

## BUILDING SPATIAL KNOWLEDGE INFRASTRUCTURE

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### ABSTRACT:

The author in the first part would like to share his experiences of a European Union sponsored LEONARDO da VINCI project – Land Information Management for Executives (LIME) co-ordinated by the College of Geoinformatics, University of West Hungary (GEO). The LIME outcomes were a knowledge resource centre and an Internet-supported distributed education service for the Hungarian Land Administration. LIME greatly improves the knowledge transfer in land administration in Hungary. The LIME project updated and enhanced the structure and developed a new short course in land information management, creating an EU conform new profession called “land information manager assistant”. Another development the NODE (Networked Open Distance Education) MINERVA project design started from a vision of educational resources available through distributed networks delivering learning media to individual learners. In order to provide a generic framework for the changing roles of educators and educational institutions a three-tiered system of content authors, educational gateways ('brokers') and points-of-learning has been conceived, with the latter institutions serving as interfaces with individual learners. Assuming that some of the traditional barriers between institutions will be broken down in favour of networks of interoperable learning objects, the NODE concept serves as a framework to improve access for individual learners and to redefine roles for networked educational institutions. The outcomes of NODE provided a set of perspectives, experiences and insights serving as starting points for further development of institutional strategies in educational markets. The second part of the paper is focusing on the functional design of an educational gateway.

### 1. INTRODUCTION

Due to advances in digitisation, processing speed, storage and communications, we are living in a networking revolution. Higher education will have a crucial role in developing these capabilities as well as educating the people who will use them. New job opportunities will be created in the processing, organizing, packaging and disseminating of spatial information. The networked world is changing the way we create products and provide services. All around us we find new tailored products, targeted marketing and customisation. Consumer demand for more choice, higher quality, lower cost, better service and convenient access is a dominant force affecting all industries, including higher education (Oblinger – Verville, 1999).

### 2. NEEDS

The Hungarian Government is investing in information technologies and services, by building up e-government. Some areas of activity are closely related to the land administration sector:

- development of digital procedures for internal administration to make government offices cheaper and quicker to run, and to be more effective;
- introduction of digital access for citizens contacting government agencies;
- creation of databases for legislation, policy formulation and information dissemination;
- encouraging organizations to close the information gap between national and local authorities, and urban and rural areas.

The efficient handling, updating and maintenance of the spatial data infrastructure needs highly qualified, properly trained staff. Learning and working are more and more similar. The concept of the ‘learning organization’, including ‘lifelong learning’ for staff, is now recognized as a key element in corporate strategies. This will reinforce consistency, common identity, shared corporate culture, common actions, clear responsibilities, coordination and dissemination of good practice.

### 3. RESPONSES

The urgent task for educational institutions is to reorganise resources for professional development services. In extending existing education and training programmes, the main objectives should be:

- to develop still further the corporate dimension of education;
- to improve the quality of training and foster innovation in education by increasing exchanges of experience and information on good practice;
- to establish an area of training by obtaining recognition of its qualification;
- to promote the virtual mobility made possible by new communication technologies ;
- to develop common databases and other sources of knowledge on skills needs;
- to conduct comparative research on methodologies used and policies implemented;
- to improve the interoperability of systems of distance learning and increase the level of standardisation.

Nowadays increasing numbers of companies are using Internet-based technologies to help them meet their training needs. In

the workplace, ICT based open and flexible, distance learning (eLearning) provides flexibility in terms of place, time, pace and style, enabling just-in-time training where and when required; integration into the workplace for greater convenience and relevancy; and possibilities for collaborative team working. Encouraging staff to take responsibility for their own learning has motivational benefits. eLearning materials for business training can be quickly updated and adapted to reflect changes in legislation, procedures or market trends.

In generalising access to skills through Information Society tools in the context of lifelong learning, LIME has the twofold objective of developing information and communication technologies in order to assist the process of giving access to lifelong learning, and of meeting new demands for qualifications and skills in connection with industrial change and the emergence of the Information Society, by:

- assisting the development of land information management within the Information Society; here the courses were designed to give a practical element to the theory behind each module. Each module contained both a theoretical and a practical element, allowing the participant to use information technology and computing packages;
- developing innovative training products and methods to help the less qualified in different areas needing land information in general; here, the training contains a significant practical element and this allows the less qualified to visualise the process. Allowing for practical examples and exercises gives participants hands-on training.

The first LIME project objective was the creation of a program of education for continuing professional development for Land Information Management in Hungary based on an existing program developed under the TEMPUS OLLO project and other projects in Hungary and the EU. Particular attention was paid to common European concerns. This program utilized the existing Land Information Infrastructure. In seeking to achieve its objective, the project developed a knowledge resource centre in land information management matters, which can be used in a flexible manner as part of a staff development program tailored to individual requirements.

The project has created a flexible and widely applicable staff development resource that can be used by individuals from many civil service disciplines. The provision of such a resource is essential for adequate staff development to support those preparing for Hungary's accession to the EU. The LIME project updated and improved the structure and developed a new short course in land information management, creating an EU conform new profession called "land information manager assistant".

#### 4. DISTRIBUTED LEARNING ENVIRONMENT

Traditional educational systems use the "campus-bound" concept, but there is an emerging trend to the "campus-based" concept. The former assumes that the quality of a programme depends entirely on the text books, presentations, faculty members, students etc. are on-campus. However, the latter allows that some of the resources and some of the learning are off-campus.

A distributed learning environment is a learner-centred approach to distance education, which integrates a number of

technologies to enable activities and interaction between students and tutors. Our model is based on amalgamating appropriate technologies with aspects of local learning centre-based workshops and co-operative Internet-based distance education. This approach gives tutors the flexibility to meet the needs of diverse student populations, while providing both high quality and cost-effective learning. There are 7 LIME local learning centres throughout Hungary at present, including the use of Technical High Schools as a resource base.

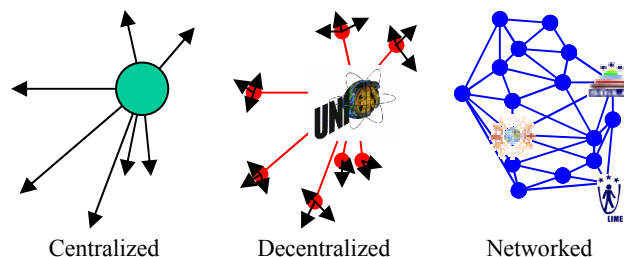


Figure 1. Educational structures

Within the LIME project, a collaborative delivery system for continuing professional development, based on a course management system and distance education technology and concepts with a comprehensive credit system, has been completed. The operation of a knowledge resource centre depended on the creation of a database of education resources and on a metadata system that would provide the flexibility needed for supporting professional development.

The resulting system has three layers:

1. an open layer giving general course information, a demonstration module, details on distance learning, frequently asked questions, and registration details for both tutors and professionals;
2. a protected layer for the actual participants that includes all the learning material and case studies and practice sessions, free software and databases, basically all they need to complete the course and prepare themselves for the examinations. There is also a dedicated news board, the facility to create study clubs, an interactive job page, relevant references (both text based and internet), a dictionary of geographical information terminology, and learning guides, with each participant being given a dedicated LIME email address and password to the site;
3. an administrative level. Here access is limited to the staff of learning centres and GEO. This level deals with the course administration, including enquiries, student records, progress reports and fee status, etc.

The technical side was emphasized above. However, the distributed learning environment is a social system too, consisting of the continuous development of knowledge, skills and competences in which subsystems can occur, distributed in time and place, and in which information and communication technology ensures collaboration. The ability of students to connect with experts around the country, as well as their group members, also opens new opportunities for learning and professional development. Students and tutors find these opportunities motivating. Distributed instruction, the explosive expansion of networks, and the trend to move bits instead of people and products will continue to erode the domination of traditional educational institutions. GEO and its project partners already have considerable experience of the education technology needed to deliver the proposed programme. The

UNIGIS network of universities is a major provider of professional education in GIS and an active developer of web and other education technologies that are available to this project.

## 5. KNOWLEDGE MANAGEMENT

Taylor (1999) has realized that distance education development reached a new phase. In his schema, the first generation of distance education, the correspondence model, was based solely on print technology; the second, the multimedia model, was based on print, audio and video technologies; the third, the tele-learning model, involved the application of telecommunications technologies to provide opportunities for synchronous communication; and the fourth, the flexible learning model, is based on on-line delivery via the Internet. The fifth generation is beginning to emerge. It will use automated response systems that scan the text of incoming e-mail and respond intelligently without human intervention, thereby decreasing the cost of online tuition and increasing access to learning opportunities on a global scale. Taylor calls this the "intelligent flexible learning model" that will enable a quantum leap in economies of scale and cost effectiveness.

According to Ackoff, the content of the human mind can be classified into five categories:

1. Data: facts or figures;
2. Information: data that are useful; answers to "who", "what", "where", and "when";
3. Knowledge: application of information; answers "how";
4. Understanding: appreciation of "why";
5. Wisdom: evaluated understanding.

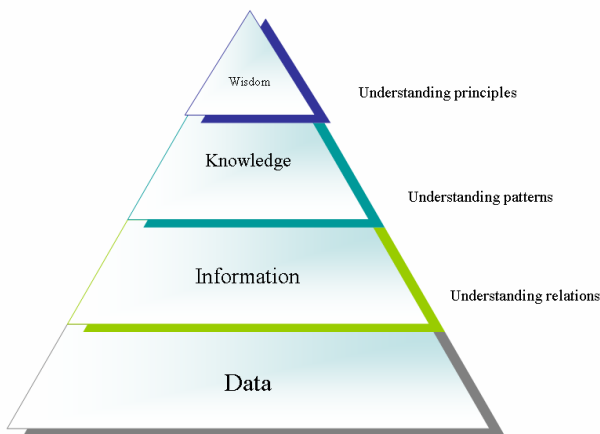


Figure 2. Ackoff's hierarchy

Learning technology is rapidly changing. In previous years we focussed on Content Management (CM): content creation, electronic publication, Internet-based communication and student support, taking into account the special pedagogy of distance education. In our profession it was time to move from building spatial data infrastructure to the development of spatial information infrastructure. In the educational arena it is time to move from CM to Knowledge Management (KM), to build knowledge infrastructure.

The definition of KM by Oracle Magazine (1998) is the following: "Knowledge Management promotes an integrated approach to identifying, capturing, retrieving, sharing, and

evaluating an enterprises information assets. These information assets may include databases, documents, policies, procedures, as well as the un-captured tacit expertise and experience stored in individual's heads." The differences between CM and KM are in the business components, including strategy, processes, and organization. Knowledge management involves data mining and some method of operation to deliver information to users.

In the dynamically changing world of business, the competitiveness of companies (and/or universities) depends heavily on the possibility to find, for a given problem, the right knowledge in the right moment. By using a Knowledge Management System (KMS), organisations increase returns, save time and money, are more adaptable, and have a far better understanding of partners, processes, customers, competitors and their business. To benefit from every customer or partner interaction, corporations must give employees opportunities to record what was learned. Efficient knowledge management needs not only document knowledge but must provide tools for collaboration to all contributors to the knowledge pool. Then, other employees must have access to the data and the means to understand it in context. Knowledge management helps an organisation gain insight and understanding from its own experiences. When employees use this KMS, best practices are stored throughout the organization, and each employee accessing the system has similar power to the best employee (ArsDigita, 2001).

For strategies to promote a learning-for-all culture, direct measures are needed to motivate potential learners and increase overall participation levels by making learning more attractive in terms of active citizenship, personal performance and employability. Schools, universities and training centres are urged to become local knowledge acquisition centres which are versatile and accessible to everyone.

In KM environment the structure of the learning materials should be re-engineered. In this new structure the basic elements are called 'learning objects'. Learning objects can be described as the competencies to be achieved, skill and knowledge outcomes, lesson plans, assessment items and other learning resources. They can exist in a variety of forms such as presentations, articles, quizzes, people, Web pages, images, maps, samples etc. They can be stored in databases and used, reused, aggregated as desired or re-purposed by learners, teachers and course designers for their own particular purposes, thus moving us towards a "learning on-demand" environment. And they can be accommodated within various delivery models such as print, CD-ROM or Web-based. The use of common standards will make these learning objects databases accessible to any organisation that shares the same standards. A consortium of more than 600 institutions has established a task force to identify the standards for this initiative (Porter, 2000). This development is already starting to change the way we think about the notions of curriculum and courses.

Educational institutions worldwide spend large amounts of money each year developing, adapting or acquiring learning resources and courses. The development of electronic learning resources is particularly expensive and often produces course materials that are platform or operating system dependent. This situation has lead to discussion of the creation of standardized learning objects that can operate across hardware platforms and software systems.

Metadata will be crucial in implementing similar systems. Whilst learning units form the building blocks of a networked and inter-connected environment, metadata is required to bind the units together and allow them to interoperate. Metadata is required to describe what learning units look like, how to build a learning route from them, what if any refinements or value adding operations have been carried out on a unit, and in a networked environment what services a tutor/learner can request from a server and what parameters the teacher/student should send to the server to request the service. Adopting a standards-based approach makes it easier to change system components in future. IMS (IMS Global Consortium, previously known as Instructional Management Systems), IEEE and Dublin Core provide a range of specifications that yield a standardised data format, allowing different systems from different vendors to work together. For seamless searching to work, the world has to agree on the specification of educational metadata (Markus, 2000).

In Hungary we realised that educational institutions have multiple reasons for loss of essential knowledge that evolves through time and experience: experienced teachers and tutors retire or change jobs. By providing access to the global knowledge base, the consortium members become more effective and competent. LIME KMS aims to fulfil the above-mentioned functions. LIME developments are continuing within the NODE MINERVA project. The new system functions as a gateway to user and course level services. The gateway brings all relevant course information to the learner on a unified home page. The tutor has extensive control over the course page and additional administrative options.

The Internet platform was designed to foster collaboration. Some of the potential functions are as follows:

- Password protection and access control
- Personalised view of all relevant information
- Content presentation and distribution (lecture notes, assignments, samples, tests, quizzes, etc)
- Course management and administration (student records, calendar, curriculum, tracking, announcements, etc)
- Communication (online collaborative presentations, discussion forums, shared file storage, group e-mail, etc)
- Uploading (multiple choice and true/ false quizzes), file submission (homework or project).

Furthermore, the last outcome of LIME was the creation of a network of EU centres: education and data / information providers with the objective of participating fully in EU activities. The partner institutions are each active in the field of professional development and there are other institutions in the EU, which have long standing links with GEO. This network is used to establish the dialogue necessary for planning the maintenance of quality in professional practice throughout the EU. This is ongoing and is expected to make use of the UNIGIS and GISIG existing networks.

## 6. GATEWAY FUNCTIONS

The NODE model is a flexible system, which allows changing faces of the nodes. Depending on the needs a node can be **gateway** from one point-of-view and point-of-learning from an other. The functions of the gateway are listed below.

### Marketing

- Needs analysis

- Research of the dynamic educational market
- Promotion of eLearning
- Enquiries from prospective learners
- PR
- Demand maintenance

### Management

- Conceptualisation
  - Mission
  - Strategy
  - Objectives
- HRM
  - motivation at aspects for author
  - workload issues (when, how intensively can author work)
  - guarantee for continuity (no hire and fire)
- Information infrastructure
  - Gateway hardware
  - Gateway software
  - consideration of organizational setting of author
  - Knowledge-base backup
- Knowledge management
- Building relationship, networking
- Quality
  - definition of quality levels
  - selection of appropriate contents
  - handling of accreditation issues
  - communications assuring quality

### Building knowledge resources

- Original developments
- Knowledge mining
  - Searching from metadata
  - Searching from public data
- Uploading learning units
- Metadata
- Copyright
- Maintenance
- Archive

### Course production

- Definition
- Accreditation
- Terms and Conditions
- Calendar
- Certification, Recognition
- FAQ
- Course maintenance

### Administration

- Academic administration
  - enrolment
  - accounting
  - certificates
  - placements
  - alumni
- Course administration
  - Content data
  - Course backup
  - Student data upload
- Author's data
- Tutor's data
- Student's data
- Financial
  - ensuring IPR for authors

### Portal

- Introduction
  - Contacts
- Overview
- Press

- News
- Events
- Course offering
  - Next course
  - Learning advises
  - Opportunities
  - Achievements
- Tutor data search
- My workplace settings
- Using my workplace
  - Selecting the right PC
  - Selecting an Internet Service Provider (ISP)
  - Solving technical problems
  - Learning how to learn online
  - Access to modules (timed out)
  - Assignment upload: auto path, name
  - Marking, feedback
  - Progress info (learning route)
  - Grades
- Support
  - Help desk
  - FAQ
- Tutoring
- Mentoring
- Download
  - Free software
  - Public data
- Library
  - www links
  - Papers
  - Presentations
- Communication
  - Net-Meeting
  - Effectively communicating with the instructor
  - Collaborating with other students online
  - Chat
- Exam
- Evaluating online courses
- Club
  - Building communities
  - Collaborative learning
  - Wanted / Offered job

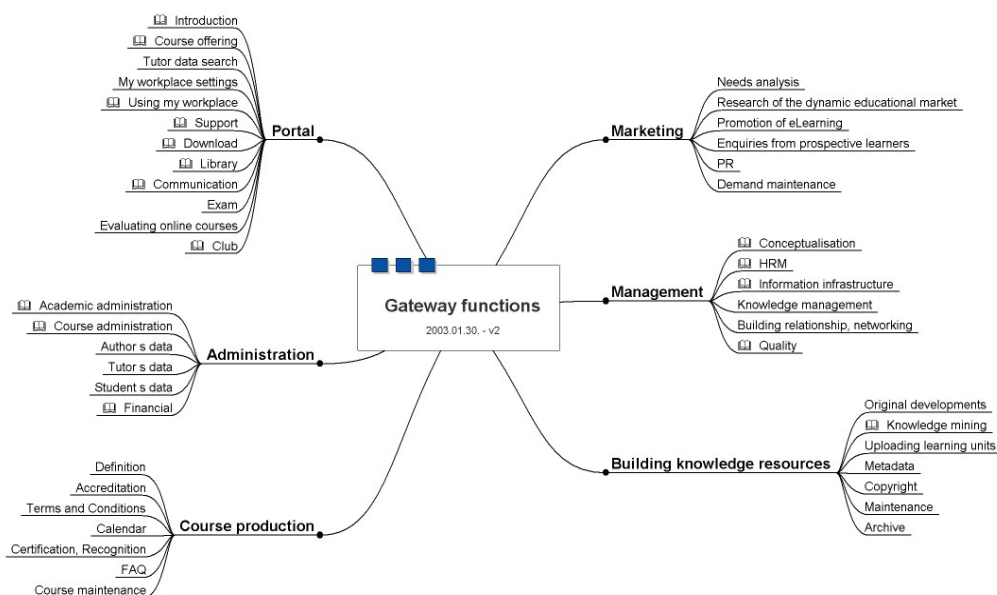


Figure 3. Functions of an educational gateway

The educational institutions are under intense pressure to get the best course in hands of their learners, in the right length, at the right time, for the right price and very important in the required quality. To do this, they have to expand considerable time and resources on planning their supply strategy to respond to demand of the industry or society. This goal can only be reached if the organisations introduce a usable and innovative tool which serves the above mentioned requirements. This tool must enable networked educational partners to work together across different and possibly flexible platforms. Moreover it must support the sharing of management and technological information.

## 7. CONCLUSIONS

The LIME project greatly improves the knowledge transfer in land administration in Hungary. LIME aimed to increase

collaboration between EU and Hungarian institutions and the sharing of learning resources. Co-operation is supporting specialization, improve quality, increase choice, and lead to a better fit with changing vocational demands in Land Administration.

The job market in general will become much more dynamic, complex and heterogeneous. LIME helps us to develop more market oriented education and training services. Since the strategic aim of LIME is to directly support European accession, the project improved interaction beyond national boundaries. Clients of LIME include not only Land Office staff but professionals in land surveying, local government, regional offices etc.

Information and communication technologies as driving forces in the network revolution will have a dramatic impact on our daily life, working routine and education. Information

technology will become essential everywhere. The IT revolution holds great promise and presents great challenges. It will be difficult to control but impossible to resist. We must transform all traditional institutions of learning in order to prepare students for their future, not for our past. In addition to basic professional skills, every learner should master communication, collaboration, and creative problem solving. These are the very important skills and attitudes needed to be a lifelong learner.

The results of the investigations in NODE imply that educational systems will be transformed by the following features:

- Future structures of open distance learning will be more “Web-centric” in that they will be information and communication technology enabled and will open increasing use of the Web.
- Systems will be more “learner centred” in the sense that they will:
  - offer learners and teachers / trainers with global access to on-line resources and assessment strategies,
  - make possible learners to interact with learning objects, teachers, tutors, mentors, administrative and service resources,
  - enable learners to tailor the learning experience to their needs.
- Original educational objects, expertise and knowledge can be incorporated to add value to learning resources acquired from elsewhere.
- Course planners, teachers can acquire learning objects from large content databases, aggregate and manage these according to the needs of particular groups of learners by and selecting the appropriate mode of delivery.
- Learners will be able to fulfil their educational needs from a world-wide list of educational / training institutions.
- Collaborative learning will enable learners to establish their own learning groups focused on their common interests.
- Because learners will be able to access virtual courses from anywhere, thus saving substantially on travel costs.

New business models assure to radically change the educational services and greatly improve the effectiveness of knowledge delivery. Principally important are customisation and community building. The web links together students, professionals, alumni etc. and allows new ways of communication and interaction. eBusiness also changes how we teach and learn, it is more about redesign the strategy than technology.

## REFERENCES

- Ackoff, R. L., 1989. From Data to Wisdom, *Journal of Applied Systems Analysis*, Vol. 16, pp. 3-9.
- ArsDigita, 2001: Knowledge Management, <http://www.Arsdigita.com>
- Bellinger, G. et.al., 2004: Data, Information, Knowledge, and Wisdom, <http://www.systems-thinking.org/dikw/dikw.htm>
- Brown, G. Markus, B. and Petch, J., 2000. LIME project documents, London - Manchester - Salzburg - Szekesfehervar - Vienna.

Brunner-Maresch, B. 2002. NODE mission statement, 2002.

EC Communications, 2001. The concrete future objectives of education systems, Brussels, 31 January 2001

EC Conference, 2000. "Science and Governance in a Knowledge Society: The Challenge for Europe" Brussels, 16-17 October 2000.

Farrell, G. M. ed., 2001. The Changing Faces of Virtual Education, The Commonwealth of Learning, Vancouver, British Columbia, Canada.

Katz, R.N. ed., 2002. *Web Portals and Higher Education*, A publication of EDUCAUSE and NACUBO, Jossey-Bass, San Francisco, USA.

Maedche, A. - Weiß, P., 2002. *Towards Ontology-based Smart Organizations*, FZI, Karlsruhe, Germany.

Márkus B., 2001. Networked education in land administration, FIG Working Week, Seoul, pp. 146-147.

Márkus B., 2002. (Global) spatial knowledge management, GSDI6 Conference, Budapest.

Márkus, B., 2000. Educational metadata, Proceedings of FIG Working Week, Prague.

Márkus, B., 2001. Networked education in Land Administration, Proceedings of FIG Working Week, Seoul.

Oblinger, D. G. - Verville, A-L., 1999. Information Technology as a Change Agent, *Educom Review*, Volume 34, Number 1.

Polsani, P.R., 2002. E-Learning and the Status of Knowledge in the Information Age. International Conference on Computers in Education, ICCE 2002, Auckland, New Zealand.

Quinn, C., 2000. mLearning: Mobile, Wireless, In-your-pocket Learning, *LiNE Zine*, Fall 2000 ([www.linezine.com](http://www.linezine.com))

Taylor, J.C., 1999. The death of distance: The birth of the global higher education economy, *e-Journal of Instructional Science and Technology* (e-JIST), 3(1), pp. 6-11.

Viteli, J., 1999. On Finnish Future: From eLearning to mLearning? The Challenges of ICT in Finnish Education (ed. Sinko&Lehtine) Juva: WSOY

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