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Knowledge Package Construction and Conceptual Navigation Using A System for Universal Media Searching (SUMS)

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1. Introduction

The software grew out of two research projects in the field of art history that began in 1975: a standard bibliography on perspective involving 180 libraries around the world, and designing a model for what will likely become the first complete works of Leonardo da Vinci in electronic form. Both projects entail problems of multi-dimensional access and thus came from a user-oriented viewpoint. The computer work is being done by an excellent team of assistants. Initial materials were entered into DBaseIII (1986), integrated with Toolbook (1991) and are now being translated into a C++ version. The present prototype operates in a Windows environment (PC 486) and comprises approximately 500 megabytes. Versions for the Macintosh and Unix environments are planned. As the projects evolved it became clear that the methods for searching subjects as complex as perspective and Leonardo could be applied to other domains, indeed universally. Hence a System for Universal Media Searching (SUMS[1]) emerged.

The SUMS system is being designed as the equivalent of an electronic bucket or container into which new materials can be entered, with a built-in set of search strategies. In the short term it will be used by students and scholars in gathering materials on a given topic to create knowledge packages[2], which will be extended to become an authoring package for the production of CD-ROM’s. In the longer term these authoring capacities will be integrated with the Internet such that one can add titles and gain access to other media at a distance. The C++ version will include a client-server technology, and effectively enable the SUMS software to become a front-end for the emerging "information highway". This has fundamental implications both for conceptual navigation and for applications of editing tools, both with respect to texts and graphics.

2. Knowledge Packages

In the past, both public institutions and private scholars used different media to separate items. We put our books in a library, slides in a slide collection, maps in a map section, drawings in a drawing cabinet, engravings in an engraving cabinet and so on. The early stages of electronic storage have continued this tradition. Databases are frequently devoted to a single medium. Even so-called multi-media projects tend to focus on a single type of knowledge or type of information carrier. Hence we typically find multimedia dictionaries, encyclopaedias, bibliographies, abstracts or books in isolation.

In its preliminary form SUMS may appear similar to multi-media authoring packages such as Toolbook, Authorware, or Microsoft's Access. These are literally authoring environments with extensive programming languages and nothing more. SUMS is different because it has a framework for organizing knowledge which also offers search strategies for navigation, the advantages of which become more visible in proportion to the amount of material being searched, accessed and organized. A simple assignment with a few pages of text and a few images can be dealt with by any multi-media package. Many of these packages can deal with thousands or even a few hundred thousand pages stored on one or more CD-ROMs. Few packages can deal with searches across complex library catalogues and complete libraries.

3. Quantity

One of the temporary problems of multi-media is that there is still a marked discrepancy between the rhetoric of salesmen and what is possible in practical terms in the everyday world. For instance, we are told about storing our slides digitally. As a scholar I have 15,000 slides and a modest collection of 150 microfilms (each with an average of about 100 pages: i.e. the equivalent of another 15,000 pages). If these slides and pages were scanned in at 1 Megabyte per image one would have 30,000 megabytes or 30 gigabytes. The European standard for scanning in images is 30 megabytes per image. This would result in 900,000 megabytes or 900 gigabytes. The IBM Brandywine project uses 50 megabytes per image, which would result in 1,500,000 megabytes or 1,500 gigabytes. To obtain the full potential information from a slide requires about 75 megabytes per image, which would result in 2,250,000 megabytes or 2,250 gigabytes. Lossless compression is presently limited to scales of approximately ten to one. It will be readily apparent that even with a tenfold reduction in size the alternatives would be 3, 90, 150 and 225 gigabytes respectively all of which are still much more than the capacity presently available on a typical PC. Yet times are changing quickly. A decade ago any of these figures would have seemed impossible to anyone outside the realm of supercomputers.

Today all these alternatives are possible in the PC domain, although it will probably take another decade before they are affordable to a wide general public.

As it now exists SUMS allows access to remote sites. It will soon be able to do so with a client-server technology. SUMS is being designed to deal with searches involving dozens, hundreds or even thousands of different sources, as happens when an individual wishes to research any major topic at an international level. As such SUMS, is being designed as a front-end for the emerging information highway.

4. Internet

At present the Internet serves as a working model of this emerging information highway. Both the World Wide Web (WWW) developed by Tim Berners-Lee at CERN (Geneva) and Mosaic, developed at the National Center for Supercomputing Applications (NCSA), offer first glimpses of the potentials involved if a fully operational network were in place. The great advantage of Mosaic is that its simplified form of Hypertext Markup Language (HTML), a Standardized General Markup Language (SGML) document type, permits one to make hypertext connections on one's homepage with great ease. The disadvantage of Mosaic is that by encouraging everyone to make their own homepage means that each page becomes a personal and often an idiosyncratic entry point into material that is potentially of interest to a much larger group of users internationally.

Mosaic in its present version is still available at no cost. However, as Wolf[3] has noted, Marc Andreessen has joined forces with Jim Clark, the founder and former head of Silicon Graphics, to develop a commercial product called Netscape through Mosaic Communications Corporation. According to Clark "Commercialization of the Internet is as inevitable as the sun coming up tomorrow"[4]. Several institutes and companies are developing commercial web browsers.[5] While none of these companies have revealed the nature of the products on which they are working, there is little evidence that they are creating systematic approaches to problems of navigation in the ways that SUMS is doing.

5. Navigation

SUMS in its initial form uses three basic methods for searching: alphabetical lists, limit by functions (which produce subsets of these alphabetical lists) and meters. These are effectively a series of some three hundred further lists, each of which contains another two to ten choices. Of these lists, there are ten initial meters which serve as points of entry: access (levels), learning (which entails goals, curriculum and kinds of intelligence), levels (of knowledge), media, numbers, quality, questions (who, what, where, when, how, why), space, time and tools. These work in various combinations. For example, one could start out with a question concerning "who", which provides a list of authors. This list can be modified by choosing a given access level, such as the research level. Next one chooses a given author, and one can then deal with that name in terms of different levels of knowledge.

The SUMS framework integrates ten basic levels of knowledge, namely: classifications (a term in itself), definitions (as in dictionaries); explanations (as in encyclopaedias); titles (as in bibliographies), partial contents (as in abstracts) and full contents (as in facsimiles) as well as four levels of interpretation: internal analyses (when one concentrates on the text or image itself, close reading in literature); external analyses (when one compares the text or picture to other objects); restorations (when the object contains the interpretations of a restorer) and reconstructions (when the object has built into it the interpretations of the person who reconstructed it).

Some other pioneering projects are also working in this direction. For example, the Rogers Communication Centre (Toronto) is working on a software package for navigation through multi-media, which began with the name of Multi-News and has recently been renamed the n-Views project. This is being linked with the n-Power multimedia network project, which aims at “exploration through multiple perspectives”. This is achieved by using events, persons and issues as three co-ordinates such that issues are on the x axis; key players are on the y axis and the events timeline is on the z axis.

SUMS will go further than this because it uses simple alternatives in combination to achieve complex sets of alternatives. The eight basic kinds of meters can be used in different combinations and permutations. For example, one could begin with questions. Of these there are six: who, what, where, when, how, why? These six questions can be multiplied by ten access levels. This gives sixty choices. These can then be multiplied by ten levels of knowledge. This gives six hundred choices. Further filters can then be applied with respect to places and times, even different kinds of time-reckoning to offer thousands and eventually millions of choices.

One begins to appreciate the full potentials of this approach if one focusses attention on a single question. Let us say that we have chosen the question: Who? and that we have made our choices with respect to level of access, then choose the name Leon Battista Alberti. This individual can then be approached in terms of ten levels of knowledge. If Alberti has been included in a major classification system, we can see where he has been cubbyholed (level 1). As a next step we might find out what has been said about Alberti in biographical dictionaries, the equivalent of a brief definition in the realm of persons (level 2). If we wished more information we would search encyclopaedic articles (level 3), titles of objects (paintings, buildings, instruments) and books and/or articles by Alberti as well as articles on Alberti (level 4). Next we might wish to consult abstracts of those books and articles by or on Alberti (level 5) or the full texts thereof (level 6). These books could then be analysed on their own terms, in the manner of close reading (level 7), or by comparing them with other texts (level 8). In the case of buildings we could further choose to examine them in terms of restorations (level 9) or reconstructions (level 10). Although these choices are arranged hierarchically[6] in terms of complexity of content, the user is free to choose whatever sequence they wish. They could, for instance, choose level 1, move to level 4, back to level 2 or in some other combination.

If one wishes to go more deeply, then one can call up the questions meter anew and ask all six of the basic questions again with respect to Alberti. Who? in this case refers to the sum of persons with whom Alberti worked as well as about whom Alberti wrote. The question: What? refers to the sum of topics with which Alberti was involved and about which he wrote. The question: Where? refers to where he was born, lived and worked, travelled, where the major events of his life occurred (e.g. schooling, marriage), where his works were published and where his works were collected. The question: How? refers to the techniques he used or described. The question: Why? refers to the reasons he gave and the reasons others have attributed as motivations for his actions and ideas.

In the case of an individual such as Shakespeare or Aristotle where there have been centuries of scholarship, finding the necessary information to make possible these links poses relatively few problems. But how is one possibly to find this information in the case of someone about whom exhaustive studies have not been made? Clearly one needs to be able to enter other databases and search them for materials. To achieve this requires co-operation. The developers of SUMS are creating templates which outline our names for fields in the left column and leave blank the corresponding names in the right column. Each library, museum or other data provider wishing to use SUMS will need to fill in their equivalents in the right hand hand column and make this available to the basic server which will then know that the field 'Name' in SUMS may be called 'Author' in one institution's database, 'Artist' in another and "Maker' in a third. Of fundamental importance here is that the participating institutions do not need to rewrite their entries or redesign their databases, a task which, in the case of major institutions such as the British Library or the Vatican would be as futile as it was impractical. All the institutions need to do is to share detailed information concerning their record fields to permit interoperability and cross relational database search strategems. It will be noted that this approach avoids all the dilemmas caused by idiosyncratic homepages as they are presently found on the Internet.

Easy access to remote databases is a necessary, but hardly a sufficient condition for the goals of SUMS. Many of the potential links need to be automated if one is to achieve the kind of wide ranging access that is foreseen. To this end the SUMS team is developing a new type of automatic hypertag system which will integrate aspects of Geographical Information Systems (GIS) and neural networks.[7]

6. Tools

SUMS is essentially an intelligent search engine. To deal with the findings of these searches, it needs tools. The designers of SUMS have no interest in re-inventing the wheel and therefore foresee using existing standard word and image (or graphics) processing packages which will be plugged into the search engine using OLE2 protocols. As more elegant and more powerful packages appear these can be adopted in a plug and play fashion. This applies equally to options which presently still seem slightly exotic such as voice annotation, audiographic annotation, stereolithography and virtual reality (VR). The challenge is to build on existing and emerging products.

The revolution of the computer is not simply in translating traditional text to the screen, but rather in creating a new level of intermedia interoperability. Text, voice, video even three dimensional objects can be translated digitally onto the screen as input and then translated back as output in the form of text, voice, video or even three-dimensional objects. The tools that are being developed will permit ever greater translation and movement between these media, such that a text becomes a spoken commentary, a video image becomes a colour photograph, or a series of photographs is combined in turn to make a video. This has important philosophical implications which are beyond the scope of the present essay.[8]

7. Other Collaborative Tools

SUMS is but one of a number of tools being developed for collaborative training, work and design. The military has been an important source for collaborative work. The term telepresence, in its original meaning, entailed efforts to control robots at a distance, such that one could operate a robot in situations that were highly hazardous to human beings: e.g. in certain parts of a nuclear plant or at the bottom of the ocean. Another context for these developments have been war games which permit players in different cities to participate in a shared simulated battlefield and share the experience of a battle scenario. Initially these games were strictly limited to military personnel. More recently some of these games are becoming accessible to university and high school students. Games such as Net-trek can be seen as simplified examples of these real time combat scenarios.

These collaborative methods are also being developed in medicine in order to provide remote areas access to expertise traditionally only available in major urban centres. One trend is to allow a specialist to do tele-operations directly. Another is to allow an expert in a city hospital to compare notes with an expert in another city. Alternatively this expert can consult with and counsel a doctor or medical orderly at a remote location. In Tokyo this principle is being applied to accident sites. Because it often takes an hour or two for an ambulance to get from the accident site back to the hospital, ambulances are now equipped with virtual reality equipment which permits a doctor at the hospital to see the scene of the accident remotely and give advice to those present concerning interim treatment of the injured person(s).

Business is a third important area for the development of collaborative tools, with respect to video-conferencing, multimedia conferencing and, in particular, boardroom conferencing. Aside from many individual software applications by companies such as Intel, Philips or Worldlinx (Vis-à-Vis), one of the RACE (R & D in Advanced Communications Technologies in Europe) projects includes a Eurobridge (2008) Video Conference Application (EURO-VISION):

> "Co-operative working is becoming the factor of success in a constantly moving world, where the time to market needs to be reduced. Computer supported cooperative working (CSCW) has been identified as a key-issue for Europe's enterprises to keep their leading edge. In the perspective of the virtual office, video-conferencing - as the support of CSCW - will play a major role for real-time communication, a role which is complementary of the multimedia mail systems for off-line communication. In this domain, international standards have

been taken into account in order to provide a high degree of compatibility with systems developed by other manufacturers."[9]

The frontiers of this field are being explored by the Gesellschaft für Mathematik und Datenverarbeitung (GMD) who are extending experiments in telepresence using a communication wall. This replaces the video-window or monitor with wall-sized displays. Among its intended uses is distributed negotiation. The viewer can see his partner as he talks in the "virtual part" of the room. In the case of multiple participants, the video images of figures are wrapped around three dimensional models of heads in order that the figures can be rotated to face the viewer.

In both Europe (in the context of the DELTA programme) and in North America considerable attention is being given to distance education. For instance, under the auspices of the SOPHIA project, SUMS is being combined with the Danish Technological Institute's Cosys Pick and Mix System, to develop new search strategies for on-line technical information. In the realm of training, companies such as Boeing are using virtual reality for both distance education with respect to repairing engines and for the design of new ones.

Some of the most dramatic new tools in this field are being developed by the Gesellschaft für Mathematik und Datenverarbeitung (GMD, Sankt Augustin). Among these is a workbench of the future whereby: "Conventional dialogue concepts for man-machine communication are put into a user-oriented shape so that virtual objects and tools lie on a real workbench. The objects appear as computer generated images projected onto this workbench. The computer screen is reflected onto a horizontal, enlarged desk replacing the two-dimensional screen."[10] These principles are being extended in an Advanced Communications and Tchnologies Services (ACTS)[11] project on the virtual Studio wherein:

> "the video signals of a real camera are combined using a digital video mixer with the video signal of a graphic supercomputer generating an artificially illuminated studio scenery. Position, orientation, zoom and focus of the virtual camera, are tightly coupled to the corresponding parameters of the real camera, sensored by an electromagnetic real-time tracking device. In this way a constantly correct perspective on the virtual scenery according to the perspective of the real camera is ensured." [12]

Audio	Telephone
Video	Video-Camera, Television
Audio-Visual	Tele-Conferencing
Audio-Graphic	Vis à Vis, Visit

Figure 1. Type of diftance communication and related devices.

As a result of meetings at the G7 International Exhibition on the Information Society at Brussels, SUMS was invited to become a contributing partner in the GMD's Digital Video Production (DVP) Project. SUMS has also been included in another European project, Multimedia Access to the World's Cultural Heritage (HOMER). It is foreseen that these collaborative aspects will paly an increasing role in future versions of SUMS.

Since SUMS functions in a client-server environment, it is foreseen that SUMS will integrate such collaborative aspects over the Internet. In so doing it will build on Interactive Collaborative Information Services (ICIS) already available on the Internet. For example, the World WideWeb's Mosaic has built into it a function for annotation of messages. A project based at MIT explores the concept of an interactive classroom[13]. Another project, at Northwestern University, called the Collaboratory notebook, emphasizes the potentials of Learning through collaborative visualization (CoVis).[14] Yet another project focusses on Collaborative decision support.[15]

In the past each sensory mode has tended to generate specific devices in the context of distance learning. For example, audio entailed a telephone; video entailed a television. Similarly combinations of sensory modes led to other devices as shown in figure 1.
Needed are new combinations of hardware and software which will integrate the functionalities of all these sensory modalities. In terms of software, SUMS represents an attempt to mov in this direction.

8. Conclusions

SUMS is more than simply another multi-media authoring tool. As the equivalent of an electronic bucket with a strategy for navigation through and organization of knowledge it is intended, in the short term, for the construction of knowledge packages. In the longer term as increasing numbers of libraries and museums become online through the Internet, SUMS will serve as a front-end for more systematic navigation. It is foreseen that various textual and graphic editing and processing tools will be added to SUMS in a plug and play fashion. In addition to education, other applications of this front-end include museums, libraries, and tourism.

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Notes

[1] The system was copyrighted in 1994. For a series of articles on SUMS see our web site via: http://www.mcluhan.utoronto.ca (now www.sumscorp.com).

[2] On this topic see also Veltman (1991).

[3] Wolf, (1994).

[4] Wolf, (1994), p. 15 4.

[5] For instance, there is an MIT project, working in conjunction with the World Wide Web to create a more effective front-end to the Internet, W3O, and there are no less than seven other companies who have licensed NCSA's Mosaic in order to make their own commercial products: namely, Fujitsu Limited, the Amdahl, Infoseek and Quadralay corporations, as well as Quarterdeck, Santa Cruz Operation, Spry and Spyglass Inc. Wolf, as in previous footnote, p. 152, provides addresses for these companies.

[6] The hierarchy is ours. A title is considered more complex than an explanation because it refers to an article or a book which typically gives more material about a topic than does an explanation in an encyclopaedia.

[7] Daniel Skutelsky is exploring neural network applications.

[8] See for instance Veltman (1991b, 1993, 1994, 1995).

[9] Reinhardt (1995), p. 4.

[10] *GMD. Innovation durch Forschung*, Sankt Augustin: GMD Selbstverlag, 1994, p. 13.

[11] This is section XIIIb of the European Commission's Directorate General.

[12] Sebastian Oschatz, "The Virtual Studio", GMD e-mail on May 5, 1994.
Cf. http://vizwiz.gmd/VMSD/PAGES.en/projects.vst.html.

[13] See: http://nu-gna.mit.edu.8001/uu-gna/text/cc/moo/what.html.

[14] See: http:// www. nwu.edu/CoVis_Wellcome.html.

[15] See: gopher://zserve.nist.gov:79/0:docs/atp/94010169.

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