Network-based Business Simulation Activities in Technical Professional Education

Vassilios C. Vescoukis

National Technical University of Athens, Software Engineering Lab v.vescoukis@cs.ntua.gr Symeon Retalis University of Cyprus, Computer Science Department retal@cs.ucy.ac.cy Dimosthenis Anagnostopoulos Harokopion University of Athens, Department of Geography

dimosthe@hua.gr

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Authors' data

Dr. Vassilios C. Vescoukis (corresponding author) App. Lecturer National Technical University of Athens Faculty of Electrical and Computer Engineering, Software Engineering Lab 9, Heroon Politehniou str Zografou 15780, GREECE

Tel: +30 210 7721688 Mobile: +30 94 4332281 Fax: +30 210 7722734 E-mail: v.vescoukis@cs.ntua.gr (preffered)

Dr Symeon Retalis

Lecturer University of Cyprus Department of Computer Science P.O. Box 20537 Nicosia, CYPRUS

Tel: +35 7 22 892246 Mobile: +35 7 99 893174 Fax: +35 7 22 339062 E-mail: retal@cs.ucy.ac.cy

Dr Dimosthenis Anagnostopoulos

Assistant Professor Harokopion University of Athens Department of Geography 70, El. Venizelou str, Athens 17671 GREECE

Tel. +30 210 9549100 Mobile: +30 94 4277000 Fax: +30 210 9577050 E-mail: dimosthe@hua.gr

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Abstract

For a long time on-the-job training has been considered as the single point of contact of technical education with the real world job market. Indeed, traditional on-the-job training activities are of great educational value and complement uniquely any classroom-based learning activity. However, it has been observed that several obstacles arise when integrating on-the-job training with traditional learning and that new network-based tools can be used to improve the situation. Following this concept, in this paper we introduce a network-assisted educational structure for business simulation activities which can be considered as an alternative or a complement to on-the-job training activities in technical professional education. Business Simulation Activities are based on the execution of business scenarios in a controlled educational environment with support by network tools. A simulation of the real world business environment is created and virtual companies are established in order to participate in a virtual marketplace using network-based learning support and aiming to provide on-the-job experience without the shortcomings of traditional on-the-job training. An operational structure, network distribution, implementation issues, as well as some experience from a pilot implementation of the concept, are presented in this paper.

<u>Keywords</u>: architectures for educational technology systems; simulations; cooperative/collaborative learning; distributed learning environments.

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1 Motivation and context

Educational systems around the world are being reformed. New technologies have played a great role in motivating this restructuring, mostly as the provider of new tools for knowledge delivery in a rapidly-changing global environment. New technologies enable the introduction of network-based, distributed, synchronous and asynchronous educational frameworks that would not have been otherwise possible. However, apart from the introduction of new possibilities, several educational challenges are now clear, as well. One of the most dominant challenges that current educational systems have to face, is the relation among the information delivery domain and the knowledge application domain - the job market.

A gap between the classroom and the job practice is now recognized as an obstacle that education has to overcome. In order to fill this gap, the EU has undertaken a number of actions ranging from continuing education to long-term solutions, that is, a large scale rethinking of the educational systems in terms of structure, content and tools. "On-the-job (or in service) learning" (or "in-service training") has been introduced as an approach for providing meaningful and engaged learning for students [Paris and Mason, 1995], even at the age between K-12 and high-school education. Other instructional approaches combine classroom instruction with employment (part-time jobs during the school year or alternating periods of study and employment), with community service, or are even based on the relationship between schools and companies [Naylor, 1997]. Whatever the case is, it is clear that high-school students need to be better prepared for the real world while still at school [Shaughnessy, 1994]. The idea of work simulation seems to gain ground, needless to say, with many flavors, approaches and assumptions [AIMM Consulting, 2001]. One approach in this context, is the employment of computer-based learning in corporate training; there are already commercially available software applications for this purpose [Innovative Learning] Solutions, 2002] mainly addressed to companies who wish to train their employees by engaging them into market simulation games. The same in-site training concept is also applied to corporate training of management personnel, as a method to bridge the gap

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between the skills provided to new managers in school and those needed in the real world [s8].

However, it cannot yet be supported that efforts have produced satisfactory results for everyone. Educators and New Technologies specialists try to discover how technology-assisted learning can bridge the aforementioned gap, as well as what the proper educational models and tools are. So far, a well-accepted approach to technology-assisted learning, in the sense of been applicable in all educational contexts, has not yet matured and perhaps it may not be possible at all. Several works focus in the area of technical professional education provided to graduate students of secondary level institutions, and in particular on the integration of traditional with network learning [Vescoukis and Retails 1998, 1999, 2000]. On-the-job training using limited part-time employment is part of the curricula of such institutions. When it comes to the real world, on-the-job training is seldom practiced "by the book" and has quite less than the anticipated educational outcome, due to reasons beyond the scope of this paper. Nevertheless, in an ever-competing world, companies ask to hire experienced employees, while experience cannot be gained without having been hired by someone - sort of the classic "chicken-egg" problem.

In this paper we introduce a computer-assisted educational structure for business simulation activities (BSA) which immerse the student in a simulated environment where he or she can practice tasks to master skills and gain understanding and useful experience while still at school. The BSAs are an alternative or a complement to on-the-job training activities in technical professional education. In a business simulation, students perform tasks such as starting a company, creating a production strategy, and defending an investment plan to a board of directors. Students are challenged to resolve unexpected events or changes in the business context [Linser & Naidu, 1999]. The point in a business simulation is that students learn by doing. The actual work environment is simulated and they perform tasks that they will have to perform on the real job. In a business simulation context, students can practice;

they can attempt to recover from poor cash positions, labor disputes, manufacturing snafus, and the like, without risking the financial health of a real company and thus, been able to learn both from successful and unsuccessful decisions and actions [Schank, 1997].

A main feature of business simulations supporting its effectiveness is the role of tutors as "simulated personalities" that interact with the student. They may play the role of subordinates, peers, mentors, or adversaries, guiding the participants to successfully navigate the simulation, or challenging them to find innovative ways to succeed in the face of competition. For example, students might get advice from tutors playing several business roles in creating a business plan. Network technologies are enabling technologies for making BSA possible and close to those of the real world, mainly because they support open, flexible and learner-centered patterns of study, provide new ways for learners to work collaboratively, and facilitate the development of communication and co-ordination skills [ALTP, 1997]. However, the use of such technologies is not straightforward in all educational contexts where simulation activities are played. It is, therefore, necessary to define an educational structure as the context where such activities take place. Such a structure, focused on secondary level technical schools, is presented in this paper.

Secondary level technical schools in Greece, provide vocational training to students aged 15 to 18. Usually, on-the-job training activities are part of the curricula of such institutions and their necessity, especially in the technical job domains, is evident. These activities take place in real workplaces provided by companies affiliated to schools. For a short period of time students leave the classroom and practice the skills in the technical job that they learn at school, within a real world environment. Details, such as the duration of the practice and the coordination with the traditional classroom learning process, may vary from case to case, yet the main idea remains the same.

Although a well-done on-the-job training activity has great educational value and complements uniquely the classroom-based learning process, it has been observed that

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several obstacles arise when integrating on-the-job training within the context of traditional learning. Typical such obstacles can be classified in three categories: Practical, legal and human-factor related.

<u>Practical problems</u> are related to the coordination of on-the-job training activities with the traditional learning procedures. The time schedule should be suitable for both students and the participating companies, the time period should be reasonably long so that trainees can get a fair idea of the job, but not too long, in order to fit in the school period. Extra-scholar activities that students undertake, as well as the constraint to finish the school period by the end of June, make the use of alternative solutions such as practice in after-school hours or during the summer, quite difficult.

<u>Legal problems</u> refer to the legal status of trainees when practicing in companies' premises: what is their social security, who is responsible for what and up to what extend, and so on. The legal responsibility and the insurance issue can lead to the rejection of any idea for onthe-job training activities, especially in technical specialty jobs which possess a high risk of labor accident.

However, even if the aforementioned issues were resolved, one quite essential problem should remain: that of the *human factor*. As mentioned above, students practicing on-the-job training might end up to be the "water-boys", practicing the "do-this-do-that" job, instead of doing what they are supposed to. Students themselves bear little or no responsibility for this fact. It seems that, for their own and well respected reasons, companies cannot always offer the human resources required for training temporary staff.

The above matches, at least to some degree, the experience of those who have worked in the field and have faced some of these problems in action. Hence, one can easily come to the conclusion that no matter how important on-the-job training is, its application in secondary education technical training, for the majority of technical specialties, faces big obstacles. In order to bypass such obstacles, several alternatives have been considered. The *business simulation activities* concept is one of these alternatives. The idea is widely applied today in corporate training, in graduate studies and, generally, in educational environments where older and more mature audiences than those of our focus, are trained.

BSAs simulate the real world job practicing conditions, in a controlled, network-based educational environment. By participating in such activities, trainees obtain on-the-job experience while operating in a safe and controlled educational environment [Naidu, Ip, & Linser, 2000]. Issues such as those mentioned earlier do not exist in such contexts. However, business simulation activities face several obstacles, too. Unless they are properly organized and supported, they fail to meet the challenge of matching the real world situation as closely as possible.

Setting up BSAs in secondary level technical training is by no means easy and straightforward. It involves thorough knowledge and dynamic monitoring of each profession and/or professional branches involved, in all their aspects, which in turn leads to defining a suitable educational structure, simulation rules, tutor and learner roles, as well as communication and assessment tools and procedures. BSA philosophy is in line with Roger Schank's Goal-Based Scenario (GBS). Typically, a GBS includes a mission, a cover story, a focus and an operations component. According to Schank "GBSs are always constructed around skills and processes. Facts and cases have no place in a GBS's pedagogical goals: while they may be helpful to a student, they must not be taken as an end by themselves. Rather, they are taught as supporting material while the student is engaged in trying out the skills around which the GBS is built" [Schank and Cleary, 1995].

Even further, as the technical jobs evolve with the rapid technological developments, this structure has to be flexible enough in order to adapt to new developments. Network-based support is very essential since BSAs can be undertaken by distributed teams rather than individually. This adds a collaborative learning dimension to the BSA architecture whose

effects have additional pedagogical benefits. In the next sections we present such a structure, which has been proven to be effective and flexible when put into practice.

This paper is organized as follows: In the next section we present the terminology, the requirements, the operational structure and the implementation steps of an educational Business Simulation Activities environment. Then, a network-based distributed computer architecture for supporting the execution of BSAs is presented. We conclude by discussing experience and results from putting these ideas in practice.

2 A business simulation environment

2.1 Definition and requirements

A virtual enterprise is a business simulation activity where real world professional activities of specific technical specialties are reproduced in a controlled learning environment. Each virtual enterprise has its own structure, objectives and operating scenarios that correspond to those of a real world company. This documentation, together with learning material, tutor instructions and implementation details, comprises the *virtual enterprise handbook*. Several types of virtual enterprises for different technical specialties may exist in a particular learning environment. Virtual enterprises of the same type (technical specialty) operate according to the same virtual enterprise handbook.

A *virtual marketplace* is the simultaneous execution of multiple virtual enterprise simulation activities. The virtual enterprises participating in a virtual marketplace can be of the same or of different types, depending on each specific implementation situation. A virtual marketplace is determined by a set of rules, common for all the types of participating virtual enterprises. These rules, as well as coordination, communication and evaluation procedures are contained in a *virtual market handbook*.

According to our approach, in order to set up and run virtual enterprise simulation activities in a specific educational environment, one needs to take the following five steps:

Step 1. *Define a vision of the virtual marketplace*. A virtual marketplace is a higher level organization, with the mission of constantly monitoring real environments and at the same time acting as a compiler/generator of sets of rules, constraints, and assumptions which compose, to the most realistic degree possible, a simulated environment. It is clear that complete simulation fidelity of the real market cannot be achieved in any educational context. A realistic approach is to rank the market characteristics according to their importance and to decide which ones and to what extend will be relevant to a specific educational environment. All the participants in the BSAs, especially trainers, must be well aware of rules, valid assumptions and constraints. Rules may be global in the virtual market or may depend on each enterprise type. Table 1 contains typical common and enterprise type-dependent rules.

Rules	Legal	Marketing/accounting	Communication
Common	 Establish procedures for the foundation of a new company Obtain tax and bookkeeping authority/registration/ Manage relations with the IRS Establish how regular and unexpected company auditing by the IRS is done Establish possible penalties by the IRS 	 Marketing principles Market environment: clients, suppliers, subcontractors Competition policies and ethics 	 Communication rules Communication tools and procedures
Type- specific	 Obtain special permit / authorisation required to practice a job Job-specific legal constraints and requirements, paperwork, etc Establish instances for the control of the above. Establish penalties by the Legal Environment 	 Develop a Bookkeeping plan and intra-company procedures Decide upon the cash-flow management policies Professional rights, job ethics and behavioural rules 	 Design of company stationery Create company profile Create staff CVs Develop recruitment policy

Table 1. Virtual marketplace rules

Step 2. *Define an operational structure*. Roles, responsibilities, communication paths, procedure valid and invalid activities need to be well defined for an effective implementation

of the BSAs. Such an operational structure is presented in section 3.2. The outcome of steps 1 and 2 is the *virtual marketplace handbook*.

Step 3. *Create/compile virtual enterprise handbooks*. Each virtual enterprise type has its own handbook which contains educational material, implementation details, rules, procedures and scenarios for the simulation activities. Part of the virtual enterprise handbook is readable only by supervising trainers.

Step 4. *Define auditing, assessment, and feedback requirements.* Needless to say, continuous tracking and evaluation of the simulation activities is imperative both for making the necessary adjustments at the correct time, and for assuring the quality of the simulation. In other words, the degree to which simulation attains to approach the desired level of reality in quantitative and qualitative terms is gained by recorded experience.

Step 5. *Create a network learning infrastructure to support the simulation activities.* As mentioned earlier, BSAs are strongly supported by network services. Operation handbooks, learning and reference material, operating scenarios, communication channels, auditing and assessment can all be implemented in a distributed network learning environment. A deployment model for this is presented later in this paper.

2.2 An operational structure

In order to define an operational structure for the implementation of BSAs, we first considered the fact that before getting involved in such activities, trainees have experienced only the student-teacher relation. In this model, trainers are taken to be trusted by students; they operate as the single source of stimulus in the learning process; they say to students what to do and students do it. This is not the case in a real workplace where in order to take any action, a group of co-workers is stimulated by real-world events and conditions. One of the most important benefits of real on-the-job training is the interaction between the work environment and trainees as workers. Hence, BSAs should be organized in a manner that

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develops interaction skills. In order to achieve that, a clear distinction between the virtual workplace and the traditional source of knowledge, has to be made.

Bearing this requirement in mind, we define an organizational structure for performing business simulation activities, shown in figure 1. The main characteristics of this structure is the distinction between two environments, called the *control* and the *simulation environment* respectively as well as the suitability of this structure for implementation in a network learning environment. The *control environment*, as its name implies, is where the simulation is conceived, managed and supported. It acts, among other things, as generator of BSAs and as training agent of the actors participating in the simulation environment. Students initially interact with the control environment for getting acquainted to the simulation rules, communication procedures and support resources. The *simulation environment* is where the simulation activities actually take place. Trainee communities are organized in cooperating, competing or simply co-existing virtual enterprises. Each community performs a number of simulated tasks by accepting stimuli from the communications centre, as will be later discussed.



Figure 1. An operational structure for simulation activities in Technical Professional Education

The control and simulation environments are organized into *units*. Each unit is a panel of trainers, supported by consulting practitioners. Depending on the particular conditions, units operate either by live sessions or by network-based communication such as teleconferencing, messaging or groupware in general. Four units operate in the *control environment*: the *directing board*, the *command unit*, the *auditing and assessment unit* and the *Knowledge management unit*.

The *directing board* is the policy-making centre of the BSAs. Trainers and industry experts that are connected to real world professions participate in the directing board, set the learning objectives, the rules of the activities, as well as the constraints and assumptions that stand for the virtual marketplace. Issues as the duration of the activities, the simulated time, the virtual competition rules and other implementation strategic decisions, are all resolved here.

The *command unit* is the "executive director" of the simulation activities. Usually, the command unit is comprised of 1-5 supervising tutors depending on the scale of the implementation. The creation of virtual enterprise instances (virtual companies) is decided here, according to the simulation requirements and the available resources. After interviewing and negotiating as in the real world, students are assigned to positions in each virtual enterprise. Finally, the command unit orders the execution of all kinds of simulation activities.

The *auditing and assessment unit* supports the implementation of the simulation activities by processing and communicating the orders of the command unit to the simulation environment, through the communications centre. Practical issues such as process auditing, reporting, log classification and processing, filtering, feedback management, as well as process assessment end evaluation of student deliverables and activities are undertaken by the auditing and assessment unit. As the simulation activities take place, trainees address

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the control environment through the auditing and assessment unit, for asking questions about simulation issues and for delivering products and reports.

The fourth element of the control environment, the *Knowledge management unit*, is the "centre of knowledge" of the business simulation environment. It is comprised of a panel of domain experts supported by Network Learning infrastructure. Reference material, virtual marketplace and virtual enterprise textbooks, rules, simulation scenarios and documentation, case studies, as well as computer-based assessment services, are all offered to the simulation environment by responsibility of this unit. The panel of experts is responsible for setting up and running the unit and for selecting, fine tuning and updating the Network Learning environment mentioned in step 5 of section 3.1. They do that by monitoring students' progress, by adding new learning and information resources, by processing feedback and by evaluating assessment questionnaires. A very important responsibility of the Knowledge management unit is keeping the learning content up-to-date according to the current evolutions in the real world jobs and marketplaces.

The *simulation environment* is where the simulation activities take actually place. Several virtual enterprise instances exist, operating independently, cooperatively or even competitively, according to the virtual marketplace rules. Each instance operates according to the virtual enterprise handbook of its specific virtual enterprise type.

The *communications centre* is an adaptation of a groupware and messaging infrastructure to a particular simulation environment. It is an element of computer and network infrastructure and services - not a panel of experts. Depending on the available resources and services, the communications centre can support group coordination, videoconferencing, voice communication, synchronous and asynchronous messaging. Design decisions about the messaging infrastructure must take into consideration the conception of the virtual time in the simulation environment, as well as the communication requirements of the Network Learning infrastructure that is used. In terms of implementation, the computer infrastructure of the *Knowledge management unit* and the *communications centre*, may share the same computer resources, depending on the the scale of each particular implementation.

2.3 The building blocks of business simulation

The building block of virtual enterprise business simulation activities is the *simulated job task*, or simply *task*. Each task is a single activity or a sequence of activities that usually occur in the corresponding real world workplace and which has specific learning objectives. The granularity of the task definition depends on the specialty domain of each virtual enterprise type. A rule of thumb is that a *simulated job task* corresponds to the same action(s) that are usually repeated altogether, every time with different instances of initiation conditions and results. For example, the placement of an order, the issuing of an invoice, the payment of a debt, the installation of an alarm control unit, the replacement of a car battery, the fixing of an appointment with a client and so on, are all examples of tasks.

A task has discrete initiation requirements (pre-conditions), as well as discrete results (deliverables and post-conditions). It is carried out by resources (human, materials, tools) properly assigned by the virtual enterprise administration. The cost estimation of a task is an essential element of the simulation activities which students have to perform. Other requirements may also be related to tasks, as shown in the task record presented in figure 2.



Figure 2. Tasks and scenarios.

A sequence of tasks is called a *simulation scenario*. A task can participate in many scenarios, not always in the same order. A scenario is a sequence of tasks that produce a result visible to the (hypothetical) client. The execution of a commercial order, the servicing an automobile, the development of a software application, the installation of an alarm system etc, are all examples of scenarios. A structure useful for representing the relation between *tasks* and *scenarios* is a table, called the T/S table. Tasks define the rows and scenarios define the columns of the T/S table; if a task T_i is part of a scenario S_k , then the rank (order) in which T_i is executed in S_k is defined in the cell of the table where T_i and S_k intersect, as shown in figure 3.

	Simulation scenario S ₁	Simulation scenario S ₂	 Simulation scenario S _n	
Simulated job task T_1	Rank(T ₁ ,S ₁)	Rank(T ₁ ,S ₂)	Rank(T ₁ ,S _n)	
Simulated job task T_2	Rank(T ₂ ,S ₁)			
Simulated job task T_k	Rank(T _k ,S₁)		Rank(T _k ,S _n)	

Figure 3. A T/S table for representing task and scenario relations

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Two scenarios are defined for all the virtual enterprise types: the first one is the "foundation of the enterprise" and the second one is the "estimation of the profit/loss result" scenario. The foundation scenario is always executed first by all virtual enterprise instances in order to bring up the legal, technical and procedural issues that trainees have to deal with when making their own company. It also introduces trainees to the field of entrepreneurship, by bringing up issues such as the need for the study of the various environments a company has to recognize, the relation the company has to establish with these environments, the recognition and analysis of the entrepreneurial opportunity, the thesis the company has to take towards the risk involved etc. The profit/loss scenario is usually executed last, in order to estimate the virtual financial result of the simulation activity. Neither of these activities usually takes place in real on-the-job training environments, despite the fact that it is indeed important for students to be guided towards addressing such issues in order to be able to start developing their own entrepreneurship aspirations. We consider this a major advantage of the proposed approach.

2.4 Setting up and running

Having mentioned the notions of *task* and *scenario*, we recognize four phases for preparing and executing simulation activities: setup, preparation, run, and assessment.

Setup phase. First, the control environment needs to be set up. Depending on each particular learning context characteristics, a modest small-scale approach where only 1-2 types of virtual enterprises exist, can be taken at the beginning. The creation of the virtual marketplace textbook and of one virtual enterprise textbook for each virtual enterprise type, as well as the installation of the computer and communication resources, indicate the completion of the setup phase.

Preparation phase. Before initiating the business simulation activities, participants are notified about the context, the procedures, the rules and the available tools and resources.

The documentation textbooks are presented to supervising tutors in order to achieve a mutual understanding about the conceptions and the content of the simulation. Decisions taken by the *directing board* are carried out by the *command centre* and virtual enterprise instances are put together. Students are informed about their assignments, roles and communication procedures, more or less in the same way that newly recruited personnel are introduced to a real company's environment.

Run phase. Depending on the enterprise type, each virtual enterprise instance is comprised of 3-10 trainees. Keeping virtual enterprises reasonably staffed is quite essential, since no real company has unlimited human resources. Under the supervision of 1-3 trainers and, using support from the network-based learning infrastructure, virtual enterprises operate by running scenarios as sequences of tasks according to the virtual enterprise handbook. It is the students' responsibility to determine how will tasks be executed (scheduling, human resource assignment and the like). Paper-based tasks are always executed from scratch to their entirety, while technical tasks are run in a lab and may or may not execute completely due to cost or other practical constraints. The result of scenario execution is a "product" or "service" offered to the virtual marketplace, internal intermediate products and documents, as well as the corresponding profit/loss result.

Assessment phase. Assessment takes place partially upon completion of the simulation activities and partially during the progress of the activities. It is based on auditing data which is available when the simulation is in progress, on electronic questionnaires filled up by all participants involved, as well as on group interviews and discussions. Questionnaires contain a common section, filled up by everybody, and a role-dependent section for every type of participant (tutor, trainee, expert, etc). Every participant evaluates his/her experience in the simulation environment, as well as the learning material and the fidelity of the simulation as they perceived it; student assessment is done both on a personal and a team basis. Personal assessment addresses the individual performance in executing tasks and in producing quality products; it involves both the tutor and the other team members. Team

evaluation takes into consideration the group performance of the participants, as well as the virtual financial result that has been achieved. Assessment data is processed according to the profiles of responders, in order to provide feedback useful for the evaluation and the fine tuning of the process.

3 Network-based support

3.1 Network distribution

The business simulation environment presented in this paper has been conceived with the implementation in a network-based environment in mind. In this case, several types of network nodes can be identified, which partly correspond to the structure presented earlier in figure 1. The service nodes, provide the network learning services, the communication services and the virtual marketplace management services. With respect to figure 1, the network learning services support the job of the *Knowledge Management Unit*, while the communication services implement the *Communications Centre* and support the *Auditing and Assessment Unit*, finally, the virtual marketplace coordination services implement the business simulation policies of the *Directing Board* and the *Command Unit*. Each Virtual Enterprise has its own node where communication services and custom software application services relating to the virtual enterprise type are provided; these nodes are connected to the service nodes through a network.



Figure 4. A UML deployment diagram for network-based BSAs

The above are shown in figure 4, where a UML deployment diagram for a network-based implementation of BSAs is presented. The nature, the multiplicity and the characteristics of each node remain to be determined in every specific implementation context, as will be discussed in the sequel. In all cases, the geographical distribution is a key factor in determining not only the scale of the network implementation, but also the model of application service provision. If activities take place in a single building, we have a simple case where a LAN is sufficient. This is the case in most small-scale implementations occurring within school premises. As the geographical distribution of the simulation activities increases (cooperating lab centers, companies, as well as other participating schools), new requirements are generated and new opportunities rise as well.

A typical case that pushes the need for strong geographical distribution of BSAs, is that of decentralized regions which are less privileged in terms of educational infrastructure, services and opportunities. Students of secondary technical schools in such areas do not have the opportunity to do on-the-job training for any technical job theoretically offered at school; instead, they can only choose from whatever is available in their region. In such

cases the situation can be improved by using network-based educational tools. In most typical computer-assisted learning environments, this improvement is focused on the provision of access to educational resources such as libraries, virtual labs and communication with distant colleagues through the Internet.

In the case of Business Simulation Activities, the Internet can be used as the network connectivity among the nodes of figure 4. This brings up the idea for the implementation of the idea of Application Service Provision (ASP) over the Internet, by independent service providers. As shown in figure 5, the same service can be provided by more than one, even competing, service providers. Each service provider can focus on a specific service in which he specializes. In this context, communication and network learning services can be offered by numerous providers that need not specialize in the issue of BSAs, making a considerable part of the required infrastructure readily available to those who do specialize in BSAs and can provide the corresponding services.



Figure 5. Distribution of BSAs over the Internet using ASP services

3.2 Implementation issues

Apart from network distribution, there is a number of implementation issues that need to be addressed before bringing such an environment to existence, especially in a secondary technical education context where several practical limitations exist. These issues are the scale of implementation, the computer-assisted learning framework, the representation and management of time, the communication requirements as well as the cost and complexity.

Should the scale of the implementation be small, the computer and network infrastructure requirements are minimal. One server, loaded with communication and computer-assisted learning software, as well as several client workstations for trainees are adequate. Larger implementation scales involve larger computational and communication loads and thus, have higher requirements. In a full scale deployment, one or more servers per virtual enterprise instance may be considered and the situation can become quite complex; however, further details cannot be considered in such a generic discussion.

The second issue the computer-based learning framework. The available choices are numerous, take quite different pedagogical approaches and have varying network and software requirements. A long discussion on this topic can be found in the literature [McCormack,C. & Jones,J.D]. The BSAs described here impose no special constraints or requirements from the network-based learning environment, apart from the procurement and provision of learning content and reference material. Integrating the communication services of the learning framework with those of the simulation activities is a good practice; it is not, however, an imperative requirement.

A critical issue is that of virtual time. By "virtual time" we refer to the execution of tasks and scenarios with or without respect to real time. Usually school homework assignments do not occur in real time, which is not the case in business activities. So, the question is whether BSAs take place in real time, or should time be simulated as well? Should the latter be the case, this should be taken into consideration when the communication issues are tackled. Time management becomes an issue also when the geographical distribution of the game is high. Communication services for the business simulation context can be as simple as plain e-mail and as complex as groupware application services. The choice of feature-loaded

groupware applications is meaningful only if the advanced characteristics of such applications are exploited.

All the above issues relate to cost and complexity, which always impose constraints in design tasks. Apart from any initial cost, the maintenance costs, telecommunication costs and software fees and royalties need to be considered. No generic guidance can be provided here, apart from a very simple piece of advice: *keep it simple*. At least until enough experience is gained, it is best to take the simplest to implement design decisions.

4 Experience and discussion

We have followed the approach described in this paper in implementing a series of Business Simulation Activities within a suitable educational context and using strong network learning support. The educational context was "Sivitanidios School of Crafts and Professions", comprised of six secondary level technical professional education schools in Greece; our work has been supported from the second EU framework program. The same context has been the area where several other innovative computer-assisted educational approaches have been put into trial. [Vescoukis and Retalis 1999] The design decisions of our implementation are shown in table 2.

Design decisions (implemented case study)				
ISSUE	DECISION			
Number of servers	1 web server (apache), 1 mail server (sendmail)			
Communication	e-mail			
Computer-based learning	Content provided by the web server. Plain html and javascript technologies have been used.			
Network	Local area ethernet, 3 w/s per virtual enterprise type			
Virtual time	No			
Software services	MS office, Star office, MS project, CAD			

Table 2. The design decisions in an implementation of simulation activities

Following the steps described in section 3.1, we have set up an operational structure as in figure 1; One virtual marketplace handbook and virtual enterprise handbooks for six virtual enterprise types have been prepared. Within a time period of almost 18 months, 11 instances of 6 virtual enterprise types have participated in simulation activities that have been run according to the process mentioned in section 3.2. A UML use case diagram illustrating participant roles as actors, and responsibilities as use cases, according to our implementation, is shown in figure 6. Virtual enterprise types and quantitative data about the simulation activities that have been run, are shown in table 3.



Figure 6. Use cases in an implementation of simulation activities

						Scenarios			
Virtual enterprise type	No of instances	No of students	Student Manhours	No of tutors	Tutor Manhours	Total	Run in average	No of auditing records	Competition
Automobile-Repair workshop	2	17	1012	5	597	10	9	84	No
Metallic Items Fabrication Workshop	2	14	840	3	606	7	3	64	No
Air-Conditioning Service & Installation Company	1	5	300	3	297	9	9	35	No
Civil Constructions Technical Office	2	11	630	3	618	9	6	63	No
Advertising Publications Agency	1	8	480	3	303	3	3	57	No
Computer Software & Network Development Company	3	25	1500	7	632	9	6	132	Yes

Table 3. Quantitative data for an implementation of simulation activities

After having completed the run of the simulation activities, we have performed an evaluation study using focused group discussions based on questionnaires addressed to BSA actors, both trainers and tutors. Several noteworthy points have been brought into our attention, which have led us to useful conclusions. The most important of these conclusions are the following:

- BSAs offer trainers the opportunity to transfer to the trainees their personal entrepreneurial experience by playing roles of business consultants within the simulation environment. In such an environment, trainers get to know better the manner their students think by monitoring their actions under two authorities: the one of the consultant who is a member of the same team operating within the simulation environment, and the other of the scenario and problem designer who is a member of the control environment.
- Such a setting, balancing among the impersonal context of network-based learning, the traditional classroom and the traditional on-the-job training, improves the communication and human relationships between trainers and trainees and enhances their motivation for mutual understanding. This seems to be because they both have to face a common problem, *which is survival and development within the context of contemporary (virtual) business and labour environments.*
- Computer and network support, enable the accumulation of written knowledge and experience derived from the problems each team has to cope with during the BSAs, into future learning material to be used in similar activities.
- When participating in BSAs, trainees have the opportunity and the responsibility of taking business decisions, applying them in practice, and being taught by the outcomes of their actions, even if their choices are not optimal. As a result, they become more selfconfident and get more prepared to deal with employers in an increasingly competitive job market.

 Trainees and trainers have the opportunity to meet and communicate with real life professionals, who might participate in BSAs as tutors or consultants. This way, the school can obtain feedback from the job market and make the necessary adjustments not to its formal education content (which usually takes a long time), but to a series flexible activities, strongly relating to the real life.

5 Further work

One of the most dominant challenges that current educational systems fail to face is the relation of the school, which is the knowledge delivery domain, to the job market, which is the knowledge application domain. New technologies alone cannot bridge such a gap, unless utilized in proper educational contexts. In this paper we presented a computer-assisted, business simulation activities context, which can be regarded as an alternative to traditional on-the-job training. Focusing on secondary level technical education, we implemented a series of pilot BSAs in six technical specialties. By studying the assessment results, several useful observations came out. Our future intentions are to proceed to a series of new BSAs implementations using support from the 3rd EU framework program, and with stronger computer and network assistance and geographical distribution, taking under consideration the evaluation results from the first pilot implementations.

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