HYPERMEDIA APPLICATIONS IN ARCHAEOLOGICAL DATA ANALYSIS : AN EXAMPLE : The Hesquiat Village Site, DiSo 1.

by

Gregory Victor Loewen
B.A. , University of Victoria, 1988

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

MASTER OF ARTS

in the Department of Anthropology

We accept this thesis as conforming to the required standard

[redacted]

Dr. Donald Mitchell, Supervisor (Department of Anthropology)

[redacted]

Dr. Nicolas Rolland, Departmental Member (Department of Anthropology)

[redacted]

Dr. John Oleson, Outside Member (Department of Classics)

[redacted]

Dr. Paul Romaniuk, External Examiner (Department of Biochemistry)

Supervisor: Dr. Donald Mitchell

ABSTRACT

The analysis of archaeological data is often fraught with difficulties that do not stem from the data themselves, but rather from lack of scientific or technical methods by which to analyse or present such data. This thesis attempts to aid in the search for new methods of presentation and analysis by entering excavated and recorded archaeological data into a hypermedia computer program. The program is designed by Apple Computer, and is called "Hypercard™". The author designed a custom version to suit the particular needs of the archaeological site of DiSo 1, or the Hesquiat Village site, on Vancouver Island's west coast. Analogic and associative links created within this data base allow for new and different analyses and presentations of such data. Previous work in computer assisted archaeological data management is summarized and practical and philosophical implications arising from the use of hypermedia applications in archaeology is discussed. The thesis surveys the excavated site data, both before and after entrance into the created program, and explores differences, while suggesting improvements to both programming procedure and archaeological recording procedures. It concludes that hypermedia can contribute to archaeology and anthropology in economy of access, frameworks for the suggestion of alternative interpretations, and as hypothesis generating vehicles.

Examiners:

[redacted]

Dr. Donald Mitchell, Supervisor (Department of Anthropology)

[redacted]

Dr. Nicolas Rolland, Departmental Member (Department of Anthropology)

[redacted]

Dr. John Oleson, Outside Member (Department of Classics)

[redacted]

Dr. Paul Romaniuk, External Examiner (Department of Biochemistry)

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ACKNOWLEDGEMENTS

Many persons deserve credit for helping to bring this thesis to fruition. The author would like to thank the members of his committee. They are Dr. Don Mitchell, Dr. Nicolas Rolland, and Dr. John Oleson. A special thank you to Dr. Don Mitchell for having the patience of a philosopher for one who would be. Thank you to Brian Richardson for introducing me to Hypercard™. A thank you to my parents for patience and support. Most importantly, thank you to Joyce Lem for her beauty as an artist and as a person.

The duration of works is the duration of their utility. This is why it is discontinuous . . . . To have genius and to create a viable work are two profoundly different things. All the transports in the world yield only discrete elements. Without a fairly accurate reckoning, the work does not hold—does not *work*. An excellent poem supposes a mass of exact reasoning. A question not so much of forces, but of application of forces. And applied to whom?

Paul Valéry (1973:562-566)

1.0 The Project

1.1 Introduction

Analysis of archaeological data is limited by many factors without archaeological origin. Presence of limiting factors can affect both the collection and the interpretive processes. Much attention is currently directed at discovering and using new and better applications in the interpretive and analytic realms of archaeology. New analytic frameworks can arise from the thesis' presentation. The basis for the thesis is a recent computer software innovation. Archaeology uses a wide variety of data and there are problems in handling such diverse information. The thesis is an attempt to reduce the restrictions imposed by data management.

The Hypercard™ computer system can bring a different organization to the many links between data collection and subsequent interpretation. Hypercard™ uses "non-linear" links amongst data. Hypercard™ also provides a data base or "text", from which alternative interpretations can arise. We use the word "text" metaphorically. "Text" means the total of all the interpretive, analytic, and descriptive work of a discipline. Each reading of the "text" that is scientific data may create a better interpretation than previous attempts. Users can not only add to the data base by entering appropriate information, they can also test the interpretations of students before them. Archaeologists can "reconstruct" the original interpretive process in the light of new data and their own experience. Although the operation of our computer program employs the standard set of assumptions that archaeology contains, and gives them their fullest range of meaning, the assumptions of archaeology can be questioned.

However intrinsically relevant archaeological assumptions are, they remain beyond the thesis' scope. For a summary of the philosophical background to the thesis, the user can read the first section of the "Introduction Stack", which is outlined in section 4.4. Instead, the thesis will concentrate on providing alternative interpretations for archaeology, as well as alternative methods for arriving at interpretation.

Of most importance, the thesis' program is designed to allow the archaeologist to experience data within the recording, analytic, and interpretive contexts. Experience denied by other forms of data management will be present in our application.

1.2 The logic of "Non-Linearity"

To the present, most computer systems having academic application have concentrated on reducing observation linearly. "Linearity" in our sense is metaphoric. "Linearity" defines a pattern of relations that exists amongst texts. "Linear links" are patterns that do not use expressly associative or analogic relations. Texts are ordered in a deductive and strictly logical manner. Logic in our sense would include chronological or numerical ordering. Observation is translated into a model, through a method of simplification that uses linear linkages. Linear links postulate a simplified world *via* the application of various forms of logic. In archaeology, analysis often involves the translation of descriptive data concerning objects of both cultural and natural deposition into usable interpretative classes. Some attempt at explanation can begin (Dunnell 1986). The effectiveness of such methods is not to be questioned here. Instead, we wish to propose as a supplement to any linear schemes, a somewhat different system of logic.

Wittgenstein's "parable of the rope" will help explain. Knowledge is like a rope. Its many strands are constantly re-woven into a form that makes up the rope as a whole. The rope represents all human knowledge. However, the states of knowledge and the intermingling of the strands within a rope change. Therefore, at any one moment, all human knowledge cannot be realized. The strands are linked in a manner dependent upon one another for meaning and function. It is the links that exist among states of knowledge that constitute knowledge itself, just as the strands make up the rope in the parable. Humans, as the possessors of such knowledge, exist within the rope. Hence, all knowledge can never be known.

The assumed impartiality of the scientific investigator is an attempt to understand merely one state of knowledge. The point of Wittgenstein's story is to place the investigation in the sum of knowledge. Placing the investigation here allows linkages to be made amongst the strands, that will not rest on the linearity of logical operations. A linear logic provides the investigators only part of what they seek, i.e. a constructed linearity of events leading to other events through a notion of antecedent and cause.

The construction of the remainder of the analysis may be accomplished through the use of a "non-standard" system of logic. Metaphoric analogy and connection *via* association are the two most important features of our system. With the use of analogy and association, the strands of knowledge may be understood in their full meaning, and not merely their logical order.

The addition of an alternative system of logical thought has relevance when applied in a computer program. Recent technology enables the investigator to analogize and associate while receiving full cooperation from new software. All that is necessary, besides the specialized knowledge of the archaeologist, is associative thinking, and the ability to link disparate events by metaphoric analogy. Analogic thought processes are assumed to be universal for any potential program user. Analogy and metaphor have contributed to archaeological analyses in the past (Wylie 1985), and such facets of thought occur constantly in the mind. Although there may be other forms of thought that do not have recourse to the basic patterns of analogy and association, it is difficult to think of what they might entail.

Now there is a scientific method that may use to their fullest extent such assumed fundamentals of human thought. We do not have to suppress any particular method of analysis that could be labelled analogical or illogical, because it does not follow a linear form. Science as a whole benefits when it includes any new system of relations that helps it attain its goals. Any suppression of relevant thoughts would be detrimental, just as the failure to include relevant data is harmful to a particular scientific interpretation.

Archaeology often uses statistical correlation and pure description as replacement for the causal explanation of the physical sciences. It will benefit from an additional system of relations. Since archaeology seems less constrained by the formalism of scientific rigour than many other disciplines, it is an ideal area for our experiment. The experiment will lead investigators to new discoveries, still testable in the context of the previous, as well as in the light of subsequent experiments. Our experiment demonstrates the logic of non-linearity.

1.3 Hypermedia—An Introduction

A brief introduction to the computer system and our particular application is in order. First, we will discuss and describe the basic assumptions of a "hypermedia".

If a "medium is the message", then hypermedia has many messages at once, because of its use of "associative links". The concept of a system of such links related to scientific analysis was first envisioned by Vannevar Bush, who was F.D. Roosevelt's scientific advisor (Ambron and Hooper 1989). In 1945, the article "As We May Think" appeared in "*The Atlantic Monthly*". It outlined the concepts that four decades later were to resurface in hypermedia (Ambron and Hooper 1989:89). The article said that computer tools could be designed to mimic the way in which human thought processes were understood. The computer software should use the human mind as an analogue, to mimic our perceptual process *via* analogy, thereby becoming an aspect of human "self-reflexivity" (Ambron and Hooper 1989:91).

The first working application of such a system took place in 1987, with the advent of the Apple Corporation's software program "Hypercard™", by Bill Atkinson. Hypercard™ uses the associative process in human thought patterning to link a variety of data, in a variety of disparate media. There have been other and earlier guises of hypermedia in the form of "hypertext" programs, but Apple Hypercard™ is the only current application with almost unlimited use. The inherent system of logic within which Hypercard™ functions, and any technical considerations, are unique to that program. The only design limits voiced by its creator are the limitations of the user's and programmer's imaginations. A custom design of the Hypercard™ program can include the considerations of an archaeological analysis. The problems that archaeology encounters are addressed dynamically.

Hypercard™ uses the "Macintosh user interface". The interface puts a premium on real world metaphor, conveniently reflecting the scientific return to the empiricality of lived experience. Hypercard™ is run with any of the Macintosh line of systems. Hypercard™ works with many other software systems designed for the Macintosh. A product is created that moves beyond that which Hypercard™, on its own a completely self-contained system, can provide the user.

Hypercard™ employs five "user levels" and five "construction concepts" simultaneously. The five user levels are as follows: a) "Browsing": basically reading of data in the system; b) "Typing": editing text by changing or adding to words already contained within the system; c)"Painting": the graphics component of Hypercard™, letting the user choose or edit all kinds of graphics; d) "Authoring": actually creating one's own system within the confines of the program, and e)"Scripting": stepping outside pre-set confines by customizing or redesigning the system by programming. Hypercard™'s user levels allow participants with varying degrees of computer experience to use it to suit their needs.

The five basic components of Hypercard™ involve the concepts of "fields", "cards", "stacks", "buttons", and "backgrounds" (see figures two and three). A field contains all types of texts except graphics, which exist outside the field (see figure three). There are two types of fields in Hypercard™. One is called a "card field", in which all attributes of such are limited to the card—or a single unit of information. The "background field" is a field that has an overarching relationship amongst all cards that are associated with that field, even though the texts may change from card to card (see appendix one figure 3). The "card", is the basic unit of Hypercard™, containing one "screenful" of information. Cards are used in the construction of "stacks", or sets of cards that share some common associative link or theme. "Buttons" are tools of navigation that are used to move around within the system. The buttons are self explanatory to users when they understand the context in which buttons are found. The "background " links a subset of cards within a stack. Backgrounds can be used as a link between many subsets of cards in different stacks. Subsets of cards are thought to share a template, to which associated cards can be added. In addition to the above ten fundamental aspects, there is the programming language, in Hypercard™'s case called "Hypertalk™". Hypercard™'s language works at the user level called "scripting".

In the construction of Hypercard™ stacks the user uses tools of various function and design. There are "menus", to borrow from the Macintosh user interface vernacular, that exhibit the tools on "palettes", or repositories of tools. Tools can used at will, without travelling away from the user's current position in the system. Paint tools aid in creating custom graphics, and can act with drawing tools. Graphics can also be imported from other more detailed paint programs, and external images may be scanned into Hypercard™. Line drawings give the best result, but photographs may also be scanned. Once inside the system, scanned material may be altered by the graphics options. Graphics take up more memory than written text, but the amount is not overwhelming. Though not relevant here, the potential exists for a multitude of sound effects in Hypercard™.

Each created system has its own map, "helpstack", and "homestack". A map in Hypercard™ is merely a picture of the entire system on a single card: a flowchart. It shows users exactly where they are with respect to all other information in the system. A helpstack is a set of cards that includes all the information necessary for navigation of the system. The user can consult the helpstack at will, by using the corresponding button on each card. The homestack is similar to the helpstack, but it contains an index of the entire system's information. The homestack bypasses all the associative linkages that are set up within any Hypercard™ system, to allow a static place of reference, or "home". A home allows ease of reference, as users can automatically move to another part of the system. The "recent" function is also useful, as it allows users to see where their last forty-two positions were, in sequence.

Hypercard™ comes with many card, button, art, and stack ideas, but of course users can create their own. Hypercard™ is designed to help the user to experience its contents while learning the system's architecture. It is the only application, based in hypermedia or otherwise, that performs such a multi-faceted role with ease of operation.

1.4 Compatibility

The question of compatibility is important for Apple and

Macintosh users. With the advent of larger influences in academic and business realms with the Macintosh and related systems, isolation is now coming to an end. With the development of "Supercard", an expanded and more powerful version of Hypercard™ and released in the autumn of 1989, as well as Windows 3.1 and the new IBM DOS system tools, compatibility and future access is assured.

Of more interest is the compatibility of such a system to the problems of archaeology. Technology is often seen as a panacea for the problems of the world in general, and academic venture in particular. A technological panacea is an illusory notion, as technology ultimately derives its usefulness from the creativity and wisdom of its creators and users. Technology cannot be divorced from its humanity, or from the problems that are to be solved. The lack of such a humanity causes many of the characteristic conflicts between uses of technology. Such may be the case here. Although seemingly benign in its applications, our variant on the technological theme should be treated as any other—with as much circumspection as is deemed necessary to get the job done. However, the means exist within hypermedia technology to pursue many more goals dealing with interpretation and data representation, or even site collection and recording techniques, than were previously possible.

A feedback is created by the qualities of a multi-media application. With compatibility, communication between computer systems is entailed. More importantly, compatibility entails relevance to human understanding, and to archaeology. However, in light of such cautions, we believe such relevances have been met and reconciled.

1.5 Practical Considerations

Apart from questions of compatibility, are practical considerations. Practical considerations address site collection and recording techniques, inter-laboratory communication, and compatibility of systems. We must tackle from both ends the problems raised by a new system, as everything from recording and collecting to interpretation could be affected. We do not think any effects will pose insoluble problems for the discipline. Instead, such implications may spur archaeologists toward a new holism.

Data collection procedures in archaeology seem suitable for use in a hypermedia system. The associative layers of Hypercard™ are akin to layers in an archaeological site. We can carry the analogy farther, as Hypercard™ allows data presentation in numerous ways, possibly as numerous as the association amongst data in the *in situ* context. We can hope to recreate the site within the computer as it was excavated.

Coupled with a program that turns any video recorder into a scanner, scanning images into the system as graphic text, Hypercard™ can present current accounts of any process to do with excavation. Hypercard™ is transformed into a monitoring system, in which data can be entered as soon as they are unearthed. Such an opportunity for investigators in the field is positive, as it allows several steps, with all their inherent biases and potential for error, to be skipped in favour of a single operation. The artifact is identified by its scanned image. A field monitor, linked to a video recorder (as scanner), would also allow for appropriate statistical operations to be performed immediately, as new data are entered. A running count of not only the visuals of an investigation, but also the statistical and interpretive series can be kept within a field-based hypermedia system. Investigators would have a time-lapsed record of all their work, to be reviewed in the light of further investigation and information.

A comparative collection could also be entered previous to a season's work, to provide a basis for on site analysis of faunal and artifactual remains. Photographic images that once acted as a supplement to excavation, as well as artist's line drawings, are now no longer necessary in order to maintain a precise record of the investigation. The system, however, remains compatible with previous excavations, as all past graphics and text are easily transferred into the new system. Record keeping within site collection procedures should be made more precise, because of the smaller amount of steps and the accompanying reduction in elapsed time between discovery and interpretation.

Contexts of sampling are also defined differently. The most relevant method is no longer purely up to the investigators, who may find it difficult to remember all the details of the many studies that are at their disposal. The previously collated details are already within the system, and a variety of sampling procedures can be run in the system that ultimately allow investigators to choose which is most relevant for a given problem.

A word of caution is necessary here, and that is that the investigatory team should never bend the boundaries of the problem to the needs of any particular technology. If a particular hypermedia program can effectively suggest certain path of investigation, such suggestions should always be of the variety of archaeological, not circumscribed technological, experience.

The implications in the practical realm of technological capability are not as important as other pragmatic implications that occur in the realm of changing research designed to exploit, not to fit the limitations of the technology. The investigator can push back the frontiers of archaeological research design by employing a hypermedia system. Several possibilities are incorporated in our thesis, if only to serve as nominal examples of what the future may hold.

Whole sites may be transferred from lab to lab, facilitating greater comparative study. Greater reference capabilities that include more detailed analyses, as well as more complete data bases are a possibility. Detailed databases are something that both archaeology and ethnology cannot now provide, for example, when students publish statistical conclusions in their respective journals.

The practical implications that stem from new possibilities involve the interpretive realm. An initial loss of standardization of archaeological technique and analysis may occur. However, Hypercard™ can be "locked", in the sense that other users cannot enter and change a data base, or rewrite the interpretation. Hypercard™ can be used as both a "read-only" and a "write-read" system.

Ambron and Hooper (1989) describe the theory behind read only and read-write documents in hypertextual systems. Theirs is the only published work that relies to a great extent on software examples to document their case. The concepts of edit, deletion, addition, copyright, and multiuser authority, or "polyauthority" are reviewed. The concepts behind access rights, made real in the "locktext", "lockscreen" and "lockstack" properties of Hypercard™ are discussed. Hypermedia's goal is to present a seamless environment for the user, across large bodies of material. Some applications have achieved such an environment, and some programs make such achievements all the more possible.

Practical implications that arise from cost are also considered by Ambron and Hooper (1989). Computer systems of any note used to have prohibitive costs attached. High costs are no longer the case, as the system to run Hypercard™ may be bought for as little as $1500. The one that is used here has a base cost of $8000. Macintosh equipment is falling in price every month. It is estimated that in order to do everything mentioned as potential for the thesis' system in its multi-role application, and be able to communicate with a second system at another university, would entail an outlay of approximately $8000. Costs aside, then, we feel that such practical implications that stem from any application of Hypercard™ can be met and overcome by its use.

Much detailed planning should preface any application. Investigators would not wish to re-define their archaeological site recording and collection procedure once in the field. The thesis also examines some possible constraints on the system's use. However, the onus will be on the archaeologist to expand and create with Hypercard™, not on the technology to upgrade itself with every new artifact that is uncovered. The discipline of archaeology, though it has striven to keep abreast of technological advances in the face of decreased funding, now lags behind. We hope our thesis will go some way in making up for lost time, in an economical and academically scientific manner.

1.6 Research Outline

What specifically is undertaken is a construction of a hypermedia computer programming system for use in archaeological data presentation and analysis. The particular archaeological case that will be examined is DiSo 1, a winter village site on Hesquiat Harbour on the west coast of Vancouver Island (Calvert 1980; Haggarty 1982).

There have been a number of works published about Hypercard™, though none are academic treatises. Hypercard™ exists on the cutting edge of published computer applications. For our thesis, the wealth of information that relates to other thesis topics does not exist. Our thesis is an addition to a growing inventory of programs using Hypercard™. However, hypermedia facilities and expertise already exist, and the novice user will not be alone while constructing an application.

The idea of "hypertext" was coined in the early 1960s by Theodor Nelson. The construction of such a system would involve the creation of interactive links within a large body of textually related material. "Interactive" would mean a "write-to" scenario, where users amend and add to the database, and follow paths through the "archive" without the loss of original context. By "archive", we mean the entire body of texts that archaeology has at its disposal. Hypermedia is an extension of the concept of interactive texts, and allows the incorporation of graphics, sound, and visual communication with other users, in addition to the textual aspect.

Hypercard™ works primarily with a system of "non-linear logic", but it can also represent data in a more standard linear manner, as defined in section 1.2. There are four major methods of data presentation allowed in Hypercard™. The methods include a systems hierarchy, a systemic flow chart, a non-linear array of interlocking data sets, and a combination of all four. The hierarchy will already be familiar, as it echoes a pyramid-like structure of other applications. The flow chart is familiar from the literature of cultural ecology, an anthropological perspective that used schematic diagrams to portray environmental systems. The non-linear associative structure is the most complex, and the most interesting. It rests on the user's ability to make associative connections within a group of data. Archaeologically, either associations suggested to the user from the data itself or some that are more intuitive are implied.

Relationships amongst data are always subject to revision, and always subject to empirical test *via* the data. For example, data can be placed on CD-ROM so it cannot be altered, or left "unlocked" Either way, the new relations created in Hypercard™ will provide an economical means of summarizing not only the data itself, but the myriad of possible links within it.

There are a multitude of potential applications for Hypercard™ in anthropology in general. Theory, history, educational introductions, ethnological data bases, and many others come to mind. Though all are beyond the scope of the thesis, it is hoped that such work will set an example for others. Similar modes of presentation and accompanying analyses may be worked into many other realms.

The programmed links in a hypermedia application differ from previous types of data base links because the new links are fluid in their design, and can be changed by the user. No obstacle is presented if the user's idea of what is associatable is different from the author's. The system has other less direct pathways for the user to reach their goal. Such types of linked inventory transform lists of artifacts into comparative collections. Links increase each assemblage's relevance to archaeologists working with related material. Assemblages now exist in the realm of constant test and comparison, complete with graphics and description. Critical commentary throughout the system's levels is available, and the creation of so-called expert systems, with the contributions of many archaeologists, is possible. A perusal of our last forty-two movements may suggest other questions, as well as providing an interesting commentary on our ingrained habits of association. Should such habits also be changed?

The thesis provides such opportunities, in addition to various entrances with which it can be expanded as further information comes to light. In section 1.3, we reviewed Hypercard's™ construction components. The defined terms will be used throughout the thesis. Our system was constructed by the following plan:

With the original construction of a generalized HelpStack, we

1) constructed a map of what the system will contain;
2) constructed a home stack as a basis of operations;
3) proceeded with the construction of the topmost layer of hypermedia, following the design of the map, and linking it to the home stack;
4) using pencil and paper first, outlined the system of interrelationships that proceeded from the top level, including buttons, graphics, and text ideas;
5) began the process of construction of stacks, fields backgrounds, and their accompanying links;
6) tested: i.e., replicated a program run by an inexperienced user to see if the system is understandable and adaptive;
7) linked the major components of the system with as many button options as possible, in the context of the information;

8) within #7, inserted data, to test associations and navigational capabilities—improved the system;
9) created entrances that allowed suitable expansion capabilities, decided what to protect, decided what is changeable without re-programming, and ran.

Now the system works with the user being able to move around within it. Each time we use the system, it can be expanded and improved. Each user can relocate buttons or insert new ones, according to the presence of relevant data. The number of possible linkages amongst information will necessarily grow because of an ongoing process of dynamic expansion. A second series of steps may be necessary to control for any expected input. However, we will be able to use such additional input to re-examine the original boundaries.

The data and the system can be transferred with 3.5 inch disks, (or in the future, a "write-to" CD-ROM), between different hard drives. Then the next user will have the same access as the last, and can contribute to a sum of knowledge about a particular area. One can envisage a step-wise growth of such knowledge from both within and outside the system. In an evolutionary sense, such a program also serves as a vehicle that facilitates step-wise growth. Copies of original constructs and data bases will have to be made at each juncture in the process. Many different versions will eventually be created. Different versions do not constitute a problem, as copies of particular versions are easily made, and the investigator can always return to the data.

The site data chosen for our attempt at a hypermedia documentation in archaeology are from Borden catalogue DiSo 1. The name of the site is Hesquiat Village. The information for the thesis include data on soils, faunal (Calvert 1980), artifactual, and feature remains. Two interpretative accounts (Calvert 1980, and Haggarty 1982), based on the DiSo 1 data have also been completed. Interpretive conclusions can be introduced into the system in juxtaposition with any suggested by Hypercard™. The site has been radio-carbon dated from c. A.D. 700 to A.D. 1450, and the level of detail provided by both collection and recording procedures are well adjusted to Hypercard™'s capabilities.

The structure of the thesis consists of a Hypercard™ application, and a standard text, or "hard-copy". The hard-copy is more than description. Section two is brief history of computer application in archaeology, relevant to the present application. The theoretical and practical implications that such a system has on archaeology as a whole, and on the individual archaeologist who chooses to use Hypercard™, will be discussed. Section three presents the context of the site, DiSo 1, and data recovered from it. The reader will also find a summary of the original recording procedures. Section four describes the process of construction of the thesis' system, and section five contains results and conclusions.

2.0 A Brief Summary of Relevant Computer Applications in Archaeology and Elsewhere

Since its invention, the computer has held out much promise to science for data organization and economy of access and use. Many applications have been designed, addressing diverse angles in academic disciplines, business, and education. Sections 2.1 and 2.2 highlight some of the typical linear media applications in archaeology, and juxtaposes them with typical hypermedia applications from a variety of sources. Section 2.3 will provide commentary on the cases discussed. The relationship between previous cases and a general concept of hypermedia will be identified. The major difference is found to be that the previous pre-hypermedia programs are numerous and relatively well documented in archaeology, while literature for new hypermedia object-oriented applications is either non-existent or poorly documented.

The entire field of hypermedia research is nascent, but in the field of education in particular, whether the actual designed programs address English literature or the history of molecular physics, hypermedia applications represent the cutting edge of computer research tools. Such an incipient movement in the computer world should be exploited as quickly and as thoroughly as possible, to bring the power and creativity of hypermedia into such academic disciplines as archaeology.

2.1 Related Predecessors to Hypermedia

Most linear applications in archaeology attempt to quantify data in either a non-manual manner, or mimic a manual process at a much faster pace. Most use tables of information as a presentation medium. The table occupies a screen, and is static. It consists of what can be duplicated on a sheet of paper. One has nowhere to go from the location of the table but to the next "page", in a linear fashion. Tables are employed in the presentation of statistics (Doran and Hodson 1975:93), or seriation, maps, scattergrams, histograms, and other plots (Doran and Hodson 1975:111-115). What such displays have in common is their theme of design. During the 1970s, archaeology moved from borrowing applications from computer science to the creation of its own networks. Most construction of archaeological programs was accomplished by *ad hoc* copying and experimentation. A number of examples can illustrate the earliest phase in archaeological computing.

The ORACLE project is a site data base typical of the kind of networks it spawned. Running from 1977, and including more than 4000 site records, ORACLE used pseudo-hypermedia links via a DOS based system to link information nets together for retrieval (Cook and Limp 1981). The problems encountered with such a massive database were defined as archaeological variables. The manipulation of large numbers of variables, such as biostratigraphic sequences, site features such as a terrace, and other biophysical matrices was important. Records of each feature were kept linked to that feature by a set of user commands. Requesting information here was similar to the use of an IBM optical ROM drive, although that technology was not available at the time of ORACLE. Command sequences are initiated by the user, and information appears. The era of archaeologist as computer scientist or programming expert had begun around 1975, and ORACLE is an early example of the potential for such personal interaction.

The ORACLE application is particularly interesting because it is one of the first of its kind to employ a multilinear hierarchy of paths towards sets of related information. Such a network of paths is linear, and associative only in the proscribed sense of the program's limitations. However, more access to the data set is created than that found in previous "flat" networks, where data are presented within a regimented schematic.

The Arizona State Museum site inventory project can be seen in similar light (Rieger 1981). On line in 1970 and modified extensively in 1980, it provided once again a massive listing of not only sites, but of "componential fields" within sites. With 31 "first level" fields and 37 "second level" fields the amount of cross referencing of information is impressive. The AZSITE program is the largest of its kind in Arizona, and is typical of the decidedly linear operation of archaeological database structure.

The SARG or Southwestern Anthropological Research Group project is similar in design and function to the popular statistics package SPSS (Plog 1981). It was first set up in 1972, using a dictionary cross reference interface between user and data. It serves as an example of different kind of access route taken by the user to arrive at a data set.

The addressing of certain archaeological problems of method and theory was attempted. The choice between a numerical source code for acquisition and storage of information or the so-called "free text" method (Plog 1981) has not yet been made in its final form. It involves a dialogue between the linear and the multilinear, but the former sacrifice descriptive detail just as the latter lose out in comparability.

An attempt to deal with large archives of archaeologically related material from a wide range of sources is made with SOFIA, or "inversion of file resources operating system" (Le Maitre 1981). SOFIA was designed in 1977 and is in use at the archaeological research centre (C.N.R.S.) at Paris. SOFIA is one of the first programs to interlink modules of information by multihierarchical ties. The operation of the system foreshadows the "object oriented programming" of current applications, but mimics the discrete packages of information on the user level of information access. Two types of relations are set up in the system, and one can approach the two from various routes. An entity has a set of expressions that define its modularity—as in a description of an artifact via statistics of length and width etc.—and many groups are linked by expressions that exist amongst modules. Each entity might be an archaeological item; an artifact or a feature, for example, or they might be whole sites, historical documents, geographical regions or paleocores.

While the effort at linking discrete objects at the user level has been mimicked within contemporary computer languages, the idea of location of the user's language is addressed with the application SATIN 1 (Bourrelly and Chouraqi 1981). SATIN 1 focuses on the dualities and ironies that exist between the level of language parameters, whether natural or computer, indexing or dating, and the level of representation. Since many archaeologists do not work from the artifacts themselves, but merely some type of description of them, ambiguities extant in the linguistic expression of such a descriptive language carry over into the realm of representation.

The SATIN 1 program is of interest for the following reason: How does one manipulate a computer language to compensate for linguistic ambiguity on the user level? The goal of the designer was consistency of information, and that goal touches on an aspect of our thesis' goals. Rules of semantics and syntax were effectively included within a program to produce an "indexing language of objects", in order to describe an object objectively.

The largest multilinear application in Europe consists of the data base FRANCIS, communicated via the EURONET telecommunications network. The system stores a massive amount of information culled from sources in many languages from the world over, and can access any journal article or abstract, as well as historical documents covering the prehistoric period in Europe to 1939 (Martlew 1984:108-9). While only French prehistory is completely covered, over 450 archaeological journals are consulted in inclusion, and over 200 other periodicals. The references for the links between hardcopy document and the system as a whole are treated as keywords. Each document's abstract contains between one and 42 keywords. When keywords are called upon, they link the user with other sources exhibiting the same keywords. The cross referencing is as extended or truncated as the amount of keywords encountered by the user.

One of the original packages that allows the user the creation of graphics and facilitates links between graphics and other types of information in one system is PLUTARCH (Wilcock 1974:64). A photosensitive light pen is employed in the drawing of graphics.

So far, we have cursorily discussed some examples of typical archaeological computing systems. The typical systems have dealt with the inclusion of already created text files, and graphics. We now move from particular case studies involving archaeological computing, to more general issues involving all such attempts. However, general issues are also explored by examples from various case studies that directly or indirectly have had an influence on the present thesis.

The idea of what computer enthusiasts, archaeologists or not, might be creating in their attempts to store, quantify, and access any discipline's information is addressed in a set of essays in Cooper and Richards (1985:5-13 *et passim*). The "archive" is defined as that which is self-created by interaction of user/author and text. The forefront in archaeological computing had shifted focus from what the text should include. Although "what the text is" may still be a concern today, the question of how one should go about accessing archival information, or "interrogating the archive" via various types of distinct softwares had gained in prominence (Cooper and Richards 1985:9).

The first time that levels of enquiry and hierarchies of archaeological data are discussed in the specific context of computer applications is important for our application. The artifact and artifact group levels are defined, as well as features, patterning of groups, and area levels of archival information. Cooper and Richards (1985) discuss the predecessors to Hypercard™'s organization of operating system. Types of interrogatives can be arranged in a pseudo-object oriented hierarchy, from the detailed close-up of a single artifact, to more global foci like topography or ethnic migrations and their relation to discarded sequences of material culture. The system that is detailed uses dBase II and III. The dBase software continues to upgrade itself and general users are currently acquainting themselves with dBase IV. The authors conclude that the material available to archaeology will continue to outstrip the pace of computer technologies available to cope with its mass.

Carver (1985:47-62), in the same volume, attempts to address the issue of too much material by proposing that the computerization of the archive can be a motive for creative archaeological work. By the mid-eighties in archaeological computing, the idea of the machine as a useful tool in the service of archaeology was replaced. Instead, the computer presents a new language in which archaeologists may think about their work.

Although authors may vary on how they see the trend of computing affecting their discipline, many agree on some pragmatic aspects. An early example of what effect computerization and/or standardization of some sort might have on field archaeology is important for our application, as it has extended its potential into the field. The future development of both method and theory *vis-a-vis* the archaeologist in the field and the interpreter in the lab, even if they exist within a single being, must be addressed (Rielly 1985). The origin of all archaeological inference and record lies in the field, as the field is where all primary discovery is made. The distance between the raw data of observational excavation and the archive of archaeological knowledge can be great, and methods to narrow such a gap should be found.

If most archaeological data is descriptive, consisting of found attributes, then description at some point during the research process must give way to manufactured or inferential data. Much published archaeological information consists of interpretation and analysis, rather than original description. The translation of such raw data into other classes is further discussed in sections three and five. Rielly (1985) describes several transformations that have important implications for any inference to which the archaeologist wishes to commit. The process of refining and redefining data as it comes out of the ground, is a process of changing the idea of what data is. Data move towards the lab, and are entered either on a computer database or some other recording device.

Whether or not data are evidence depends on one's argument, and often data from the same site are used in contrary documentation and argument. Such data, if seen at the level of site context, may not prove contrary. The ideas of "site as location of argument" *versus* "inference as a location for an argumentative language" cannot be outlined by the reduction of detail to generality, from the particular to the comparative (Rielly 1985). Data are constantly reworked, and the location from which the investigator creates and observes data is always moving to a unique position, never to return to exactly that previous.

In 1987, Wilcock and Biek joined others for an international conference on science and archaeology in Glasgow. Out of that conference came two relevant articles (Biek 1987:541-3; Wilcock 1987:497-507). The first is an attempt at a summary and a pulling together of directions in archaeological computing, the first of its kind by an archaeologist. Wilcock wants to create a cohesive body of texts to outline where the discipline has moved, and where it is likely to move in the future. Knowledge of past and present computer trends within archaeology is lacking. Computers have been used in archaeology for over three decades, but their employment is diverse and purpose disparate. For example, statistical analyses were first performed by computer in archaeology in 1963, while site records were entered into a machine in 1959, and geophysical variables collated and organized by computer in 1968 (Wilcock 1987:498).

Developments in the areas of archaeological computing are necessarily tied to advances in technology. If such developmental advances are to be recognized by archaeologists, one must assume that applications, if they are to serve a serious purpose in a proposed area, must be designed at least in part by the growing body of archaeologists who are also computer scientists. A group of computer experts must not become a clique, but rather should be a body of consultants, to be consulted as well as consulting other students in areas of need. A creative process can result, if one allows for the often disorganized and unstandardized situation of computer archaeology to continue, while trying to lessen the impact of redundant innovation. Coping with redundancy can only be accomplished by published communication *via* journal articles and reports on symposia (Wilcock 1987:501).

Problems that are important to focus on in the present include the unorganized attitudes towards research and the lack of funding for such research, but most importantly, the incompatibility of the many interesting and new programs being developed, and the incompatibility of the hardware to run them on. Wilcock suggests that all archaeologists use the same machine and the same programs.

Biek's (1987:541) article outlines an alternative to Wilcock's solution. Here, one of the original versions of the laser ROM videodisk, DOMESDAY, is outlined. It has impressive storage capability of 100,000 graphic frames, and an acceptable speed of about two seconds per movement between frames. Conventional hardcopy reports in archaeology eventually could be made obsolete by videodisks, and in the three years since the DOMESDAY application, much more powerful disks have arrived.

One of the earliest mentions of interactive media and diagrams in archaeology is detailed by Ryan (Ryan 1988). The purpose of Ryan's interactive application was the analysis of stratigraphy, and the operating system is similar to standard graphical representations of extended kinship genealogies. "Gnet" allows the user to create diagrams from previously stored information. There is no correct manner of construction for the stratigraphic diagrams included in Gnet. The program can also interact with other sources of data, linking a created diagram with variables that make up that graphic.

Another aspect that is potentially implicated by our thesis' application has been referenced in previous literature. The possibility of the introduction of expert systems into the archaeological realm is addressed. Stutt, (1988), details some problems and prospects. How does one prevent such a system from becoming statically formalized, with its knowledge base regarded as complete, holding the correct answers for a finite set of questions that may be asked of a certain data set? A static expert would be a major problem for Stutt and other imagined users of expert systems. "Second generation expert systems" is seen as the answer, as "SGES" has the ability to interact with the user. SGES can learn, or add to its data base with interpretation and statistics. There would be a reciprocal dialogue between the system and the user. For Stutt (1988), an expert system might model a colleague, with whom the user would dialogue with on a certain archaeological problem. Explanation capabilities, though in the past difficult to add to a program, might now be present in the system if there was enough cross correlated "expert" interpretation of similar data. A list of possibilities could then be called up for the user to add to, or dialogue with.

The problem of suitable vocabulary of such a dialogue is also of interest to the thesis, and Chadburn (Chadburn 1988) addresses the issue. Her discussion relates to the lack of a uniform or standardized classification for archaeological finds in general, and a simple solution might be to gather all agreed upon labels, (agreed upon in the sense that they are in use at any one particular time and place in the world), and link them to one another. The conception of categories, and what is in them relates to the use and placement of such labels. The user can request a piece of information in their own vocabulary of training, and would hopefully get the same result as another user, requesting information access with a different word. The thesaurus method is recommended for such an application. Educational lexicons could then be set up.

Related to educational aspirations, the present project also hopes to be a catalyst in the explanation of archaeology in general. Along explanatory lines, Rahtz (1988:473) outlines another project with similar intent. The computer program INGRES is used, and the software would take the student through a detailed account of the archaeological process. The student, as part of the teaching role of the program, creates an initial research design, site survey and research, detailed excavation of the site, and analyzes all the results in a final report. The available database would be enormous, and the graphic sequence of excavation too complex for the machinery quoted in the two year old publication. However, INGRES was used in the simulation of a cemetery excavation, with moderate success.

An improvement on educational software for use in archaeology is the dBase IV based system SYASS. It takes a student through the excavation procedure in detail, and allows input from a tutor, so that all levels of experienced "excavators" can benefit from the system simultaneously (O'Flaherty 1988). Students can choose the level of detail and constraints of knowledge they wish to perform under, and thereby teach themselves the methods of field archaeology in a gradual and progressive fashion. Analysis of data also takes place within the program, and an assessment may be made by the instructor on the student's grasp of data management skills. The SYASS system came on line in October of 1988, and was planned to be tested on a wider audience in the summer of 1989, with results still unpublished.

A further point of interest in the documentation of predecessors of and influences upon our thesis' application involves the use of interactive technologies. The Leicester Interactive Videodisk project is described as the first program using interactive technology. It serves to spur students on in the interpretation of visual images, part of the main task of archaeologists in general. The economy of retrieval, storage, and interaction with software using a videodisk or laser optical disk is greatly enhanced (Ruggles 1988). The potential for education is recognizably enormous, either through student workstations, tutorials, and/or interaction between students and instructor through the technology away from the classroom. (In the following we will review cases where educational work is ongoing with Macintosh technology).

Ruggles' project uses a combination of objectively oriented response sequences of questions and answers, with which the student can be "marked", and a "free exploration sequence". Both of which can monitor progress of the student, though not in a necessarily step by step manner. More importantly, LIVE helps the user-instructor judge the impact of the system in its application.

The LIVE project at Leicester is the most advanced of its kind to date in archaeology. It enlists the ideas of "Browsing", and "Authoring" as discussed in section one. It allows similar functions to that of the "Paint" property as well, by having the capability to let users make their own slide carousel out of selected images.

We have seen that there has been a progression from the static archive to the dynamic interaction of created texts. Such a movement was foreseen as far back as 1968. Some saw archaeology's stasis, and hoped for a more creative context that would stimulate researchers, and not merely act as a storage facility (Doran and Hodson 1975:318-9). The idea that promoted the study of how archaeologists process data within their minds, let alone in their computers, exists at the nub for all research using computer applications, and it should guide questions to the formulation of problem-solving devices in software engineering.

The thesis' application addresses the cognitive issue strongly in the following sections. The data, although subject to often inconsistent though non-random modifications, can be kept whole at all levels by the design of a particular application. The idea of the juxtaposition of different stages of the research process is one of the themes behind the archaeological adaptation of Hypercard™.

The above applications all have indirect reference to the following. Computer innovation does not exist in a vacuum, and communication, although seldom direct across disciplines involved in creating computer applications for custom use, nevertheless takes place. From the earliest beginnings of computer use in archaeology, moving from static storage to incipient hypermedia, from the SARG project to that of LIVE, archaeologists and others have progressed in their quest for ways to solve some of the problems of their discipline. Some progress has had direct input from computer use, and the results of such input have furthered research. The next section will explore how other disciplines have created similar progress by their use of real hypermedia applications, with direct influence on our project.

2.2 True Hypermedia Applications

Two key works stand out in the nascent field of hypermedia and interactive multimedia. Both are published by Apple computer, and are edited by Sueann Ambron and Kristina Hooper (1989; 1990). They contain essays and articles dealing with the wave of hypermedia research and applications in education and are titled "*Interactive Multimedia*" (1989), and "*Learning with Interactive Multimedia*" (1990). Both are recommended to anyone wishing research the interactive trend in computer application design. The present section will review some of the more interesting cases. Although none are from archaeology, their design and context can have direct effect on archaeologists, should researchers choose to harness such applications.

The theory of hypermedia had its beginnings at SRI laboratories in 1951 with Doug Engelbart. The "augmentation system framework" expands the user's self-knowledge, by presenting the human system with the tool system of a computer program. It is the interaction of the two systems, one socialized and enculturated, the other created in a machine, that begins the earliest multimedia events. The computer is seen as a tool to augment natural human abilities, and not to transform human abilities into something foreign. Such an idea is important for us because it echoes the sentiment regarding the non-linear application of associative logic in Hypercard™. We take a very human characteristic of our thought process and mimic it in software. With the interaction between human cognitive skills and computer tools, our knowledge and capabilities grow in a step-wise manner. Hypercard™ also replicates hierarchical growth in its programming structure.

In 1968, Engelbart demonstrated the capabilities of the mouse (or hand moved keyboard accessory), special keyboard, hyperlinks between video and audio documents, and computer connected individuals communicating with one another. Engelbart's presentation was the true birth of hypermedia, even though it was two decades before hypermedia tools were available in a commercially viable medium

(Ambron and Hooper 1989:23). Engelbart should be credited with constructing a "methodology" of hypermedia, although it might rather be called an ideology.

Brown University is a world leader in the development of both hypertext and hypermedia. Early applications for the SUN microsystems and the UNIX system included INTERDRAW, INTERPIX, INTERVAL, and INTERSPECT, each performing a particular function of what is now contained in a single program. Eventually, "INTERMEDIA" was born, the system that UNIX users rely on to keep abreast of hypermedia and Macintosh's Hypercard™. The programs are very similar, but Intermedia is in general run on a more powerful hardware system. Icons, buttons, windows, hyperlinks, screen cards and scrolling fields etc., are all present in Intermedia. It was designed in 1987, the same year as Hypercard™ came on line.

Brown University's program "Context 32: A Web of English Literature" (Landow 1987), is a model application. It is a very impressive and massive hypermedia document, that covers the major figures in English literature from c. 1700 to the present, and presents them within their own historical context through other links or sidelines. Users may create their own paths and journey through the corpus at leisure. Intermedia would be a very powerful application in archaeology, if more expensive than Hypercard™ due to hardware requirements.

The hypermedia definition of an expert system might contain software able to explain its own actions within the web of associative and analogous thought. The expert environment would involve "user-constructs", replicating the real world (Ambron and Hooper 1989:95). The content of the data base is unstructured unto itself, but interaction with the user structures it by intent, source, implication, and function, as well as style of presentation—the delivery long sought after in previous works. MEMEX is such a system. Not commercially available, and still in the testing stages, it can perform interactive and other operations using Boolean or numerical syntax. The software can instruct the user, guide questioning sequences, inform, amuse, or merely allow browsing with no guidance whatsoever. In the above senses it is far more powerful than Hypercard™, but its links are necessarily programmed to react to user moves, and do not allow for self-created pathways once the machine is set up in operating mode.

NOTECARDS is a similar system that, while not stressing the expertness of its program, does recapture the semantic and arbitrary links of true hypermedia. "Notecards", "links", "browsers", and "fileboxes" are NOTECARD's equivalent to the similar Hypercard™ objects menu. It runs on a Xerox 1100 machine in the LISP language environment (Halasz 1989). It is also still in the experimental stages.

One of the drawbacks that is noted with NOTECARDS and hypermedia systems in general is that access to information is constricted by the heavy reliance on "navigational" links such as pre-programmed buttons and their destinations. The older concept of linear or hierarchical search, or query based command sequences, might be reinstated into hypermedia programs to give them an added resource. Ironically, the idea guiding hypermedia systems was to move away from the static linearity of older search-string based applications.

However, as we will mention in following sections, there is no reason to throw out an entire network of relations because the motive or ideology driving their use is archaic or technologically outmoded. Previous ideas and softwares can be improved and harnessed within hypermedia applications. Scrolling fields in Hypercard™ allow for the linear listing of items in what is still a uniquely economical manner. The navigational links that information access in hypermedia is based upon do not as yet have a common rhetoric to guide users familiar with other applications. Once again the problem of standardization appears.

The "Shakespeare Project" is a remarkable program, allowing users to do the following:

- "attend" rehearsals with directors and performers,
- "discuss" a play's key issues with interviewed actors,
- view and instantly compare several intriguing different versions of a particular scene,
- design their own "versions" of a crucial scene on a computerized, digital stage,
- peruse an archive of hundreds of historical photographs documenting the rich array of sets, costumes, and props,
- browse through an "electronic" wardrobe and prop room, choosing costumes that suit their own interpretation of the play,

- create their own "case study" of a character's motivation and psychology,
- skip through the expanse of a play almost instantaneously, making comparisons that reveal the large, embracing structure of the play,
- "read" a staged performance with the ease and freedom with which we now read a text—stopping, starting, viewing, re-viewing, and selecting segments for detailed study (Friedlander 1989).

Three programs were employed in what became the "TheatreGame", one each for scholars, directors, and actors, to be worked within an enveloping program called "OnStage". The software is complex and unique, and it is beyond our scope to detail it any further. Suffice it to say that such an application is possible, and creative minds can turn technologies in any direction they wish to move, including archaeology.

The CICERO project attempts to guide students of classical civilization at U.C.L.A. through an immense documentation of text and images. CICERO is a state of the art multimedia education tool in use at a large university. The students tour the baths of ancient Rome on videodisk, or choose some other path. The student cannot alter the program, so interactivity is limited, but CICERO's express design is to educate a class. The student collects and collates information to be used in writing term papers on the screen, and can print after the tour is concluded (Frischer 1989).

Bernard Frischer designed CICERO, and the design stemmed from an interest in hermeneutics. Hermeneutics is an interpretation of events or texts based on interaction and experience rather than empiricism. Frischer's background in hermeneutics served as a keystone for the work.

Another multimedia education project similar to the above is called GRAPEVINE, and educates the user in all facets of dustbowl era midwestern United States, using Steinbeck's novel *The Grapes of Wrath* as a centrepiece. GRAPEVINE is designed to be run on a Macintosh with a CD-ROM player attached. However, it is not a Hypercard™ application.

Other programs such as the "Voyage of the MIMI" and the

"JASON Project", which Royal British Columbia Museum in Victoria, Canada was a participant, are wide in scope and interactive in nature. However, their main thrust is education, employing most of the user's senses.

The issues current in the fields of cognitive science, and cognitive psychology in particular are important to the interactive multimedia applications reviewed in *Interactive Multimedia* (Anderson 1989). "Beyond Einstein" is a hypermedia project that educates the user about all aspects of post-Einsteinian physics, and also includes the historical context leading up to and embracing Einstein's discoveries. Nobel physicist Stephen Weinberg was involved in "Beyond Einstein". The project was for demonstration only, but it is to come on line with the advent of motion picture videodisk in the near future.

Grolier Encyclopedia Corporation has created an application that allows hypertextual access to encyclopedic resources. It runs on the Macintosh, and utilises hyperlink like systems of navigation through menus and windows. It is also not a Hypercard™ document. Other hypermedia programs can work on the Macintosh if programmed from the ground up. They must be created by expert programmers, and would not be applicable to most archaeologists. Such systems also lack the compatibility of Hypercard™ based applications, which will run with any other similarly based system, creating an infinitely open network.

There are many applications in use in corporate and academic settings that are interactive, and that are constructed with hypermedia software. It is equally clear that many disciplines have a long way to go in recognizing the potentials of use and adaptation of existing technologies, or the creation of new ones. The positive factor in lagging behind may be that the technology becoming available will make translation of a discipline's motives and problems into a hypermedia environment much less painful. However, a cautious wait and see approach can be overemphasized, and educators themselves need to be educated in the opportunities that so far, many have been unaware.

Some of the problems encountered in the use of hypermedia applications are akin to losing touch with the real world. Users can easily get lost in a cumbersome and confusing application, and the cognitive load of such enormous databases can be overwhelming. A map of the system is always a must, and guaranteed access to that map is just as important. Hypercard™ can satisfy some user grievances by its own features, such as major navigational commands placed under available menus, and the recent function, which displays on one screen the user's previous 42 moves, or cards.

Both Ambron and Hooper are educators trained as cognitive scientists, and in their second volume (Ambron and Hooper 1990) they address important issues concerning "cognitive load" on students, and the psychological effects of computer use in schools. Many more applications are coming on line each month, and some are tested in classroom situations. Last year saw the introduction of Hypercard™ into the U.S. school system at all levels. It is the most commercially viable hypermedia product, and the easiest to use.

At the elementary school level, "Hyperrooms" have been designed and are in place for educational purposes. Complete interaction is available for students and teachers, with a Macintosh on every desk connected by modem networks to a common resource pool. The hyperroom is an upgraded version of a mainframe system. The hyperroom is interactive in that, while a mainframe facility does not allow the individual workstations to input and override the instructor's access to the mainframe data, newer versions allow just that, creating real dialogue throughout the classroom, augmenting the natural oral conversation between users.

At Drexel University, Apple has organized the staff and students into a giant experiment. Every incoming student is required by Drexel to purchase a Macintosh of some type, and then is immediately linked to every other personal computer and workstation on the campus. The implications of over 25,000 Macintoshes linked together to potentially form a massive interactive storage network are numerous. Many university departments across North America are now experimenting with hypermedia applications in general, and Hypercard™ in particular.

Ambron and Hooper (1990) detail a few such applications, and also address the methods or "art" of construction of such programs, and ways and means of initiating teachers into the universe of multimedia events and systems already in use. The hope is to inspire others to continue what is fast becoming the first grass-roots public revolution in computer technology. Such a technological revolution in access to information is comparable to Gutenburg's invention of the printing press in 1450.

Comparison of the cases summarized in the previous two sections highlights definite differences. The differences between the non-hypermedia computer programs and the true hypermedia applications and Hypercard™ will be outlined in the following section.

2.3 Advances Provided by Hypermedia

Critical comments on the preceding applications are made with the direct experience of relevant advances provided by hypermedia in general, and Hypercard™ in particular.

The links and data organization in ORACLE are sound, and economical for the early period of computer research. Such applications as site database archives have a direct relationship with the present thesis, even though they were bound by technological innovation in their now indirect borrowing from computer science. Unfortunately, users of ORACLE must contend not only with the learning of the access code, which does not seem difficult, but also with entry through a DOS. The computer requires an in depth and often lengthy sequence of "demand/command" strings where the user must dialogue with the program in order to gain correct entrance to one of the many paths in the actual data set. Just contemplating such distance between user and information is alarming to a Macintosh programmer.

While the DOS feature is archaic, the ORACLE system is typical of even current database applications (Cook and Limp 1981). Such a system type is valuable, but it represents poor economy of information and poor access to users, especially students inexperienced with its retrieval system. The fact that ORACLE is a typical example both growth in multilinearity and media, while suffering from the leviathan syndrome of data management is ironic. However well archaeologists record their findings within such a system, the program's design is still limiting.

While AZSITE is impressive in its storage capabilities, it is also oppressive, as the media in which data are presented both for browsing and for input are not only the same, but are page by page imitations of a site record file. The realistic analogies cannot be faulted aesthetically, but the program itself is merely a faster way of doing what the recorder already does, and provides no new method of database management (Rieger 1981).

The construction of SARG illustrates a classic problem in archaeology and anthropology in that it highlights the differences between the methods and goals of a "historical particularism" with a "comparative method" (Plog 1981). The tableau of often static ideologies is now set on a computer generated stage. Obviously, it has yet to be resolved in linear applications. However, our thesis may point a way towards a considerable compromise of overall positions, while not jeopardizing the particular or the comparative methods. The other interesting aspect of SARG is that it is one of the original multidisciplinary projects in archaeological computing.

While impressive in its handling of the intermedia of links between objects in an archive, SOFIA suffers from similar archaic user interface and access command strings as do all the others so far reviewed. The entire set of such commands for SOFIA consists of approximately 1500 acronymal phrases. Even worse, all commands are written and accessed through FORTRAN, a once popular but now surpassed computer language which currently is quoted as the example of how not to write a language (Goodman 1988).

Although the philosophical motive behind the SATIN 1 system is empirical, with the concentration on moving away from the ambiguities of human perception, the system is of interest because it identifies a problem often ignored in archaeology. The problem is the identification of differences between the recorded event of an archaeological find, its description, and its interpretation(s). All levels of occurrence are included in the thesis' application, but we can see an indirect precursor to the inclusion of all archaeological "events" in SATIN 1. The operating system is made up of a set of "Boolean, or numerical matrices" (Bourelli and Chouraqui 1981). Data are organized by fields, or sets of linearly related data. The organization of the information is very typical, although the ultimate goal of the SATIN 1 application is fairly unique.

The amount and depth of links in the FRANCIS data base is both a positive and a negative, for, as massive as the cross references can be, quick access to particular articles is denied by FRANCIS. Much previous knowledge within an area of European prehistory must be present to use FRANCIS with any efficacy. FRANCIS is a system for the professional, and as such risks ghettoization. One of the aspects that current computing in archaeology is focussing upon is information access and economy of time. FRANCIS lacks the foci of other albeit much smaller systems including our thesis, but serves as an example of the great lengths the operator can move to with an ordinary linearly linked database.

All features of the PLUTARCH program are rendered archaic by current paint tools, especially tools from industry standard graphics applications like SuperPaint Version 2.0, and MacPaint II. It is the idea that lay behind PLUTARCH that points in the direction of much later developments in graphics, and all the manipulations that have become possible with them. The motive for PLUTARCH's construction was the production of high quality computer generated diagrams and charts for hardcopy publication. Most of the basic functions of a modern graphics package are foreshadowed with PLUTARCH, including scalograms, dendrograms, circles and other plotted polygons, cutting and pasting of items, deletion, and the positioning of text and graphics. Functions are accomplished with the use of the "light pen", which acts as a "mouse".

For archaeologists in particular, PLUTARCH was a boon, and the ideas that were captured on computer for printing created a new level of high definition graphics for investigators. The graphics within PLUTARCH could be interlinked with statistics, maps, piecharts and other data media to produce the finished work. The interesting and archaic aspect of PLUTARCH is that it was not designed primarily with software use in mind, but to produce quality documents for hardcopy perusal. Our thesis' application is well on the way to doing both in its graphics aspect, and can do both for the accession of textual and statistical materials.

The discussion in Cooper and Richards (1985) is worth some comment. The discrete yet intermingling quality of reviewed data sets evoke images of the aforementioned object oriented programming. Here, discrete units of language are packaged in "containers", acting on specific requests and performing particular functions. The containers are ordered in a hierarchy of specificity of function, and, at least in Hypercard™, requests in the form of messages sent to the program by the user are processed in an ever ascending order of command levels. For example, if the application cannot show the requested material to the program's operating system, the program will eventually tell users that their request cannot be fulfilled. Responses as disparate as a wrong file name, to a complete lack of such data might be the computer's answer.

However, the DiSo 1 application will not tell the user that they have failed in unlocking the secrets of the DOS, and cannot yet have access to the application itself, let alone a particular piece of data. All source paths in Hypercard™ are navigated by the program, and the user merely waits a short time (response time in the DiSo 1 application varies from immediate to approximately three seconds depending on the user's movement) for the requested point of arrival to appear.

We must disagree with the idea that there will always be too much archaeological information to computerize. It is becoming ever more evident that the pace of change in the computer industry alone may be enough to surpass archaeological data in storage capacity. The question for us is not whether technological advances will keep up to the amount of knowledge, but rather whether archaeologists themselves will keep pace with such advances, and put them to a constant and ever improved use. The thesis attempts to point the user in that direction.

The archaic aspect of Carver's (1985) article is that he asks for standardized pieces of text, serving as the interrogators of a soon to be standardized computer archive. While we agree with Carver's sentiments regarding the pace and language of adjustments archaeologists must make in order to take advantage of what creative opportunities the computer might present, we disagree that any new language will or should be a standardized one. In fact, hypermedia makes an idea of such a language redundant. Hypermedia also transcends argument towards a particular type of computer technology or how archaeologist's might talk about that technology.

It is clear that for Rielly (1985) and ourselves that the computer has the potential to contribute far more than just a series of more complex manipulations of static data than could be accomplished manually. The problem of equal access to data by users of different level machines is one that might be met with a technological standardization of potential applications *via* each type of machine. Rielly may think that such a standardization is more important than the idea of homogenizing the "What?" of archaeological data, and we agree.

However, Rielly is unlikely to see a movement in such a direction from the computer industry. The industry is competitive and mostly profit motivated. Instead, it is our hope that archaeologists will have access to many different hardware set-ups and programs to suit all abilities and needs. The standardization of media, even a medium that in theory can house all types of possible representations and stories, is still ultimately monolithic. Standardization contradicts part of the philosophy of hypermedia, which allows a dynamic creation of new applications, and hence changing "standards" .

Reilly's article is the first to address in a detailed manner idiosyncratic aspects of the computer and the user in an archaeological and general context. The prestige factor in being computer literate, and owning or developing custom programs cannot be underestimated even in scientific circles. The development of such software is just as likely to contribute to the non-cooperation and competition amongst scholars as it is to create an atmosphere of cooperational holism. Rielly is closest to us in saying he "does not subscribe to the belief that archaeological data are somehow passive objects, or just "things in themselves", waiting for discovery. Nor is it likely that field archaeologists rely on serendipity to isolate the entities that they recognize and record" (Reilly 1985). Instead, the constructs of the investigator's historical consciousness allow for the occurrence of such events, and it is to the archaeologist's intuition that the innovation of computer technologies must look for ultimate guidance.

The thesis acknowledges the intuitive problem in particular, but it suffers from the parochialism of Macintosh's competitors. It will be shown in the following that the Macintosh world is fast becoming the world of science, but it still has a long way to go to supplant the well entrenched third party IBM clones and their type fossil, the PC. We cannot disagree more with Wilcock when he recommends that the microcomputer standard in archaeology should be the IBM PS/2 clone, with a 512 Kilobyte RAM and 10 Megabyte hard disk, along with 360 Kilobyte double-density floppy disks (Wilcock 1987:503).

Even in 1987, Wilcock's configuration was archaic, although certainly affordable. It should be noted that the computer systems in evidence in the academic community are there because they are inexpensive, and not because they are good. The prevalence of older systems is the fault of the researcher alone, but has to do with the other problems outlined, funding and disorganization. Other of Wilcock's recommendations are generally agreeable, but many pertain to the use of the above system, with all its inherent problems. Problems with the older systems can be ignored in a Macintosh application, as most have been solved by the more creative computer company.

Biek's article addresses the potential storage and retrieval of whole assemblages, in three dimensional laser read graphics, and laser read text. The key to videodisk technology is speed and amount of storage capacity, both of which are exhibited in exemplary fashion by optical disks and drives. The DOMESDAY 86 software application is the predecessor to more current and industry standard drives, with which the Macintosh Hypercard™ application is in some cases, entirely compatible (e.g., the NeXT computer, and the SUN microsystems optical drive). It only remains for departments to avail themselves of the present technology to register many leaps forward in the pragmatic realms of economy and efficiency of data management.

Ryan's program seems only in the experimental stage, but the early use of "system mapping" as a way to enter the program itself follows concurrent hypermedia events of note, and in use in our thesis' application. The ideas of interactive media and graphics are combined in Ryan's unique if somewhat limited discussion.

Does the expert system require artificial intelligence? The short term answer must be no, for technological capabilities have not yet been able to provide "AI". Seventh generation computers will supposedly have intelligence of human quality, but some Japanese corporations are merely beginning work on the fifth generation. However, if enough possible responses to user questions are available, then the program may be able to think for itself based on certain archaeological and theoretical paradigms. The program might answer questions, or at least participate in a dialogue with the user.

The machine should also be able to critique the user's case or model by comparing it to its own programmed model or sets of alternatives. A dialogue is created. The system might cooperate with the user towards an explanation for certain findings or patterns, more "democratic" than setting up the computer to tell the user what they are doing wrong, or merely critiquing (Stutt 1988).

The best attempt at "AI" so far is based on an AES system or "arguing expert system" program. AES simulates as closely as possible an exchange between expert human actors, even if only one is human, and one programmed. Arguments are sustained in the usual manner, with the employ of the expert's reserve of knowledge of the subject. It is unlikely that computer programs will be able to work in the analogic or associative realms as well as humans. However, using "rock logic", or sets of linear relations and given parameters, the machine should "argue" well enough to dialogue with a human expert.

The model that Stutt introduces is an old one in Western philosophy, and takes the form of a chess-like game, another old and well-tried program in the computer world. Moves follow explicit rules, captured and communicated in a symbolic medium, with actors taking turns defending their own argument or attacking the other. There are winners and losers, and also a means to assess the strength of the overall argument.

We feel that Stutt limits discussion by masquerading a linear and dogmatist logic in the guise of a dialogue. The problem with AES systems, of which Stutt's is taken to be typical, lies in their inability to mimic more than a few human aspects or ranges of thought. The analogic and associative links, of which the human perceptive faculty is primarily composed, are beyond the arguments of Stutt's systems. Such logic has its place in the scientific realm, as part of a nomothetically deductive path. However, the linear path is merely one manner of exposition, and it has been absorbed into the archaeological discourse at the expense of other often more creative alternatives.

The thesis attempts to introduce other logical paths towards knowledge and potential explanation, and introduces a truer form of dialogue than the AES system. The links within the thesis can be modified, something impossible to do within the paradigms of logical discourse, or "rock logic" (De Bono 1990). It would also be very difficult for Stutt to program into a computer some of the capabilities he imagines might take place in such software, such as memory of opposing arguments' style or location of language, delivery and strength of argument.

Stutt quotes Wylie (1987:5) in clarifying that analogic reasoning would be a help in drawing conclusions archaeologically, from a given set of inferences. However, Wylie immediately transforms analogy into a form of deductive reasoning, with its basis in logical relationships (Stutt 1988). We feel that the reverse is true. The DiSo 1 hypermedia application aids in demonstrating that the hypothetico-deductive relation in the human sciences rests fundamentally on analogy, and that analogy is not a form of deductive logic. Analogy cannot be programmed into a machine, as the weight of the entire programming effort rests on analogy and similar relations.

The thought process of the human mind exists within a recursive structure, and little would be gained by replicating a recursive formula while basing the programming upon a linear set of relations. Such a set of relations would couch it in the archaic language of philosophical logic. Hypermedia, although related indirectly to the AES attempts in particular applications, realizes a much closer mimicry by dissolving logical relationships, and putting control of all linkages to be made within the program with the user. Only now can the user dialogue with the machine.

The problem with Chadburn (1988) is that if the reference itself were not made interactive, then it may become static and archaic at the same time. Over a century of archaeological work has produced not only vast quantities of data, but also vast lists of terms and labels to cope with such items, and to include them in our discourse. If science is a process of attaching names to "things", then the process of "renaming things named" is also an integral part of our work. The indexing approach is offered as an alternative to the thesaurus, but, where there is no governance of labels by meanings that are attached to them, the potential inflexibility of the thesaurus gives way to the potential chaos of unrecorded, unlisted meanings of listed words.

Hypermedia has a similar problem of vocabulary relations in that its programming language uses certain terms by certain restricted definitions, and the programmer must pay attention to a given set of restrictions and none other, if the command string is to be successful. Chadburn (1988:396) encounters the same problem—how to define meaning across users, and let them know that their colleagues "mean what they say", in a discipline that does not always allow its students to say what they mean.

Callow's article, (Callow 1988) details a long term archaeological project in which the computer acts as a communicator of past work to the next generation. The La Cotte site in France is the subject of the discussion, and INGRES the application, but the point of mentioning it in relation to ours is that Callow's piece is one of the first in the literature to spell out such claims for the computer's enhancement of any particular archaeological project. The open-endedness of the DiSo 1 hypermedia application leaves open the possibility of return and modification in the future. Our project can become the basis for a long term experiment in data organization and storage. A modified version of the DiSo 1 application will be part of an educational project in the Alberni/Clayquot school district, as noted in section 4.

The operating system for the application of INGRES relies on a DOS, and therefore greatly hampers the ability of the user to "excavate" or analyse in a quick and economical manner. The disk operating system command lists do grow simpler each month in the computer industry, and the five commands listed for the INGRES application are not difficult to commit to memory. Setup of the dialogue screens is archaic and linear, and overall INGRES is simple, although extremely complex to program. It is typical of many such applications that exist on certain types of hardware. Much programming is needed to get simple results in software.

However, INGRES is interactive, and involves use of created text fields and data bases (even though such fields are created from an already available and static data set), and most importantly in view of the thesis, is a sound educational tool for students in archaeology. The INGRES application could be improved by adding graphical representation and colour photographs from a videodisk. The technology is available to make Rahtz's educational program very sophisticated, but there has been no update of Rahtz's further work.

The technological problems mentioned in Ruggles (1988) have largely disappeared in the last 18 months, and the potential for educational applications using CD-ROM technology cannot be underestimated. Our thesis also attempts to provide a catalyst, as much more data presented by Hypercard™ or some other hypermedia application can be stored on high density optical drives than on hard disk. The write-to program that Ruggles envisions for the near future is already available in Japan. It is called "Write to ROM". The name is a contradiction in terms, as it allows authoring changes to take place on the disk, and can provide true interaction with the program's data base. Hypercard™ allows interaction on a smaller scale, and can be expanded with the amount of hard disk expansion and addition of space in memory.

The goal of all educationally oriented projects in archaeology is to present the most flexible and interactive software to the student as technologically possible. But, as stated before, it is the creativity of the user that will dictate how far one can go with such software, more than it is the limitations of a particular technology.

The Leicester project is innovative in user interaction and creativity, as it allows the user to impose an abstract structure on the data base. The abstractions exist apart from the data, and do not change the base of data to something other than originally programmed (Ruggles 1988:528). The protection of the data has the advantage that the DiSo 1 Hypercard™ application replicates. The data can remain "aloof" from the user's manipulations by staying on a different level than the user's interpretations. Other future users will not be distracted by previous work, if they wish to use the "original" or "unmarked" data set in their analyses. The LIVE software was to have been available in March of 1989, and we await further review of its application.

The LIVE project is not as interactive as Hypercard™, but it is much closer than previous attempts. As soon as Interactive ROM disks and drives appear, incipient uses of hypermedia environment tools could be activated to a greater extent. The LIVE project is also linked to hypermedia through its keyboard and mouse operational systems. Features within the software allow the user to click the mouse with a cursor in areas of the screen to evoke a response. Interactive screens are similar to the button navigational function in Hypercard™. However, such screens are static as they only allow the user to navigate, rather than create the paths of navigation.

Operation of the mouse shortcuts commands evokes the Macintosh user interface by the distinction in the program between a "click" and a "double-click", initiating separate though related actions on the part of the computer. Icons are also employed in the Leicester application, and generally the operational interface is very impressive. However, it is still fraught with command lists, a holdover from the days of the monopoly of DOS codes. For example: a list of 16 mouse maneuvers includes the following—*to run from start*: left click towards the top or bottom of screen, *to freeze frame*: double click towards left or right of screen, *next frame*: right click towards right of screen, *previous frame*: left click towards right of frame, and so on (Ruggles 1988:541).

The idea of next and previous card is within the Leicester application, but the programming involved in getting the application to respond interactively must have been a gargantuan task. The mouse commands are confusing and convoluted compared with the button navigation system in Hypercard™. Hypercard™'s programming language "hypertalk" is a definite improvement in the economy in actual scripting, or use of the language, and the learning of the language itself.

The LIVE project remains the most up to date example of interactive technology in the archaeological realm, and the thesis, although it can show improvements in many ways over LIVE, cannot duplicate the image processing and access to large amounts of stored information that the optical disk accessory allows LIVE users. Apart from a few technological considerations, in all aspects of information access and interactive creation of accession paths, Hypercard™ is still at the forefront.

The genealogy related above should tell the reader that Hypercard™ is the latest program stemming from a long line of related applications and ideas. That is why Hypercard™ is used in our application. The next section accounts for the data used, and section four relates the process of merging data with the hypermedia system.

3.0 The Site, DiSo 1

3.1 Background and Context

The Hesquiat Village site is the traditional winter village of the Haim'ai'isath peoples of Hesquiat Harbour. It is located on the west side of the harbour near the southernmost point of the Estevan Peninsula (see figure 1). The site became the principal winter village for groups aggregating during the period of European contact. Due to demographic shifts caused by depopulation and new trade networks, Hesquiat Village or "Heckwi" expanded its kinship ties with the other three remaining groups that occupied the harbour from pre-contact times. Increased inter-group fighting due to the introduction of guns to the coast may have also encouraged amalgamation for protection (Haggarty 1982:99).

Remains of both historic and prehistoric lifeways are in great evidence at the site. Remains can be found both underneath new construction—as Hesquiat Village is still the centre for the Hesquiat peoples' community—and in now abandoned areas of the settlement.

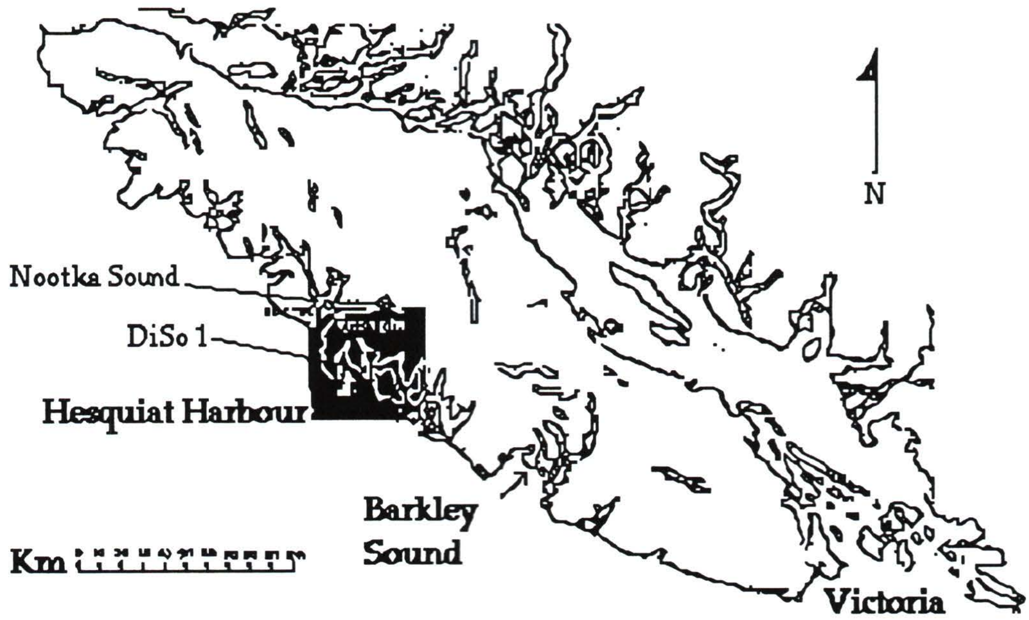

Figure 1: Hesquiat Harbour, on the west coast of Vancouver Island.

The natural environment of Hesquiat Harbour seems to have been similar to the present throughout the periods excavated. However, not all the Hesquiat Peninsula could have been the site for human occupation during the entire time that humanity has been present on the coast. Until about three thousand years ago, much of the area in and around DiSo 1 was covered by salt water. The land has slowly uplifted, producing a different set of micro-ecotones in places that were once submerged.

However, none of the newly created ecotones was different from what was already in place on the remainder of the peninsula. The existing peninsular vegetation and biome gradually expanded over the reclaimed areas. Pollen cores (Hebda and Rouse 1976:8) show a gradual reclamation or activation of flora over an ever expanding area. There is little evidence that human colonisation was also gradual, but lack of evidence may be due to the limited amount of excavation in the Estevan peninsula, and specifically the recovery of cultural remains older than what were found at DiSo 1.

The dating procedure for DiSo 1 involved eight radiocarbon estimates from charcoal collected in the excavation. One date (GaK-4394) was discarded as being too early for human occupation—between 355—805 B.C. using the dendrochronologically corrected range (Damon et al. 1974). The other seven dates give an approximate range from A.D. 700 to A.D. 1400. The site seems to have been occupied for the last c. 1300 years.

The quaternary history of the entire area was also examined (Howes 1981). The deposits preceding the "advance escalante deposits", dated from 38,000 B.P. to 29,500 B.P. remain unknown. It is possible that there then existed a cooler climate than at present, bordering on the subalpine. The till deposits of the escalante drift are dated from 25,000 B.P. to 11,000 B.P., and span the last period of the Fraser glaciation. The Estevan peninsula was one of only four parts of the central and northern North West Coast known to be left free of ice during the last glaciation, sparking interest that humanity could have settled there very early on in the prehistory of the new world. No evidence for early settlement has yet been found, but offshore work is lacking along almost the entire coastline, and there remain some possibilities.

The escalante deglacial deposits move from the fluvioglacial to the marine. Such a transition is to be expected, as the glacier melt runs toward the lower elevations on the coastline, carrying soil and debris. The marine climate and sediment gradually replaced the glacial as glacial runoff dwindles in simultaneity with its source's retreat. At the point of deglaciation, sea levels were at least 23 metres higher than present (Howes 1981:13). However, even that level was already seven metres lower than the highest limit of inundation reached by the glacial seas.

The beginning of the holocene on the central west coast of Vancouver Island saw the type of topography and sediment that one is familiar with today. Raised beaches are joined by delta areas. Caves and grottos, both marine and wind eroded, are present along with vast stretches of open gravel and sand beach. Long stints of uninterrupted rugged coastline laid down in the tertiary are also common.

The ethnography of the area consists of a reduction of what is generally said about the Nuu-Chah-Nulth nation as a whole. The Nuu-Chah-Nulth existed from the Chickliset at Cape Cook in the north, to the Pacheenaht at Port San Juan in the south. The Hesquiat, existing from Escalante in the north to halfway to Refuge Cove from Hesquiat Point to the south are part of the greater "Nootkan" ethnolinguistic zone. Five local groups inhabited Hesquiat Harbour in the prehistoric period, and four survived into historic times.

As mentioned, the remaining Hesquiat groups amalgamated c. 120 years ago at Hesquiat Village, which then turned from being the winter village of the Hai'ma'isath, to being a centre for all the groups including the Homisath, Kiqinath, and Ma'apiath peoples, the Ya'qsisath having joined the Ma'apiath.

Non-unilineal descent groups co-habitated in association with patrilineally related lines of noble individuals, or "chiefs" (Calvert 1980; Drucker 1951). The descent groups formed the local group, which had a name, and through its "nobles" a right to certain resources and territories. The local group was largely autonomous and most were associated with other local groups through kinship and the prevailing prestige hierarchy. The leader of each local group, due to his elevated status and accumulated wealth, owned resource areas, and doled them out to his local group members in return for the best of the subsistence returns. Such property rights were like a legal blanket covering the entire area to include most stretches of beach and rivulets of fresh water that extended from the forest to the littoral zone. Salvage rights were also contained in such tracts.

Most local groups were incorporated into tribes and some into what have been called confederacies (Drucker 1951:220). Integrating of the local hierarchies was also accomplished within larger groupings. Although amalgamation of the Hesquiat groups occurred in the historic period, nothing larger than the independent local group was ever exhibited in the Hesquiat area at the time. It is possible that none were present as far back as there was a population surrounding Hesquiat Harbour (Haggarty 1982).

Each of the four historically known independent local groups had its own winter village. During the non-subsistence portion of the annual cycle, the group would gather at the winter village for approximately 14 weeks to participate in more ethereal cultural matters. Re-affirmation of kinship took place by potlatching, and exchanges of wealth and priveledge took place. Some subsistence activities were entered into during the winter, but on a small and very local scale.

Each local group also had its own fishing stations and other suites of resource procurement sites. Not all groups had a summer village or villages. Such a pattern is witnessed in the archaeological record for each group's territory as known ethnohistorically. The pattern is echoed by contemporary native accounts of kinship affiliation as extended to territorial and winter village site names. The archaeological evidence points to the fact that the relatively small, independent local group was present in similar manifestation as in the recent period approximately 1200 years ago (Calvert 1980:iii). The Hesquiat groups had access to differential resource procurement zones which remained statically in their possession for most of the period to the point at which traditional group's territories were amalgamated at Hesquiat Village.

The known archaeological sites within traditional Hesquiat territory are as follows, listed for each local group;

Hai'mai'isath: DiSo 1, winter village, DiSp 1, summer village, and DiSo 26, fishing station (historic).

Homisath: DiSp 2, winter village, DiSp 4 summer village, and

DiSp 3, fishing station (historic).

Kiqinath: DiSo 2, winter village, DiSo 21, summer village, and DiSo 3, fishing station (historic).

Ma'apiath/Ya'qsisath: DiSo 14, winter village, DiSo 7, DiSo 23, and DiSo 25, historic fishing stations.

Numerous cave, rockshelter and small subsistence procurement sites are also in evidence, as well as red ochre source sites, historic burial sites, and petroglyph sites (compiled from Calvert 1980:88,92,103,110, and Haggarty 1982:87).

In the 1972 field report, a native informant tells the investigators a story of the migrations the Hesquiat people have made. According to the tale, the ancestors of the Hesquiat people moved across the harbour from a position to the north of Heckwi, and then directly back across to Heckwi, where they defeated the people there and absorbed them. The motive for all related migrations was an effort to find better beaches for beaching whales. The original place of the Hamai'isath people seems to be the site of DiSo 2, the Kiqinath winter village, then to DiSo 21, that same group's summer village, then finally to DiSo 1.

The 1972 field season at DiSo 1 was the first of two full field excavation seasons at the site. It represented a continuance of the nascent Hesquiat archaeological project, a multi-disciplinary cooperative between departments at the then British Columbia Provincial Museum, and the Hesquiat people themselves. Both groups took an active role in the investigation, from the excavation to the identification stages. Native views were ultimately incorporated into the two interpretive works that came out of the DiSo 1 excavations, Calvert's 1980 dissertation, and Haggarty's 1982 dissertation. The Hesquiat project has continued intermittently during the decade between excavation and the publishing of the two interpretive works.

Our thesis project is not directly associated with the Hesquiat Project, although copies of both the hardcopy and the software will be sent to the Hesquiat Cultural Committee and the Royal British Columbia Museum.

Some of the succeeding comments are from the unpublished manuscripts of the 1972 field report, and the manuscripts are used for the following synopsis of events.

Sampling was done by gridding a randomly and arbitrarily selected area. The designers had to avoid peoples' houses and property and some oil storage tanks, the area surrounding them being churned over through bulldozing. The land left formed a sample area of 850 2x2 metre squares. The sample area was converted from a universe to a sample population through a list of random numbers obtained from Snedicor (1956), and 49 squares were chosen. Seven excavation units were randomly chosen from the reduced sample. There is no reason given as to why the original universe was subjected to the reductions involved in a second step.

Topographically, the investigators found that the site consisted of two ridges and a playing field associated with the Hesquiat Village school. The upper ridge area was not investigated in any depth, and was presumed to be culturally sterile. The assumption of cultural sterility was made because no surface finds were in evidence on the upper ridge. The lower ridge consists of a two metre high accumulation of black humus soil matrix covered with scrub bush. Quantities of fire-cracked-rock were found in the top layer. Historic dumping for the clearing of the playing field may have added some deposits to the midden. The two outhouse holes and an 2.75 metre deep garbage pit that were dug for the excavator's convenience showed little. The playing field is a relatively new buildup of beach sand, that was recently levelled off.

The initial survey used various extant structures as landmarks. The site was laid out with a metric grid. The datum plane (Datum "A"), was about 2.60 metres above average surface level. Deposits were trowel excavated using a combination of 10 centimetre arbitrary and cultural levels.

The next three pages of the 1972 site report contain the details of the non-provenienced units included in the investigation. Some detail is contained within the application proper, but their origins are worth relating here.

The "Swamp Drainage Ditch" was constructed by the investigating team to alleviate an anticipated problem of flooding. Hesquiat residents informed the investigators that flooding occurred regularly in the area. The ditch is 0.75 metres wide and from 1.00 to 1.50 metres deep. It runs across the site from swamp to the edge of the embankment, following a path where a previous trench had been dug. The old ditch had been filled in with a mixture of historic artifacts from the 1920s, and prehistoric matrix and artifacts. The faunal remains are designated by Crozier and Boehm (1972) to be from the 1920s as well, and contain halibut, cod, and dogfish. Artifacts numbered 1—100 and 794—800 were catalogued.

A creek used to flow through the area in question, and despite renewal of the drainage ditch, water rose to such a height in excavation units 10 and 4 respectively, to call a halt to excavation for two weeks. The flooding occurred after only two days, or three inches of rain. The water table in the DiSo 1 midden can be near saturation point during heavy rains, and yet DiSo 1 is technically not a wet site. The types of artifacts preserved in the DiSo 1 midden are typical of alkaline enriched soils and not of waterlogged matrices.

Ozette has set the standard for what one would expect from a wet site on the coast, and, apart from historic materials made of wood or other extremely perishable raw materials, none of the vast and enlightening array of articles from Ozette has turned up at Hesquiat. Historic artifacts were not saved from the screening of the ditch. Due to various non-coincidental finds all across the area of the playing field, and the northern and eastern extremities of the midden, prehistoric material may account for at least the top 0.30 metre of the beach sand in all areas.

The "Jumping Pit" was dug by a Hesquiat man to practice broad and triple jumping for the upcoming Ahousaht sports day. It is located at the south end of the playing field, and was judged far enough away from the already plotted grid to be excluded from the excavation units. It is unclear if it was systematically excavated, but the material found was screened, with both faunal and all artifact remains collected. Prehistoric artifacts # 733—760 were catalogued. The sands yielded most of the historic remains, and it is possible that had a greater depth been excavated than the 0.30 metres of the pit, remains of a longhouse might have been in evidence.

The tale that was told to the investigators earlier in the manuscript suggested that there might have been a longhouse in the area, but one cannot be sure that the pit was the precise location. Great quantities of fire-cracked-rock and charcoal flakes within an organic black soil matrix were also found in the vicinity of the pit. The playing field was constructed in 1918. The overburden, much of it containing late nineteenth century material as well as some precontact material, was dumped to the west of the drainage ditch, forming a low mound that is still in evidence.

The garden of Alice Paul's house presented yet another diversion for the 1972 field crew. It was dug at the end of May, and is 0.15 metres or one spade height deep. Artifacts # 501—536 were catalogued from the garden, and faunal and some historic remains were also saved. Ten centimetres below the surface, at co-ordinates South 3.70, East 18.20 a post was found. There appeared to be a longhouse at the stated co-ordinates, and Alice Paul informed the team that the post was where the front door was attached.

The entire area surrounding the modern house has been a garden for many years, and digging accounts for the lack of abrasive stones in the garden area, relative to all other excavated areas of DiSo 1. Abraders were collected over time, and either discarded or kept as mementos—some even as functioning parts of a syncretic toolkit.

The "wash stand trench" was dug to a depth of 0.15 metres to accommodate water from that device. It runs from the front porch of Alice Paul's house to the edge of the embankment. From screening, artifacts # 701—732 were catalogued, and all historic and faunal material was kept.

The "longhouse postholes" are not ancient features, but were augered for the two front corner posts of the new Hesquiat Village longhouse, dug on July 19, 1972. A different set of squares was devised, and 0.20 metre levels were excavated by spade, and screened through 0.25" mesh. Only two of the many longhouse postholes were dug semi-systematically, though no three dimensional provenience was attempted. The frontal posts would be closest to the DiSo 1 midden. From long house post hole number one came artifacts number's 2201—2249. A clay floor was eventually reached. From longhouse posthole number two came artifacts number's 2250—2290. Clay again ended excavation.

The remainder of the 1972 report is devoted to Hesquiat elder's descriptions of some of the artifacts found, as well as a glossary of native terms for both prehistoric and historic artifacts. The names for described items appear in the thesis' application, as well as the many descriptions of artifacts that were systematically collected from native elders. Regrettably, most of the native interpretations, were unable to be found in the published and unpublished work relating to the Hesquiat excavations.

The data from systematic excavation in 1972 and 1973 showed cultural deposits estimated as being about 800 metres in length, with the prehistoric midden deposits occupying a sandstone bluff approximately eight metres above sea level. The midden adds about two metres to the elevation.The uppermost layers of the midden are historic. The data within our hypermedia application are strictly from the prehistoric layers of excavation units 2, 4, 10, 12, 14, 18, and "B", randomly and systematically dug into the overlying cultural deposits. As well, data were entered from the surface collections of both years, and the various disturbed matrices.

Artifactual and faunal material is documented for both field seasons, and soils analyses are available for the 1973 season. The only burial found at DiSo 1 was uncovered on May 25, 1973 in excavation unit 18, level five. The burial is included in the matrix and feature stacks. Radiocarbon dates give a range of c. A.D. 885 $\pm$ 70 (WSU-2268), to A.D. 1430 $\pm$ 90 (WSU-2266) (Haggarty 1982:102). Seven natural stratigraphic layers, zones A-G, were identified extending from the surface to 2.25m. Only zones B, C, and D exhibited extensive cultural deposits, and also formed the bulk of the midden matrix.

3.2 The Record

The seven natural soil deposits identified at DiSo 1 were translated to five faunal units for the purposes of economy of analysis (Calvert 1980). Clam and rockfish species dominate in all five units for bivalve and fish quotas respectively. If all the faunal units are compressed to form one overall picture, the percentages would be as follows for faunal remains based on the number of identified specimens present: 81 percent fish, 10 percent sea mammal, eight percent bird, and one percent land mammal. If the minimum number of individuals measure is preferred, the percentages are 70 percent fish, 18 percent bird, nine percent sea mammal, and three percent land mammal (Haggarty 1982:116). Shell remains were weighed, and clam species accounted for 75 percent. Mussel and sea snail accounted for 12 and 10 percent respectively. The remaining three percent including all other shell categories.

Food value for each grouping of faunal remains was not expressly attempted (Calvert 1980). However, it was estimated that fish provided the major staple, with sea mammal second in importance, followed by birds and land mammals respectively.

Not all the remains were identified, but both Haggarty (1982:116) and Calvert (1980:195-6) agree that the additional information to be had from the remainder would only complement their statistical and interpretive findings. All bivalve and vertebrate species excavated can be found in the same area today, although some species numbers have been vastly reduced due to modern exploitative methods.

Faunal remains are contained in four stacks in our computer program. One accounts for land and sea mammal finds, a second details bird remains, the third accounts for remains of all fish—the largest stack of statistical information presented, and the fourth contains bivalves. The faunal system contains 20% of the larger Hypercard™ program. The ratio comes from memory allocation.

A total of 6,280 artifacts were excavated at DiSo 1. Only 904 of the total assemblage, accounting for 14%, were of indigenous manufacture. Not all of the 14% were produced in the prehistoric period. Only the prehistorically made artifacts and some from the surface collections are included in the present hypermedia application. There are a total of 413 non-lithic objects and 491 stone artifacts. They account for about 60% of the computer program.

Artifacts were collected by not only systematic excavation, but also by surface collection, and from various disturbed areas of the site. All the relevant and detailed information on each artifact, as well as on units of provenience is included on the cards within the respective artifact stacks. The stacks include two abraders stacks, (making up 88 percent of the lithic artifact total), another stone artifact stack containing the remaining 12 percent of the lithics, as well as three non-lithic artifact stacks. The last three include "objects collected throughout both seasons with no provenience", "objects with three dimensional provenience from the 1972 season", and "objects with such provenience from the 1973 season".

The artifacts were recorded on site, on sheets that were coded for fields derived from a computer program. The program is the Canadian Heritage Inventory Network, or CHIN. CHIN was an attempt to avoid some of the lab analysis steps in the archaeological research process. CHIN was not altogether a success, as data entered lost most archaeological contexts, and links amongst fields followed linear paths.

The fields coded for on each artifact sheet were as follows:

A), Collection related fields—location, institution, acquisition #, catalogue #, collection, donor, microform #, published citations, restrictions.

B) Artifact description fields—category, material, class, description, modifiers, "determined information", length, width, thickness, weight, (the "units" for each of the last four measurements), qualitative measure, condition, conservation, age, technique, archaeological culture identification, "s" identification, remarks, and "third party", and

C) Provenience fields—Province/country, Borden number, site name, natural region, ethnolinguistic area, excavation unit, location in site, bearing, datum plane, datum plane reference, North/South direction, NS measurement and units, East/West direction, EW measurement and units, $\pm$, vertical datum, vertical datum reference, vertical datum measurement and units, distance below surface and units, "comp/zone", level designation, level description level reference, stratigraphic designation, stratigraphic reference, and qualitative provenience.

A total of 50 code fields are allowed, but on average, only half are filled out on the DiSo 1 record sheets.

Stone artifacts made up 54% of the total assemblage (Haggarty 1982:120). Abraders accounted most of the percentage, translating to 47.52% of the entire artifact list. The abraders class seems to be of great importance in the pre-contact period examined. The other classes include, a lignite bead, cores, a chipped point fragment, adze blades or celts, flat-topped hand mauls, saws, perforated stones or sinkers, and cortexs, cobbles, and flakes. No lithic detritus was found on site, and most artifacts, whether of lithic or non-lithic manufacture, are manufactured by grinding or abrading. Non-lithic artifacts made up 46% of the total assemblage. The miscellaneously worked raw material classes accounted for 43.1% of the non-lithic category. Bipoints and unipoints, accounted for 16.1% and 4% of non-lithics respectively.

In recovering the above artifacts, the matrix was dry screened through a 1/4 inch mesh, and all vertebrate remains were kept. Molluscan remains were sampled by arbitrarily collecting as many of the dry screened remains as possible (Calvert 1980). The total number of shell remains recovered was 49, 770. So much shell was recovered that it was impossible to count all the smallest individual remains. The sample was weighed after species and/or type sorting. Such shell fragments are so small that counting would be uneconomical, and virtually meaningless to any inference.

Soil samples were taken from excavation units 12, 18, and "B", and level sheets were kept for all units. The faunal remains come from units 12, 18, and "B". Matrix analysis was performed for each combined cultural and arbitrary level. Small remains of vertebrates were similarly recovered.

The midden seemed to be of a depth between 1.1 metres and 2.16 metres in the areas sampled. It was divided into five stratigraphic layers:

Unit I, lasting 37 cm. from 3cm. below the surface to 40 cm. consists of brown humus. Fire cracked rock and shell, as well as many historic period artifacts were found within Unit I. Some of Unit I within excavation unit 12 has disturbed stratigraphy, but it is basically historic.

Unit II is a large layer of brown soil, shell lenses, fire cracked rock, and at least two features—a sand pit and a hearth. In some areas sampled, Unit II extends from 40 cm. to 1.05 metres, but in others, it only adds 7 cm. to the depth of the midden. Excavation unit 18's level II was too disturbed to separate from the above layer. Faunal remains from excavation unit 18 were not analysed as part of level II results (Calvert 1980:132).

Unit III is a concentrated layer of compressed shell lenses with dense quantities of fire cracked rock. It varies in depth from 70 cm. to only 3cm.

The variation in Unit IV goes some way towards the creation of a uniform surface for itself, as it makes up for the variety of the previous Unit II. Unit IV layer was found to be discontinuous in excavation units 12 and 18. Unit IV contains brown sandy soils. Much lower concentrations of shell lenses were found here, but even higher amounts of fire cracked rock. For excavation unit 18, Unit IV constitutes most of the midden, adding 80cm. to 1.40 metres of depth. For units 12 and "B", Unit IV adds 20 to 65cm. Unit IV is the last layer exhibiting certain cultural occupation. Unit IV dates the origins of habitation at DiSo 1.

Unit V is the geological bed upon which the midden rests. It contains a few intrusive elements from unit IV, but basically consists of densely packed clayey sand and gravel. It was judged to be a culturally sterile deposit.

The DiSo 1 midden has a continuous occupation represented by four overlaying cultural layers, spanning approximately 1300 years. The dates for each level are as follows: Unit I—from c.1780—present, Unit II—from A.D. 1400-1780, Unit III—also within the A.D. 1400s period, and Unit IV—from A..D. 700-1250. The top two layers are considered by Calvert to be comparably ethnohistoric, while units III and IV are very similar, although prehistoric. Unit II is also technically prehistoric, if we wish to call its end at 1778, but for all archaeological purposes, it represents the same people doing the same thing as their known successors. Unit V remains undated, as it was deemed culturally sterile. DiSo 1 is a single component site.

All events observed within units "B", 12, and 18 were recorded, forming a massive set of data documents. The data were translated into the Hypercard™ application. Excavation unit 12 provided the radiocarbon estimates. Excavation units 2, 4, 10, and 14 had a level record notebook kept, but the amount of detail and data contained within units 2, 4, 10, and 14, although probably of similar quantity empirically, is in actual archival form and in human memory far less. Level sheets for the 1973 excavation season do not display some inconsistencies found on the artifact sheets. Such inconsistencies are both a function of the amount of experience certain team members had, and the duties they were assigned.

The general information fields on the level sheets are as follows: Site #, Site name, Ethnographic area, Excavation unit, level, Datum plane, Surface, Distance below datum, Distance below surface. The matrix fields were defined as follows: Soil content—type, colour, texture, compaction, moisture content. Each field has various possible answers or sub-fields. There are also fields defining type of "scattered rock content", "plant remains", as well as features, burials, photographs, carbon samples taken, soil samples taken, and artifact catalogue numbers found in that level. Space is provided for both general comments and comments outlining the nature of the relation of the particular level to that above and below it.

The profile sheets have a graph paper side to use for the drawing of the profiles. The other side of the sheet contains coded fields for site, unit, "record of profile at", "wall at", description of strata, scale of drawing, photographs, recorders name, and the date. The profile sheets are accompanied with a photographic record. Unfortunately, most of the black and white prints were taken by amateur photographers, and the contrast levels were seldom high enough for the computer scanner to present any kind of detail. Lack of detail in scanned images is a problem of a disagreement between older and newer technologies, and will be discussed in section four. Drawings were also made of all profiles.

Feature record sheets were considerably less detailed than the other two types of soils analysis. However, there were many features found in the three excavation units that were analyzed in detail.

The soil sample forms had the same coded fields as did the level sheets in the general category, but substituted in the secondary categories "main matrix sample", description, lense, associated features, burials, etc, treatment, analysis, and comments.

The feature record sheets had coded fields for feature #, excavation unit, site, depth from surface, depth from datum, horizontal location, definition, associated objects or features, stratigraphic notes, comments, names of the exposers, recorder's names, the date, photographs, sketch, scale, and what the sketch and/or photographic record shows.

All fields and information contained within them was transferred to the Hypercard™ application. Section four explains the process employed to move the DiSo 1 record from original sheets to hypermedia.

4.0 The Process

Technical summary of the steps taken in construction of the computer application follows. The process is somewhat similar to that of all other computer based applications. One constructs, at the level of programming, a set of commands which perform an express set of actions. However, commands do not dictate how the user might move through the system. All practical information concerning how one might use the actual program will be found in the DiSo 1 "Helpstack". The Helpstack is described in section 4.4, and includes information about hypermedia navigation and use of programmed links. No correct set of links or moves can be outlined, as the point of the program is to allow users to create their own pathways through the DiSo 1 database.

Hypercard™ is different from most other software on the general level of programming. Besides the differences outlined in the first section, the ease of programming and the economy of data organization which such a program produces bear mention. With very little programming knowledge, one can construct a sophisticated looking program. The present application was built with a small amount of knowledge. We chose to operate from the simple to the complex.

Our attempt serves as an example for non-computer specialists. Archaeologists with little background in computers can develop a hypermedia application that is custom fitted to particular needs. One interesting fact about Hypercard™ literature in particular, is that the more complex chains of hypertalk sequences often perform functions that are more akin to "video game" programs, and would have little place in a serious scientific work. However, one must also recognize the vast potential of more complex programming, when adapted to custom use.

Most of the programming needed to create an application of similar quality and magnitude one can learn in less than a week. One week is much less time than it takes to engineer software from other quarters. Obviously, one has not mastered programming after a week's period, but, as far as some archaeological data are concerned, one can work comfortably within the user framework.

The difference that makes such a program possible, when compared with past programming efforts outlined in section two, is the Macintosh user interface, as discussed in section one. There is no "disk operating system" apart from the hardwired set of commands within the computer. Once the system is installed, all system commands used to enter, perform within, and exit, as well as transfer documents amongst various applications, are negotiated by the computer's automatic system tools. One does not see the DOS, nor does one have any interaction with it.

It is the same for Hypercard™ applications. The user does not see or initiate the programming on a command based level. All actions take place at the level at which Hypercard™ is designed to run—all by itself. The application is opened, and immediately the user is immersed within the data set. There are no screens barring access to information important for that user. The style of the program is geared toward ease of use, as if it were for the computer handicapped. A vast and more satisfying universe of information is opened to the user, displayed in a more economical manner than any before.

The construction of the DiSo 1 system required five months of study and operation. Twenty percent of that time was taken up by reviewing and learning the methods of computer operation and construction, and by pure experiment. The whole process was of course one large experiment, which is never finished, due not only to the open-endedness of the program itself, but also to a similar situation regarding the data entered. Data and program are united, and hypermedia is the only current method of reaching such a *détente*. Four months of actual construction followed the period of study, two-thirds of it expropriated by the artifacts stacks, and the remainder by the soils set and the faunal stacks. Each of the stacks is impressive by itself. Each set allows a fairly detailed glimpse at DiSo 1. The thesis marks the first time a site has been translated to computer in the manner of hypermedia.

Since our attempt was the first to experiment with archaeological data and Hypercard™, we had to improvise a set of hardware and software requirements. The system was constructed on a 1989 Macintosh SE with a 43 megabyte Mac-Crate hard drive, and 4 megabytes of internal RAM. Peripherals included a Datacopy Kurzweil 730 greyscale flatbed scanner. The amount of internal memory, though large, was necessary to use "MultiFinder", the Macintosh's "pseudo-virtual-memory" program. Multifinder allows several different applications to be used at the same time, without closing or quitting any files. All equipment was personally purchased and all information needed to construct such a system was self-taught. It will be easy for a future researcher to replicate our program, or construct one completely different.

We also used archaic hardware. Much of the hardware is currently relatively inexpensive, and easily available. The software, however, is state of the art, upon which the cutting edge of computer applications are being based. Hypercard™ version 1.2.2 was employed, as well as Xerox's MacImage 2.2 scanning software. The graphics were translated via MacPaint II, and the entire hardcopy text was prepared on WriteNow 2.0. We have user copyright material for all applications, but all are readily available and range in price from $400.00 to free of charge. The created program is to be registered with Shareware Scientific Services, but is available to all in contact with the sources previously mentioned as having a copy of the DiSo 1 application.

4.1 The Artifacts Set

The artifacts set of stacks is the largest in the program. The assemblage has been divided into abraders one and two, other stone artifacts, non-lithic artifacts with no provenience, provenienced non-lithics from the 1972 field season, and the same for the 1973 season. Six stacks are present, but the user will only see five as the two abraders stacks are joined by a "silent bridge". Explanation follows.

The abraders stack is the largest, two linked stacks above accounting for over 2 megabytes of memory allocation. The first part of the linked system accounts for 958 kilobytes, and contains 198 cards. The second part contains 210 cards. They were labelled "ThesisAV1" and "ThesisAV2" for scripting and identification. With the exception of the latter name, all "V1" in the phrase means is "version 1.0".

One starts, after opening Hypercard™ from the Macintosh desktop, with the "new stack command", which has no "macro", or keyboard equivalent. It is located under the file menu, and must be selected with the mouse. One is faced with a blank screen, daunting at first, but full of endless possibilities. For the abraders stack, we chose to use a single background for all cards in the stack. All manipulations that might have required a second background, and therefore already an increase in complexity, were performed on the cards themselves. Three of the 198 cards in the first stack required such amendments, and two of the 210 cards of the second stack required the same modifications.

First constructed were the background buttons. The buttons are navigational icons that shared the same function no matter on which card they were placed. Five background buttons were used: one to go to the first card of the stack, one to go to the previous card from the user's current position in the stack, and one to go to the next card. As well, icon buttons were used for the other two button functions, one to get to the interpretive information about the artifact in question appearing on that particular card, and the other to move one to the statistical and cataloguing information about that same artifact, or artifact class.

The buttons were chosen with the use of the set of dialogue boxes one is presented with when one chooses "new button" under the "objects" menu. One can create custom icons as well, as will be seen in the review of the faunal and preparatory stacks systems. Buttons are then dragged and placed on the screen in strategic locations. The buttons are programmed to perform the functions or actions that are required by the user. The phrases that follow are found in the "script editor" in the Hypercard™ application itself. They are presented exactly as they would look written in the editor. The programming for the five background buttons is simple, and the scripting is as follows:

```
on mouseUp              on mouseUp          on mouseUp
Go to previous card     Go to next card     Go to first card
end mouseUp             end mouseUp         end mouseUp
```

The mouse direction phrases are hypertalk parameters, placed in the scripting window by the program itself. One does not have to write parameters into the scripting window for many command sequences, only that which is in between them. Parameters can also be changed, as we will see later. All parameters do is tell the application to pay attention to the following commands when inside stated parameters, and no others. One could have also written "go previous card", "go prev card" or even "go prev" to get the required result in the first case.

Hypertalk is a very forgiving language, that works within a recognizably English vernacular. The actual Hypercard™ program is in

English. No matter what language the scripting is written in, (Hypercard™ is now available in most European languages as well as Hindi and Japanese), the program works in English. Hypercard™ translates the constructor's language into ours, and its own (Goodman 1988:366). On the other hand, one could have scripted "Go to the first card of the stack "ThesisAV1"" and gotten the same result. What is ultimately used depends on one's own familiarity with the application's internal networking.

The following contains the other two background button scripts, in between the established parameters:
Go to card "Artifact.Ints.1." of stack "ThesisAV1". and,
Go to card "Artifact.Stats.1." of stack "ThesisAV1".

One could supply the reader with a long list of other possibilities, some of which are increasingly redundant. Other similar phrases used in the DiSo 1 application include: "go card id 3802 of this stack", or "go card 198 of this stack". Each card has its own personal identification number, which never changes, and is not given to any other card no matter what stack it is placed into.

We also chose to name some individual cards, to create a small class of similarly functioning cards that would act in tandem across stack boundaries. The text on the named cards detail statistical and interpretive material to do with artifacts or artifact classes, and are linked by their accompanying fields. One can name each card separately, but such a process would entail a master list of hundreds of names, to remind the user where they were going. Links created through the use of different card names are definitely inappropriate for a large scale application. Card identification numbers, on the other hand, while just as individual, are more easily remembered and are constantly available through various connected dialogue boxes. Card identification numbers are created by Hypercard™.

The difference between a card's identification number and a card's actual chronological number in the stack sequence is important. Card i.d. number 38096 may only be the second one in sequence of a particular stack. Card i.d.'s are randomly chosen by the program, within a set of created parameters.

Once the five background buttons were placed, we chose to insert a background text field (see figure four). The background text field contains all the descriptive information given on the site record sheets regarding each particular item. Since the amount of information varied a great deal from sheet to sheet, a scrolling field, or a text field allowing for more text than seen on screen at one time, was chosen as the basic form for text entrance. The advantage of a scrolling field lies in its ability to store a large amount of text while taking up very little space on the screen. Hypercard™ limits itself to nine inch diagonal cards. It does not matter how large one's screen is, the size of the working space or card remains the same. Supercard and Hypercard™ 2.0 have varying sizes and full page screen cards that are entirely compatible with the thesis' application.

The background field for the artifacts stacks was set on the right hand side of the card. Text fields are dragged, resized, and placed in the same manner as buttons. Scrolling fields have the ability of storing up to 30,000 characters, including spaces, on one field. Even such a large amount of allowable characters proved too small for our application in one circumstance.

Each artifact description was entered on the individual card fields. Data entry is relatively easy in the DiSo 1 application, but it can become monotonous. Even with progressive software, there is still no substitute for time spent doing the work. However, our thesis offers some consolations. Text can be cut, copied or pasted by the mouse with the usual Macintosh economy. As well, entire fields can be copied and pasted onto any card in any stack at any time, without loss of information or archaic sequences of system manipulation commands. Two keyboard commands or moves with the mouse accomplish each function.

The same is true for buttons, graphics, entire cards, or backgrounds. The programming script that is contained within objects is also automatically transferred. There is no need to retype any data already entered, whether from the data set that the program media is representing, or from the program itself. All feature manipulations work amongst different applications outside of Hypercard™, and Hypercard™ can be set up to run one's entire computer hard disk and system tools if necessary.

Lastly, the remaining space on the artifact cards was used for the placement of line drawings of the actual artifacts (see figure five). Over

300 different drawings were prepared by an artist, and were made from both the photographic record of DiSo 1, and from record sheet descriptions, as not all the assemblage was photographed. The line drawings were done in black and white, on 3x5 cards. The size of the cards was not chosen to mimic the screen size, but rather to aid in scanning and filing during the scanning operation. The flatbed scanner was used, with the MacImage software. The setting called up is labelled "Hypercard™ Line Art", and uses that program's 75 dots per inch capability. Other programs offer much more refined graphics, but Hypercard™'s are satisfactory.

The job was an easy one for the scanner, which can perform with up to 256 greyscales and 300 DPI. The item is scanned into the graphics software, saved with the command "Paint, clipped at right and bottom", and placed in a file folder on the desktop. It is important to strictly follow the correct sets of commands, for, although other sets do exist, the devised sequence was found to be the most economical. The graphic must be placed in a file, otherwise Hypercard™'s hierarchy of search commands will not recognize it. One must then move back to Hypercard™, and choose a paint tool, underneath the tools menu. Then, by selecting the "import paint" command from under the file menu, the graphic is placed on the card selected, through a series of dialogue boxes. The outlined process is immediate after the first initial set up, but it must be reconfigured each time one opens the applications.

Once entered, the graphic takes up more room than the card space reserved for it allows. One should select the "eraser", and erase the unnecessary white pixels from the card. Clear pixels replace the previous, and the remainder of the card, buttons, text field, and text is revealed. The graphic is selected and placed using the "selection" tool, and the sequence of events comes to a close for that card. The process is repeated.

The entire process ultimately takes the experienced only a few minutes. Most of the time was spent waiting for the microprocessor within the Mac SE to deal with the complex graphics package during the scanning process. The hardware uses 12 seconds to recognize the image, and 62 K of RAM to operate.

A discussion of the import of graphics comes with some cautions. The higher the resolution for a line drawing, the longer it takes to scan. As well, the more memory the scanning program acquisitions, the less the system itself has to carry on the routinely fast operation of the entire machine. If one moves to 300 DPI within a line art command, one waits 0.7 minutes and uses 386 K. Photographs are even less economical. It is easy to create a command for the scanning of black and white images that takes 1.7 minutes and 993 K to scan. Larger pictures also take more memory to store, especially if the greyscale is stored.

While the majority of line drawings in the DiSo 1 application need only an average of six kilobytes of hard disk space to store, photographic images can take up at least tenfold that space. Photographs were not used here for a number of reasons. As previously mentioned, most of the proofs were far too dark to be manipulated in any experimentally satisfactory manner. Haggarty (1982) also found the negatives too dark to use in the University Microfilms International publication. The copies of plates in Haggarty's dissertation are all but unrecognizable. For our thesis, an Apple flatbed scanner was also used, as were numerous translative photocopiers. The function "blue erase" found on some photocopier machines does help the contrast levels. However, since one works with black and white pixels, with little greyscale capability outside of the scanning software, the reproduction of photo images was not found to be satisfactory for any presentable media.

Besides the data quality, there is the quality of the hardware used. We have no doubt that with a faster machine, the Mac SE-30, or IIcx, IIci, or IIFx, photographic scanning would be accomplished, provided normal contrast exposures are available. There is also the question of the speed of scanning. MacImage takes into consideration the capabilities of the machine it is working with. Photographic scanning is hereby not recommended to Mac SE users, if installed with the original 68000 microprocessor. A 68030 is recommended. A Mac IIcx and an Apple scanner equipped with Hyperscan™, performed much better, but for both logistical and data quality reasons, such an alternative route was deemed uneconomical.

As we have an original experiment for the thesis, we feel it is best to try as many different software routes as are available, and compromise based on technical, temporal, and financial constraints. Photographs will undoubtedly appear in important roles in future versions of the DiSo 1 application, or in new works.

The only remaining cards in the abraders stacks that do not fit into the above pattern of construction are cards that contain statistical and interpretive information, as well as one introductory card, which is self-explanatory in the application. The introductory card's i.d. number is 11198. The named cards "Artifact.Ints.1" and "Artifact.Stats.1." are mimicked throughout the artifact stack system. They consist of one screen size scrolling field, filled almost to capacity in all cases. The linear medium was chosen to remind users that there remain some economical aspects to the presentation of data in such a manner.

The lengthy scrolling field lists provide information from interpretive works written on the site, (Haggarty 1982, Calvert 1980, Boehm and Crozier 1972), from the record sheets themselves, and our statistics derived from the sheets. The field comments are very interesting in some cases, dull and monotonously repetitive in others. The technology allows for the presentation of both, and for the easy removal or passing by of that which is not of interest to the user. We firmly believe that as much data as possible should be included, no matter at what level the user wishes to engage the program. The opportunity for a detailed study using Hypercard™ should at least potentially exist.

The amount of textual information on one field created a problem worth detailing, so it might be remedied, or avoided. As mentioned, scrolling fields can store only 30,000 characters each, including return characters and spaces. If the maximum is exceeded, authors receive a message from Hypercard™ informing them that no further text changes will be saved. Hypercard™ has many different ways of saving information, but the most common one is movement to another card. Moving to a new card will result in the deletion of all text characters over 30,000 in the scrolling field.

There were several ways to remedy the situation. Chosen here is a simple silent bridge maneuver that links two stacks behind the scenes, so that the user does not have to manually move from one stack to another. Such movement is not economical when using portions of the stacks in tandem. As stacks were meant to be used together, we converted the script on the buttons of cards 195 and 196 of "ThesisAV1" or part one of the abraders stack, and similarly card 1 of "ThesisAV2". The conversion allows for a smooth transition made by the program between stacks. It also creates another stack for the inclusion of not only 208 more abrader cards, but of two more scrolling field cards with the continuation of interpretive and statistical data.

Three other buttons were added to scrolling field cards. The three buttons were placed at the card level, and were not shared through a common background with any other card. One button takes the user to the "Home card", the second to the "HelpStack", and a third moves the user back to the card they were at just prior to moving to the statistics or interpretive card. The first button icon is simply a house, with accompanying script—"Go home", or "Go to stack "ThesisHomeV1"". The second button consists of an interrogative icon, and takes the user via "Go to stack"ThesisHelpV1"" to the HelpStack, which will be discussed later. The third is also simple, containing the same words both in its script and in its icon—"Go back". It serves as an example that layering commands in Hypercard™ in relation to what the user sees or does not see is often a product of mimicry through a hierarchy of levels.

After the above additions, it only remained to connect all text in hypermedia fashion to complete an economical set. Connections were made by text and transparent buttons. After some experiment, the use of buttons was deemed the most simple procedure.

An example of what not to do bears mention. To move from field to field, we imagined that we could create a short set of commands that would move the user from the last line of one filed to the first line of another, even though they were in different stacks. We also wished to limit the parameter of movement to the above, so that any entrance by the mouse into the text field would not result in an unanticipated movement. The script that was eventually concocted is contained in the following:

```
on mouseWithin lines, uno, of, card, field, id, ono
  closeField "Abraderstats2"
  Go card id 3282 of stack "ThesisAV1"
end  mouseWithin
```

The string performed the actions required. However, more than one such string working in tandem created an infinite loop between the selected fields, and other experiments were tried instead. Because of the detail involved in explaining the above script's wording, it is better to move directly to the actual navigation employed. Transparent buttons were created, and placed over already typed in text. By clicking the text, one can move in the desired fashion. The white portion of the screen immediately surrounding the text in question, e.g. letters composed of black pixels, space made from white pixels, "highlights" or reverses colour after it is selected. Highlighting tells users that they have done the right thing, and will get the action promised by the text. In the application, the highlight function appears to the user as the following: "For items on cards 1—194, click here!" .

There are many different "transparent messages" within the DiSo 1 program. They are as subtle and refined if not as flashy as, for example, the above scripting experiment.

The text for the abraders stack(s) took the majority of construction time. The actual placement of the stack controlling features, navigational tools, and programming script took a very short time relative to the text. It is worth mentioning that with a 68000 microprocessor, manipulation of buttons and other objects on a card that contains a lengthy scrolling field text become very slow. The text itself also involved experimentation. We wished to impress upon users that once static forms of data can be made dynamic, and categories more fluid and interconnecting than similar categories found in hardcopy. Some of the data problems and discrepancies, as well as more definite conclusions will be presented in the following fifth section.

The data and the program are not interchangeable in the sense that either can act as a universal substitute for any other set of data or Hypercard™ application. Only the program, or "shell", can act as as a substitute, if others wish to copy the structure of our application. Data must still be placed in the context of what is known about DiSo 1, but we will see that what was known, and what is now known about the site are two different things.

The stack containing stone artifacts other than abraders was called "ThesisSAV1". It was constructed in the same manner as described above, but with considerably less experiment and in less time.

It is the smallest of the artifacts stacks, containing only 71 cards and accounting for approximately 475 K of hard disk memory. The movements allowed for in the application are the same as described above, via similar behind the scene procedures, but looking exactly the same to the user.

The non-lithic set of stacks are larger. "ThesisBnpV1" contained non-lithic artifacts with no three dimensional provenience. The non-lithic stack contains 118 cards and takes up c. 650 K of disk space. The artifacts' cataloguing numbers start here. Artifact catalogue #1 is on the first card. However, the sequence is interrupted, as many different days of recording artifact finds in the field took place over two seasons.

The non-lithic stack was constructed in an identical manner to the ones described, with the exception that buttons could now be transferred from one stack to another, and to various new cards from cards already constructed. Hypercard™'s memory function can store one object's provenience in the entire system until the user selects another item they wish to copy, or cut and paste.

For example, the card button "Go back" from the scrolling field cards is copied and pasted, occupying the exact space on the new card as it did on the old. It resumes performing the identical action in its new position, even if it seems that the button's new location has only an obscure linear reference to the one previous. The movement of button functions is a prime example of a hypermedia or "neural synaptic" link. What is perhaps most interesting about the construction of a Hypercard™ application is that the method of construction mimicks the result. The process of hypermedia is self constructing and self-reflexive in an "hermeneutic" manner.

The other two stacks of the non-lithic set are logically divided by field season. As previously mentioned, discoveries made in 1972 are to be found in the stack called "ThesisBP72V1", and non-lithic artifacts from 1973 in "ThesisBP73V1". The 1972 stack contains 149 cards and occupies c. 775 K of space. It was constructed in a similar manner as the other stacks, and looks the same to the user media wise, but with different data. The artifact catalogue is very discontinuous, and it is important to remember that one should use only the relevant card sequence numbers to move to the promised or wished destination.

For example, a composite toggling harpoon valve, or "CTH valve", might be first found on card 2 of the 1972 stack, but on card 9 of the 1973 stack. All references to individual cards and hence to a class of artifact are stack particular. By virtue of the chronology of the recorded catalogue of artifacts, such references bear no relation to another stack's artifact information. The artifacts exist in the same class, but in a different sequence from stack to stack. It is possible to construct a much more complex set of hypermedia relations to link all types of artifacts to their cohorts in a defined class. Although more complex linkages were deemed beyond the project's scope, the DiSo 1 application attempts a nascent set of complex links by informing the user the location of other objects similar to the one they are interested in. Such information is included on both the interpretive and statistical scrolling fields cards in each stack, for that particular stack.

The 1973 stack also contains 149 cards but occupies approximately 850 K of memory, due to more information available for artifacts recovered in 1973. The extra information is contained in the background and card scrolling fields. The second field season saw more detailed recording than the first, and that detail is translated into the application.

4.2 The Faunal Set

The faunal system aspect of the DiSo 1 application contains four stacks, one for all mammals, three others for birds, fish, and molluscan remains respectively. The faunal stacks were constructed in essentially the same manner as above, including the operation of the construction actions. However, they are much smaller and simpler in scope.

It was not economical for our project to create one card for each of the nearly 50,000 faunal remains, and our hardware would not have allowed such large stacks. Instead, four stacks were created divided by major Linnaen taxonomic breaks. Each consists of a set of line drawings scanned from the RBCPM booklet series titled "Intertidal Bivalves of British Columbia", or other such species groupings respectively. For each drawing, statistics of faunal remains recovered are included, as well as provenience for percentages of items per unit, per species grouping, and shell by weight. One card for each species or arbitrarily grouped related species or sub-species was used. Each card contains the image, and the textual information. Classes of species are linked to a card that summarizes faunal remains for that particular class, by excavation unit, stratigraphic layer, and more importantly from Calvert's (1980) thesis, micro-ecotonal zones.

The higher level cards are in turn linked with a "tables" card that contains summarized statistics of all faunal remains recorded in that stack. The tables card acts as a gateway for more detail, or as a warning not to proceed if one merely wants a cursory glimpse at faunal remains. The tables cards, as well as their underlings in the grouped hierarchy, are also linked to their cohorts in the other three stacks, for instant hypermedia access. All the script's phrases are similar to phrases already described, but card i.d. numbers are strictly adhered to in the faunal set. Some of the buttons that navigate the user through the faunal stacks have different icons, but the differences are either explained in the HelpStack, or are self-explanatory.

The faunal stacks serve as examples of the compact, highly visually oriented aspects of Hypercard™. The stacks can be seen as somewhat of a relief after the artifactual set. The motive for such preparation was part coincidental, and part predestined. In the use of data from a limited context of one site, many different ways of presentation were experimented with. The interconnection between sets of stacks is either accomplished through the "Map" card, or via a set of associative links through the stacks themselves. Stacks look different, but the same processes in their navigation apply.

The faunal stacks were called respectively, "ThesisMV1" for all mammals, "ThesisMollV1" for molluscs including bivalves, "ThesisBV1" for birds, and "ThesisFV1" for fish. The introductory card to the faunal system is placed at the front of the molluscs stack. One can get to any other stack via the functions placed on the introductory card.

4.3 The Soils and Features set

The last of the sets containing detailed site information include stacks that deal with the soils, features, profiles, and levels, both stratigraphically arbitrary and cultural, found in the excavation units of DiSo 1. The soils and features stacks, while not as large as the artifacts stacks in most cases, were in many ways more detailed and complex to construct.

We settled for the economy of creating one stack for each individual excavation unit, and then linking the stacks together in the various ways the reader is familiar with. Excavation units "B", 12, and 18 have their own stacks, while EU's 2, 4, 10, and 14 share a fourth stack. Units excavated in 1972 were recorded in level notebooks, but much more detailed examination was undertaken in the following season. The division of data into the form the soils and features set takes is a logical one. The stacks were called "ThesisEUBV1", "ThesisEU12V1", "ThesisEU18V1", and "Thesis72euV1", replicating the divisions.

The soils and features stacks involved the importation of many more complex graphics than the artifact stacks. Drawings of features, profiles, and levels were scanned and retouched using Hypercard™'s paint tools. Photographs were studied and reproduced, and the final result is a detailed set of line drawings. Transparent buttons were affixed to drawings in relation to the features and other points of interest recorded on site. Clicking the "transparent" and/or "features" areas of the line drawings moves the user to cards that contain the relevant textual documentation, and presents to the user yet more possible links between discovered *in situ* events. The level sheet information is included here. The distinctions between angular or rounded gravel, pebbles, rocks, and/or fire-cracked-rocks is kept as well, but placed in a less linear structure.

Archaeological description, as in any human scientific endeavour often involves the linguistic reduction of observable events or processes. Such reductions form archaeology's archive. To translate the archival documents back into a space consonant with the original reality of the site remains a theme for hypermedia research.

There are many such detailed reductions present on the DiSo 1 level sheets, taking both the form of a narrative as well as a taxonomy. The investigator's narrative comments are kept in double quotes in the application. Scrolling fields contain level statistics as well as descriptive observations. Every attempt was made to insure that the full range of identified data and observer comment was reproduced. Of course any author is but one reader reflexively re-creating such text. Our application also wishes to address the issue of reflexivity through its open-endedness, and the issue will be discussed in section five.

Soil sample forms and feature record sheets are also kept to a detailed degree of authenticity, but even Hypercard™ cannot reproduce yellowing sheets covered with dirt and casually incomprehensible script. The soils and features set of stacks is similar in size to the other sets, although smaller than the artifacts set, and larger than the faunal set. It is not necessary to detail the exact sizes of each stack or set. None is larger than the abrader stack.

The entire system containing the DiSo 1 data set accounted for just over seven megabytes of hard disk space. The DiSo 1 program is the largest "silent" Hypercard™ system encountered, hence it does not overstate memory storage by the addition of sound or complex graphics, both of which stretch hardware memory capabilities. However, it barely scratches the surface of hyperstack potential, as the maximum size of just one stack can be 512 megabytes.

4.4 The Special set

The "special" set is so named from the special menu on the Macintosh desktop. Like the desktop menu, the special set of three stacks accomplishes functions that do not directly relate to the bulk of the system, but are necessary for its operation in a user-friendly, economical environment. The set consists of the "Home stack", or "ThesisHomeV1", the "Help stack", or "ThesisHelpV1", and the introduction stack, or "ThesisIntroV1". The last of the three stacks can be explained first.

The introduction stack presents to the user a general overview of the site, its location, climate, geography, context within surrounding complexes of archaeological sites, brief synopses of local ethno-history, and interpretive arguments regarding west coast local group territories (Haggarty 1982), and micro-ecotonal zones (Calvert 1980). All variables are tied together by graphics imported from Calvert (1980), and Haggarty (1982). Copyright has been received from both, and all graphics have been altered to an acceptable extent in lieu of such restrictions.

The introduction stack contains 12 cards, and accounts for about 100 K of memory. Each card has five background buttons that perform similar navigational actions as previously described. A background scrolling field was placed at the bottom of the card, to free the remaining space for the import of graphics. The introduction stack might also be called the map stack, as it consists of a dozen computer altered maps illustrating the various introductory remarks contained on the scrolling fields. However, the map that is of greatest importance is the one that shows the geography of the entire system, and that is found both in the "Home" and "Help" stacks.

The home stack is the smallest, consisting of two cards. One has a small version of the map found in the help stack, and the user can immediately move into the system from the map card. The second card contains a scrolling card field for the sole purpose of containing any comments a user might wish to type in after travelling through the system. The system has the potential to be made better after each use, and the comments card provides a fitting finale to our philosophy of interaction. In the browsing version of the DiSo 1 system, the user comment's card field is the only one left unlocked. The only card in which a user can modify in any way is the comments card.

The home stack, even in its minute size, serves another important purpose for the system. It replaces the "Homestack" of the actual Hypercard™ application, so that the user is not suddenly transported outside of the realm of DiSo 1, into some of the Apple stacks that come free of charge with the Hypercard™ application and any Macintosh.

The help stack replaces a similar stack that comes with the Hypercard™ application along with the Apple "Homestack". The DiSo 1 help stack, or "ThesisHelpV1", is custom designed to explain Hypercard™ functions in the context of the thesis' particular application. The stack contains nine cards amounting to 32 K. It is by far the most economical of all the stack designs, and is the only one designed expressly to the guidelines found in Apple's official booklet (Hypercard™ Stack Design Guidelines, Apple Computer 1989). The cards are of various form and function and the less said about navigation of the helpstack the better. As a test stack of our own construction, it is motivated by the inability of Apple's own helpstack to address the needs of the user of DiSo 1.

The helpstack stands alone in its ease of use. The user should consider studying the helpstack before entering the application proper. All navigational and textual information and rules are outlined in the helpstack. Most of the information is in card text fields, and scrolling card fields. The stack was constructed with a single blank background. The construction demonstrates the possibility of differing card permutations outside of a given structure. Such a structure can make much of what is on a card similar to much of what is contained in a background. As well, the text has a completely different style from either the thesis' hardcopy, or the rest of the system.

The helpstack purposely evokes the standards of Apple computer's software guidelines in general, and especially their educational stacks. It serves to tell the researcher who uses it that an application, if presented in the right way, can communicate with all levels of user. A modified copy of the DiSo 1 program is destined to serve as part of the archaeological and ethnological educational project co-op between the RBCPM, the Hesquiat nation, and the Alberni/Clayquot school district. The project will inform all students of various ethnic backgrounds of the rich history of native cultures in the area. Some examples of the alternative style of presentation used in the helpstack follow:

On what a stack is:

"Each stack in the DiSo 1 hypermedia application is like a library with an infinitely linked cross-reference capability. Stacks are groups of cards that are related by their backgrounds, and of course the information that is contained on all related cards. In creating a stack, one must first visualize the properties that stack will eventually contain. For DiSo 1, stacks are the equivalent of buttons on the application's map. Click any button and it will take you to that stack that has the most information on the subject heading contained in the button. Each set of related cards will detail all relevant information—but only to a finite degree. For the "whole" story, one must utilise all the connections that allow you to travel both within and amongst stacks. The section on buttons will tell you how to do that."

Or, on what to do in creating a stack:

"How is a stack created? The Hypercard™ programmer can follow certain steps, starting with a good idea. Use of the "New Stack" command under the File menu, the first card of a newly created stack appears, blank, but with the potential for a "background"—an overarching linkage acting behind a set of cards—already in place, copied from a previous stack. Then the particulars of each card that will comprise the finished stack are added as the cards are added themselves. For Diso 1, each card in each stack is different, although a set may share a more than one background. In each stack and on each card, however, some properties will remain constant—what you are reading, for instance. The field font will always be Palatino 10 or 12 point. The button font is Geneva 12. The map directions are also in Geneva 12.

Texts provide an important part of the story of the site, and the DiSo 1 application. Buttons on cards and stacks will either be labels or icons. Click them to move around within the project. More rare are stacks containing their own graphics. Most of what you could call "stack specific" information will be the buttons, fields, labels, and other directions that are found to be common for all cards in that stack.

Most importantly, DiSo 1 contains seventeen stacks, all interconnected. Within the stacks one will find three rather large sets, (the site assemblage information stacks), one stack of moderate size, (the introduction to Hesquiat Harbour and Heckwi), and two small stacks, (The Home and Help stacks)—you will find one story of one example of a prehistoric Northwest Coast site, and one example of hypermedia at work."

A final example might detail how a screen "works":

"All the information that you will see will be given one "screenful" at a time. In order to move to other screenfuls of information you use the navigational buttons in each stack. Each screen is also a card in a stack, and you will understand better the structure of such a form of hypermedia if you realize that each screen is itself an entirely representational unit of the system. You will travel via buttons, but your places of departure and arrivals will always be cards—or screens!

The screen itself can be used in various ways. Graphics, text, numbers, and buttons will all appear in many forms, but each will have its own singular screen—like a set of transparent sheets—on which it rests, and interacts. Each "screen", then, as one might define it *via* the Macintosh itself, consists of a set of overlaying "cels", or transparent sheets. Each cel has a different function, particular to that piece of information, (graphics etc.), that rests upon it. During the construction of a single card—and screen—each part of the story is laid down in order consecutive to each operation. The screen will ultimately be seen as a totality of image. So, the idea of a single screen is deceiving. Each is more three dimensional than two."

One will also note that even the prescribed style of discourse will not effectively communicate with all users. Graphics are used to supplement and illustrate the above ideas, and are often found surrounding the text, for greatest impact.

The help stack is the place that the user should travel to first, in order to begin to grasp the full extent of the DiSo 1 application's potentials and actualities. It also demonstrates by its construction how all the navigational button tools work, as well as the concepts behind background, card, field, and information sets. If the introduction stack is an introduction to the DiSo 1 data set, then the help stack is both an introduction to the unifying themes of hypermedia in general, as well as to our application in particular, creating that necessary link.

4.5 Summary of Construction

A far lengthier text would be necessary to describe every aspect of the construction process in minute detail. It is not only an experiment, but one with a reflexive and "hermeneutic" context. By the time of completion, one story, discontinuous and distanced, is transformed into another, personal and accessible. A few comments may serve to bridge the technical description of section four and the broader summary of section five.

The language in which a construction of a hypermedia application is described is necessarily technical. One follows certain sets of defined rules towards an imagined goal or result. When rules fail, if they are not flexible enough to perform in any given way, improvisation is resorted to. The change and experimentation with such rules is the true nature of scientific experiment. The broadening of accepted or inherited rules of human perception in the empirical and human sciences is the goal of the study. The broadening of such rules was a goal not apparent from the outset. The completion of which was eventually realized as not an ending, but a *coda*, or resting place in anticipation of a further future movement.

A technical discussion should never hide the actual doing of the work, or the feeling of the stages of progression, or process. Two themes are present in the thesis' transformation of archaeological data. The themes are the inherent and created economy of access, and the wish to communicate that access in an alternative form. The user acts in a more comfortable symbiosis with the data than with the archaic archive, and the archive ceases to become archaic with its use.

5.0 Results and Conclusions

The computer application DiSo 1 is approximately seven megabytes large, containing seventeen Hypercard™ stacks. All available data from the 1972 and 1973 excavations are included, with the exception of the particular record sheet data for the faunal items. What remains is an economic and easily accessible system that exhibits new and interesting forms of data management and representational media. Graphics, text, and the navigational tools of Hypercard™ have been combined in the DiSo 1 presentation, and the construction of a skeleton or model system provides a basis for future addition.

One goal of the thesis is a success, that of providing an alternative method for the storage and presentation of archaeological data. Another goal, to provide an alternative medium of representation from programmer to user is successful as well. The construction of the DiSo 1 system enables the user to participate in a new experience. Looking at the design, use, and practical and philosophical implications of our project, have all other goals been reached?

5.1 Results

Pragmatic problems are of concern to archaeologists. "What does hypermedia mean to me?", might be an obvious question. The answer depends solely on the ability or will to experiment creatively with the software. The thesis attempts a response to such concerns by letting archaeologists provide alternative answers to questions asked in other contexts, and previously presented by other media.

The data of archaeology in general cannot change by its inclusion in a new computer program, but the variety of readings that data is given may increase. The implications for contemporary students *vis-a-vis* what they have found change. We can keep track of the change. Each reading of the associations worked out by the user may be preserved by copying the user's links into a blank Hypercard™ stack. The copying of one's own links creates a new set of associations. As the research process proceeds, no "new knowledge" is lost. Each reading serves as a supplement to the next, and as a criticism or complement to the previous. Only with the use of interactive hypermedia software is the above possible.

For the DiSo 1 data, differences between recorded items, groups and classes and the categories found in an interpretive work (Haggarty 1982:121-2 *et passim*), exist and manifest themselves in a subtle fashion at various levels of Haggarty's discussion. Although such differences are a recognized part of the archaeological research process, it is rare that the student is able to observe all facets of that process in close proximity with one another. A discussion of both Haggarty's (1982) and Calvert's (1980) interpretations will follow. We will compare their decisions regarding the DiSo 1 data and that which is presented as an alternative by the thesis' application. Ultimately, any alternative will be produced by interaction between user and program, and not the latter itself.

In Hesquiat Harbour, the local group seems to dominate in the ethnohistoric period. Such presumed dominance provides Haggarty with his basic premise. Can the utility of a west coast local group be demonstrated archaeologically? Does the archaeological record reflect only manifestations of prehistoric local group structure? If only artifacts were considered, we would reply in the negative, but with the addition of faunal remains, prehistoric local group dominance is more plausible.

The introduction stack in the DiSo 1 application details the Hesquiat Harbour sites' relative positions to DiSo 1, as well as their placement in ethnohistorically known territories, and associated resource zones. Each group had direct access only to hinterlands proximate to their habitation sites. For example, the Ma'apiath

/Ya'qsisath had no way to procure outer coast resources.

The differential resource exploitation found at Hesquiat Harbour is reflected in the faunal assemblages from each set of respective sites that were excavated in each group's territory. The Homisath and the Hai'ma'isath had basically all outer-coast resource zones. Only the Kiqinath had a variety of both inner and outer coast resource opportunities. From the faunal assemblage from the Hai'ma'isath winter village of DiSo 1, little evidence for exploitation of inner coast resources is revealed. The opposite characterises groups occupying the inner harbour. Therefore, Calvert (1980) demonstrates that archaeologically, differential access to resources characterised each local group's subsistence habits in Hesquiat Harbour.

All inferences drawn by Haggarty and Calvert are based almost solely on the relative frequency of species present, which in some cases proves deceiving. The faunal stacks in the DiSo 1 application were not meant to detail the frequency affiliation between inferences about resource exploitation and territory, but, as is the nature of an open system, such analyses could easily be added in the future. In the main, however, Calvert's conclusion, that differential access to resource types documented ethnohistorically is reflected as far back as the archaeological record goes, holds in lieu of further investigation.

Remains of winter season resources have also been found, and the seasonality studies that have been done seem to favour the idea that certain times of the year were appropriate for harvesting some species, other times for exploitation of other species. However, some species remains exhibit year round harvest, such as the bivalves, crabs, and numerous other invertebrates, in addition to many bird species.

Most of the artifact manufacture took place during the winter. We have a "seasonality" for the procurement of artifacts, much more so than a seasonality of most food procurement. Many of the larger items, such as the huge abrasive stones, never left the winter village. There are essential aspects of material culture that are sedentary, and some that travel with their makers along the seasonal subsistence run.

The Ma'apiath and the Yaqsisath were basically sedentary, as their resource hinterlands were very close to their regular habitation sites. The middle group, or Kiqinath, was as mobile as the still proximal resource exploitation areas allowed, and the outer groups, the

Hai'ma'isath, and Homisath were similar, if restricted to the outer coast. The Kiqinath were hereditarily the most powerful, and the possession of power may reflect their superior geographic position, allowing for a more holistic exploitation of resources.

Permanent structures are documented in general for the west coast of Vancouver Island at all three major archaeologically designated site types, the summer and winter villages, and the fishing stations at salmon streams. At Hesquiat Harbour however, there is no evidence for permanent dwellings as witnessed by remains of decayed house frames or surface depressions at any site type other than at the various winter villages. Apart from DiSo 1, others remain to be investigated. The winter villages are also the only village site type to exhibit prehistoric deposits. The shell midden is still the most obvious indicator of a primary or an extensively used habitation site in Hesquiat Harbour, as well as being a site marker on the North West Coast as a whole.

Such middens, especially the very deep and extensive ones, contain as many problems as answers. The systematic excavation of middens runs the risk of missing important shell lenses—features of crushed and compacted shell that form within middens due to very provincial "metamorphic" properties, as well as intrusive burials and other important features. Some previous excavations, though not specific to the North West Coast or Hesquiat Harbour, assumed a basic uniformity of deposition and post-depositional process affecting the site (Klein and Cruz-Uribe 1984:3-8). Examples from DiSo 1 that run contrary to beliefs in the uniformity of taphonomic processes include the "swamp drainage ditch".

In the ditch, uncontrolled collection was made due to the impossibility of locating initial three dimensional matrix provenience for items moved fluvially over the years. Other non-systematic investigations were made through gardening, ("found in Alice Paul's garden while digging"). Steps were taken to document "non-provenienced" finds more fully, ("from the trench running from the washstand in Alice Paul's garden to the edge of the embankment"). The two systematic surface collections were also uncontrolled three dimensionally.

Problems related to archaeological excavation come from sources such as random sampling, the use of augers, recovery techniques, staff fatigue, and many others must be kept in mind. It is beyond the scope of the DiSo 1 application to suggest remedies for all possible biases, but their presentation in hypermedia might have the effect of reducing associated problems. The inconsistencies within archaeological excavation are acknowledged.

Haggarty's work does little to address such problems, and confines itself to the argument of local group utility. The rest of the lithics found at DiSo 1 were lumped into twelve rather ambiguous classes by Haggarty (1982:121-2). Three of Haggarty's classes were based on raw material only—echoed in the non-lithic classification where four miscellaneous categories included most of the unidentifiable pieces and made up the largest percentage of items. The classes may reflect archaeology's concern with the constant push and pull of splitting up assemblages for greater detail with possibly less meaning, or of lumping categories to prove a point.

The DiSo 1 assemblage as a whole is very standard for the northwest coast in general, and the west coast of Vancouver Island in particular. The artifacts recovered from an assured pre-contact provenience have close affinity with the Yuquot "late period" assemblage dated from A.D. 800-1790 (Dewhirst 1978:19), which is the standard type listing of its kind. The Yuquot taxonomy also represents about the only well documented example from the "late period". The Yuquot taxonomy is also expressly functional in its orientation, and its influence may be seen in Haggarty's work (1982:121).

Many items were functionally described on the record sheets, but the functional typologizing failed to materialize in the latter stages of the research done. Sometimes functional names can be used in a descriptive sense, but the use of identical names can be confusing. Either artifacts were reappraised, or were lumped for a more convenient interpretation. Both the descriptive detail and the general look of the DiSo 1 assemblage are preserved in the DiSo 1 application. The field identifications, ignored during the remainder of the archaeological process are present. Errors in identification in the recovery stage can be compared with subsequent identifications from the analytic stage. The labels affixed in the laboratory stage are superior, if only because artifacts are being prepared to be placed in the context of an interpretive argument. However, without an argument in mind, and the bias created as baggage of a particular argument, the identifications made in the field are in a very narrow sense, closer to the real, originally observed thing. The renaming of things as part of the archaeological process is presented for comment and critique.

Non-lithic items also presented some problems. Some artifact record sheets have been lost during the intervening years of storage. Our application recognizes losses and includes them as a fact of a scientific process.

There were other problems more unique to the DiSo 1 classification that our application attempted to address. One matter of interest involved the manner in which artifacts were described *in situ* on the site record sheets, and the way field descriptions were ignored in the construction of the analysed taxonomy. The predestined irrelevance of field identifications is standard in archaeology, as assemblage categories often cannot be defined until the excavation is complete. However, the methods of recording and procedures of field documentation can be critiqued with such a process in mind.

The DiSo 1 application uses both original field descriptions, native ideas, and interpretive ideals to provide a more processual kind of classification. The application exists as a more fluid knowledge base than that derived from any one of the above descriptions alone.

The classification of abraders into unifacial and shaped, unifacial and irregular, bifacial and shaped, bifacial and irregular, had little to do with the records kept by on-site investigators. It is probable that Haggarty viewed the abrader assemblage and came up with logical analytic classes of abraders to replace the statistical classes created in the field, but it is not possible that he could have come up with the same numbers or even classes had he used only the record description sheets.

The direct and obvious relation between the numbers of abrasive stones and the overall style of the rest of the assemblage is demonstrated. A functional typology was not expressly used in the Haggarty scheme, but was often employed on the artifact record sheets. Another translation, then, has been effected. Hypercard™ preserves translations intact, and another part of the archaeological process is revealed. For example, a "micro-blade" was thought recovered in the field, but not listed by Haggarty. It is probable that what was identified in the field as an artifact turned into something quite different in the lab. Neither microblade nor its analytical guise is mentioned in a manner that one, without contact with the raw data, could possibly understand.

Hypermedia permits all facets of research to be contained in a network of synaptic links. The user becomes almost as fluent as the excavator, the recorder, the statistician, and the interpreter combined. Fluency is accomplished by use of the hypermedia application, provided that programmers have done their part to include all possible types of data, or all data allowing some economy

Points were also descriptively translated from record sheet context into categories apparent to Haggarty. Interestingly, Haggarty's category of "miscellaneous pointed bone objects", of either "slender" or "medium" width technically does not exist at the level of particular artifact description. Again, such renaming is a product of the classification that appears as part of the analysis stage in the archaeological research process. The miscellaneously pointed category makes up 22.68% of non-lithic artifacts.

Miscellany accounts for almost 56% of the entire non-lithic assemblage. Although identifiable as artifacts, we are at a loss at the interpretive level to call them something that differs from bare geometric description. We estimate that at least 70 percent of all miscellaneously categorized worked and/or pointed pieces were called something different at an earlier stage of research. The process of science is indeed a process of renaming things. However, the analytic stage in archaeology creates classes for either other purposes of investigation, or in response to further research which has suggested that earlier classifications were faulty.

In emphasizing the classification of raw materials, there is a parallel to draw between the relative frequencies of usage of different materials and the relative frequencies of exploitation of animals from which different raw materials originally come. There was an abundance of types of stone and bone to use, and some types were inevitably used for some classes of artifact. The ratio of some species' use is far higher than that of many others. A few species of animal dominate the pie chart of species present, while numerous others are grouped into a residual category.

The same is found for raw material and artifact classification in the DiSo 1 data set. Numerous raw materials are used for some items, for example, the fish-hook-shanks and composite harpoon valves, but multiple raw material use is obscured by the tendency of some classifications to group identifiable artifacts by functional typology, and unidentifiable artifacts by that which is at its basis, descriptive. Within the same typology we see both extremes of classification.

Our application of hypermedia relieves the tension between extremes of classification to some extent, because the detail of the record sheet not found in interpretive works is restored. The original names are important in two fundamental ways. The field identifications express the actual moment of recovery of an archaeological item, giving it the status of an artifact. All further work, whether in the analytic or interpretive stages, stems from the moment of discovery. As well, the process of cataloguing artifacts, used in all further research steps, is impossible without at least a casual attempt at field labelling.

To name things is to classify them. One can also create new classifications that ignore original field names, just as in the laboratory. With a functional analysis, variety of raw material used in the manufacture of particular archaeological and/or indigenous classes of artifact is underestimated, while the remainder of potential classes is silenced. The total number or variety of "things" is underestimated. The large and somewhat ambiguous categories of worked bone and antler tell us little, about their classification, or prehistoric lifeways. However, when assemblages are small, miscellaneous categories are necessarily larger, due to the lack of artifacts with which to compare unidentified objects.

Such a lack of information is also transported into the DiSo 1 application. Inclusion of information gaps is in lieu of a new and more detailed understanding of unidentifiable objects. Not all the artifacts or objects can or should be named, as many are exactly what they look to be, miscellaneously worked, adzed, hacked, sectioned, abraded, and sawed bits of bone. In the absence of any detritus from the percussion flaking of stone, Haggarty is not surprised to find so much miscellaneous worked bone (Haggarty 1982:127).

Better are the relations cross cutting artifact classes. They give us a sense of what native items were manufactured for. A higher level distinction is made when Haggarty realizes that about 70 percent of the entire assemblage, or 630 artifacts, relate directly to the technology of manufacture—that is, tools to make other tools. Of course, the abrasive stones form a large part of the lithic class.

The import of abraders is not to be underestimated. Witnessed by record sheet descriptions of modification on raw material, abraders were used in the manufacture of over 95% of all other DiSo 1 artifacts. Abrading, or "shaped by abrasion" is by far the most common phrase used, and reflects a common manufacturing modification on the coast. Softer materials, such as wood, are seldom preserved, but do represent the "carving" modification more than the "abrading" one. If one could divide prehistoric Hesquiat technologies by modification process, one might use a dichotomy of either abrading or carving. We would leave out flaking, as it does not make an appearance at DiSo 1.

Besides the abraders, the category of manufacturing tools also includes adze blades or celts, hand mauls, wedges, chisel blades, saws, awls, and the worked bone classes. All tools in the manufacturing category are interrelated at a functional, or actual "use", level.

The next higher level category is called the "procurement technology" class and it contains 250 artifacts accounting for 27% of the total. Fish hook shanks, all the point types, including the miscellaneous class, composite harpoon valves, and unilaterally barbed fixed points are included here, as aspects of fishing technology in particular.

Three percent of the total assemblage is said to be representative of a "food processing" class (Haggarty 1982:128). The procurement technology is related intimately to the biome in which DiSo 1 is situated. Here, artifacts are roughly divided into fishing technologies and sea mammal or sea otter hunting technologies. The harpoon valves and their arming points, as well as the unilaterally barbed fixed points and fragments are associated with the latter category. It should be kept in mind that the categories "bipoint" and "unipoint" are rather fluid, as is the "miscellaneously pointed objects" class. Many miscellaneous items may be arming points used in sea mammal and otter hunting, but have been classed with the fishing technology. Many of the unidentified points may be part of either sub-class of technology.

The important thing for both Haggarty and Calvert is that bone points are related in some way to food procurement, and especially related to exploitation of the natural resources found in the pelagic and the pelagic/littoral zones (Calvert 1980:113).

The actual excavation procedure is interesting in the hypermedia context. Some archaeologists make a distinction between the arbitrariness of scientific excavation and the arbitrariness of the cultural deposit that has undergone non-random postdepositional translation (Schiffer 1976). The "N-Transforms" of Schiffer (1976) are merely the identified "C-transforms" of the investigator. What is meant here is that scientifically identified taphonomic processes are part of our cultural knowledge, and as such also "transform" the archaeological record. The predepositional throwing out of trash into a heap is also analogically identified by our own culture, which disposes of garbage in a similar fashion.

The thesis' application presents results of natural and cultural transforms without assuming natural processes are uncontrollable in the sense that we cannot identify them. "N-Transforms" are identified in part, although a shell midden provides its own distinct problems. More importantly, however much we wish to control the data once it is identified as relevant, we also distance it from our own discipline's "C-Transforms", by looking at the site as a black box within a system of communications—from the archaeological culture to our own. Our application asks the user if such a distinction need be made, or if it can be made at all.

Besides the 6,280 artifacts, and 49,770 faunal remains catalogued and represented by various media in our application, the soils stacks constituted approximately 15% of the program. Each excavation unit was given its own stack, where all three of level sheets, profiles, and feature record sheets were present. Units were kept homogenous, but links were created across units to give each type of soils and unit analysis a certain homogeneity as well. Such homogeneity represents a progressive economy, allowed by hypermedia links. Level sheets were more detailed than artifact sheets. A shell midden is a very complex site, and our program reflects its complexity.

The soils and features system in the DiSo 1 application raises the fewest questions of method and interpretation. It is still not certain how much soil analyses can contribute to a major sequence of cultural events as outlined by artifacts. Perhaps the future holds the promise for creative study of matrix. It was only about 30 years ago when faunal analyses became standard for a truly scientific and anthropologically holistic excavation. For soils, more detail is looked at less closely. Potential differences between observed and recorded events are eased or underestimated. The exact opposite is the case for the artifactual record, with the faunal remains lying somewhere in between. Of course, no one has yet written an interpretive work focussing on the soils analyses of DiSo 1.

Perhaps similar tensions would develop amongst data sets and their ever translatable meanings. The DiSo 1 application attempts to dissolve such antinomies by providing as many levels or locations of data and detail as possible. Data are linked in the way they are thought about in investigators' minds. Our application intends to create its own subject/object universe, which the user enters. The application attempts to change minds by use, as well as letting the user alter the program.

Although the original links that make up the Hypercard™ application are programmed by one author, users have just as creative and active roles. During the process of association, users will reconstruct the database to solve their own particular research problems. Such reconstructions of hypermedia links may be saved apart from the original database, allowing an evolutionary growth of archaeological knowledge. Users are independent from the original links as soon as they create new paths. The research process is still judgemental in its articulation of archaeological material, but hypermedia allows for many more judges to participate in an open environment. Only when many different interpretations of the archaeological record are juxtaposed, do users have the opportunity to decide amongst them.

The archaeological research process is made more economical by the entrance of data into a hypermedia context. The manipulation of data in an intimate association with previous analysis and interpretation strengthens the possibility of the birth of new analyses.

5.2 Conclusions

The DiSo 1 application's goal was in part to reveal such events that we believe to be inherent in the archaeological process, and give a detailed viewing of that process *via* the translated data. Such data are renamed, or reclassed, and constitute the major variables distancing our interpretational work from our excavated findings. Renaming is simple in practical terms, and allows a reduction of masses of data into a form which is then made to cooperate with potential explanations or interpretations. The negative implication arising from the scientific process, which the thesis does not replicate in the construction of its program, is that much raw data, or descriptive statistic, is lost. Not only is description lost in the published work, but it is also lost to the archive. Lost description has to be recreated from the record, often with some imagination. If not, then excavation itself must be the only "true" form of doing archaeology, for in its process is contained the only moments of real "communion" between finder and found.

However, our thesis does not attempt to judge standard archaeological processes in juxtaposition with any other method which might be more or less critical than the standard. Instead, the thesis demonstrates that, if archaeological data are presented in a different way, then they have the potential to be seen differently. Although no credit is taken for the program, philosophical themes it works within, or the bringing of such themes into an archaeological focus, we believe our presentation to be a contribution to archaeology in particular, and to scientific thought in general.

The most important implications arising from the thesis' experiment involve the translations that take place during archaeological research. Translations occur when archaeologists decide what an object is. However, such decisions happen repeatedly, and it is the changing of what we think things are which is an interesting process to present. If forms of perception in archaeology are somehow different from forms occurring in other disciplines, then a "phenomenological" stance would be consistent with the idea of "perceptual relativism".

The archive of archaeology is created by a process of classification and storage. Data are stored and accessed by class, in a taxonomy of the archaeologist's creation. Alternatives to a certain taxonomy should be pursued. The thesis allows many translational events in the archaeological process, from excavated item to catalogued number and name, to be presented. It also allows users to construct their own personal paths. The storage of archaeological information is given fluidity. The archive is moved from the static location of linear storage. Linear storage is exemplified by most previous attempts at archaeological data management, and hardcopy resources.

The thesis accomplished the following:

A) In relation to archaeology in general:

i) Demonstrated that large amounts of archaeological data can be stored in a simple hypermedia application,

ii) Demonstrated that the hardware and software used are compatible with data previously manipulated by a different class of computer,

iii) Allowed, by the construction of hypermedia linkages, a once static archive to become dynamic and fluid, with much more potential interaction between user and data, and much greater economy of time in interaction than previous non-hypermedia applications,

iv) Allowed the transitory nature of archaeological data to be analysed through the translations it underwent in the research process, and

v) Provided the basis for further research involving hypermedia and archaeology.

B) For site DiSo 1 in particular:

i) Found differences between reported artifacts on the record sheets and the taxonomy employed by Haggarty (1982:121-2),

ii) Allowed for both stages of naming archaeological items by juxtaposing their inclusion in the application, making possible their direct comparison, and comment upon them,

iii) Found that the difference between what is excavated in an archaeological site and what is used in archaeological work in general is often great,

iv) Allowed for the closing of the distance identified between excavated material and interpretation in "B-iii", by bringing together all related facets of works done on the DiSo 1 site, and

v) Suggested various alternative interpretations to published interpretations, based on the original data, and allowed for the possibility of still more interpretation and manipulation.

Ten aspects of the thesis' goal are accomplished, from the particulars of one site to the general comparative realm of the discipline as a whole. The ten aspects alone allow us to feel we have made a small contribution to archaeology.

Where do we go from here? There are some prospects that come directly out of the thesis, and are reviewed in the following.

The system was tested on four colleagues from various disciplines. One user is a student of history and political science, one from computer science, one from child and youth care, and one in education. Each observed different things, and voiced differing concerns. It was judged that any feeling of boredom expressed was a direct response to the massive amount of encapsulated information contained in the system. The overall experience of similarity of data within the hypermedia medium contributed to user fatigue. The links amongst data groups to some extent fail to create interesting data in and of themselves, for some users.

Some fatigue is to be expected, and the DiSo 1 application's scope did not include complex chains of commands to turn what might have been excavated archaeological data into a video game. For some education purposes a more bold and fancy presentation might be an advantage, but for the target audience, archaeologists and technicians, the types of media links employed seem to serve their purpose.

However, the sameness of the data when seen in the hypermedia context raises interesting implications. The similarities and differences between archaeological items were never more graphically displayed than on laboratory table. In the context of the thesis, graphics and other illustrations combined with textual description and statistical remarks attempt to create a similar atmosphere. In the present work, the juxtaposition of similar artifacts can be re-created. By grouping artifacts from stacks based on the chronological excavation of catalogued objects, the user is offered a different form of presentation.

The DiSo 1 stacks are ordered in a chronologically catalogued manner. The stacks leave room for an open-ended discussion *via* the creation of new stacks, based upon stacks already present. The decision to stick to the ordering found in the record sheets files is sound because the order contains the potential for addition and emendation. Often, inferences made on individual specimens from archaeological sites will quote catalogue numbers for easy reference. A dictionary reference stack of all catalogue numbers within DiSo 1 might be the next improvement to the system. A hypermedia dictionary would be easy to design, and although strenuous and repetitive work would be involved to capture all the links by button navigation and button scripting, the result would be instant access to each artifact. Access to an artifact would be guaranteed, without moving through a sequence of numerous items preceding it in a linear list, or even in a hypermedia link.

However, no work done on the DiSo 1 site actually quotes catalogue numbers in the interpretations. A replication of the current state of knowledge about DiSo 1 is achieved without the inclusion of any other addition to the application. Obviously, such a system is not complete, and it can never be so.

Other possible improvements in the linkage of data have been brought to our attention, mostly by our own use of the system at hand. Included here are the creation of buttons to perform many of the links and actions currently executed by the program's response to commands typed into the message box. If each artifact on the linear listings at the end of the artifacts stacks, for instance, could be given its own transparent button, then the time spent relaying action commands such as "Go card 47" into the message box would be eliminated. The scripting of such individual buttons can contain the exact words the user types into the message box, with the same result. However, the idea of using the message box to link information and cards was appealing because it gave the user hands on experience with the scripting language of Hypertalk, at its most common-sense level.

The use of pop-up screens *via* the "Hide" and "Show" commands in the soils and features set was attractive because we wanted to explore and present different Hypercard™ possibilities. Some more complex items in Hypercard™ have been critiqued because of their novelty effect. We do not make any direct judgement on the offerings of Hypercard™, as they provide too many diverse options to the programmer to be considered a disadvantage. However, complex items can also be used in many ways that are redundant. There is an art to good programming, the construction of user-friendly systems, and the creation of aesthetically pleasing computer languages and applications. However, the hype that is beginning to surround the creation of "correct" hypermedia applications relating to attention paid to certain principles, threatens to render creativity impotent in hypermedia.

The DiSo 1 system does not borrow its appearance from any other known stack or set of stacks. It is possible that no future student would wish to borrow the appearance of our system, and that is not a negative comment upon its present application. Just as original research stands on the shoulders of that previous, so the DiSo 1 application and the programming shell that makes it possible follow in a lengthy genealogy of related attempts. The present model or skeleton application should be treated no differently.

Other possible changes that were suggested to us include hardware dependent options. For example, the speeding up of run-time by way of a newer and faster microprocessor, and the use of more RAM allocated to the Hypercard™ program itself to make some operations faster, would be positive additions. Obviously, employing newer technology means more financial outlay. However, higher costs cut amounts of time and effort spent on the project. The "aesthetics" of the DiSo 1 application also improve with greater input from hardware faculties. The time elapsed between command sequences given and acted upon by the computer is nil, and the time taken to alter large bodies of text on long scrolling fields, or place buttons for further navigational aids is normal, instead of progressively slower as the amount of text on the card is increased.

The computer, when it opens Hypercard™, must store in active memory all the information found on a single card, which may be accessed at any time. The rate at which actions occur when the user is employing particular cards slows incredibly. The example present in the thesis involves the cards that contain lengthy linear lists of information on scrolling text fields. The potential of a multitude of buttons accessing information from one card to many other cards in the system does not seem to produce the same effect.

There are other limits that have not been experimentally encountered in the DiSo 1 application. The maximum stack name size is 31 characters, the maximum stack script size is 30,000 characters, while the maximum number of combined graphic illustrations, cards, and backgrounds per stack is an impressive 16,777,216 (Apple Computer 1988:267). A problem with another limit was practically encountered, and that is the 44 kilobyte "bitmap", or graphic illustration limit. It is recommended that the bitmap limit be extended, although Supercard has a higher limit.

Regarding scripting in Hypertalk, relevant limits for our application include the maximum command sequence being 254 characters. The maximum active variables, or operations pending an action or participating in an action from a set of commands is 512. Neither limit holds drastic implications for archaeological data analysis in the near future, but other aspects of the technology which make hypermedia applications such as ours possible will move ahead and allow for complex operational potential, while the programming language will lag behind. Hypertalk has been updated to version 2.0. The fast pace of computer technological changes leaves us unable to guess when the limitations of the original language might cause a problem on the ground.

The DiSo 1 system encountered no software problems. Hypercard™ is a well proven programming shell, and should be able to serve any archaeological problem by providing alternative paths through that discipline's knowledge. Any limitation encountered during the thesis' experiment, as mentioned previously, was due to the archaic hardware employed. Possibilities within hypermedia will only increase when newer equipment is used.

There are other angles of our work that should be briefly discussed. A brief summary of philosophical angles has in it implications for the work of archaeology, and other human scientific endeavours.

The philosophical themes of Merleau-Ponty (1935; 1964) might be used as a theoretical framework for the thesis project. The "phenomenology", or study of phenomenon, holds within it many understandings of its "ground". The "ground" means human perceptual reality. The ground, both in literal and phenomenological senses, holds all that archaeologists wish to understand. Territory investigated by the archaeologist is the ground of past human experience, but it is also linked with the experience of the present. The discovery of an artifact or a site is an experience of a new phenomenon, created by the interaction of archaeologist and world. Hermeneutic interactions create archaeological knowledge, with all its conflicting views.

The "newness" of the archaeological events or phenomenae continue to be recreated during the archaeological process. Analogy, associative logic, and "common-sense" are all cited as "non-scientific" factors exerting their influence on the scientific process. The combined influences of "non-logical" variables creates archaeological knowledge. Such influences also guide in the creation of all interpretation based upon archaeological knowledge, and directs scientific enquiry back to the data. The data themselves are often renamed and recreated, thereby becoming new phenomena once again.

Capturing the above changes might seem like an indomitable task, but in the last few years, technology has been created that allow a glimpse of our cognitive processes. Hypermedia and Hypercard™ were advertised as brilliant steps forward in the computer sciences because they were the first software to mimic the neural-synaptic links thought to be the main communicative passages in the human brain and nervous system. From the electro-chemical languages of our thought process, comes the analogic or associative thinking of our species. The technological expression of non-analytical processes in a system than our brains was thwarted until 1987, when Hypercard™ was introduced.

However, the Hypercard™ programming shell is a simple one. Hypercard™ cannot be expected to replicate the unknown and mysterious complexities that might be enveloped inside our brains. The "humanity" of our thought may never be technologically apprehended, and we do not advocate such a move. Other languages, not directly identifiable as analogic or associative, linearly logical or psycho-physical may remain expressed in the fine arts and music, for example.

However, there will always be an aspect of such languages in the sciences, and although the "hermeneutics" of human perception of events and our interaction with them are not included in the DiSo 1 application, the potential for such to be created by the user is enormous.

A science, like any human endeavour, is subject to the changes inherent within our working with it. Sometimes the extent of inherent changes, and their effect on a discipline's state of knowledge, can be taken for granted, or statistically ruled out as a given. The sum of scientific knowledge is the total of the changes taking place within research. We cannot hope to claim a complete knowledge of even the processes of scientific enquiry until such a time as its inherent changes are brought to light in a systematic manner. They should not be subject to a reduction of method or statistic. Such changes might be better understood in the hypermedia context.

To keep track of all the constant and multitudinous changes, a student might advocate their being kept in a dynamic archive. Such a repository might allow the translation process, constantly occurring in archaeology, to be accessed and studied. Some portion of that process may be changed. The mere analysis of it may be satisfying enough, all the while creating changes through such manipulation. The "phenomenology of perception" means making change through interaction. The archive, if not used, does not "exist". It does not exist not only in experiential terms, but more importantly for archaeology, in the practical terms of access to knowledge. Without the reminder of archaeological work done previous to ours, we cannot build upon it, and risk going in circles over points that may have been resolved to the consensus' satisfaction years ago. As well, such points resolved during past work may need to be reviewed, another impossibility if the data are not readily available.

The logical solution to the above concerns is the construction of a computer system that allows some of human perception to run its course in the open, with less mystique. Hypercard™ is the logical choice for an experiment in associative analogy and cognitive study, for reasons outlined in the above. The thesis' application is only one of many possible, with limitations being the creative potential of the users involved.

The DiSo 1 hypermedia application is the result of our work, and we believe it to be important because of a more fundamental reason than the previous ten: It changes data analysis in archaeology by allowing the entire process to be explored and juxtaposed in an intimacy impossible previously, and in an interaction not allowed by past efforts.

Interaction involves not only the data and the user, but all the links amongst related data. Links are originally set up by archaeological recorders on site, and recreated through the user. A much greater intimacy of contact will be created in archaeology between the story told and its tellers. Within such an intimacy, it is hoped that students will further the grand aims of archaeology, including the understanding of humanity's present story by directly experiencing the present, through the indirect reflection of our past.

Bibliography :

Allen, Peter S., and Carole Lazio
1983 *Archaeology on Film: A comprehensive guide to audio-visual materials.* Archaeological Institute of America, Washington.

Ambron, Sueann, and Kristina Hooper
1989 *Interactive Multimedia,* Microsoft Press, Redmond.
1990 *Learning With Interactive Multimedia,* Microsoft Press. Redmond.

Anderson, Thomas
1989 Beyond Einstein. In*Interactive Multimedia,*edited by S. Ambron and K. Hooper. pp.193-214. Microsoft Press, Redmond.

Apple Computer
1988 *Hypercard™ Stack Design Guidelines,* Apple, Menlo Park.
1989 *Hypercard™ Script Language Guide,* Apple, Menlo Park.

Biek, L.
1987 Archaeology, Science, and Domesday. In *Science and Technology, Proceedings of the Glasgow Conference, 1987.* edited by A.R. Hands and D.R. Walker. pp. 541-543. BAR series 146 (ii), Oxford.

Boehm, Gay, and Neal Crozier
1972 *A Report on the 1972 Field Season, DiSo-1.* Unpublished Manuscript in the possession of the Royal British Columbia Museum, Victoria.

Bourrelly, Louis, and, Eugene Chouraqui
1981 The SATIN I System. In*Data Bank Applications in Archaeology,* edited by Sylvia Gaines. pp. 130-140. The University of Arizona Press, Tucson.

Callow, Paul

1988 Across the generations: A long term computing project. In *Computer and Quantitative Methods in Archaeology, 1988*,edited by S.P.Q. Rahtz. pp. 453-470. BAR series 446 (ii), Oxford.

Calvert, Gay

1980 *A Cultural Analysis of Faunal Remains from Three Archaeological Sites in Hesquiat Harbour, B.C.* Unpublished Ph.D. dissertation, the department of Sociology and Anthropology, University of British Columbia, Vancouver.

Carver, M.O.H.

1985 The Friendly User. In*Current Issues in Archaeological Computing*,edited by M.A. Cooper and J.D. Richards. pp. 47-62. BAR series 271, Oxford.

Chadburn, Amanda

1988 Approaches to controlling archaeological vocabulary for data retrieval. In *Computer and Quantitative Methods in Archaeology, 1988*, edited by S.P.Q. Rahtz. pp. 389-398. BAR series 446 (ii), Oxford.

Cook, Thomas Glenn, and Frederick W. Limp

1981 The ORACLE Computerized Information Retrieval System. In*Data Bank Applications in Archaeology*, edited by Sylvia Gaines. pp.57-66. The University of Arizona Press, Tucson.

Cooper, M.A., and J.D. Richards

1985 *Current Issues in Archaeological Computing*.BAR Series 271 Oxford.

de Bono, Edward

1990 *I am Right, You are Wrong: from this to water logic.* Viking. New York.

Dillon, Brian D.

1981 *The Student's Guide to Archaeological Illustrating.* Archaeological Research Tools, volume 1. University of California, Los Angeles.

Doran, J.E.
1989 Formal Methods and Archaeological Theory: A Perspective in*World Archaeology*, vol.18, number one. 1989. Routledge and Kegan Paul, London.

Doran, J.E., and Hodson, F.R.
1975 *Mathematics and Computers in Archaeology*. University of Edinburgh.

Dorrell, Peter G.
1989 *Photography in Archaeology and Conservation*. University of Cambridge.

Dunnell, R.C.
1986 Methodological Issues in Americanist Artifact Classification. In*Advances in Archaeological Method and Theory*, vol.9, edited by M.B. Schiffer, pp.149-194. Academic Press, New York.

Drucker, Philip
1951 The Northern and Central Nootkan Tribes, in *Bulletin of the Bureau of American Ethnology #144*. Smithsonian Press, Washington.

Foucault, M.
1972 *The Archaeology of Knowledge*. Pantheon, New York.

Friedlander, Larry
1989 The Shakespeare Project. In*Interactive Multimedia*,edited by S. Ambron and K. Hooper. pp.115-142. Microsoft Press, Redmond

Frischer, Bernard
1989 Links or Stories—A Compromise. In*Interactive Multimedia*, edited by S. Ambron and K. Hooper. pp.299-302. Microsoft Press, Redmond.

Gaines, Sylvia.
1981 *Data Bank Applications in Archaeology*. The University of Arizona Press, Tempe.

Geertz, Clifford
1980 Blurred Genres: The Refiguration of Social Thought, In *American Scholar*, Spring, 165-179.

Goodman, Danny
1988 *The Complete Hypercard Handbook, second edition.* Bantam, New York.

Haggarty, James
1982 *The Archaeology of Hesquiat Harbour.* U.M.I., Ann Arbor.

Halasz, Frank G.
1989 Notecards: A Multimedia Idea Processing Environment. In *Interactive Multimedia*,edited by S. Ambron and K. Hooper, pp.105-110. Microsoft Press, Redmond.

Hebda, R.J., and G.E. Rouse
1979 Palynology of two Holocene Cores from the Hesquiat Peninsula, Vancouver Island, B.C. In *Syesis* vol.12. pp.112-131.

Hodder, Ian.
1982 *Symbolic and Structural Archaeology.* New Directions in Archaeology, Cambridge.
1985 Post-Processual Archaeology. In*Advances in Archaeological Method and Theory* vol.8, edited by M.B. Schiffer. Academic Press, New York.

Howes, Don E.
1981 *Late Quaternary history of the Hesquiat Harbour Region.* Manuscript on file at the Royal British Columbia Museum. Victoria.

Hugget, J.
1985 Expert Systems in Archaeology. In *Current Issues in Archaeological Computing,* edited by M.A. Cooper and J.D. Richards. pp. 123-142. BAR series 271, Oxford.

Jones, M. and D. Myers
1988 *Hands on Hypercard —Designing Your Own Applications.* John Wiley and sons, New York.

Klein, R.G., and Kathryn Cruz-Uribe
1984 *The Analysis of Animal Bones from Archaeological Sites* University of Chicago Press, Chicago.

Kuhn, Thomas.
1970 *The Structure of Scientific Revolutions , second edition.* University of Chicago Press, Chicago.

Landow, G.
1987 *Context 32: Using Hypermedia to Teach English Literature.* AEP IBM Conference Proceedings, 1987.

Le Maitre, Jacques
1981 SOFIA: A Data Base Management System Applied to Archaeology. In*Data Bank Applications in Archaeology,* edited by Sylvia Gaines. pp.123-129. The University of Arizona Press, Tempe.

Loy, T. and G.R. Powell
1977 *Archaeological Data Recording Guide.*British Columbia Provincial Museum. (heritage record #3). Victoria.

McMillan, Alan D. and Denis E. St. Claire
1982 *Alberni Prehistory: Archaeological and Ethnographic Investigations on Western Vancouver Island.* Theytus Books, (Alberni Valley Museum) 1982, Port Alberni.

Martlew, Roger
1984 *Information Systems in Archaeology.* New Standard Archaeology, Alan Sutton Publishing, London.

Merleau-Ponty, M.
1935 *Phenomenology of Perception.* RKP/HP, London.
1964 *Signs.* Northwestern University Press, Chicago.

O'Flaherty, Brendan

1988 The Southhampton-York Archaeological Simulation System. In *Computer and Quantitative Methods in Archaeology, 1988,* edited by S.P.Q. Rahtz. pp. 491-498. BAR series 446 (ii), Oxford.

Patrik, Linda.

1985 Is There an Archaeological Record? In *Advances in Archaeological Method and Theory* , vol.8, edited by M.B. Schiffer. pp.27-46. Academic Press, New York.

Plog, Fred

1981 SARG: The Computer in a cooperative Effort. In *Data bank Applications in Archaeology,* edited by Sylvia Gaines. pp. 46-56. The University of Arizona Press, Tempe.

Rabinow, Paul

1977 *Reflections on Fieldwork in Morocco.* University of California Press, Berkeley.

Rahtz, Sebastian

1988 A resource-based archaeological simulation. In *Computer and Quantitative Methods in Archaeology, 1988,* edited by S.P.Q. Rahtz. pp. 473-490. BAR series 446 (ii), Oxford.

Richards, J.D.

1985 Standardizing the Record. In *Current Issues in Archaeological Computing,* edited by M.A. Cooper and J.D. Ryan. pp.93-102. BAR Series 271, Oxford.

Rieger, Anne

1981 AZSITE: The Arizona State museum Site Survey Data Base. In *Data Bank Applications in Archaeology,* edited by Sylvia Gaines. pp.27-45. The University of Arizona Press, Tempe.

Rielly, P.
1985 Computers in Field Archaeology: Agents of Change? InCurrent Issues in Archaeological Computing, edited by M.A. Cooper, and J.D. Richards. pp. 63-78. BAR series 271, Oxford.

Ruggles, Clive
1988 Software for the Liecester Interactive Videodisk Project. In *Computer and Quantitative Methods in Archaeology, 1988,* edited by S.P.Q. Rahtz. pp. 523-542. BAR series 446 (ii), Oxford.

Ryan, N.S.
1988 Browsing through the stratigraphic record. In *Computer and Quantitative Methods in Archaeology, 1988,* edited by S.P.Q. Rahtz. pp. 327-334. BAR Series 446 (ii). Oxford.

Schiffer, Michael B.
1976 *Behavioural Archaeology.* Academic Press, New York.

Shell, Barry.
1988 *Concise guide to Hypertalk.* MIS Press, Portland.

Snedicor, W.
1956 *Statistical Methods, 5th edition.* Iowa State University Press.

Stutt, Arthur
1988 Expert Systems, explanations, arguments and archaeology. In*Computer and Quantitative Methods in Archaeology, 1988,* edited by S.P.Q. Rahtz. pp. 353-368. BAR series 446 (ii), Oxford.

Valéry, Paul
1973 *The Collected Works of Paul Valéry.* Jackson Matthews, eds. Bollingen Foundation, volume II. New York.

Waite, Mitchell
1989 *The Waite group's Tricks of the Hypertalk Masters.* Hayden Books, Indianapolis
1989 *The Waite group's Hypertalk Bible.* Hayden Books, Indianapolis.

Wilcock, J.D.
1974 The "PLUTARCH" System. In*Computer Applications in Archaeology, 1974.* Proceedings of the Annual Conference Organized by the Computer Centre, edited by J.D. Wilcock. Birmingham University Press.
1987 Past and future directions in Archaeological Computing. In *Science and Technology: Proceedings of the Glasgow Conference, 1987,* edited by A.R. Hands and J.R. Walker. pp. 497-507. BAR series 146. Oxford.

Wylie, Alison.
1985 The Reaction Against Analogy. In*Advances in Archaeological Method and Theory,* vol.8., edited by M.B. Schiffer. pp.68-103. Academic Press, New York.
1987 " *'Simple' analogy and the role of relevance assumptions: Implications of archaeological practice*" unpublished paper University of Western Ontario, Guelph.

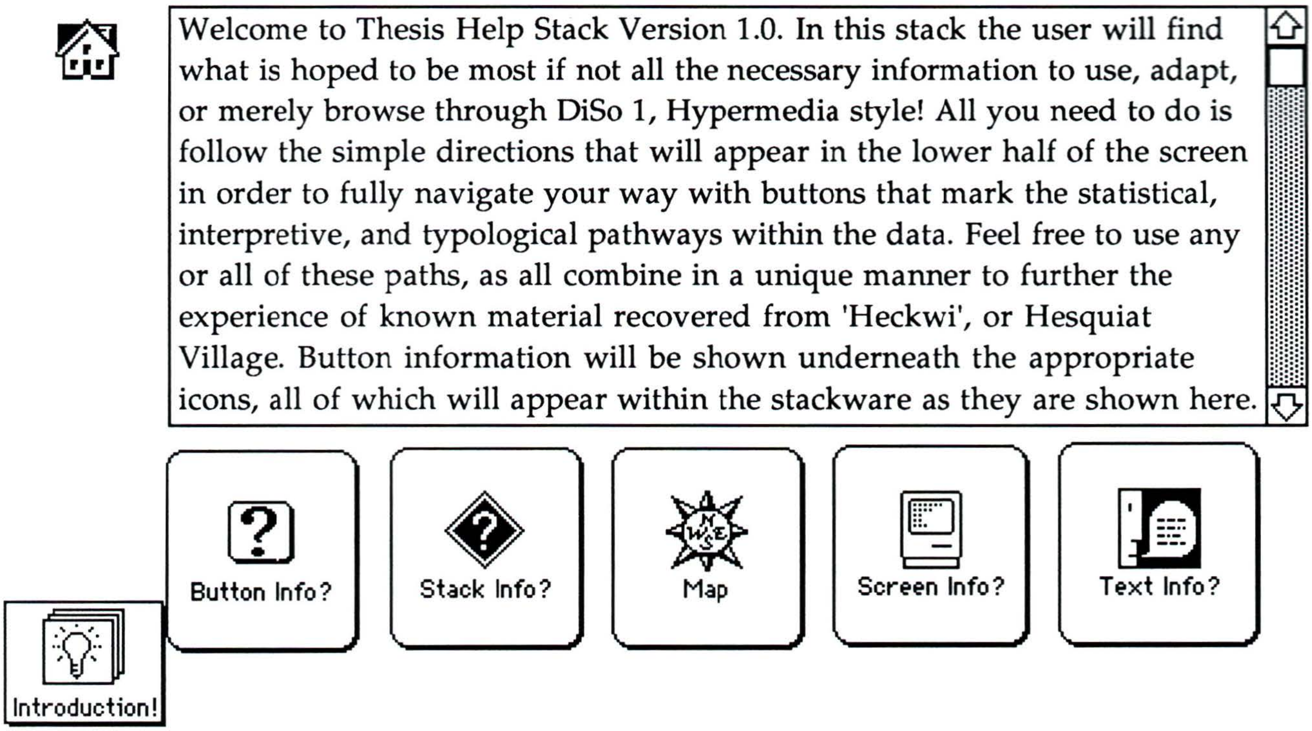

Figure 2: The Introductory Help card showing various button formats.

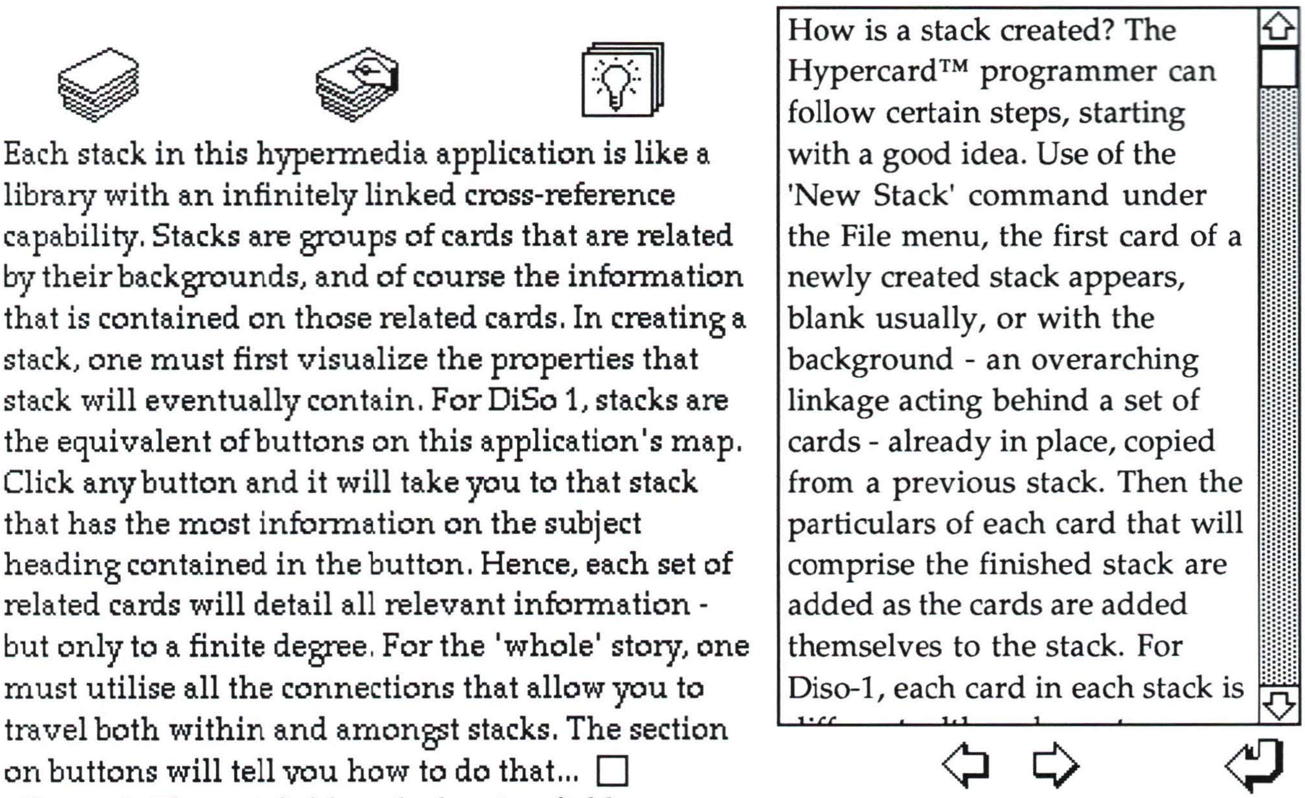

Figure 3: The text field card, showing field types.

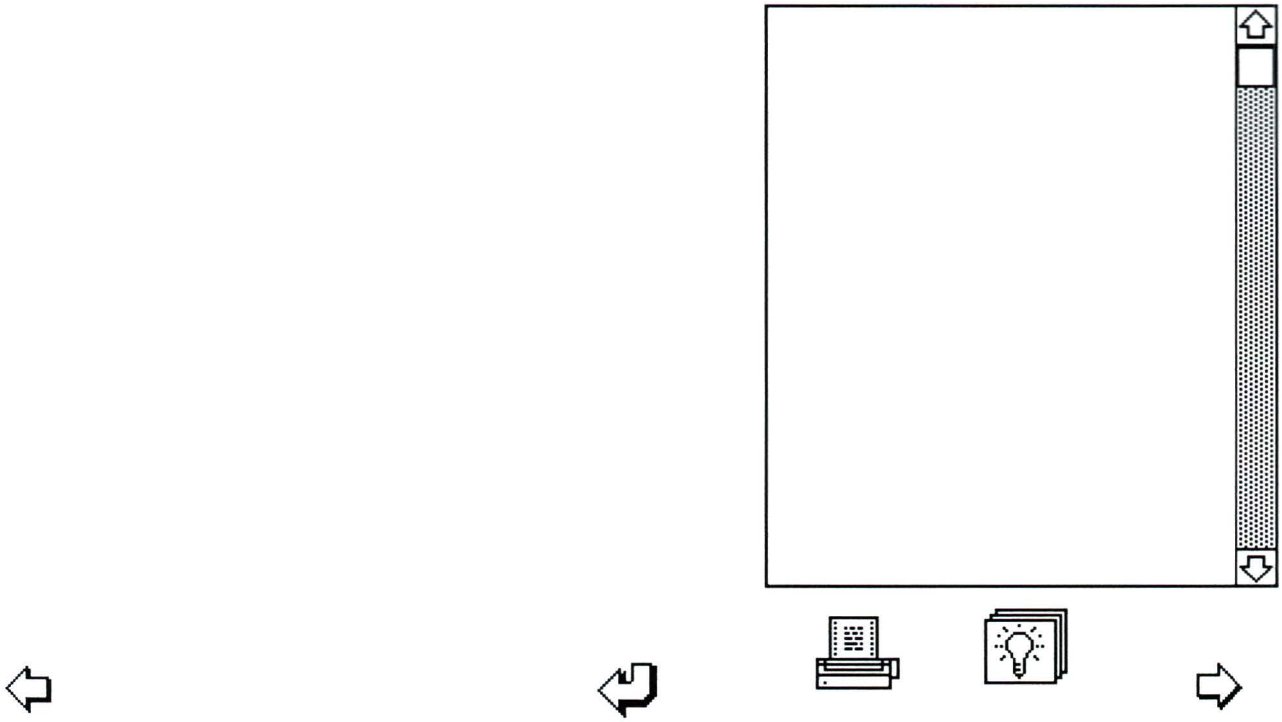

Figure 4: Card 1 from "ThesisAV1" background template.

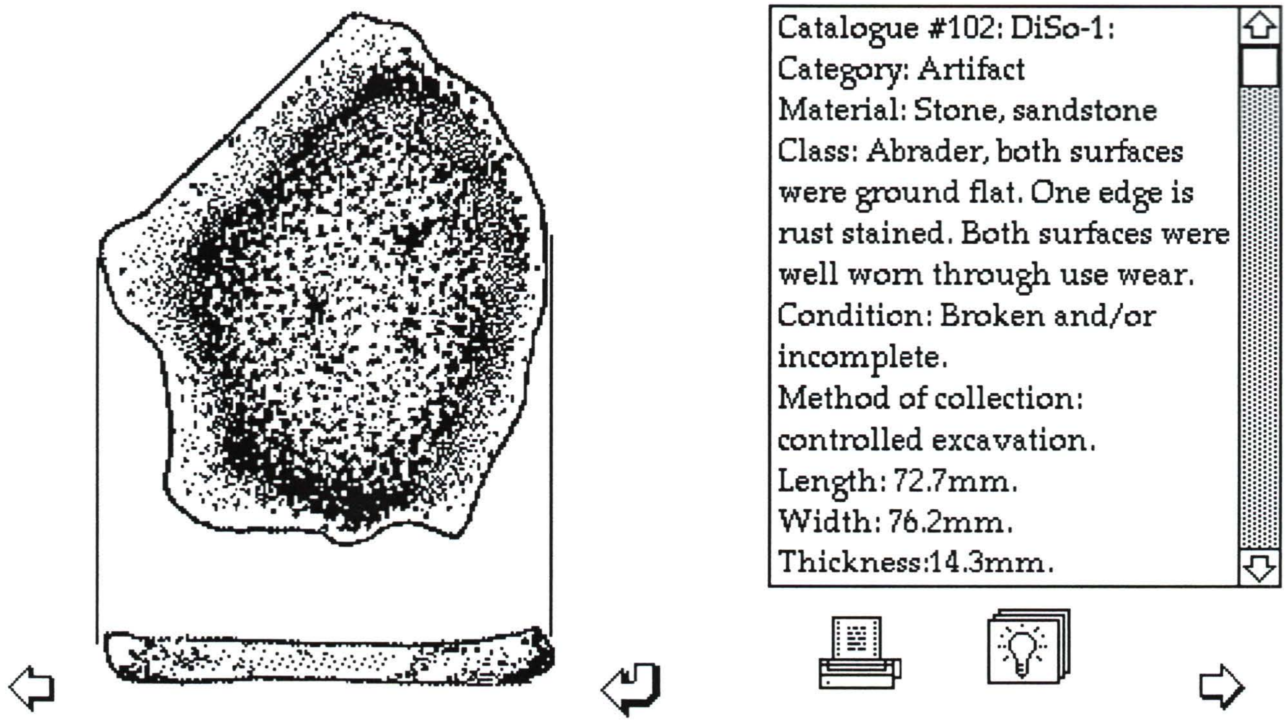

Figure 5: Card 1 from "ThesisAV1", completed card.

VITA

Surname: Loewen Given Names: Gregory Victor

Place of Birth: Victoria, British Columbia Date of Birth: January 31, 1966

Educational Institutions Attended:

University of Victoria 1984 to 1990

Degrees Awarded:

B.A. University of Victoria 1988

Honours and Awards:

University of Victoria Fellowship 1989-1990

Publications:

N/A

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Author [redacted]
(Signature)

Greg V. Loewen
(Name in Block Letters)

Sept. 6. 1990
(Date)