarily to group artefacts which had identical combinations of mask types. Certain other information about each artefact was also relevant. It was decided that the data used by the programs should be organised in terms of artefact descriptions because:

i) the information was organised in this way in MNC and the program should therefore accept it in this form to avoid forcing the program user to reorganise it,

ii) the output from the program would also consist of artefact descriptions, since the function of the program is to group artefacts according to combinations of mask types and other criteria discussed later.

The following characteristics of artefacts were relevant:

1. Provenance. Webster's scheme in MNC was followed, each area being indicated by a letter code.

2. Artefact-type. Webster's scheme was used here also, each type being indicated by a letter code.

Webster identified different artefacts by means of a name consisting of a provenance letter, an artefact-type letter, and a number, in sequence, the function of the number being to distinguish between different artefacts having the same provenance and type. Webster's naming scheme was also followed.

Other relevant characteristics were:

3. A range of dates for the artefact.

4. A list of masks found on the artefact. Webster's scheme of introducing a number to indicate mask-type was followed.

In addition it seemed appropriate to provide:

5. A feature to allow the artefact to be labelled as 'special', i.e. that there was additional relevant information not included in the artefact description.

This scheme for artefact description is similar to that of Webster's but proved to be an oversimplification in that some relevant aspects of his information had not been taken into account. Apart from the asterisk (5 above) no provision was made for:

i) situations where mask types could not be definitely assigned by Webster, i.e. masks which were only tentatively assigned a type, or which could not be assigned a type at all,

ii) artefacts where the list of masks present could be divided into groups, the groups as well as the list of masks as a whole being of interest,

iii) situations where masks on several associated artefacts were to be considered as a single group.

These problems were avoided by the program user by:

i) creating an 'Undetermined' mask type,

ii) using a different artefact description to correspond to each interesting group of masks,

iii) using a single artefact description for the whole groups of artefacts, such as artefact descriptions being accompanied by the asterisk. The artefact descriptions thus correspond to 'cases' and not always to single artefacts.

Having defined the nature and organisation of the data to be manipulated, it then remained to define the processes to be carried out upon it. The starting point for this definition was the objective of the program, which was primarily to group artefacts with identical combinations of mask types, though grouping artefacts on the basis of other characteristics was also required. These groupings could be communicated to the program user by means of printed lists of artefact descriptions corresponding to the artefacts in groups. It was noted that:

i) a variety of different ways of grouping the artefacts would be required,

ii) because no person involved had experience in using computer programs in this area it was difficult to decide exactly what grouping procedures a program user might wish to use, or, for that matter, the most appropriate decision for other aspects of the design. There was also the possibility that experience might suggest uses for the program other than those originally envisaged.

These factors implied that a flexible approach needed to be taken to the design of the program. Therefore:

i) the program gave the user a broad range of different grouping procedures from which to select,

ii) the programs were written so that they could easily be modified to alter or extend the range of grouping procedures provided.

The actual grouping criteria provided to allow the archaeologist to describe the grouping procedure required fall into two categories:

i) selection criteria,

ii) sorting criteria.

Selection criteria follow directly from the idea of grouping. Those artefacts which satisfy the criteria are selected from all artefacts known to the program to form the required group. Sorting is included to reduce the amount of criterion-specifying involved in generating certain frequently required sets of groups. The application of a sorting criterion causes all artefacts involved to be divided into groups and the groups arranged into order. The various criteria may be applied in arbitrary combinations. Selection criteria are applied first and sorting criteria are then applied to the items selected. The grouping procedure carried out is the net effect of the application of all the selection and sorting criteria.

The following criteria are currently provided:

i) Selection

a. include only those from specified geographical areas (an arbitrary selection may be specified)

b. include only those of specified artefact-type (an arbitrary selection may be specified)

c. include only those within a specified time period (which must overlap with the range of possible dates for the artefact)

d. include those artefacts which possess at least one of a specified list of masks (an arbitrary selection may be specified)

In order to be selected an artefact's characteristics must satisfy all criteria.

ii) Sorting

a. geographical area (alphabetical order on letter code)

b. artefact-type (alphabetical order on letter code)

c. time period

d. combination of masks (numeric mask codes are arranged in ascending order and sorting is carried out on their value, starting with the first)

An arbitrary selection of sorting criteria may be applied in arbitrary order.

These facilities allow a wide range of grouping procedures to be carried out. These may be very general: e.g. select everything and sort it on the combinations of masks present. This takes every combination of masks which is present on any artefact and lists every artefact on which it occurs. Alternatively, very specific groups may be listed: e.g. select all Northern and Central Italian sculptures which could have been made in the 1st century AD.

Organisation of programs

The functions described above were carried out by two programs written in FORTRAN, running under RT/11, for the Faculty of Architecture's GT44 computer system. This consists of a PDP 11/40 processor equipped with two small disks, a teletype, and a graphics display screen.

As well as the two programs, a file is involved by means of which the programs communicate. This file contains all the artefact descriptions known to the program at any given time. An input program enables the required artefact descriptions to be entered into the initially empty file, as well as allowing checking and modification to take place. Checking features were incorporated to ensure that the information to be used is accurate. Modifications are necessary when errors are discovered or when archaeological information is extended or revised. An output program carries out the actual selection and sorting procedure on the artefact descriptions in the file and prints out the groups of artefact descriptions deduced.

Both programs were implemented interactively, that is, there is a dialogue between program and user as the program executes. This makes the use of the programs easier and more accurate; the need for complex and tedious organisation of information is eliminated; the user types information in response to requests from the program. In addition certain errors (those which result in invalid information) are detected immediately and the user requested to retype the incorrect information. Interactive operation is rapid because of the availability of a graphics screen which displays program responses during the dialogue.

The file consists of fixed-length records, each capable of storing an artefact description. Records currently in use are scattered across the file since the input program accesses the file by hashing. A simplified flowchart of the input program is given in Figure 1. After a dialogue to transfer an artefact description to the program, the program searches the disk file for an artefact description with the same name. If one is found it is compared with the typed artefact description. The result of the search and the comparison, if it occurred, are reported on the graphics screen. The user then has the choice of four operations he can carry out on the file, though under any given conditions some of them are invalid.

Using these facilities, the user can manipulate the file as required. Artefact descriptions can be initially entered with the RECORD operation. Checking may be done by typing each artefact description a second time and observing whether an identical

description with the same name is already present on the file. Any meaningful modification can be carried out since artefact descriptions may be added or removed, or different information be associated with the same name.

Records are accessed by using a hashing with overflow table technique (Maurer and Lewis 1975). The name is based on the use of the hash key. Use of hashing is not necessary with the number of records currently in use since a linear search through the disk file would have been fast enough. However, the use of this technique means that the program can be used efficiently with larger numbers of artefact descriptions, if later required, with almost no modification.

A flowchart (Fig.2) and sample printout (Fig.3) are given for the output program. In the sample printout portions of the dialogue typed by the user have been underlined. As a result of the dialogue the selection and sorting criteria discussed above are obtained. When the criteria have been obtained they are applied to the artefact descriptions stored on the file. First the entire file is scanned sequentially and those records which contain artefact descriptions satisfying all the selection criteria are copied into an array in core memory. These are then sorted into the order specified by the sorting criteria, using a conventional quicksort algorithm (Martin 1971, 151-52) which has been modified by substituting a composite comparison for the usual simple comparison. This modification compares records according to each of the sorting criteria in turn until a difference is found or the sorting criteria are exhausted. The artefact descriptions are then printed out, headings being inserted as required.

The output program can currently only cope with a limited number of selected artefact descriptions because they are held in core after selection. This is adequate for the number of artefact descriptions currently held, but if the program is later used with a much larger number of descriptions, the selected records will have to be held on a second disk file and the sort altered to a sort-merge.

Using the program

The initial problem from the archaeological point of view was the recognition of valid mask groups. Such a group should have been created in antiquity as a conscious decision and should not be the result of random factors or artificially created by the intervention of the archaeologist. It was decided to experiment with several criteria for the determining of such mask groups: the most evident seemed to be the clustering of several masks on a single object, as for example, a marble relief, Naples Museum 6687 (Webster NS 25), which has a group of four masks. However, in some instances, it was found necessary to divide a large group of masks although they occurred on one artefact and were accordingly listed under one entry by Webster, as, for example, the mosaic floor in the House of Masks at Delos (DM1). This was divided into three cases for the program, on the basis of different mask clusters on different parts of the floor. Another form of grouping which was deemed valid consisted of individual artefacts with only one mask each, but

found together; thus, the terracotta statuettes from Myrina Tomb C (MT3, MT4, MT5, MT6) were combined under the heading MT3, with an asterisk to denote the nature of the case.

The artefacts themselves often presented problems in relation to their state of preservation and the circumstances in which they were found. The reduction of the information for each artefact to a uniform descriptive scheme thus involves a degree of interpretation which must be recognised in the examination of any grouping of these cases.

Conclusions

The artefact description produced by the computer conceals, as any model does, the complexity of interpretation in relation to each artefact and mask group. In examining the various groupings listed by the computer the degree to which such groups were created by the simplification of the information had to be checked by reference in each case to MNC and to more detailed publications of the evidence. Of particular importance was the degree to which the different criteria for determining mask groups had been substantiated.

In all, 21 groupings of identical mask combinations were formed simply on the basis of masks present on the 196 cases (artefacts) examined. Two groups which were of 'Undetermined' masks are to be left aside, as being created artificially through an inability to precisely identify mask-type. The highest number of cases in the other groupings is 4 only, and this occurs 3 times. The remaining 16 groupings are of 2 or 3 cases, each with its own identical combination of 2 or 3 mask types. This seems a fairly low number of groups even for the 196 cases involved.

Listing cases according to the presence of each particular mask shows that there is a clear group of mask types which were favoured for mask combination. For each of the dramatic characters there are two mask types which are by far the most popular: for the old man, 3 and 4, for the young man, 13 and 16, for the slave, 22 and 27, for the young girl, 33 and 39. The only major character not represented in this group of high occurrence is the old woman, for whom only one mask type occurs more than once (29, 11 times). The program has thus been successful in locating those masks which were not commonly used and has detailed those instances of use which seemingly mark an unusual and deliberate change from the conventional type. A general comparison between the groupings according to identical mask combinations and those according to the presence of one particular mask type reveals that there was a series of conventional mask types, but that such restraints of convention were not present in the creation of mask combinations. Of the 19 groups of mask combinations, 9 consisted only of the common mask types listed above. Ten groups have thus been isolated for which the presence of an uncommon mask type, or types, could suggest an unusual circumstance, e.g. the use of the mask in a particular play which had gained popularity, etc.

The question as to whether actual plays or scenes can be identified from mask groups has not been conclusively answered from this study. The reason for this becomes clear from an examination of the main single piece of evidence for such an identification, the 3rd

century AD House of Menander on Lesbos: here are found mosaic depictions of scenes from Menander's plays being performed by actors wearing masks. In each case the scene is identified by mosaic letters within the composition which abbreviate the play's title. Of the ten mosaic scenes, only two find parallels in mask combinations from elsewhere; in one of these (*Misoumenos* Act 5, YM982, Webster YM2B3) only one of the 3 masks can be identified as a Pollux type (15, young man). Webster has compared the scene with one represented on a Roman cake-mould (IT80), with three actors whose dress and gesture show a strong resemblance to those on YM982, but here the young man's mask is 16, not 15.

If different mask types were used to depict an actor in the same scene, and if the same set of masks was used for an entirely different play, this would seem to prevent any immediate identification of a combination of mask types with particular plays or scenes. In view of this, the program should have been designed to group the variations possible on each particular mask type within the context of the mask of the other characters always being present, which could be done by a minor modification to the existing program. From this, groups based on the identification of the dramatic figures, and not on mask type, could be arranged. For example, all those cases in which a young man, an old woman, and a young woman are present, instead of the identical mask combination groups, which have proved to be of little use. This is shown in YM972 (Webster YM2 B1), *Kybernetai* Act 3, and YM992 (Webster YM2 B4), *Phasma* Act 2, both of which show the same masks for old man, young man, and young woman (3, 13, 33).

In the study of the artefacts, however, the results of the program can suggest an answer to several problems. The incidence of a particular mask type in combination with others in relation to the occurrence of other mask types, or to chronology, or to provenance, can be of assistance in identifying indistinct masks. This is particularly so where uncommon mask types are concerned: mask 38, for example (the full-grown hetaera, a version of the young woman), occurs in only seven cases and appears to be confined to the first three centuries AD. Its association with mask types 16 and 27 has strengthened the identification of these two mask types on a 2nd century AD Italian terracotta (IT80) and a 3rd century AD Italian mosaic (IM9).

The criteria which were used to determine these mask groups have only been supported by case grouping for mask combinations found on one object, or where they are clearly defined on certain mosaics, such as those in the House of Menander. The results of the listing according to chronology show that the most common mask types have a long history and this attests to a consistency in the means of presentation both in the theatre and in the way it was popularly referred to. The program has been successful in revealing mask types which appear at the moment to have a particular significance in their use. It is hoped that in the future more groups may be determined and added to the computer record which, with the detailed research on individual mask types arising from the present study, will provide a clearer understanding of mask groups.

References

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ANNUAL REPORT OF THE ARCHAEOLOGICAL SOCIETY OF VICTORIA, 1977

D. Wayne Orchiston and C.S. Johnson

On behalf of the Committee, we are pleased to present the 13th Annual Report of the Archaeological Society of Victoria.

Committee

The composition of the Committee underwent substantial change during the year. In March the elected Assistant Secretary, Miss Cynthia Grove, was transferred to Sydney, and the Committee selected Miss Beverley Webster to take her place. However, Beverley had to step down in July, owing to evening lecture commitments, and she was replaced by Miss Dianne Saunders. Miss Joan Henderson resigned from the position of Syllabus Organiser in April, and Eric Willacy was elected to replace her, and Gavin Low acted as Treasurer during Frank Hanham's prolonged overseas trip. Finally, as a result of Gary Presland's departure for the Institute of Archaeology in London, the Committee gained the services of Dr Nairne Elder. Those who remained on Committee throughout the year were Drs Douglas Berryman, Peter Coutts, and Ron Vanderwal; David Davies, and Miss Brenda Wallace (as Ordinary Members); Ron Miller (Vice-President); Allan