COMPUTERS AND THE STUDY OF ARCHAEOLOGY in BRITISH COLUMBIA, CANADA

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Introduction

This paper will concentrate upon the current research and development of programmes and systems used or planned in British Columbia, Canada, to integrate various types of excavation and museum data. Though this type of paper is essentially one of simple reportage, some theoretical problems are perceived and deserve comment. The specific problem to be dealt with concerns the formulation of guide lines of a methodological nature that must be considered if computers are to be used to their fullest potential within the field of archaeology.

In-field Data Recording

The use of in-field data recording suitable for computer manipulation in British Columbia archaeology is approximately two field seasons old. Having had the experience of using existing data recording techniques, I became painfully aware of the limitations of data manipulations deriving from this type of recorded data. The norm is to record a minimum of detail about artifacts, burials, features and other types of data; and later, following the field season, to gather this data together for particularistic analysis. Processing of this type imposes serious limitations upon the amount of data analysis possible given the usual reliance upon volunteer labour and the necessity of reporting upon the excavated site as soon as possible.

With this in mind, I developed a coding format (Loy 1972 and 1973) for use at the Glenrose Cannery Site (DgRr 6) in Delta Municipality, British Columbia. The format included the recording of artifact number, provenience information, stratigraphic unit and arbitrary excavation level designations, soils type designations, artifact material type (general and specific), artifact manufacturing technique (primary and secondary), artifact type classification, artifact condition, and metric attributes of the artifact.

The recording of this information was done in two stages in the field: (1) In the pit, provenience, soils, level and stratigraphic unit, provisional artifact type and condition were entered upon a recording form. (2) In the field lab the artifacts were cleaned and the information from the artifact record sheet was coded along with the remaining information onto a coding sheet. Full coding sheets were then submitted for key-punching at the University of British Columbia Computer Centre.

Although the time required to perform this data recording in the field amounted to somewhat more than the usual recording method, we found that as many as 200 artifacts per day could be processed by one person.

In the second excavation season the coding designations for artifact type categories, stratigraphic units, and soils were changed following examination of the first season's results. Translation of the original coding into the new format was done by machine and all records were updated using programmes specifically written for that purpose.

Following the initial success of this type of data recording, two other investigators modified the format slightly to conform to their own project's needs. Professor Fladmark of Simon Fraser University added detailed attribute codings that recorded artifact shape (especially for chipped lithic artifacts) and the orientation of the artifacts in situ. Mrs. Boehm of the University of British Columbia modified the soils and materials categories. It is now planned that the British Columbia Provincial Museum and the British Columbia Archaeological Sites Advisory Board will adopt similar recording procedures.

The advantage of this type of field-data recording technique lies in the subsequent speed of analysis permitted. The often time-consuming jobs of compiling artifact catalogues, plotting artifact distributions, calculating simple statistics such as percents, means, deviations and the like can be done even while in the field (given that the site is not too remote); this could provide valuable feedback for infield decision making.

Recently there has been an increasing emphasis upon the study of many more types of site data, especially when dealing with complex Northwest Coast midden sites (Conover 1972 and Luebbers 1971). It is becoming evident that to interpret such complex sites a great many patterns of cultural and environmental interactions must be sought and analyzed for. This emerging methodological paradigm demands the ability to examine a large variety of types of data that can be accomplished in part through in-field computer processing.

Computer Aided Statistical Analysis

Computer aided statistical analysis of archaeological data has been in use for only a few years in British Columbia archaeology. In most cases computerized statistical analysis has been directed toward the solution of specific problems connected with the interpretation of the site record, or with the investigation of postulated "Phases" and "Phase Components" of the occupation of the Gulf of Georgia area in British Columbia. To my knowledge, until this year's analysis of the material from the Glenrose Cannery Site and Dr. Fladmark's analysis of recently excavated material from the Northern

interior of British Columbia, no investigator has used an integrated computer aided statistical investigation of the data from one or more sites.

Boehm (1973) has used multi-dimensional scaling to investigate the relationship between tool function and the represented faunal remains suite at the St. Mungo site (DgRr 2) Delta Municipality, British Columbia. Hanson (1972 and 1973) used multi-dimensional scaling techniques to investigate the relationships of the seasonality of various resources in order to establish a possible explanation of the observed occupation pattern at the Katz site (DiRj 1). Loy and Sneed (nd) used these same techniques to investigate the structural attributes recognized in early historic log cabins; a typology of these cabins was proposed as well as were inferences as to the intended length of occupation and the occupation of the builders.

Monks (1973) used multi-dimensional scaling on a selection of artifacts from the Gulf of Georgia area, British Columbia, in order to test the "reality" of the division of site components into Phases as postulated by Borden (1970) and culture types as advanced by Mitchell (1972). Matson (1973) used a series of statistics including clustering and multi-dimensional scaling toward the same end.

In the analysis of material from the Glenrose Site, both Q and R type analysis is being done using, for the most part, binary (presence/absence) co-efficients of association and non-parametric multi-dimensional scaling--MSA1 and SSA1, (Lingoes and Roskam 1971, Lingoes 1966, Kruskal 1964, Torgerson 1967.) These methods for analysis are being applied to the faunal remains, artifact types and occurrences, shell remains, features and stratigraphy. Geophysical (seismic) testing was done at the site to establish the conformation of the sterile/cultural interface and a series of regression analysis and computer contour plotting programmes developed at Harvard University were used to reduce the raw data to an interpretable form.

With the exception of Matson's work, all of the statistical procedures employed to date have been packaged programmes available at University Computing Centres. Of the non-parametric multi-dimensional scaling techniques used, the programmes developed by Guttman and Lingoes appear to be the most heavily used. In addition, the most preferred index of comparison of attributes or cases has been binary in nature (cf Cheetham and Hazel 1969).

Hierarchical Clustering and Factor Analysis have not received much usage to date in British Columbia archaeology; I believe that the availability of non parametric scaling routines has precluded the wide-spread use of these two types of analysis. The MSA 1 and SSA 1 Programmes produce printed output that

provides (for 2 or 3 dimensional solutions at least) a clearly delineated pattern that then can be used directly, for the solution is intuitively intelligible.

Following some thought, two conclusions arise concerning the use of computer aided statistics: Where statistical analysis was used on site data for the purpose of elucidating and explaining the site contents, the lack of in-field data recording severely limited the scope of data that could be analyzed owing to the amount of labour necessary to put the data into the proper format at a later time. The relatively limited success of this type of analysis nevertheless had provided a certain impetus toward greater use of these techniques.

The other conclusion is based upon a common complaint by the archaeologists concerned, lamenting the lack of sufficient data. It is quite true that there is still a relative paucity of excavated sites considering the size of the Province; but there is another factor operating as well -- the lack of reportage of site data using comparable terminology, typology, and methodology. This should not be construed as a call to adopt a rigid "standard" method. Rather, considering the increased potential for large-scale site or regional analysis conferred by the computer, serious thought must be given to adopting a set of at least minimally constraining standards. Perhaps, for example, this would take the form of a standard terminological and typological dictionary and an associated list of synonyms, from which any particular investigator could choose -- reflecting his own methodological bias.

Also, the current lack of data reflects the nature of the times; these computer studies have been done upon data collected with the older, more established methods of analysis in mind. This mixing of older data acquisition techniques, and high speed computer analysis indeed could not result in anything but a lack of sufficient data.

The Federal-Provincial Archaeological Data Bank

The British Columbia Provincial Museum in conjunction with the National Museums of Canada, Information Systems Division is participating in a pilot project that will lead to the complete inventorying of museum archaeological artifacts. A tentative recording format has been agreed upon and we are now in the process of recording information from the Museum's collection. The recording format is word based and the coding terms consist of descriptors and modifiers as well as simple numerical entries (measurements, provenience etc.). The central computing facilities are located in Toronto and we will be using an I.B.M. Communicating Magnetic Card Terminal to enter and retrieve data. The recall system is essentially of a word-in-context (logical) nature. The different headings contain one or more sets of logical fields that include one descriptor and one or more modifiers. The words used are in the process of being standardized in dictionary form; and a list of common synonyms that have appeared in the literature is being compiled at the

same time. To date 800 artifacts have been entered onto the Magnetic Cards.

In May 1973 the entry of the British Columbia Sites Location File into a national inventory was started. This file is now awaiting conversion into machine readable form and will be functioning as an active file for our use within the next six months.

As part of the Provincial participation in the programme the Museum is planning to add files to store and retrieve information on faunal and floral remains, features, burials, archival and bibliographic references. In conjunction with these data files, we anticipate building a small file of statistical and plotting programmes for in-house use as well as for use by individuals who have either limited funds or do not have regular access to university computing centre facilities. These programmes will be drawn from the SPSS routines (Nie, Bent and Hull 1970) for many of the statistical applications, as well as programmes for clustering and scaling, plotting (Gunn 1970), contouring and manuscript editing (I.B.M. 1971).

Theoretical and Other Problems

Unless certain problems are dealt with, the place of computers in British Columbian archaeology will be uncertain. These problems stem in part from the stage of archaeological development in which British Columbia Archaeologists find themselves. Archaeology is a relatively recent phenomenon in the Province, and the majority of the work has been oriented toward investigations of a cultural-historical nature. This approach seeks to establish the historical sequence of cultural phases and components of phases (Willey and Phillips 1958) based upon the presence or absence of a limited number of "diagnostic" artifact types. The dichotomous relationships between phases when viewed from the diachronic perspective appear to result from the synchronic occurrences of diffusion, migration, acculturation, trade and other interactions of these types (cf. Trigger 1968: 26-46).

The reliance of this method upon the analytic reduction of the range of possible archaeological data implicit within the concept of "diagnostic" attributes of an archaeological culture (primarily in the form of artifacts, house styles, and in some cases resource bases) in part reflects the lack of techniques suitable for the processing and analysis of a large amount of data. Indeed, most of this type of analysis predates the availability of the computer to the research community. Computer aided analysis of the type of data allowed into the Cultural Historical method (cf. Kuhn 1964) will by the very nature and application of these data, be useful only in investigating the similarity/dissimilarity of components and phases.

Recently the impact of the Processualist School (Binford 1965; Deetz 1965; Hill 1971; Kushner 1970; Watson, LeBlanc and Redman 1971) has been felt. To the Processualist, culture is conceived primarily as the adaptive mechanism which enables man to cope with his environment (Kushner 1970: 125). To be used

this methodology requires that the researcher isolate causative factors relating to cultural/environmental interactions and thus seek regular, statable and predictable relationships between these causative factors (Binford 1965: 205).

The analytic reductionist approach appears to the Processualists (Watson, LeBlanc and Redman 1971: 69) to be inadequate in light of the increasing number of variables found to be relevant in the study of cultural processes. Thus the sheer numbers of variables thought to be relevant to the understanding of a cultural/environmental interaction demands the use of the computer to aid in analysis. Currently, the use of traditional, non-systemized methods of data collection in the field, and the emphasis of the Processualist school upon environmental/cultural interactions has limited the use of the computer to that rather narrow concern (considering the scope of the actual data encountered in the field).

The ability of the computer to aid in the analysis of large numbers of very complicated variables and relationships between these variables, however, appears not to be used to its fullest extent at present. It would seem that our use of computers is, in British Columbia archaeology at least, an afterthought; the computer is used to study those questions that are appropriate to formulate given the restriction of the investigatory paradigm. Therefore in order to utilize the very helpful abilities of the computer, we must design our methodological paradigms with the capabilities of the computer forming an integral part of the research structure.

At present the use of all available archaeological data to solve questions of a broader nature than simple Culture History or cultural/environmental interations appear to be resolved through the application of Systems Theory (Hall and Fagen 1956; Rapoport 1968; Ashby 1962; Buckley 1967; Clarke 1968; Hill 1971; Flannery 1968; Watson LeBlanc and Redman 1971). As a general definition Hall and Fagen (1956: 18) state that "a system is a set of objects together with relationships between the objects and between their attributes." Defining "environment" more broadly than the Processualists, Watson LeBlanc and Redman (1971: 71) posit that the system's environment" ...is the set of all objects that directly affect the system or are affected by the system. The environment can include climate, topography, natural resources, food sources, other social groups, and other influences external to the system itself." Ashby (1962) urges that the analysis of systems be based upon the regularity of the system's behaviour. The ability to identify the states and rules governing the behaviour of the system will allow a definition of the nature of the changes in the system's states through time. Following from the predicative nature of System's Analysis is the ability to explain more closely and understand the extremely complex nature of recovered archaeological data. In order to use Systems Theory in Archaeology, the computer with

its intrinsic abilities to perform massively complex manipulations would have to be considered as an integral part of this methodology.

Summary and the Future

The use of the computer in British Columbia archaeology is in its formative stage. The primary uses of the computer have been the investigation of the relationships of archaeo-cultural components and phases; and also in specific investigations into the causal factors resulting in and from environmental/cultural interactions. In addition, the last two years have seen the development of data recording and storage/retrieval systems suitable for archaeological data.

It becomes evident that there is a relationship between the archaeologist and his theory and the computer: The application of a theory is constrained by the tools available to effect the implementation of the proposed theory; the computer represents a vast widening of the analytical range of the archaeologist. The culture historical paradigm reflects, in part, the earlier limitation through its reliance upon analytic reductionism. The Processualist paradigm, although it calls for the multivariate treatment of complex data relationships, uses the computer as an ad hoc tool - investigating only certain selected problems in detail.

As the ability to manipulate more data is recognized, more data become important and thus are included in the investigatory paradigm. Although recognizing the power of the computer, and the need to incorporate the newly perceived data into more accurate statements about the cultural past of British Columbia, there exists a vacuum of theory into which this newly expanded data base can be cast. One solution is seen to lie in the concepts of Systems Theory.

The future of computer applications in British Columbian archaeology lies in two alternative strategies: (1) the continuation of the emergent pattern of ad hoc applications for the solution of specific problems; or (2) the creation of a new research paradigm and its attendant methods that will facilitate the analysis of complex archaeological data in the search for understanding of truly complex phenomena.

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