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E-LEARNING METHODOLOGY
FOR HIGH-TECH ORGANIZATIONS

The online learning has been in use for 20 years in one form or another (surprisingly enough, a kind of e-learning was offered even for mainframe applications), but the Internet technology has shifted e-learning from a local curiosity to commonplace. In the year of 2002, Gartner Inc. has predicted that by 2005, e-learning will be the most-used corporate application on the web, and the web will become the lifelong learning platform for much of the world (Harris et al., 2002). This forecast turns out to be close to the reality. Our considerations will be carried out in the context of high-tech organizations and will also touch the matters of staff competence development. High-tech organizations are almost by definition learning organizations in the sense defined by Peter Senge (Senge, 1990). In such organizations learning must be seamlessly integrated with day-to-day activities rather than something that is done occasionally on ad-hoc courses. Permanent learning has become a condition sine qua non of maintaining a competitive advantage in a highly competitive business environment. Therefore, fostering, boosting and developing specific skills, and also providing a general knowledge and awareness for the whole staff on a daily basis are the tasks that have to be supported by state-of-the-art educational and training tools and practices. By the same token, permanent education contributes to shaping the organization into an adaptive enterprise, what has become a necessity on a rapidly challenging hi-tech scene. In this paper we argue that the need for providing permanent and overwhelming learning in the context of contemporary high-tech organizations can be addressed by e-learning, and that it is important not to consider e-learning as a cost centre within an organization, rather – it is a significant component of income generating processes.

1. E-LEARNING FEATURES

Electronic learning, usually referred to as e-learning, is a relatively new approach to teaching and learning. However, the concept that lies behind the e-learning is pretty old and
originally had nothing to do with electronic media and computers. While seeking the roots of e-learning we should pay our attention to *distance learning* which, as reported in (Phillips, 1998), was for the first time proposed in 1840 by Sir Issac Pitman\(^1\) in a form of correspondence courses by mail. This type of learning gained a large amount of popularity and developed into an important sector of education, including higher education. Rephrasing James Hall (Hall, 1995) we can say that the movement of distance education has been first and foremost the one that sought not so much to challenge or change the structure of learning, but to extend the traditional learning ways and to overcome its inherent problems. It seems that the distance education developed as a creative political response to the increasing inability of the traditional teaching institutions to grow larger and meet the needs and ambitions of democratized societies. Distance education employs media in many forms and to varying extents. It may include mail, facsimile, radio, television, satellite broadcasts, videotapes, CD-ROM and DVD disks, teleconferencing and, most recently, the Internet.

Owing to its recent appearance within the hi-tech environment e-learning is still an ill-defined concept among hi-tech technologists and managers. Also the usefulness and suitability of e-learning for hi-tech is subject to opposite opinions spreading from skepticism to enthusiasm. Obviously, there are also those who do not see any significant difference between classroom courses and asynchronous course, adding sometimes that a blended approach may be even more effective. There are a number of definitions of e-learning. For instance, W. Waller and J. Wilson say that: *E-Learning is the effective learning process created by combining digitally delivered content with (learning) support and services* (Waller and Wilson, 2001). They draw our attention to some important words appearing in their definition. ‘Effective’–there are many types of learning process but, in some cases, they are ineffective. ‘Combining’–it is the combination that makes the difference, not the individual parts themselves–although each part is perfectly valid on its own. ‘Digitally delivered content’–this excludes, for instance, paper based materials that, although still a perfectly valid medium for learning, are not e-learning. ‘Support’–theoretically, a CD-ROM based program can be done anywhere and anytime, but it is often not supported by tutors although, of course, it could be. Noteworthy, this definition says nothing about the way the content is distributed.

However, his matter is important, what was reflected in a survey amongst 204 United Kingdom companies conducted by the SkillSoft company, in which 63% of those interviewed spontaneously identified the following description as e-learning: *Internet or intranet based*

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\(^1\) Interestingly enough, Sir Issac Pitman was the inventor of shorthand.
training that enables users to access training courses and learning materials on a desktop computer (A survey..., 2001). A pretty comprehensive definition of e-learning was proposed by Knowledge and Learning System Group NCSA of the University of Illinois at Urbana Champagne: e-learning is the acquisition and use of knowledge distributed and facilitated primarily by electronic means. This form of learning currently depends on networks and computers but will likely evolve into systems consisting of a variety of channels (e.g., wireless, satellite), and technologies (e.g., cellular phones, PDA’s) as they are developed and adopted. E-learning can take the form of courses as well as modules and smaller learning objects. E-learning may incorporate synchronous or asynchronous access and may be distributed geographically with varied limits of time (Wentling et al., 2000). Incidentally, the report (Wentling et al., 2000) includes a comprehensive survey of e-learning definitions done from various perspectives, including the business one.

We are of the opinion that while considering e-learning the following aspects have to be taken into account: (i) quality, design, configuration and organization of e-learning resource materials, in particular whether the materials are network/web-based or available through other electronic media; (ii) nature of the virtual classroom and its fitness for educational purpose; and, (iii) nature and quality of digital collaboration and online communications. Points (ii) and (iii) have a lot to do with the organizational culture that we mentioned above as a critical issue to introducing e-learning. The properties of the training process are obviously highly dependent on the organization that implements it. There are, however, some general principles for reviewing the organizational fabric’s conduciveness to e-learning, and that govern implementation and operation of every e-based training system.

(i) Leadership must encourage knowledge sharing through behavior.

(ii) There is an acute need for considering education as a process being part and/or going across of other organization’s business processes. The organization must find a way to integrate e-learning technology and learning exercises with daily tasks of the employees—what is often referred to as on-the-job training. Thanks to that skills and knowledge upgrade become part of day-to-day activities in the company. It is important that the training activities be explicitly mentioned in job descriptions that are handed over to the company employees.

(iii) There is the need for operating standards, including terminology. Standard terminology is particularly critical when communicating across functional lines, and having a lingua franca is a necessary condition for effective information exchange and cooperation.
The training system should offer different types of educational activities and working modes, while–what can be especially difficult to achieve–keeping the training curricula always complete and updated.

Training should be attractive and compelling and induce proactive attitudes towards education among the staff. Moreover, it is vital to provide the trainees with tangible and intangible incentives.

There is the need for training quality control. The control has to include both the training material and trainers themselves. If an organization expects employees to dedicate time to knowledge sharing and learning, the organization must ensure that their time is well spent. E-learning technologies must be easy to navigate and the resources have to deliver real knowledge value.

There is the need for measures. Measuring the effectiveness of educational programs serves two purposes: to motivate individuals to keep using the program and second, to persuade managers to keep funding it.

Lastly, a company training system can be used not only by company’s employees but also by external parties, such as corporate customers. Obviously, this creates a need for appropriate security mechanisms and requires the training system architecture to be flexible enough to be able to collaborate not only with the local company ICT infrastructure, but also occasionally with external ones.

As far as the educational needs to be addressed by e-learning in hi-tech organizations are concerned a survey reported in (e-Learning..., 2001) identified the following themes: finance; quality management; marketing; project management; research and development; human resources management; strategic planning and development; globalization; organizational development. Our experience allows us to add to this list such topics as: specific business applications (e.g. software packages, sales, call center); new products and services offered by the company; personal data safety; labor safety; general orientation training on the company organization and functioning, foreign languages.

2 In (Harreld, 1998) we have found an interesting note that integrating knowledge management and e-learning to compensation and reward systems is desirable and has more persuasive power.

3 It is worth mentioning that the IBM company has created a scorecard that combines quantitative and qualitative assessments of Intellectual Capital Management (ICM) system return on investment that can be used for measuring e-based training effectiveness.
A general list of major functions to be available to the users of an e-learning system includes the following items: access to curricula and intranet public domain opinions on courses; access to FAQ; participation in courses; access to training materials; on-line tests; results of on-line tests; information of the courses undergone by certain users; specific and aggregated reporting; courses’ management (creating new courses, updating the courses, closing the courses); creating e-learning content; publishing e-learning content in the corporate system; user’s management; access restrictions. More comprehensive information on the e-learning functionality is given in Section 3.

It is interesting to note that nowadays the e-learning market focuses on four sectors:

− corporate;
− higher education;
− government and self-governance;
− public education from kindergarten through high school.

Most likely e-learning will be conquering other sectors such as health, police, civil security and risk management, etc.

The corporate sector, i.e. commercial enterprises, in particular hi-tech companies in which we are particularly interested throughout this paper intends to use e-learning in order to provide: (i) career and job-related learning for their own employees or those of business partners; and (ii) product, service or business-related learning opportunities to customers. Here, the concept of e-learning is rapidly evolving, from focusing exclusively on classroom replication to including new models such as just-in-time delivery, knowledge management, and rich simulations. It is important to note that e-learning systematically introduces new learning models different from classroom training and thereby it changes corporate learning culture.

The corporate world is basically served by five segments of products and vendors:

− learning management;
− authoring/learning content management;
− virtual classrooms/delivery;
− content creation (custom or off-the-shelf);
− professional services.

Below are given some comments on them borrowed from Gartner’s survey (Lundy, 2001).
Classroom replication

Traditional e-learning as a replacement for classroom training will continue to play a role in competency and skill development. However, enterprises considering implementing e-learning programs should also look to advanced e-learning models to develop needed skills more quickly or as a means to reduce or eliminate the expense of maintaining some personnel competencies.

Knowledge Management-based e-learning

Supporting the knowledge transformation in business, e-learning becomes key to the growth of enterprise information assets. Knowledge management-based e-learning supports the development of intellectual assets, workplace collaboration and innovation. As such, it is a core component of a mature knowledge management program and should be linked to personnel and organizational competency models, compensation plans and reward schemes for contributions to the organizational knowledge base, as well as to innovative applications of the knowledge.

Embedded help/performance support

The second model–embedded help/performance support–emphasizes the movement away from traditional classroom courses to ubiquitous tools, learning objects and short tutorials embedded in ICT applications. Teaching end users how to use complex ICT applications using traditional courses converted to a computer-based training or on-line format has almost always failed in the workplace. Therefore, many vendors are spending around 8 percent of their total development budgets on embedding context-sensitive mini-
tutorial videos, sometimes only seconds long, into applications so that the users could get acquainted with the tool itself, and next to start working with the subject matter courses.

**Immersive simulations**

As evidenced by the popularity of video games, high-adventure team-building courses and high-tech simulation theme parks, people crave new experiences—virtual and real. Accelerating the experiential learning process through immersive, frustrating, fun simulations will be the dominant form of pre-packaged management training, especially in the hi-tech environment where, almost as a rule the staff is young. Immersive simulations will benefit organizations that want to ensure that market-facing knowledge workers develop the skills to work as part of a team and at the same time hone skills for rapid decision-making necessary for the very competitive marketplace.

**2. BENEFITS AND LIMITATIONS**

**2.1. BENEFITS**

The mission of corporate e-learning is to supply the company workforce with an up-to-date and cost-effective program that yields motivated, skilled, and loyal knowledge workers. The direct benefits of e-learning as felt mainly by the employees who are subject to e-learning in the hi-tech environment are really numerous. Basing on (Urdan and Weggen, 2000) let us try to summarize the most important ones.

**Substantial cost savings due to elimination of travel expenses**

The biggest benefit of e-learning is that it eliminates the expense and inconvenience of getting the instructor and students in the same place. Courses can be pared into shorter sessions and spread out over several days or weeks so that the company would not lose an employee for entire days at a time.

**Learner controlled – anywhere, anytime, anyone**

Technology has given the individual greater authority over the learning environment. Learning does not have to occur in a classroom. The fact of hi-tech companies is that the lion’s share of the staff already uses computers on the job. Technical obstacles, such as access, standards, infrastructure, and bandwidth, are usually not an issue. The growth of the Internet, high-capacity corporate networks, and high-speed desktop computers have made
learning available to people 24 hours a day, seven days a week since the employees can also access their corporate e-learning platforms from their residences or even holiday sites. In addition, an employee may proceed through a course or program as the information is fully comprehended. Employees can convert information to knowledge on their own timetable.

**Customizable Content**

Information can be developed with individual users in mind. Courses and programs can be created to deal with each individual's strengths and weaknesses. As employees progress, information is delivered based on what they have learned and how they have performed. The ideal situation is when every employee has her/his own “learning profile” whose attributes are a learning method (for example: visual, sound, interactive), the pace of learning and the position in the company, etc. The information collected in a user’s profile is used while planning or controlling the user’s career path, for instance in order to identify knowledge or skills gaps and suggesting relevant training, and also to provide the user with the most appropriate training method.

**Just-in-time access to timely information**

E-learning products allow instructors to update lessons and materials across the entire corporate network instantly. This keeps content fresh and consistent and gives students immediate access to the most current data. Information can be retrieved just before it is required, rather than being learned once in a classroom and subsequently forgotten. Our experience shows that technology-based training has proven to have a 50–60% better consistency of learning than traditional classroom learning.

**Higher retention of content through personalized learning**

Since they can customize the learning material to their own needs, employees have more control over their learning process and can better understand the material, leading to a significantly faster learning curve, compared to instructor-led training. The delivery of content in smaller units, called "chunks," contributes further to a more lasting learning effect. Whereas the average content retention rate for an instructor-led class is only 58%, the more intensive e-learning experience enhances the retention rate by 25–60%.
Improved collaboration and interactivity among employees

E-learning can be more stimulating and encourage more critical reasoning than a traditional large instructor-led class because it allows the kind of interaction that takes place mostly in small group settings. Another study found that online students had more peer contact with others in the class, enjoyed it more, spent more time on class work, understood the material better, and performed, on average, 20% better than students who were taught in the traditional classroom. Teaching and communication techniques which create an interactive online environment include case studies, story-telling, demonstrations, role-playing, simulations, streamed videos, online references, personalized coaching and mentoring, discussion groups, project teams, chat rooms, e-mail, bulletin boards, tips, tutorials, FAQs, and wizards.

Online training is less intimidating than instructor-led courses

Employees taking an on-line course enter a risk-free environment in which they can try new things and make mistakes without exposing themselves to criticism. This characteristic is particularly valuable when trying to learn soft skills, such as leadership and decision-making. A good learning program shows the consequences of employees’ actions and where/why they went wrong. After a failure, employees can go back and try again. This type of learning experience eliminates the embarrassment of failure in front of a group.

In addition to the aforementioned e-learning advantages, the ones that are equally important from the company perspective the benefits include:

- reduction of overall staff education related costs;
- better management, control and administration of education related business processes within the company;
- a possibility to integrate e-learning with other process, especially with human resources development;
- enhancements and better effectiveness of human resources development;
- providing the company top managers, including the Board of Directors with the state-of-the-art reports on the human resources development issues;
- easier cooperation, such as joint development and/or exchange of learning content, with organizations working in partnership with the company.
From the usability standpoint the success of the e-learning approach is judged on the basis of its deployment smoothness, user-friendliness and satisfaction, maintenance costs, scalability, and the ability to absorb changes and modifications. In particular, it is important to ensure: (i) an efficient provision of the learning content to trainees; (ii) an efficient administration of the system, including all databases and repositories; (iii) a full integration with other systems within the company, especially with the human resources management system; (iv) integration of the e-learning systems with the company extranet, if any, preserving all the security measures while not dropping the company flexibility.

2.2. DRAWBACKS

As mentioned above e-learning offers a number of advantages. However, one has to remember that the e-learning coin has its darker side which reveals, *inter alia*:

− pedagogical: it may happen that e-learning which is actually the technology of the future is used to empower the pedagogies of the past whose major principle was that knowledge was viewed as content to be transferred into the heads of the students;

− conceptual limitations: e-learning cannot substitute face-to-face communication; designing e-learning concepts very often requires a higher effort than traditional ones;

− technical limitations: corporate networks won’t allow ‘everything’ (e.g. transmission limits, presentation constraints); a PC for learning purposes installed at a workplace has to fulfill specific requirements (e.g. headphones, microphone, camera);

− human limitations: competency to work with media is not always developed; fear of the ‘new’; it may happen that corporate e-culture needs to be developed or improved.

3. FUNCTIONALITY

The required functionality of an e-learning system can be roughly categorized into three groups. The first one refers to the properties of training deployment procedures. The second one contains management (both user and content) and reporting features of the system. Finally, the third group contains IT technical requirements of the system.

**Training deployment**

− centralized training courses catalogue available to prospective trainees;

− an updated agenda of learning/training events to happen in the company or recommended by the company;
− fast and easy delivery of various forms of training regardless of a location of the users;
− asynchronous training;
− synchronous training (virtual classroom);
− individualized approach to learning, with optional adjustment of speed, extent and intensity of training to learners needs;
− sequential and free choice modes of learning;
− tools for creating various tests and exams compliant with assessment and certification mechanisms;
− efficient support for multimedia formats (audio/video on demand, streaming video/audio, video conferences, etc.);
− support for corporate knowledge base creation.

**Management, reporting, planning features**

− defining and management of key competencies and certification requirements for employees, customers, partners and suppliers;
− assessment of individual and group competencies and increasing them to the level needed for efficient everyday operations of the company;
− features of logistic services for conventional training (classroom, trainer, beamers, handbooks, etc. reservation and management);
− possibility to check models of human capital management: recruitment processes, reengineering or takeovers;
− long-term planning of recruitment and training policy in order to identify key competencies crucial for new business targets;
− confirmations of course application, enrolling the course, application rejection, schedule changes;
− selective distribution of information on new courses in the system;
− administrative subsystem with wide range of access rights and authorization control;
− identifying competencies and competence gaps for employees;
− defining competence goals;
assessments of goals accomplishment;
reporting efficiency of training;
financial bookkeeping of the training services offered and delivered.

Technical features

− applicability of standard content formats (SCORM, IMS, AICC, etc.);
− open architectural model - possibility to adding new, developed in-house modules;
− minimization of system administration;
− user friendliness for content creators and trainers;
− scalability with the number of users for intranet and extranet;
− system stability and safety for the client workstation;
− access rights management;
− authorization mechanism for external users;
− module for commercial access to the learning content (online real-time transactions, links to financial systems of the company, credit card processing);
− integration with Exchange server, instant messaging, chat feature;
− e-mail notification of any relevant events in the system.

4. CATEGORIZATION OF E-LEARNING ACTORS

The protagonists of e-learning processes can be categorized into several groups which are characterized by their duties; it may happen that certain company staff members can be assigned to different groups. Let’s take a look at these groups (below the term person means one person or a group of people):

− **Administrator** – a person who manages the system and grants privileges to all categories of users; has unrestricted access to all system functions and data;

− **Trainers Manager** – a person who is responsible for the organization of e-courses, which means, *inter alia*, creating lists of participants, identifying Trainers, scheduling courses and tests;

− **Trainer** – a person who selects “off-the-shelf” courses, or prepares course contents and oversees content preparation process, and then conducts courses; defines the schedule of
the courses; if courses are not automatically evaluated Trainer introduces the scores for the trainees;

- Trainer’s Assistant – a person who performs auxiliary material preparation tasks for the courses thus assisting trainers with more complex content editing;

- Trainee – a person (being a company staff member or not) who participates in the course; has access to the training material associated with the course to which the Trainee was enrolled, and is subject to test at the end of the course; he/she has also access to the courses agenda published in the system, can use discussion groups and other e-learning system facilities;

- Organizational Unit Manager – has access to his/her employees “study record”; accepts the participation of his/her employee in a given course.

In addition to the aforementioned categories there are other staffers who are involved in the e-learning processes, such as (i) HR Department staff who is responsible for defining and monitoring training policy of the company, as well as, responsible for career paths management; they are provided with the analyses of the scope of training and the results, and the information on competence gaps of the company staff; (ii) Financial analysts who receive specific and aggregated information about the courses conducted and costs incurred; and (iii) Company top managers, including the Board of Directors who are provided with strategic reports on the human resources development issues.

The correspondence between selected users groups and the e-learning system functions depends on the company policy and internal regulations. An example of such correspondence taken from a real hi-tech company looks as follows (Table 1):
<table>
<thead>
<tr>
<th>Function</th>
<th>Global Administrator</th>
<th>Trainers manager</th>
<th>Trainer</th>
<th>Trainer’s Assistant</th>
<th>Org. Unit Manager</th>
<th>Trainee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Access to training materials</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Participation in on-line tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Access to results of on-line tests</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Information of the courses undergone by certain users</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reporting</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Course management (creating new courses, updating the courses, closing the courses)</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creating e-learning content</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Publishing e-learning content in the system</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granting access to e-learning content to the users</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Users’ management</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1

As mentioned, access to the data (training material and course management information) stored in the e-learning system has to be restricted. The access to on-line materials and courses is managed by the Administrator. It is also necessary to give at least limited access to trainer’s manager. The trainers themselves should be also able to add and update the training content. In general, the training materials are made available to the participants of a certain course or to a certain organizational unit and on-line tests are available to course participants. Each employee has access to his/her study record but also each Organization Unit Manager has access to study record of all his/her subordinates. The system collects the information on all training activities of the users such as access to learning material and progress in the course and access to tests and their respective results.
5. E-LEARNING SYSTEM DEVELOPMENT VITAL ISSUES

A corporate e-learning system is a pretty sophisticated, hi-tech entity, mainly owing to its large coverage and relations with other systems such as human development system, what requires special attention while designing, implementing and operating/maintaining the system. For the e-learning system to succeed three critical development matters have been identified, namely the issue of basing the system design and operation on *de facto* industrial standards, and the issue of security, and the problem of bandwidth. The three issues are elaborated on in the sections to follow.

5.1. STANDARDS

Common standards for things such as content meta-data, content packaging, content sequencing, question and test interoperability, learner profiles, run-time interaction, etc., are pre-requisites for the success of the e-learning in a company. The major task is to integrate these standards into the e-learning platform. They help to ensure the five "abilities" mentioned below and to protect and even nurture e-learning investments:

− *interoperability*—the e-learning system can work with any other system;
− *re-usability*—courseware (Learning Objects, or "chunks") can be re-used;
− *manageability*—the e-learning system can track the appropriate information about the learner and the content;
− *accessibility*—a learner can access the appropriate content at the appropriate time;
− *durability*—the e-learning system technology evolve with the standards to avoid obsolescence.

The three most important content, usability and interoperability related standards that are recommended to be supported by the a corporate e-learning platform are: SCORM, IMS Content Packaging Specification, and AICC. Their brief characteristics are presented in the following tables.

**SCORM** (Sharable Content Object Reference Model)

This standard is a product of the U.S. Government's initiative in Advanced Distributed Learning (ADL); it is a set of specifications for developing, packaging and delivering education and training materials. SCORM-compliant systems can access and reuse content
conforming to the SCORM definition. To note that the current SCORM Version 1.2 incorporates the IMS Global Learning Consortium's Content Packaging Specification.

**IMS (Content Packaging Specification)**

Provides the functionality to describe and package training materials (such as individual course or a collection of courses) into interoperable, distributable packages

Prepared by IMS Global Learning Consortium, Inc.

**AICC/CMI (Aviation Industry CTB Committee)**

This is a standard for controlling the process of training. AICC/CMI test suite provides the verification of compliance with AICC standards for e-learning systems. CMI (Computer Managed Instructions) System is used for managing training process and student’s progress.

5.2. SECURITY

Although a bit witty, the following rule seems to be adequate to the e-learning system security facilities: “The system should know the user better than the user knows the system.” In what follows brief summaries indicating the e-learning corporate system security issues, access rights and data protection mechanisms for the e-learning platform are given; they are based on recommendations formulated in (Feibel, 1995).

Security is about ensuring that the data, circuits, and equipment being part of the whole e-learning system are used by authorized users and in authorized ways only. More fundamentally, security is about ensuring the following issues:

*Availability* – System components, information, and services are available whenever needed.

*Confidentiality* – Services and information are available only to those who are authorized to use them. This may differ for different users, i.e. certain users may have more privileges and access than others.

*Integrity* – Components and information are not destroyed, corrupted, or stolen, either through outside intervention or through in-house incompetence.

Traditionally, there are three fundamentally different areas of security, which are illustrated below (Fig. 2).
Hardware security encompasses all aspects of physical security and emanation security. Compromising emanation refers to unintentional signals that, if intercepted and analyzed would disclose the information transmitted, received, handled, or otherwise processed by telecommunications or automated systems equipment. Information security includes computer security and communication security. Computer security deals with the prevention and detection of unauthorized actions by users of a computer system. Communication security encompasses measures and controls taken to deny unauthorized persons access to information derived from telecommunications and ensure the authenticity of such telecommunications. Organizational or administration security is highly relevant at hi-tech organizations even though some people sometimes tend to underestimate it in favor of technical solutions. Both personnel security and operation security pertain to the administration aspect of security.

5.3. THE BANDWIDTH PROBLEM

As previously mentioned, an e-learning solution should provide a seamless way for employees to access training information. In an ideal world, managers or human resources officers would select the most relevant content for employees to be viewed from their desktops at their own pace. However, because of bandwidth limitations, many online trainers have eschewed video in favor of creating text-based training. Considering that five users simultaneously downloading 300k video streams can “waste” an entire T-1 high-speed line (see Table below). Companies that have networks with broadband connections are not fully
immune from delivery problems, even if they have enough bandwidth. The end result is that video is not delivered to employees effectively. It should be noted that the bandwidth issue has been identified by many prospective users as one of the largest barriers to mainstream adoption of online training.

As indicated in Section 6 at the heart of all online training products is the Learning Management System (LMS), which provides the tools to deliver content to employees through their networks. By creating an efficient LMS, the company can significantly reduce the drain on the e-learning systems, allowing more users to access video training courses without shutting down their IT infrastructures. The problem can be fixed only when a conscious effort is made to deliver content that is as low-bandwidth as possible through an LMS that is designed for peak efficiency.

The issue of bandwidth has to be given a priority while designing and implementing an e-learning system. The table 2 provides a comparison of time needed for transferring 250 Kbyte and 2 Mbyte files via channels of different speed.

<table>
<thead>
<tr>
<th></th>
<th>56 kbps</th>
<th>2 channel ISDN</th>
<th>T1</th>
<th>DSL/Cable</th>
<th>10bit Ethernet</th>
<th>2X CD-ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical Download Speed</td>
<td>7KB</td>
<td>16KB</td>
<td>187KB</td>
<td>187KB-250KB</td>
<td>1.2MB</td>
<td>300KB</td>
</tr>
<tr>
<td>Real World Download Speed</td>
<td>5.2KB</td>
<td>12.5KB</td>
<td>150KB</td>
<td>125KB-150KB</td>
<td>0.75MB</td>
<td>250KB</td>
</tr>
<tr>
<td>250KB file</td>
<td>35 sec</td>
<td>17 sec</td>
<td>1 sec</td>
<td>1 sec</td>
<td>&lt;1 sec</td>
<td>1 sec</td>
</tr>
<tr>
<td>2MB file</td>
<td>5 min</td>
<td>2.4 min</td>
<td>13 sec</td>
<td>13 sec</td>
<td>3 sec</td>
<td>9 sec</td>
</tr>
</tbody>
</table>

Table 2

Let us remind that the following three key hardware components can significantly influence the bandwidth:

Server – hardware specifications for the machine give some indication on how many simultaneous hits it can handle and it potential responsiveness to these requests. The location of the server is crucial as well. Routers and other load balance hardware and software can be critical to the success of a large deployment to help direct request to available servers. Proxies can both help and hinder a deployment.

Line Speed – line speeds fluctuate because of the request being sent out by multiple people at different times throughout the day. The companies usually see spikes in the
line utilization for both their LAN and Internet around 8:30-9:30 a.m., 12:00-1:00 p.m., and 4:30-5:30 p.m. It has to be noted that most web surfers will not wait over 8 seconds for a screen to paint without getting frustrated. Considering that e-learning is most of the time mandated, the screen paint times should be considerably quicker;

**Client** – to the best of our knowledge intranet performance of typical hi-tech companies in terms of the transmission speed is adequate to the needs, and they should not be faced with the bandwidth problem; however, the their extranets may pose tangible bandwidth problems. To cope with these problems and to improve the speed of transmission it is recommended to make use of content cashing servers in external sites. Picture below displays an outline of the architecture equipped with a caching server (Fig. 3).

![Fig. 3](image_url)

6. ARCHITECTURE

Now, we shall take a look at architectural solutions related to e-learning platforms. Within an e-learning architecture one can usually distinguish two segments, namely: (i) environmental and infrastructure components; and (ii) learning components. The chart below shows how the e-learning components are embedded in the computerized tissue of the company (Fig. 4).
The infrastructure is relatively stable an organizational and technological platform on which educational and managerial processes are carried out. It includes computer equipment (which usually is an intranet/extranet with all necessary technological facilities), an array of corporate databases, various types of legacy systems, including an enterprise resource planning system (ERP), if any, authentication and security and recovery mechanisms, etc. This part of the working environment is in principle invisible or meaningless for the terminal users of the e-learning facility (trainees, managers, HR officers, administrators, etc.). The learning components include two sub-systems, viz. a Learning Management System (LMS) and Learning Content Management System (LCMS) that altogether provide, *inter alia*, tools for developing, publishing and managing content, administering courses and providing access to the courses and other facilities that should be available to the terminal users.

A core component of any full-featured e-learning system is an LMS, which governs all the activities of the e-learning system. The LMS usually consists of: administration of curriculum and courses; registration module (curriculum, courses, instructional responsibilities); learning programs administration (instructor assignment to the courses, test and assessment capabilities, etc.); employee skills and records management; employee interfaces to learning content, including the ability to launch a course or interact with a Learning Content Management System (LCMS); external system application programming interfaces (e.g. to human resources management system and/or a financial system). In the next sections we shall elaborate on the LMS and LCMS systems.
A Learning Management System (LMS) is the major component of the e-learning platform. Below are summarized chief LMS functions.

- **Assessing the job** – this function consists in recording skills and competencies required to effectively fulfill the responsibilities of each of the major roles in the company;
- **Assessing the student** – to record what competencies, qualifications, licenses, certifications are required from the employees;
- **Measuring the gap** – to determine the difference between what the job requires and what the person can offer;
- **Creating learning resources** – to develop online training materials;
- **Cataloguing resources** – to recording all available resources regardless of format;
- **Filtering resources** – to allow the searching of those resources that match criteria like time constraints, location, available space, favorably reviews, preferred suppliers, and cost;
- **Building the plan** – to assign courses to individuals or groups, assisting individual employees in selecting the right combination, sequencing selected resources, and creating a learning plan;
- **Agreeing to the plan** – to limit access aimed at specific target groups, provide a wait list for classroom events, obtaining electronic approvals, providing a range of payment schemes;
- **Off-line Delivery** – providing online messaging to course participants, sending instructions and pre-work, and providing collaborative tools (e.g. discussion forums, chat rooms, and managing inventory);
- **On-line Delivery** – to support the delivery of on-line learning resources;
- **Monitoring progress** – to keep up-to-date information on who and when has done what;
- **Assessing results** – to measure usage and completions, quiz/test/assessment scores, item analysis, information analysis, trends, etc.
6.2. LCMS

Learning Content Management Systems (LCMS) create, manage, maintain, deliver, and track web-based content. They provide functionality such as content migration and management, learning object repositories, content re-use and individualized learning via learning objects, asynchronous collaborative learning, testing and certification, and interconnectivity with virtual classroom and learning management system applications. LCMSs are designed to support the rapid capture, delivery, and management of knowledge in a web-based fashion. The key features of LCMS’s are summarizes below.

Centralized repository

A key attribute of an LCMS is the use of a repository—a structured data storage system— that helps track and organize online learning content. A centralized repository allows the organization to put an arm around all the learning opportunities throughout the enterprise, even when they may be physically located in distributed locations. The repository needs to support rich set of content types such as documents, rich multimedia content and streaming data.

Tagging and search

Tagging and indexing the content ensures that content may be searched meaningfully. Each piece of learning content is tagged with meta-data (name, author, date, job, skill, etc.), so that it may be appropriately and consistently searched by both the content creators and consumers on the network.

Shared and reusable resources

According to the Advanced Distributed Learning (ADL), http://www.adlnet.org/, initiative, studies and field experience indicate that an environment where designers can share, reuse and easily modify shared media resources—such as graphics, custom templates and other "look and feel" elements—can save from 30 to 100 percent of the time and the cost of content development. Many LCMS environments allow for the reuse of company specific elements, like navigation bars, backgrounds and tables of contents, and the modification of these elements to support a specific application or objective.
Reusable learning objects

A complete LCMS provides the ability to manage content not just in a monolithic course format but also at a lower level of granularity through learning objects. Learning objects offer production efficiency on the side of content composition and precision in the quality of the learning experience. Learning objects add "just-enough" to the desire for "just-in-time" learning. Organizations can save a tremendous amount of cost and time by re-using content and reducing redundancy in production of new courseware by reusing the content (by linking or copying content from existing courseware) at different levels of granularity (whole or part of the courseware structure).

Publishing workflow

Content creation, review, publication and assignment to different audiences is a complex process, similar to the review stages of a document. Yet, learning technologies provide for little or no workflow management. A LCMS should also then manage the workflow through which content is reviewed, accepted and released for general access and consumption. These activities include: (i) communication between authors and reviews; (ii) ability for authors from remote sites to be able to access content; (iii) notification (update, review status), content expiration.

Support for industry standards

Finally, and perhaps most importantly, an e-learning product that does not support industry standards such as IMS (Instructional Management System) and ADL's SCORM is a poor investment. The ability to support and manage internally and externally (third party) created learning content preserves the investment companies are making in learning content. Needles to argue that standards are the best way to achieve this.

Having briefly described the LCMS functionality, now, we can take a look at its basic elements, which are as follows:

- learning object repository;
- automated authoring application;
- dynamic delivery interface;
- administrative application.
These four components along with the relationships indicating schematically actions/objects occurring between them are depicted in Fig. 5. A more detailed characteristic of the these components is as follows.

**Dynamic delivery Interface**

**Automated authoring application**
- Creation of new learning objects and metadata
- Editing of existing objects
- Delivery of existing objects for editing
- Appropriate learning objects
- Automated authoring application

**Administrative application**
- Modify student profiles
- Delete stale objects
- Bookmark student progress
- Administrative application

**Learning object repository**

The learning object repository is a central database in which learning content is stored and managed. It is from this point that individual learning objects are either dispensed to the users individually or used as components to assemble larger learning modules or full courses, depending on individual learning needs. The instructional output may be delivered via the web, CD-ROM, or printed materials. The same object may be used as many times and for as many purposes as appropriate. The integrity of the content is preserved regardless of the delivery platform. Typically, the XML facilities serve this function by separating content from programming logic and code.

**Automated authoring application**

This application is used to create the reusable learning objects that are accessible in the repository. The application automates authoring by providing authors with templates and storyboarding capabilities that incorporate instructional design principles. Using these templates, authors may develop an entire course by using existing learning objects in the repository, creating new learning objects, or using a combination of old and new objects.
Authors may be subject matter experts, instructional designers, media production artists, or communities of practice leaders. The tool may also be used to rapidly convert “libraries” of a company’s existing content, typically adding media, a customized interface, and instructional methodologies. An author may reside within a company or at an outsourced provider. Authoring Application allows one to: create screens, add in media, create hyperlinks, do branching, allow user input, program answer judging, record learner response.

Dynamic delivery interface

To serve up a learning object based on learner profiles, pre-tests, or user queries, a dynamic delivery interface is required. This component also provides user tracking, links to related sources of information, and supports multiple assessment types with user feedback. This interface may be subject to customization for the company using the LCMS. For example, content may be presented on web pages emblazoned with the company logo and a look and feel designed to reflect the desired corporate image.

Administrative application

This application is used to manage employee (student) records, launch e-learning courses from course catalogues, track and report student progress, and provide other basic administrative functions. This information can be fed into an LMS designed with more robust administrative functionality.

To conclude the discussion on the architectural matters of e-learning platforms it is worth to list here the important features of the technology to be used for implementing such a platform.

(i) Technology must be transparent.
    - must not distract from content;
    - has to provide usability, reliability, responsiveness.

(ii) Technology must be interactive.
    - must create learning experience;
    - has to provide interaction with content, students, trainers.

(iii) Technology must be adequate.
technology has to reflect nature of tasks to be undertaken, rather than the need for having the latest equipment;

different solutions for different problems—static/dynamic media, synchronous/asynchronous communication.

Physically, the e-learning platform hardware equipment typically includes the following elements: web servers, database servers, application servers, streaming servers, caching servers, client desktop, networking Infrastructure (intranet–LAN, extranet–WAN).

7. CRITICAL STEPS OF AN E-LEARNING PLATFORM DEVELOPMENT

Gartner strongly encourages taking e-learning initiatives in the corporate environment. According to its predictions enterprises that employ simulation exercises as part of an e-learning deployment will have higher knowledge retention rates for their employees, partners and customers than those enterprises that do not (0.8 probability) (Lundy, 2001). Basing on Gartner’s recommendations and our own experience now we sketch six critical steps in successful development of e-learning programs.

Needs Assessment: The necessary starting point

Alike any other ICT project the implementation of an e-learning system and integrating it with a hi-tech enterprise has to be preceded by a detailed analysis and evaluation of the status quo situation and identification of actual and prospective needs. In case of e-learning being a new formula in a company, the identification of prospective needs might be difficult since the future users have no reference points. Therefore, it is recommended to precede such an exercise by a series of tutorials and demos that will provide the users with the awareness about and potential of e-learning solutions.

Deployment of an LMS: A backbone of the e-learning platform

An enterprise needs to track the knowledge base and development needs of its employees. To this end, enterprises should deploy a learning management system (LMS) as an administrative hub of an e-learning infrastructure and, more importantly, as a management tool to track the progress of an overall knowledge transfer campaign. LMSs come in two "flavors" today: a full-blown system and a lightweight system, which is often part of a hosted application service provider e-learning service. Either approach can work, but the lightweight offerings often provide only basic tracking and oversight capabilities. A full-blown LMS
should be viewed as a key enabler to building a resilient hi-tech enterprise and should be
treated with the same importance as any other mission-critical software application, including
making it part of a disaster backup and recovery plan.

The Corporate University: A partnership between ICT and the training department

The failure of an e-learning program can often be tied directly to the failure of internal
departments to work together. Often, an internal training group thinks it can "go it alone" and
implement e-learning with little or no involvement from the whole organization. That is a
recipe for disaster. The most successful e-learning deployments are the result of close
working relationships between the information management systems and training units and
the lines of business. E-learning success usually requires a mandate from senior management.
Typically, a small team involving business managers and ICT leaders work together to build
an agenda, set forth requirements, supervise the implementation and monitor (and reward)
employee involvement with the effort as the program is carried out.

The Pilot Implementation: The reduction of risk

Almost as a rule we recommend the implementation of e-learning solutions in hi-tech
companies in two major phases, namely: the development of a pilot platform, and then–after
having it positively evaluated–the development of a full-fledged system. The benefits of
having a pilot version of the system are many. One of them that we want to emphasize is that
the company staff can better get acquainted with the e-learning concept and its potential and
better specify the final system.

High-quality content: The secret ingredient

Enterprises often realize during a pilot test for an e-learning system that their content
is not going to work well. The primary reason the pilot fails is that a project team assumed it
could port classroom content to an e-learning platform. Creating quality e-learning is often a
project within a project. Just as finding good instructors to deliver live training can be
challenging, so is the challenge of developing high-quality e-learning content that entertains
as it trains. Increasingly, the money spent on e-learning content will be used to create
simulation exercises that allow learners to apply their knowledge in real-world settings. One
of the most effective ways of ensuring that content is productive and reusable is to use an
LCMS (see Section 6.2). Learning content management allows developers to create, review,
manage and deploy learning assets and programs throughout the enterprise, even extending the programs to partners and customers.

Attracting users: The need of users’ acceptance and cooperation

Since the hi-tech enterprises are typically technology-based and knowledge-based companies, so technological adaptation and adjustment to the requirements caused by the introduction of an e-learning system should not be a tremendously painful process. However, equally important as smooth technological and organizational roll-out is staff and end-user buy-in. An e-learning project will most likely bring a huge change for the organization. Although the change will impact the entire organization, one can expect that at the outset the major influence will be felt in the training and human resources departments. To create the ‘buy-in’ in these areas, it is important to demonstrate business improvements and facilitations that can be achieved (and credited to these departments) and that the associated changes do not adversely impact the resources of these departments. It is believed that good cooperation between various protagonists of the system should greatly diminish tensions and negative occurrences that may happen, especially at the inception phase of the system operation.

REFERENCES


Kształcenie online w różnych postaciach stosowane jest od dwudziestu lat (ciekawe, że pewien rodzaj e-learningu zaproponowano już dla technologii mainframe), jednak technologia Internetu przekształciła e-learning z lokalnego kuriozum w działalność powszechną. W 2002 r. Gartner Inc. przewidywał, że do 2005 r. e-learning stanie się najczęściej wykorzystywaną usługą w Webie, sam Web natomiast stanie się platformą kształcenia ustawicznego dla większości świata (Harris et al., 2002). Przewidywania te okazały się bliskie rzeczywistości. Nasze rozważania prowadzone są w kontekście organizacji wysokich technologii i dotyczą także kwestii rozwoju kompetencji pracowników. Organizacje wysokich technologii już na mocy definicji są organizacjami uczącymi się w sensie zdefiniowanym przez Petera Senge’a (Senge, 1990). W takich organizacjach kształcenie musi być płynnie zintegrowane z codzienną działalnością, a działaniem okazjonalnym. Permanentne kształcenie staje się warunkiem sine qua non zachowania konkurencyjności w wysoce konkurencyjnym środowisku biznesowym. Stąd propagowanie, doskonalenie i rozwijanie specjalistycznych umiejętności, a także zapewnianie ogólnej wiedzy i świadomości całego personelu w trybie działań codziennych to zadania, które muszą być wspierane przez wyspecjalizowane narzędzia i praktykę edukacyjną. Z tych samych powodów permanennta edukacja przyczynia się do przekształcania organizacji w przedsiębiorstwa uczące się, co staje się koniecznością na wymagającej scenie wysokich technologii. W artykule przekonujemy, że potrzeba zapewnienia permanentnego i wszechstronnego kształcenia w kontekście współczesnych organizacji wysokich technologii może być zaspokojona przez e-learning oraz że ważne jest, aby nie postrzegać e-learningu jako centrum kosztów wewnątrz organizacji, lecz raczej jako ważny składnik procesów generowania wpływów.