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FEASIBILITY DISCUSSION OF A COLLABORATIVE VIRTUAL ENVIRONMENT

FINDING ALTERNATIVE WAYS FOR UNIVERSITY MEMBERS INTERACTION

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The paper discusses the potential impact and roadmap for the creation of a Collaborative Virtual Environment. The actual university environment is presented to justify this evolution as feasible. As a particular use, the creation of a virtual incubator to simulate entrepreneurship bias in students, teachers and associates is presented.

INTRODUCTION

In 1995 University Fernando Pessoa set, as a requirement for admission, that every first year student should have a laptop computer. The University offers courses in areas such as social sciences, psychology, management, literature, advertising, and engineering, and wanted its students to acquire the basic skills to use, interact and survive in an information sea similar to the one that they will encounter in a information society environment.

In fall 1997 figures, the University has about 2300 students and 40% of the staff with laptops, and a 400 “plug-in” network to support them. The total University population is 4500 students, and 250 teachers. The "laptop for all" initiative enters its third year. The existing infrastructure provides connection between different locations on campus (classrooms, library and social locations). The infrastructure offers an opportunity to develop an information system that generated a virtual organisation enhancing the University concept of a dialogue community: the so called NetLab (Gouveia, 1998).

One technological research area that brings great expectations to support virtual communities are the ones used in Collaborative Virtual Environments (Oravec, 1996) and (Barnatt, 1995). A Collaborative Virtual Environment (CVE) uses distributed virtual reality technology to support group work. A CVE must have simultaneous multi-user access to a virtual reality system that actually supports co-operative work. Also, the CVE must support the needs of users who wish to work together; users are explicitly represented within a shared space where they interact between them and with information resources (Benford, 1997).

This paper discusses the potential impact and roadmap for the creation of a Collaborative Virtual Environment where all university members can interact in novel ways. Some actual NetLab figures are presented to justify this evolution as feasible. A related project that uses the potential created by the “laptops for all” action is a virtual incubator to simulate entrepreneurship bias is presented.

The main goal is to introduce new forms of educational situations where students and information play the major role. The learning materials are just one of the components and the system itself (NetLab), along with teachers represent the triangular area where the action takes place. The teachers will act as regulators. The underlying idea is to stimulate virtual groups to interact driven by a common information base, and to compete and collaborate for achieving their task with the maximum richness possible.

THE ACTUAL ENVIRONMENT

The Fernando Pessoa University

University Fernando Pessoa is the merging result of two private Higher-Education Institutes in the year of 1994. The University had a significant growth in 1995. It is located in Porto, which is Portugal's second largest city.

Besides the 4500 students and 250 teachers, the university has an administrative staff of about 80 people. The students belong to four different departments: Administration Sciences (*Ciências da Administração*), Communication Sciences (*Ciências da Comunicação*), Political and Behavioral Sciences (*Ciências Políticas e do Comportamento*), and Science and Technology (*Ciência e Tecnologia*).

Presently the University offers twenty courses and three graduations. Most of these courses and graduations are from areas non-related with technology. Fernando Pessoa University has also a second location in *Ponte de Lima*, in the countryside, offering three courses, with more two planned next year.

Actually the University is in a phase of more consolidation than growth, assuming a process of summing up its educational project with the quality required to a university born (as stated by the university strategic board) "*for the innovation and for the difference*". The innovative position hold by the University can be seen in his laptop initiative, discussed in the next section.

As a private university, Fernando Pessoa is one of the new private universities that started evolving in the last ten years in Portugal. In the Portuguese Higher Education environment most of the universities are public and the older ones have more than four centuries of history (the first portuguese university was located in Coimbra in 1308 and definitively in 1537).

The technological environment

The laptop initiative already mentioned is based on that every freshman in all university courses has a laptop as a requirement for admission at the university. Table 1 gives the minimal specifications for the laptop computer since beginning of the project until now. In the first year of the project (1995) there was an agreement with a computer company to supply the laptops. In the second and third years there is just a public announcement of the minimal specifications and each student can buy his laptop computer following the recommended minimal specifications.

Year	Hardware	Software (student licenses)
1995	Intel 486 dx50MHz, 4 MB RAM, 270 MB HD, LAN pc-card	MS-DOS, Windows for Workgroups, MS Office 4.1
1996	Intel Pentium 100 MHz, 8 MB RAM, 840 MB HD, multimedia, LAN pc-card	Windows 95, MS Office Pro 95
1997	Intel Pentium 133 MHz, 16 MB RAM, 1 GB HD, multimedia, LAN pc-card	Windows 95, MS Office Pro 97

Table 1: laptop minimal specs

An important issue is that every student becomes a laptop owner. In local private universities, the use of computer labs requires a monthly fee (its cost varies from institution to institution but it is somewhere between $22,25 and $41,50 USD).

In Fernando Pessoa the fee for using computer labs has been dropped in 1995 with the beginning of the "*laptop for all*" initiative. The laptop minimal specifications are developed assuring that the computer price is inferior to $1625 USD (which students can pay in four years for about $2200, a monthly value of $46 - values from December 97) (Gouveia, 1998). This means that the difference between paying services for computer labs or having their own laptop computer is just a small one (approximately $5 USD!).

The network infrastructure for the project is based in LAN connectivity. It started late 1995, with a Ethernet 10 Mbps LAN in labs and classrooms, with 170 DHCP entry points and 1 server (Windows NT, Intel box). In 1996 it evolved with LAN segmentation with 300 entry points, including the library. In this phase Intranet services were started: www, ftp, mail, proxy, and news server, with a 64KB WAN connection to the Internet. The network has five servers (including two Sun boxes). In 1997 the LAN segmentation continued (with some segments with 100 Mbps), and the number of entry points increased to 400. The network has now 10 servers (with Solaris, Linux, and NT). Table 2 summarises the network evolution.

Year	Number of entry points	Number of servers	Entry points per server
1995	170	1	170
1996	300	5	60
1997	400	10	40

Table 2: network evolution at Fernando Pessoa

In table 3 the actual number of laptops at Fernando Pessoa are shown (these figures include students and teachers and are from December 1997) (Gouveia, 1998).

Year	Students	% covered	Teachers	% covered
1995	1100	25,6%	50	21,7%
1996	800	38,7%	20	28,0%
1997	400	53,5%	30	40,0%
Total	*2300*	*4500*	*100*	*250*

Table 3: laptop numbers at Fernando Pessoa

Based on these figures, it is possible to say that the actual infrastructure at Fernando Pessoa has a coverage of 1 entry point for each 5,75 students or 1 entry point for each 6 laptop owners. These values are even better if we consider that not all students need to be connected at the same time (simply because they are not always at university premises). Further information about the Fernando Pessoa University technology infrastructure can be found in (Gouveia, 1998). This environment brings new opportunities to explore information and technology education with online facilities in classrooms. This potential is presented by some authors (Harasim, 1995) and (Rossman, 1993) and is discussed using Fernando Pessoa University facilities in (Gouveia, 1998a).

The Netlab concept

Every student can connect to the network infrastructure using its own laptop through the campus facilities. Students are able to use networked facilities, and set up projects on their area. The massive presence of laptop computers now makes part of the IT infrastructure of the university. This affects in a different way the needs and the use of a Campus Wide Information System - CWIS (Gouveia, 1998b).

It is possible to consider the technological infrastructure just as the first layer that can enable the production, communication, change and share of content between students, students and teachers and even between teachers by linking computer resources and their respective contents.

To make the network use a daily activity for everyone, content (quantity and quality) is a very important factor. First to enter discussion on the NetLab concept itself, it is important to discuss the content layer. It is a major advantage for most of the higher education institutions because they constitute the great producers of content material and have a proper workforce to maintain these materials update and usable. To get the students involvement and even other teachers' involvement, it is necessary to gather content and publish it online (Gouveia, 1998b).

At the third layer, stands the NetLab. The NetLab intends to be neither a virtual campus network nor a distance learning environment. It wants to be a local interaction engine that provides a structured approach to services and content generated both by students and professors. But what is really different in NetLab?

First, it is people-centered and not technology oriented; second, the environment where NetLab exists has a strong reinforcement in mobility (with laptops and DHCP network entry points); third, it provides a greater involvement between students and university by sharing of technology investments. At last, because the network allows the use of tools for information manipulation out from classrooms to all spaces of the university (Gouveia, 1998b).

The NetLab can be seen as a first step to prepare and prototyping on-line material and off-campus on-line courses and train teachers to integrate Information and Communication Technologies (ICT) technologies in the teaching-learning process.

When integrating these goals with the various resources, information technology and adequate organisation, the institution can shift to offer on-line degrees off-campus and offering Open and Distance Learning (ODL) courses as a normal part of its service catalogue wich define the last layer: the virtual university. This situation has been defined as corresponding to the ones in reporting as virtual university (Rossman, 1993), and (Mason, 1998).

Figure 1 (Gouveia, 1998) helps visualising the role of NetLab as an educational lab that introduces innovative practices and that takes advantage of the Fernando Pessoa University environment.

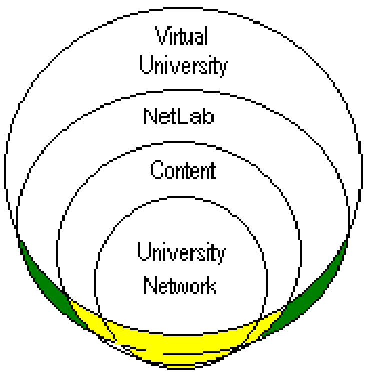

Figure 1: The NetLab concept

THE TECHNOLOGICAL SUPPORT

Collaborative Virtual Environments

A global concept and one that is used frequently is cyberspace. The term itself was coined by (Gibson, 1984) as a name for a virtual environment, in a science fiction book. Besides its origin, it lead to a concept that had significant influence on both theorists and designers of virtual reality systems (Moulthrop, 1993). According to (Tomas, 1991), cyberspace is a "*postindustrial work environment predicated on a new hardwired communications interface that provides a direct and total sensorial access to a parallel world of potential work spaces*".

A more useful definition for our purposes is done by (Benedikt, 1991) where he states: "*Cyberspace is a globally networked, computer-sustained, computer accessed and computer-generated, multidimensional Artificial, or "virtual" reality. In this reality, to which every computer is a windows, seen or heard objects are neither physical nor, necessarily, representations of physical objects but are rather, in form, character and action, made up of data, of pure information*". This last cyberspace characterisation lead us to design a potential project that takes advantage of the environment at Fernando Pessoa and actual inexpensive information technologies to propose a service that could evolve as described by Benedikt.

The research area related with Collaborative Virtual Environment (CVE) gives the opportunity to implement and assess the validity of the described concepts in terms of today technology and their evolving applications. A CVE is defined by (Benford, 1993) as a "cyberspace meeting point" which allows several people to interact through their computers in order to obtain a common goal. A CVE involves the use of distributed virtual reality technology to support group work. In (Benford, 1997) two conditions are presented to a system to be considered a CVE: the provision of simultaneous multi-user access to a virtual reality system and explicitly consider and support the needs of users who wish to work together.

One important aspect in this kind of systems is the existence of a virtual space that (Trefftz, 1996) defined as an immaterial world which allows distance interaction to several users via a set of networked computers. He also states that the interaction can be accomplish from an exchange of written ideas up to a 3D space with the possibility of movement and voice exchange. A more open definition where systems like the Multi-User Dungeons (MUDs) systems and Internet Relay Chat (IRC) are included. Both MUD and IRC systems are discussed as well as their social implications in (Rheingold, 1993).

However both perspectives share the point that each user needs to be aware of other users. In fact, (Benford, 1997) states the essence of CVEs as that users are explicit represented to each other within a shared space. For (Rodden, 1997), a CVE can be stated as shared spaces existing within the machine, who are inhabited by users who have their representation in the space and that is already realised in a number of stable technologies (like the MUDs and MOOs, for 2D and Distributed VR environments, for 3D).

(Benford, 1997) points out three main reasons to develop CVEs. First, the support for natural spatial social skills which offer a more natural way to human interaction, second, the inherent scalability, to address the interaction of a large number of users. Third, applicability to co-operative spatial tasks, where current VR-applications offer design support that can be extended to support collaboration.

Computer Supported Cooperative Work

One important contribution area to the development of a CVE is Computer Supported Cooperative Work (CSCW). As stated by (Greif, 1988), CSCW has emerged as an identifiable research field focused on the role of the computer in group work. One of the primary CSCW characteristics pointed out by (Agostini, 1997) has been its interdisciplinary as a research field, involving people from both computer and human sciences. A CSCW system must provide means to give answers for questions like how groups of people can collaborate using computers? How can people plan to work together using the computer as a medium? How group work must be redifined to take advantage of computers? For (Greig, 1988) the focus on helping people work together is the unifying theme of CSCW.

(Agostini, 1997) proposes general requirements that new CSCW systems should meet as completely as possible: openness, multimedia continuity, contextualisation and integration of communication and action added to personalised and selective workspaces interfaces.

Also, (Wexelblat, 1993) defends two principles of CSCW, namely, the cooperation is not a separable activity, meaning that some computer support to be used must fit into the normal users work pattern. The second principle is that CSCW applications must allow people to cooperate by overcoming barriers of space and time that are imposed on people. This leads to a time-space functionality discussion.

One important factor in CSCW applications is the degree of collaboration aware, that (Wexelblat, 1993) defines as the degree to which knowledge of, and support for, the cooperative activity has been designed specifically into the application. Wexelblat was also among the first to propose virtual technology as an enabling technology for CSCW (Wexelblat, 1993).

Virtual reality

Virtual reality (VR) is one of the enabling technologies for CVE systems. (Chorafas, 1995) treats VR as *a new generation of solutions address multimedia, direct end-user interaction, the ability to visualise one's ideas, and user-activated visual programming processes*.

(Chorafas, 1995) proposed that VR bring change in three levels: In the strategic level, with the emergence of the virtual organisations. In the implementation level, the change will be in the way we work (the virtual office). In the tactical level, interactive 3D graphics play an important role along with artificial intelligence artifacts and object orientation.

For (McGreevy, 1993) VR is *a display and control technology that can envelop a person in an interactive computer-generated or computer-mediated virtual environment*. The same author proposes VR as a technology that *creates artificial world of sensory experience, or immerses the user in representations of real spatial environments that might otherwise be inaccessible by virtue of distance, scale, time, or physical incompatibilities of the user and the environment*.

(Chorafas, 1985) sees the essence of virtual reality as a multimedia environment within the user's reach. (Harrison, 1996) proposes VR as *the delivery to a human of the most convincing illusion possible that they are in another reality*, where this *reality exists in digital electronic form in the memory of a computer*.

VR can be seen as an enabling technology in the sense that it can bring new metaphors for interaction between human and machines. A metaphor (for information technology) is used to create things that people and machines can understand. As (Chorafas, 1995) states, VR *is a metaphor of the real world*.

Among the potential applications for VR are education (Harasim, 1995) and information visualisation (Chorafas, 1995), (Fairchild, 1993) which are central for the creation of a virtual incubator. (Harasim, 1995) report also the importance of simulation, as used by the US Army, as the biggest applications already developed, for education.

Implementation issues

Some classifications arise when we think of a CVE as an immersion tool. This way, we can have a classification from the user interface perspective where we can historically list text base interfaces and virtual reality interfaces. Some examples from the first type are the traditional MUD and IRC systems (although these systems cannot be considered strictly as CVEs systems). Examples from the virtual reality interfaces are the Distributed Interactive Virtual Environment (DIVE, http://www.sics.se/dive) who provides a general development environment and the MASSIVE-2 system, from Nottingham University Department of Computer Science (Benford, 97b).

In order to support communication, we need specified links between parts. As (Araujo, 1997) states, the communication among group members depends upon the existence and the potential of these links. These links include mechanisms for message exchange, electronic meetings and discussion foruns. Different approaches to support communication can be identified. One of these approaches is based on shared workspaces. In shared workspaces participants share a common area where they express ideas and build products. Shared workspaces are the most used resources for cooperative interaction support. As referred by (Rodden, 1993) this information sharing model to support collaboration involves the use of conferencing facilities, real-time conferencing systems, desktop and multimedia conferencing and electronic meeting systems. (Benford, 1996) classify shared spaces in media spaces, spatially oriented video conferencing, collaborative virtual environments and telepresence systems.

An alternative way for classifying CVEs is by their application: some examples are computer games and VR CVEs. The last ones are the more promising and are designed to support a medium to a large number of users with virtual representations. A virtual world can have many users represented but also can exist some autonomous agents whose behavior is controlled by a computer program (Zyda, 1993).

Some of the challenges for using CVEs in higher education are: adding video, stabilising the platform on PC's, a managed set of services and Campus Building Facilities (Rodden, 1997).

A detailed discussion of the implementation issues for virtual environments is presented in (Brutzman, 1995), also available on-line at http://www.stl.nps.navy.mil/~brutzman /vrml/vrml_95.html. For an introduction discussion on the software required for developing virtual environments a value source is the (Zyda, 1993) paper.

To assist in virtual spaces building, the AC3D tool provides the necessary software for the rapid construction of 3D objects in virtual environment and allows these models to be saved in formats like VRML, MASSIVE and DIVE (Bullock, 1997).

USE AND APPLICATIONS

Computer Supported Collaborative Learning

One of the dimensions that must be preserved in ODL and also in general education and learning is the interaction between students as an essential learning requirement (Meuter, 1998). Some technologies prove to have potential dealing with co-operation requirements and interaction demands, like the more oriented to education, Computer Supported Collaborative Learning (CSCL), and the more general purpose CSCW systems, already discussed.

Co-operation is defined by (Argyle, 1991) as *acting together, in a coordinated way at work, or in social relationships, in the pursuit of shared goals, the enjoyment of the joint activity, or simply furthering the relationship*. (McConnell, 1994) refers that co-operation *is seen as central to our everyday lives* and *cooperative learning is process driven.* In the definition of the group, (McConnell, 1994) states that a human group is a collection of individuals, who have interdependent relations, and who perceive themselves as a group that is recognised by non members. Finally, group members have interdependent relations with other groups and whose roles in the group are functions of expectations (internal and external).

In open learning situations where there are many different simultaneous influences on the group including distributed systems and the use of virtual technologies to augment the group environment it is possible to add some influences from beyond the social structure of the group itself (Wexelblat, 1993).

Co-operative (or collaborative, as it is also called) work produces information products like decisions, designs, analysis, minimises information loss, and operates at finer levels of detail (Scherlis, 1996).

What are the outcomes of cooperative learning? In their work, (Slavin, 1990), states that cooperative learning increases the positive effect of classrooms, and that students working cooperatively become more cooperative; they learn pro-social behaviours such as how to get with others, how to listen and so on.

In addition to the individualistic and competitive learning goal structures, the cooperative one can be relevant to education, learning and training, justifying the introduction of ICT that supports it. This way, to enhance a CVE system, some CSCL principles can be adapted to take advantage of the referred outcomes.

Virtual environments in higher education

For today students the amount of information available about anything, anywhere and anytime, accessed from everywhere in huge amounts makes it impossible to anyone to maintain a global knowledge, even in a restricted area, on an individual basis. This will be called the *any phenomena*.

Facing the huge amount of information available in a daily basis and in a global scale, we need to prepare students to use ICT to deal with the *any phenomena* (anything, anywhere, and anytime). This need is just not only for students in ODL environments but it's also useful for all kinds of education environments. We can see this need as a complement to more specific needs for each type of education, training and learning.

As individuals, students can use VR to enhance learning. Virtual Reality seems to offer new forms to deal with huge amounts of information and explore them, since it combines 3D representations, interaction, and a more clever use of human senses. These facilities bring the feeling of immersion - locking as many of the human senses as possible - (Fairchild, 1993) and (McGreevy, 1993) and the feeling of presence (Harrison, 1996) in a different place that current literature refers as cyberspace (we can call this, following the any phenomena, as an *anyspace*). In that sense, we can have as many spaces as needed to represent different contexts in an individual or group perspective.

If we offer a technological environment where students can use some form of a information space where they can interact with information using some multimedia and 3D representation facilities, we are extending the library concept, making the gaming of search, browsing and understanding a more technological one. In this situation, the students rely on their own capacities to organise their activities and gather the required information. These activities are done in an individual basis, but tasks, assessments and work must be the result of collaboration efforts.

How about some co-operation on this kind of activities, sharing knowledge between students and extend interaction to the system itself, combining virtual reality techniques with CSCW. This brings the essence of a CVE system: make possible to someone to interact with an shared information space and with other individuals to share, discuss and make as much visual and representation information organisations as wanted.

Each student organises his own activity in *anyspaces* that can be private or shared among other related students. This introduces a real bias to CVE systems where we can make some individual or group actions, co-operate and compete for information and credits, and use this potential as a real work tool, not as a substitute but as an improvement.

A rationale for the virtual incubator

As (Chorafas, 1995) points out, the creation and enhancement of technology-augmented environments raises many issues in technical, social and biological areas. The technical issues arise because there is a need to offer solutions to novel requirements and provide complex infrastructure functionality. The social issues arise because it's important to deal with student expectations (different kinds of students, from different backgrounds), the teacher interests and the institution itself that must answer to an evolving changing environment where the relations with the whole society are an actual crucial requirement. The biological issues must be considered for the creation of the appropriate input and visualisation solutions.

The information society can be described as a society based on digital interaction and one that is predominant computer mediated. Based on the assumption that we are entering into an information society environment, we present the following rationale for the virtual incubator project.

Information has become a dead resource, as (Barnatt, 1997) refers, information is fast becoming a *hygiene factor, something we only notice the value of in its absence*. Due to the excess of information sources and the increasing difficulties dealing with huge amounts of information that is available on-line, sometimes freely, we can say that for students and even teachers searching for a definitive list of references upon a topic has therefore become impossible. This is also true for professionals, and this means that these three groups of people have a common problem.

In this context, as (Barnatt, 1997) states, *hunch and intuition-gut instinct, creativity, knowledge, expertise and imagination* possess an importance and growing value. The last four characteristics mentioned are available in university environments and constitute valuable assets that can be traded.

In conclusion, we can see some potential in CVEs use for production and trade of the creativity, knowledge, expertise and imagination. This production and trade must result from collaborative efforts from all the people involved. As (Barnatt, 1997) states that *new knowledge media, if they are to be effective, therefore have to allow for the sharing of experiences, whether in environments virtual or real.*

Some virtual incubator experiences in the Web

There are several types of virtual incubators experiences using the World Wide Web. We can classify them between profit and non-profit initiatives. Other possible classification can be between organisations that use the web as another alternative communication channel (mix) or the pure ones that exclusively use the web (pure virtual).

Some of them result from a specialised division of a consortium, like Spacecraft Productions, from TSTC, oriented to *promote the interest in and understanding of advanced technology with emphasis on the space program*. Spacecraft Productions is one stop shop for pre-production, and post production including concept development, research, writing, archival support, and access to technical experts. His web site can accessed in http://www.techware.com/tstc /spacecra.html. The interaction within the system is based on membership.

Other examples of virtual incubators are foundations initiatives, like The Peregrin Foundation (http://members.aol.com/peregrinfd/Home.html). The Peregrin foundation promotes Virtual Incubator Programs (VIPs) that are, in the foundation words, *primarily focused on information technologies, especially knowledge navigation and representation, multimedia applications for education and law, scientific visualization, spatialization, virtual reality, linguistics, text encoding, digital libraries, cognition and total immersion computer aided learning*. These areas constitute a good list of examples of potential areas to develop in virtual environments. The interaction with the system is based on submissions for participation by the user that can gain an access account.

There are some virtual incubators that offer services like virtual catalogs and indexes. One example of this type of virtual incubator is the Microbusiness Online©, sponsored by WORC, available on-line at http://www.atworc.org/program_sites/microbiz/, which provides a business card and search services. The International Business Incubator uses the web to promote their services to enterprises giving some price information, like the one available at http://www.internationalincubator.com/costs.htm.

One last example is the Web Bidness Incubator by Midwest Technical Associates and Web Merlin. This incubator proposes a partnership where the entrepreneur contributes with the idea and they provide the Internet expertise. In their site at http://www.bidness.com/incubator /index.html, is available interesting information about the rules, general guidelines of making virtual products and a potential line of action explained.

As we have seen there are already many available implementations of virtual incubators in place, with dozens of different services offering. However most of these services are based in providing some information that is expensive to gather and expensive to timely maintain with quality.

The proposed project

In the context of the proposed virtual incubator project, information is not the issue. It proposes a global information system environment where several thousand people work and produces potential answers for someone's specific problem.

We have three types of users, with different roles: students, teachers and associates (these later, already discussed, as the professionals from outside university environment like enterprises and government).

The products, services or activities that classify for potential use are the ones that match the four characteristics already mention (*creativity, knowledge, expertise and imagination*). The system is web based and is organised into projects that can evolve to virtual spaces with credit offering in classes.

Students can exchange competences, skills and several kinds of work among them, providing that they be effective members of the related virtual space. Each virtual space (named an *anyspace*) can be created by students, teachers or mixed groups that can contain any number of individuals from one to many.

The credit system is based on hours to teachers, credits for students (that way we can redefine the time in which a particular student can take his degree) and traditional membership cost to the associates. Associates contribution can also be valued by giving them credits for professional certification (a need in a lifelong learning society).

As may be possible to easily verify, this can have a tremendous impact in the way a higher institution works. How will this work in a real situation? Who will adhere to this kind of system? How will the actual university information system support a virtual incubator centred education system? What will be the impact in the creation of new professionals and business opportunities? What are the scale problems in dealing with students, teachers and associates? What are the roles for each one of the three mentioned user groups?

All this questions remain without a clear answer, and the implementation of the virtual incubator project seems to open the need for a full line of experimentation. In (Gouveia, 1998b) one of these trials has already been conducted to demonstrate a viable path of innovative use of web facilities in an Intranet environment.

In this particular use, we test a group assessment, where groups of three students make their exams in a collaborative way. One of the students stays in the exam classroom where his goal is to write the answers in the examination form. The second student stays in the library where his goal is to access available library resources. The third student is in a social space (his goal is to gather other expertise from people that he manages to bring to the social space). All the three students can communicate with their laptop computers using the network and Web services. The experiment results are presented in (Gouveia, 1998b).

CONCLUSION AND PERSPECTIVES

In order to access the value of the use of a CVE system at Fernando Pessoa University we need to evaluate its feasibility in operational, technical and economic perspectives.

The operational aspects to start a CVE system are the need for a communication infrastructure, a user community with some literacy on computers and networks and an environment that facilitates and justifies the use of the CVE system.

At Fernando Pessoa University these operational items can be fulfilled with the NetLab environment. However the technical support of the laptop users and the network infrastructure is crucial to the success of a CVE implementation. It is also important to the normal NetLab operation but more important in a complex system where users need intensive support and the infrastructure has even more demand. A discussion of the issues dealing with laptop support at Fernando Pessoa is made in (Gouveia, 1998a).

In the proposed project, the technical perspective has two faces. The technological system itself, with the hardware and software that take advantage of the laptop initiative. In the second technological face we have the services and applications offered to the community. These services and applications must be developed as a natural evolution to the use of the web facilities.

The combination of HTML, CGI-bin, JAVA and VRML seems to be the more appropriate to the Fernando Pessoa environment in a way to integrate the proposed system in one single (and known) interface - the Internet browser - and have a maximum of system usability.

This way some experience is gathered in testing and using more services and functionalities. Some functionality like the use of video or real time applications can be tested within small groups of students that can have enhanced laptop systems and knowledge to deal with that. These king of experiences are not difficult to set up in terms of voluntary students (with their own machines) because their number is high and some of them have the expertise needed and economic possibilities to buy high-end laptops.

One important factor is the role of the student to disseminate and help support new system functionality. Some technical issues like dealing with scale problems and network traffic are just considered as the need to upgrade servers and the network itself (this actually constitutes another reason to use Internet proven known technology). The experience resulting from this first phase will be used to redefine these two items: the student's role in promoting the system and assess technologies application.

In the economic perspective, first of all, it's important to have the support of the management board of the institution. Without this, it is very difficult to have the necessary funds to invest in infrastructure when the system use rises (with technological scale problems to resolve, from network power to security and software complexity). It also needs a strong investment in people to start a CVE system as a project and to support the user community (both in technical staff and in the user community involvement, to promote the system and support their use).

This support goes from technical support, to hardware and software, and to functional support of new needs and functionality. At last, in a pure economic view, a CVE system can not easily be assessed because the impacts of this kind of systems are still in a evaluation phase.

Conclusions

The offer of virtual labs in higher education seems to reduce maintenance and operational costs, after the necessary investment phase to develop them. In fact, with student's laptops and a clever use of Internet/Intranet facilities it is possible to develop and maintain a system where the major institution costs are network investments and general support.

The existence of a large community of laptop owners and a offer of a system like the proposed one will cause the reuse of more materials between teachers and helps dealing with physical restrictions like classrooms, schedules, time/space compatibility between teachers and students, and between different students from different classes.

The digital base of the virtual labs can also permit to construct information databases resulting from their use, but this still needs to be supported by more complex software systems that needs to be developed (which costs money and time).

The introduction of a virtual infrastructure to enhance tools for on-campus education can also be used to ODL offerings. Can we say that this will lead to a redefinition of the higher education activity, namely the "business side" of education, training and learning? The impact of an experimented infrastructure to offer a digital support to education, training and learning constitutes a real competitive advantage for any higher education institution (which, in that sense is not new). But it also presents the basis for the transformations needed to deal with new realities like life long learning and deal with the new education competitors - the enterprises.

Introduce group activity in more situations than the actually used in higher education seems to be another great advantage of using a CVE system. It will be possible to prepare and assess students in collaborative activities in an implicit or explicit way. The assessment issues are, along with the administrative work, the activities where teachers spend more time.

If we support teacher activity in assessment and administrative work we can expect that they will become more productive in making education materials. Can this contribute to transforming teachers into creators? This will lead to a different kind of teacher, substitute his predominance role of a facilitator by the role of a creator - some sort of an *anyspace* producer.

At last, a CVE system can enhance the creativity, since it fosters interaction between different people, leading to the creation and development of new forms to represent, search and browse information and knowledge. This last issue seems a viable work theme where further research will be conducted.

Perspectives

In terms of the application described in this paper, one important aspect is the study of the results of his operation. Gather information from the development of the virtual incubator environment, monitor his use and evolution constitutes one important study to assess the real impact of a CVE system.

One interesting point of the particular project described is the introduction of the associate member. Further work will be needed to introduce the associate member as a third element in the university (along with the student and the teacher). The associates who can be partners in teaching and also learners, seem to have a great potential and constitute a possible way to bind higher education to the industry.

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