

# **Emerging instructional technologies: towards Personal Universities**

## **Introduction**

The emergency of powerful and low-cost Information Technologies (IT) permits us to imagine radical changes in higher instruction. Since instruction is mainly a communication activity, these changes could be expected from the introduction of systems suitable for supporting all human communication acts. IT could provide a strong support for teaching/learning processes, improving their quality and efficiency. Personal universities seem a good suggestion from the technology developments. These personal universities would substitute in a single unit most of the traditional communication technologies (black-boards, papers, pencils, books, calculators, libraries,...) and many of the related teaching/learning activities. In this order of ideas we present here reviews and suggestions. These are taken both from the literature and from the development of a Personal University (PU) project.

Personal Universities could easily integrate all the software and the documentation of an entire university curriculum in a single workstation that can be used both by teachers and by student.

## **Why a personal university workstation**

The availability of powerful portable computers and large storage devices like CD-ROM makes it possible to introduce new proposals for the design of instructional systems. These systems have to deal with many problems that inhibit the advance of computer-based instructional technologies. We roughly may divide these problems into two main classes: the technological and the commercial one.

The existence of different and incompatible types of components is the primary source of technological problems. Actually, configuring an instructional system implies the selection of several elements. Among them:

- Computer platform
- Operating system
- Graphical user interface
- Author system
- Data support and format
- Communication devices.

The large number of possible configurations leads to an atomized market influenced also by commercial and logistic constraints such as:

- High cost of instructional software production and maintenance
- Cost of organizational efforts
- Lack of established circuits for instructional s/w distribution

The outlined situation makes mostly impossible the establishments of standards (h/w, s/w, and courseware) that would accelerate the growth of the sector. However, all disciplines have been influenced by computing tools and technology. Computer-based systems are used for data collection and analysis, modeling, intensive calculation. Faculty use computers to write papers, lecture notes and (instructional) software. Students prepare their reports with computers; they use them for writing, drawing, computing, modeling, learning and accessing literature. Nevertheless, these activities are far from being integrated. This becomes even more evident for a lecture, i.e. the typical interface between faculty and students.

Computer support for lecture performance is still limited. This is due to the previously described problems, as well to the lack of integration among currently used applications.

Fortunately, the decreasing cost of high-power notebook-size-computers and the availability of large optical memories permit us to foresee a time when many activities related to the academic environment will be integrated in a single portable workstation. This trend in academic computing has been delineated by many. Weissman, for example, prospected personal academic workstations for students and faculty and he called them, respectively, scholar and faculty workstations. Being higher education an intensive form of training, we assume that teachers and students have to use almost the same tools. This seems a constraint in the development of Personal University workstations, but that constraint has the advantage of simplifying distributions and developments.

In a personal university framework a teacher could work out the following activities:

1. Personal time management
2. Scientific writing
3. Scientific computation
4. Personal literature collection
5. Access to data and literature banks
6. Cooperative work with colleagues
7. Lecture preparation
8. Drill, practice and exercise preparation
9. Students' evaluation
10. Course management
11. Communication with students
12. Lecture performance with the aim of a projector.

As just stated, students will certainly be in the same situation as the teachers. As today they can have access to the same library, tomorrow they will have available the same information sources. A personal time management system will allow students to take care of the different subject matters that they have to master. The students' workstation will become a tool for independent study and evaluation, also an evaluation tool used by faculty during examinations. As already showed, an integrated environment including facilities for lectures and examinations will reduce the gap between research and study. Since teachers and students use the same environment to study, the training aspect of university life will become more evident. Teachers and students will become knowledge explorers working together. The use of the personal university workstation could become an obvious activity as the use of the paper.

### **Development issues**

The amount of software to be integrated to build up a personal university workstation is rather high and requires extensive experimentation. Selecting a single workstation, as suggested here, has many advantages and makes many communication activities related to teaching/learning affordable. Usually lecture performances supported by computer represent a technical challenge. Tuning all system components is time consuming and troublesome, even when a single h/w and s/w platform is in use. Hardware configurations, operating system version, software installation often become problems when a teacher uses his set of tools. Using a single portable workstation is a simple alternative. Once a video signal standard is selected, the teacher has only to plug in and play his PU station in the classroom.

Standards for multimedia data interchange are currently being defined. With the development of these standards, communication among personal universities will increase, even if they were developed using competitive technologies.

From this point of view it is far more important to center the research efforts on architecture definition rather than on technology selection of software development.

A low-cost, notebook-size PU station, featured with a CD-ROM player could represent a paradigm shift. As this tool will become less expensive than a video cassette recorder or a compact disc player, the emphasis will shift from hardware and operating environments to software and information contents.

### **Requirements for the development of a personal university**

It is rather evident that the development from scratch of the software needed for a personal university is beyond current financial ranges of the instructional field. Indeed, the budget for instructional purposes is generally limited, even if certain examples of big projects are underway. The integration of existing application permits us to withstand economical constraints. This implies that the first mandatory requirement for PU is the availability of operating system that allows communication among applications, possibly existing applications.

Given the actual state of the art in this field it seems correct to project the solution of a working Personal University workstation within the next two years.

The second requirement concerns software selection. The availability of future software versions supporting openness or interapplication communication is the primary criterion. This requirement is not stringent for developing prototypes. It will not be difficult or costly to substitute entirely some components.

A design methodology arises naturally as the third requirement: realistic prototyping. This methodology suggests the implementation of prototypes building-up them with the best available components (h/w or s/w) and with a minimum software development effort. The availability of communication among applications will give a large premium to this attitude when such an integration facility will be fully available. The fourth requirement (that sprang from PU experimentation) is that the project goals have to be quite advanced. In this way during the lifetime of the development cycle there will be little chance for the competition to prevail. Anyway, some of the competitors will reach similar solutions, helping "commercial" synergy.

The fifth requirement for the development of a workstation for higher education is inherent to publishing problems. As we have previously observed, software distribution channels are not fully ready to distribute software instructional material. There are many reasons for this situation and we will not discuss them here.

Rather, we want to say that a good integration with paper publishers would make things better. Contrasting "electronic" and hard-copy books is a suitable frame for research, but not for production. Traditional editors have well-established experience from various points of view regarding promotion, advertising, incentives for authors, quality control, distribution, etc.

There are many technical routes to reach such as a good integration. Here we suggest one that could be fully sustained by paper publishers in the case electronic media will emerge.

- 1 Electronic version has to reproduce the appearance of its paper correspondent
- 2 All the snapshots of electronic version must be printable
3. Electronic version must be treated as an added value of the paper version by which all the activities that can be performed by hand, with pencil and paper only, will be automated in the electronic version.

## **The architecture of personal universities**

If we depart from the requirements, only a few possible choices remain. Integration with traditional publishing strongly suggests that the Personal University has to be centered on a library of books in electronic format. We call up-book the electronic book of a personal university. The up-book must satisfy the criteria pointed out in the fifth requirement, and has to be well integrated with all the test of the personal university to comply with all other requirements.

It easily follows that the test of the personal university has to communicate quite well with the up-book. This will provide the basis for the activities we mentioned above, both for the teachers and for the students. The library, the data bank, the presentations, the communication channels, the personal documents file and all the other information sources or destinations will be integrated. Since some of these sources or destinations are elements of selected commercial applications, it follows that integration will develop from communication among applications: that is, from higher order software, not necessarily provided by commercial application developers. We would like to suggest a name for this higher order software (software linking commercial application): agents.

In our hypothesis agents have to deal with:

- Filling up empty up-books, that is, developing or modifying an up-book
- Adding personal notes to the up-book
- Navigating in the PU-library
- Producing and performing lectures with suitable presentation systems
- Doing computations (mathematics, graphics.) on the entities of the pu-book
- Developing evaluation (examination) dialogues, for example, multiple choices
- Producing printed material

We will not give the complete list, because it can grow and in any case is related to many factors. Obviously standard packages suitable for making possible all the activities suggested in the first chapter have to be integrated.

### **The human interface: the "hyper" dimension**

The human interface represents an important element of every computer system. There are many aspects that have to be considered in order for the choices to be made. Hypermedia certainly represents a good choice for scientific workstation. Facilities to make buttons launch other communicating applications have to be provided. For example, mathematical formulas of the up-book have to be computed directly upon request by a mathematical agent. The result will be placed where it has been established during the book design by means of a simple script language based on the notion of context. It is necessary to take care of similar considerations also for function graphs or other computational entities.

All reference entities are good candidates for buttons/links that can connect them in a bidirectional symmetrical way. Indexes are a collection of links to corresponding paths and all paths can be used to recover the corresponding index. The same happens for figure identifies, references, notes, formal content. Definitions will be easily referenced by a suitable agent.

In order to conserve the paper book structure, a default navigation path, based on the page structure, could be selected. However, the reader will have other navigation possibilities following associative links. To avoid cognitive difficulties the path followed by the user is certainly the best entity to be used as an "Adrianna's wire". We call the user path hyper dimension or hyper.

Hyper is analogous to Bush's idea of trail in Meme and, as a trail, it is essentially a medium for communication. All the information collected and the activities performed during navigation have to be stacked to hypers. The hyper dimension can obviously be stored and it is a way to build up a lecture. A lecture preparation is just navigation in the PU-library. A lecture performance is just a reply driven by the teacher or by a clock or by students' question on a previously prepared hyper. The information elements associated to the hyper are just information taken from books, insults of computations, computation requests, graphs, pictures (animated or not) and segments of vocal comments.

So the human interface suggests a style for building up lectures that are not biased by pedagogical suggestions. Transferring traditional material into electronic form, we allow an easier way of lecture construction and presentation, minimizing interference with the teachers' educational habits. Integration between hyper dimension (an agent) and a presentation system is a natural result of this consideration as suggested by efforts in developing the PU project. Last but not least, the hyper dimension is a good candidate for transporting work from teacher to student, from student to teacher or to other students, or for cooperative learning. Hypers are just like files, they can be opened, displayed, filled, closed, stored, mailed, copied, edited, combined, browsed, protected, shared .

### **Intelligent tutoring in a Personal University**

Navigation paths could be used by intelligent agents as a way for learner modeling. Such an intelligent tutoring system will advise the user about learning strategies, retrieval of useful information, performance of practices and exercises.

Hypers are a good base for the development of a user observer because they collect all the user interactions within the system. Anyhow, to allow the use of hypers as a knowledge-base about learner habits, their content has to acquire a semantic significance suitable for machine interpretation.

A simple way to start intelligent tutoring is through the observation of reading. A recording of the time spent on any page can provide a useful parameter to start a comparison among different learners. The sequence of browsed pages is another useful information. When a formal representation of the subject is available, a check about page sequence consistency can be performed. When some inconsistency is detected, the system could start a dialogue with the user discovering new association possibilities or advising a better sequence.

Integration with evaluation tools will offer another optimal opportunity for making the tutoring system aware of learner's characteristics. Response to multiple-choice tests is the starting point of a similar tool, but the integration with intelligent applications will lead to a more sophisticated approach. For example: intelligent tools for grammatical verification are already available. Integrating them with an up-book would make it possible to compare detected mistakes and hyper contents, and to discover where the user has to be addressed for improvements.

## **Formal disciplines and up-books**

The development of up-book could represent a good opportunity for understanding a possible use of the formal content of disciplines.

Indeed, given a network representing the formal description of the book subject, it becomes possible to browse through the book by network navigation. Such a network could be based on the notion of conceptual dependency: a concept depends on others through connections elements (nexuses). Taking concepts and nexuses together produces a network.

Browsing in the network means stepping among concepts. For this reason we call the kind of browser we developed for the personal university, conceptual browser. Others entities can be associated to concepts and nexuses: examples, references, explanations, notes, comments, user notes, parts of text ... these entities become detachable components of a formal structure of the text In the PU-book developed by the authors Petri Nets have been used. Obviously, any other net or graph can be used, as, for example, semantic nets.

Many suggestions seem to emerge from the experience of the development of formal browsers related to the possibility of stepping from the formal description to the formal network content and vice versa. The usefulness of such navigation for all readers is not always obvious: but if a user wants to enter deeper into the subject matter, it is a strong advantage to have the possibility of understanding its formal structure.

From the design point of view, the link between formal and informal content can be related to textual chunks producer and to the maintenance facilities. These notions seem related to an extension of the mark-up techniques to the case where mark-up have a formally treatable meaning.

It is probably a good line of experimentation to develop technologies that can finally show one real use of the formal contents of the disciplines. At that point theorem provers could be used for formal deductions. An intelligent dynamical book could result. This is perhaps the scientific meaning of all research activities.

## **Conclusion**

This paper is a mix of results and suggestions emerging from our experimental activity. The suggestions have all been tested with some prototyping activity. Sometimes this prototyping has been carried out with different machines, without any intention of being ready for an engineering effort and in any case lacking a good operating system suitable for supporting communication among applications.

Results are mainly a set of simple architectural suggestions that the reader can easily find in out notes. With them we hope to give a contribution to minimizing mistakes in future developments.