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A computer-based tutorial workbench

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32.1. Introduction

This paper outlines a model for a computer-based teaching system which moves beyond the current practice of tutorial development and generation (albeit poorly realised in most cases) and looks towards a system which teaches both concepts and techniques in a highly flexible and effective manner.

32.2. The background

Archaeology has a strong track record for computer-based teaching. This has drawn support and funding for software development, in particular the SyGraf excavation simulation system (Wheatley 1991) and the Leicester Interactive Video (LIVE) project (Ruggles 1988, Ruggles *et al.* 1991). The success of SyGraf in terms of its widespread distribution is demonstrable, as is the general application in archaeology and other disciplines of software derived from the LIVE project.

In March 1992 the Universities Funding Council announced a new initiative, the Teaching and Learning Technology Programme (TLTP), making £5 million available in the first year and an anticipated similar amount for two subsequent years for the support of projects designed to develop the integration of new technologies into the mainstream of teaching and learning in higher education. Competitive bids were invited to be submitted at short notice from institutions and consortia of institutions. A consortium of 16 archaeology departments from the universities of Bradford, Bristol, Cambridge, Durham, Edinburgh, Glasgow, Leeds, Leicester, Liverpool, Newcastle, Nottingham, Oxford, Sheffield, Southampton, UCL Institute of Archaeology, York, together with the History of Art department at Birkbeck College, London submitted a successful bid which is discussed in the previous chapter by the Consortium coordinator, Dr Ewan Campbell. This paper is concerned with just one element of that original bid — the model behind the proposed Glasgow contribution.

It was argued at the original creation of the Consortium in May 1992 that a proposal for the TLTP had to be seen to build on past achievements without discarding them. The Glasgow proposal involves a natural development of the methodologies and packages in current use and at the same time represents a new departure arising out of the experience of the past few years and the problems and shortcomings of existing systems. It also provided the basic framework within which the successful Consortium bid was cast.

32.3. An Archaeological Workbench

There are several main issues which this model would seek to address. For example:

- existing authoring tools are often restricted, whether to a hardware platform or to a particular pedagogical approach — whether linear or multiple choice, as seems to be favoured by many science applications, or a more open exploratory system constructed within a hypermedia environment.
- tutorials produced with such tools are often perceived as restrictive, prescriptive and insufficiently open-ended for general use.
- the maintenance of tutorials can be problematic — updating and modifying tutorials is rarely carried out.
- computer-based learning materials often suffer from the "not invented here" syndrome, and so need to be capable of local customisation. At the same time, the opposite problem of "re-inventing the wheel" needs to be avoided. Different people teach the same subject in different ways, and this needs to be recognised for any computer-aided learning (CAL) system to be successful.
- computer-based teaching materials are often insufficiently challenging to provide more than rote learning for students — a crucial element has to be the application of tools and techniques which is often poorly catered for. To be really useful, CAL has to do more than simply replace lectures: the communication of ideas and concepts has to be reinforced with practical experience.

Such criticisms are obviously generalisations drawn from a wide range of tutorials developed for a variety of different subject areas. Clearly, a teaching package like SyGraf already addresses a number of these issues — additional datasets can be added, for instance, which more closely reflect local interests. Similarly, the LIVE tutorial system provides a flexible authoring system and a high degree of potential portability between different software and hardware platforms because of the level of abstraction employed in the design of the actual authoring package itself. These and other features need to be built in to any successful system.

The proposed model consists of three primary software elements which are ultimately combined into a single authoring and delivery system. Each element communicates a different level of information in (from the point of view of the software development) an increasingly complex way. The three levels can be characterised as a hierarchy composed of:

- concepts.
- methodologies.

- applications.

These three elements could be summarised from a potential user's viewpoint as:

- What is it?
- How is it done?
- What happens when I try?

As well as there being sound pedagogical reasons for this staged development, there are clearly also advantages from the perspective of software development. Each level can be developed in a largely self-contained manner, gradually building up into the final system, and, most importantly, each element functioning prior to the production of the next.

32.4. The delivery system

This tripartite development can be visualised in the following manner:

Level 1:

a tutorial system in which a student is presented with information, images, animations, film clips *etc.* which illustrate a particular aspect of the subject. The student may be presented with data in a linear fashion, or provided with an environment within which the subject can be explored. This is essentially where many tutorials are now; however, there is a critical shortage of suitable tutorials available and the TLTP project will be addressing this problem. Such tutorials would be based on HyperCard-like stacks, the LIVE tutorial methodology, or any of the more common authoring systems. AuthorWare has been selected for testing but there are a number of other possibilities. Essentially, these increasingly standard CAL techniques are used to communicate ideas and information to a student, perhaps reinforcing what has been heard in a lecture or providing a new slant on those ideas.

Level 2:

a tutorial system which links concepts communicated through the first element to the techniques that are applied in order to achieve those ends. Methodologies are actively demonstrated with the student interacting with the tutorial system which controls either an accurate simulation of industry-standard or archaeology-standard software or preferably the software itself.

This could be achieved in a variety of ways. Where a macro language is available in the client software, these could be set in motion by the tutorial program which stands aside while they run, and then resumes upon completion. Control would be therefore surrendered to the client program (*e.g.* Excel, Paradox for Windows, SPSS for Windows *etc.*). A less satisfactory and more complex method would be for the tutorial software to emulate the screens and menus of the client software without actually running it, and hence the tutorial program would retain absolute control throughout. Typical examples of this type of approach are the Microsoft tutorials accompanying programs such as Word and Excel. Ideally, however, the tutorial would instigate and retain control over the client software whilst it was running. This presupposes that the environment under which the tutorial and client software operated provides the facilities through which one application (in this case the tutorial) can communicate with and ultimately control another application. Similarly, potential client applications would have to be capable of surrendering control to a controlling program. Here, the Dynamic Data Exchange (DDE) and Object Linking and Embedding (OLE) facilities within Windows on a PC and similar facilities on a Macintosh are likely to be of great significance, as will the increasing emphasis on a common macro language.

A combination of industry-standard software and archaeological software (such as SYGRAF and ^{14}C calibration programs) would therefore be used to by the tutorial to demonstrate the methodologies applied to a particular area. The use of this software could be as overt as required — there could for example be clear advantages in *not* linking the methodologies too closely to a specific software package and instead use the relevant package as an analytical or processing engine hidden beneath the tutorial.

Level 3:

a tutorial system which enables a student to approach a data-related problem, but not one which is prescribed by the system. This means that the individual would be able to apply the concepts learned in Level 1 and the tools and techniques illustrated in Level 2 to a dataset or problem that they themselves provide. The tutorial system would act as a guide to the methodologies available and as a software supervisor in the use of the relevant software package, able to provide assistance but also to stand back and give the individual free rein.

This might be implemented using macros generated by the tutorial program to suit the data brought to the system and described by the user. In effect these would provide the importing mechanism for the data into the relevant client program, before triggering a series of pre-defined macro procedures. Ultimately we can visualise a situation in which the individual operates the client software directly, with the tutorial system acting as observer and advisor. There is no substitute for practical, personal experience, and this is what this would seek to provide.

32.5. Discussion

The resulting system has the potential to work on a variety of levels to suit the nature of the student and course. For example, the concepts and uses of typology could be illustrated at Level 1. What is a typology? What is it used for? Why are typologies important? The derivation of typologies using a suitable example dataset could then be illustrated at Level 2. How are typologies created? Which numerical methods can be applied? What are the problems? The student could then bring their own example dataset (as part of a project, dissertation *etc.*) to Level 3. Alternatively, an individual already versed in the theory but who is not familiar with the techniques could enter at Levels 2 or 3. Such an approach is equally applicable to the teaching and demonstration of radio-carbon dating, relative dating, stratigraphical analysis, all shades of statistics, and so on.

Such a system would therefore considerably more powerful and flexible than a traditional computer-based tutorial program. It enables active reinforcement on an individual level by combining the activities of teaching and learning more tightly within a single system. By working at several levels, it fulfils the requirements of a wider audience than

simply those who need a supply of basic introductory information.

Rather than attempt to develop such a system from scratch, tools which are already available will be utilised and developed. This means in particular that actual tutorial software development is largely restricted to Levels 2 and 3, while development of tutorials and general courseware is applicable at all stages. Windows as an environment has already been mentioned, and a number of authoring systems have been developed to take advantage of the facilities offered by Windows. The majority of these commercially available packages already provide the majority of facilities necessary for the first element of the system and would provide the foundation for the development of Levels 2 and 3. The use of Windows would have a number of advantages, such as:

- it would utilise a reasonably standardised widely-used interface.
- it provides basic facilities for software packages to communicate with each other, and more are being developed.
- it has a wide variety of drivers and interfaces to CDROMs, videodisks *etc.*
- it operates on comparatively cheap and widely accessible equipment.

Any Windows-based authoring package will therefore inherit these features and add its own — whether it is image-handling or transportability across hardware platforms, for instance.

None of this can be attempted in isolation, however. This model presupposes the existence, or parallel development, of a range of tutorial resources. This additional development work carried out alongside the software development outlined above would need to include:

- extensive development of specific tutorials, initially produced using the Level 1 software, but subsequently utilising the facilities brought in at stages 2 and 3.
- development of tutorial resources — image databases on videodisk and CD-ROM, complete excavation databases, example datasets *etc.*
- modification of existing archaeological software (essentially DOS-based) into Windows aware packages (*e.g.* ^{14}C, stratigraphic analysis and matrix generation programs, air-photograph rectification, survey plotting and analysis, SYGRAF) which could then be operated within the tutorial environment.

Many of these areas are already the subject of proposals by the other members of the Archaeology Consortium. Similarly, it would be necessary to ensure that the system was not bound to a particular hardware or software platform — we cannot assume that everyone will have Paradox for Windows available, for instance. In this respect, many of the elements developed under the aegis of the LIVE project with regard to the transportability of tutorials might be utilised.

32.6. Summary

To summarise and conclude:

- such a system clearly has considerable potential for wider use beyond archaeology. While this is perhaps of less immediate concern, it is a factor which is emphasised in the original TLTP announcement and it opens up the possibility of additional support and funding through sales of the end product.
- it builds upon and is a development of work carried out under earlier initiatives, in particular the experience gained through the LIVE project in its various forms and the Archaeology videodisk itself.
- it would ideally support and develop the proposed CAL generic tutorial standard developed under the LIVE project. This is targeted at enabling the interchange of tutorials across different hardware platforms — again, this is perhaps of less immediate concern since a recent survey has demonstrated that the overwhelming majority of university archaeology departments in the UK use PCs (Campbell, this volume), but I would argue that cross-platform support will remain a significant factor in the success or failure of the resulting systems.
- the emphasis is consequently on transportability through the development of common tutorial software and courseware standards and the utilisation of industry standard software packages as an element of the delivery system.
- such a system will improve the productivity of teaching and learning as much as any software package can do. The emphasis on the delivery of both concepts and techniques is a major element of this proposal and should ensure that it improves the learning experience. Whether it addresses the perceived problem of handling increasing student numbers is a quite different issue.
- there is considerable potential for widespread involvement of archaeology teaching departments and associated organisations, not just in terms of the software development and testing, but in particular in the development of tutorial courseware, utilising the strengths and special interests of individuals to the benefit of the community as a whole. Core curricula, the transferability of course elements between archaeology departments and other similar issues are increasingly discussed and this system might provide a vehicle for such developments.
- the increased flexibility of approach ought to make the integration of computer-based learning into existing courses much easier than at present and would clearly be of value in introductory methods-based courses.
- the utilisation of standard interfaces, standard software packages, and standard tutorials and datasets would ensure the ease of use and accessibility of the resulting system.

This model is essentially very simple yet that simplicity disguises a powerful, far-reaching and all-encompassing approach to computer-based learning which addresses many of the shortcomings of existing tutorial packages and seeks to enhance the use of CAL in education. All that remains is to realise that model in software terms.

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