

Network-Training Collaboration in Europe and China (NCEC)¹–

Issues and Promises

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Abstract

This paper presents *Network-Training Collaboration in Europe and China (NCEC)*, a joint project between two European and four Chinese institutions aiming at designing and developing network-based course production, delivery and presentation systems for China. Sponsored by the European Union, the NCEC project is designated to provide on-line collaborative teaching and learning facilities in both Chinese and English on CERNET and ChinaNET, the two major China Internet networks. The paper addresses the major managerial and technical issues in the NCEC development processes and system operations of project management, related projects, Chinese information processing, course supply and tutoring, etc. The NCEC is expected to benefit both China and Europe in many ways.

Keywords: distance education, China Internet, project management, metadata, Chinese information processing.

Introduction

The Internet has developed and expanded exponentially in China in both the corporate and the academic environments and has become widely available to the public as well. Currently, there are four major Internet networks operated countrywide. ChinaNet is the leading commercial Internet in China with the largest user population. CERNET (China Education and Research NETwork), headed by the Network Research Center (NRC) in Tsinghua University, has been built up since 1994, connects thousands of universities and research institutions in China. The ChinaGBN (China Golden Bridge Network) is the outcome of the Golden Bridge

Project launched in 1995 to serve government organizations. CSTNET, the network for China Science and Technology, is based on the pioneer effort by IHEP (Institute of High-Energy Physics), in connection with the research institutes of China's Science Academy. The Internet user population in China has been growing explosively with a number of 2.1 million in January 1999 and 8.9 million by the end of 1999. In April 2000, ChinaNET alone has issued 10 million Internet user accounts and CERNET user population has reached 2 million. The rapidly expanding user body has imposed ever-increasing application demands onto the Internet, particularly in business and education. Internet-based distance education is a promising application that is targeted at China's fast-growing education demands.

The NCEC is aimed at designing and developing network-based course production, delivery and presentation systems for China to improve the utilization of the Internet in China (Gordon et al. 1997; Gordon et al. 1999). The specific objectives include:

- Developing methods and an integrated set of tools for the cost-effective production of electronic course materials
- Carrying out experiments by describing a set of training exercises and delivering pilot courses within the network-based learning environment
- Implementing a pilot of the network-based collaborative learning environment for training, teaching, tutoring, assessment, and providing feedback to the learners
- Developing a set of training needs templates, which will allow us to assess trainee needs in the NCEC environment in order to support trainee profiling for customized production and delivery

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- Promoting research in Chinese courseware management—developing Chinese information processing technology and knowledge management for Chinese information

The NCEC project was originally proposed to the European Union (EU) by Tongji University, EVITech, the University of Paislay, the Fujian Economic Information Center (FEIC), and the New Service Development and Research Center (NSDRC) affiliated to the Ministry of Information Industry (MII), in the summer of 1995. It was finally approved by EU in late 1998 and is to be completed by June 2001. Between 1995–1999, several distance education projects in China were carried out in light of the NCEC idea. For example, the Network Research Center (NRC) of Tsinghua University² started a pilot distance education research project in 1997 sponsored by the *Focal Research Projects in the Ninth Five-year Plan*. A distance learning system with TV and Web technology has been developed and tested (Li, Geng, and Li 1998). Recently, Tsinghua University has launched a generic distance education project, *Demonstrative Multimedia Distance Education System on the High-speed IP Network in China* (DMDDES)³. The objective of the project is to build up virtual classrooms available on the 155Mbps CERNET backbone to provide electronic courses to the universities participating in the pilot operation. Satellite and TV technologies are also to be adopted by DMDDES to complement the Internet technology.

As an on-going project based on the idea proposed five years ago, the NCEC has been not only reinforced but also challenged by rapidly developed information technologies, ever-improving network facilities and higher user demands. The management of the NCEC is even more complicated by the form of the development consortium, which is geographically separated in 5 cities and is coping with two different education systems that use two different languages—English and Chinese. This article is intended to provide a brief view of the issues and current situation about the project. Further research outcomes will be reported later.

NCEC System Structure

The NCEC project will provide an on-line education system that offers courses both in English and in Chinese. This is not only a difference in language, but also in cultural and socio-pedagogical aspects. Considering the huge population in China and the type of the students, one of the major strategies is to switch pedagogical patterns from conventional paper-and-classroom-based delivery to computer-and-network-based delivery of courses. The on-going China Internet construction will provide a

supportive environment for this effort. On the other hand, continuing and distance education will become one of the major services, adding value to the network infrastructure.

The NCEC system is planned to have three major subsystems (Figure 1):

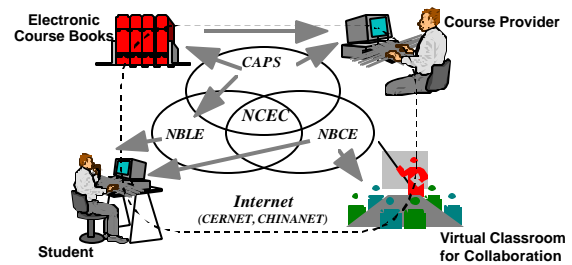


Figure 1. Structure of the NCEC System

Courseware Authoring and Production System (CAPS)

CAPS will support the authoring and production process. It will supply users with a set of tools capable of supporting courseware development tasks such as authoring electronic textbooks, updating courseware, maintaining course element repositories, and providing other complementary elements. The elements are authored with office tools and other common tools. NCEC specific authoring tools will be developed only when necessary. Document-structure templates for each tool will be used to ensure consistency of materials. Courses are produced according to selected structure templates by using elements in the repository. CAPS will apply the results of complementary research in related projects. The course material repositories of reusable elements, which may be distributed on different servers and partially duplicated for local use, are accessible via the Internet.

Network-Based Learning Environment (NBLE)

NBLE makes full use of the hypermedia features of the WWW, providing a good environment to present users with a versatile interface and content. The learning resource is presented as a *virtual library* with *electronic books*, which can be annotated and shared by groups of students and tutors on the network. The electronic books contain course materials, such as texts and learning tools, available either locally or remotely, and customized to the needs of groups of trainees. The virtual library contains relevant external/internal information resources linked to electronic books. In addition, there are assessment and feedback tools for self-evaluation as well as for instructor assessment and feedback. It is important to note the system will support individualized electronic books, delivered to the learners based on their actual needs. These needs may be determined using pre-exams to tailor the content. The approach of knowledge management is to be applied to the courseware material search and retrieval.

² The NRC of the Tsinghua University officially allied with the NCEC project in January 1999.

³ Project#: 863-317-01-04-99

Network-Based Collaboration Environment (NBCE)

NBCE will provide the users with an integrated network-based collaborative workspace. This includes an electronic conference (in English and Chinese), a virtual classroom, a tutoring facility, and collaboration support. Currently, the collaboration facilities available on the Internet include e-mail, audio- and video-conferencing and whiteboard, IRC, ICQ, interactive Web-systems (annotations), etc. These allow users to communicate by voice, images, video and text. The NCEC research group will analyze the basic requirements for the training in sharing and exchanging information, and NBCE will be designed in accordance with a set of interactive scenarios for the activities.

Our basic model for the NCEC system is to develop an environment which allows the NCEC system to support the expansion of relationships between suppliers of training and users of training over networks with the supply being demand led. Although we have chosen the Internet to underpin the research and development of the NCEC system, the system will later utilize a combination of technologies, including satellite TV, mobile telecommunication systems, and Internet-based environments.

Issues in NCEC Project Development

Project Management

The Project Executive Management Committee (PEMC) has been formed for NCEC with a representative from each partner. The mission of the PEMC is to coordinate the progress of the research consortium across the five partners and monitor the progress of the project, so that the targets of the research will be assured.

The University of Paisley is acting as the coordinator for overall quality management and financial control. Tongji University takes responsibility for the scientific coordination and leadership of the project. Day to day management of the project has two components representing the two geographical areas involved. In the EU, one member of the staff acts as local coordinator. In China, a local coordinator has been appointed. In each case, the scientific coordinator and the two local coordinators report to the PEMC.

The lifecycle of the NCEC project consists of five phases: initialization, system development, system integration, system customization, and evaluation. The strategy adopted throughout the project lifecycle will focus upon the quality control and the actual products being developed and delivered. This product-oriented approach is particularly meaningful when applied to the development of tools and the experimental phases of the project. Quality criteria have been negotiated with individual partners doing their own initial product specifications and will be applied through to final product realization. The resulting quality metrics for each tool,

section of research, and instantiation of tests should not only address the technical needs, but also the socio-pedagogical requirements of the end user.

At present, the quality management system for development, production and delivery of course materials has been designed and implemented by the University of Paisley. A set of evaluation methods and standards has been built in complementary European projects. They will be applied to ensure that the project proceeds with due diligence and care. A documentation and report system has already been established to facilitate managerial information exchange and project monitoring.

Related Projects

The NCEC project will link to a number of ongoing projects, and provide a platform for more extensive testing and exploitation of their results. These projects include ARIADNE (in which the University of Paisley and EVITech have been partners), a research and technology development project in the "Telematics for Education and Training" sector of the 4th Framework Program for RT&D of the European Union. The NCEC project will complement the development of the broker-based "University for Industry" of the UK as well as the broker systems in some other EU funded projects (such as the INCO-COP KNIXMAS project) in which the European partners are intimately involved. The NCEC project will be directly benefited from the DMDDES project and KWAFU⁴ system developed by the Tsinghua University.

The NCEC system may also utilize and adopt results from other European and Chinese projects that the partners are involved in, which may provide the basic research results to be deployed in the NCEC.

The infrastructure and basic standards for the NCEC project will be based on the developments in the ARIADNE, the IMS, and the IEEE-LOM projects leading to international standards for training products. The NCEC project partners have links to all of these projects. In this way the NCEC will be developed in a parallel manner with other projects, leading to the creation of a seamless market for training products between China and Europe.

Chinese Information Processing

⁴ KWAFU is a prototype of distance learning systems based on Internet technology. It offers individualized learning on demand. Learning materials can be differentially arranged to fit students' qualifications and needs. Students can make use of methods such as bookmarks, notes, etc. to help construct personalized knowledge during the study process. They can take advantage of real time or an asynchronous means, including chat, e-mail, forums, etc. to communicate with teachers or other students. A self-help test is a useful utility of KWAFU for students to check themselves in the mastery of the knowledge learned.

NCEC applications are both Chinese and English language enabled. The Chinese information processing—input, indexing, tagging and displaying—has three issues: the encoding of Chinese characters, the platform of Chinese information input/output, and the techniques of separating and automatic indexing Chinese words. There are three most common Chinese character-encoding sets: GB2312-1980 (the National Standard of the People's Republic of China), Big5 (used in Taiwan and Hong Kong), and Unicode (which encodes about 21,000 simplified and traditional characters). Adopting these Chinese character encoding schemas automatically suggests that Chinese Microsoft Windows (95/98/NT) is preferable. Other Chinese shell software programs for Windows are also able to process Chinese characters coded in GB or BIG5. For example, RichWin and NJ Star are popular in supporting web browsers such as IE 4.0 (or later version) and Netscape 4.7x. IE with a Microsoft Windows supported Chinese font set is more stable than Netscape and has been widely accepted by Chinese users. Linux installed with the Chinese font set is also recommended.

Chinese word separation is a special technical issue in Chinese information input and indexing. Since the LOM (Learning Object Metadata) schema, based on XML, has been adopted as the basic documentation standard, manual Chinese text tagging in accordance with predefined DTD (Data Type Declaration) files has become a basic approach. However, to convert existing Chinese text files into courseware repository elements, automatic Chinese word separation is also needed and will be implemented accordingly.

Issues in NCEC System Operation

The Construction of Courses

It is expected that the idea of the course content will evolve to include regularly-updated materials including seminars and streaming presentations, and that a market will grow with the customers' access to the content provided from these repositories. Cryptographic techniques such as digital signatures can be used to ensure accuracy and provenance. In all areas of academia and industrial training, materials date very rapidly and pirated copies are frequently inaccurate in other respects as well, so customers will look to such digital signatures as their guarantee of quality. In the NCEC environment, customers can individually or collectively shop around for content in order to create suitable courses. Institutions can accredit particular content to their demands, so the author might even pay the institution for such endorsement. Once endorsed, the author should expect a bona fide supplier to use this content to pay appropriate royalties. Suppliers will be accredited by institutions on the basis of the quality of the experience they offer to students, and the materials they provide in support of their courses.

The Role of the Supplier

Suppliers create tutorial and assessment facilities, and will recommend lists of tutors and centers that students could select. Suppliers need to maintain their relationship with their institution, which would monitor their quality and performance. The quality of service provided by the supplier will include: the selection and delivery of course materials, the registration and supervision of students, the provision of physical facilities such as laboratories and other learning resources that the student might visit, mechanisms for assessment, and lists of tutors.

Assessment of students in the distance learning situation is not a straightforward matter. Students must consent to, and the supplier must maintain, sufficient monitoring to enable detection of abnormal behavior. The tutor's role in this is crucial, and there will always be a place for some assessment conducted under examination conditions.

The role of the tutor

Tutors or other instructors are regarded in this work as an indispensable component of the learning process. At or above degree level, students acquire the transferred skills of organizing their own education and conducting their own brainstorming activity. It is very important that human tutors or instructors are provided to enthuse and motivate at the earlier levels of education and are also crucial to help build the analytical concepts required by the student.

In order to maintain a sufficient quality of service, suppliers will need to provide adequate tutorial support of various kinds. Much of this can be a NCEC central service: responding to e-mail requests, moderating bulletin boards for self-help discussions, and providing some formal demonstrations and live tutorials, which might then be available on-line. But the human contact referred to above implies a network of local tutors, close enough for students to meet occasionally. The supplier has an interest in recruiting and training a network of tutors, who make possible the growth of student numbers in their local areas. Tutors can monitor student work in detail and give feedback on courses, as well as provide other feedback to students and facilitate their learning.

What is revolutionary about network-training collaboration and the promise it offers, is the ability to scale existing provisions to mass education, and provide potentially global course choices, while using the human contact provided by local tutors and the hands-on practice available in local centers. The main collaborations envisaged are between authors and institutions, institutions and suppliers, suppliers and tutors, and finally tutors and students. All of these can be electronically assisted, and provided at a distance, apart from the local support that in our view students need.

The NCEC envisages the growth of a market for these services in the same way that Internet service provision

has become a diversified market, with its own special niches. Students will realize, just as the Internet subscribers do now, that there is a range of providers and services for them, all offered in simple ways. The international standards enable the global infrastructure that make feasible the networks of service contracts that, in turn, will go to make up the distance learning programs of the future.

Recent Progress

The NCEC project is currently in its system-development phase. In the beginning of the phase, a gross system design was carried out and other technical explorations were simultaneously conducted by each project partner.

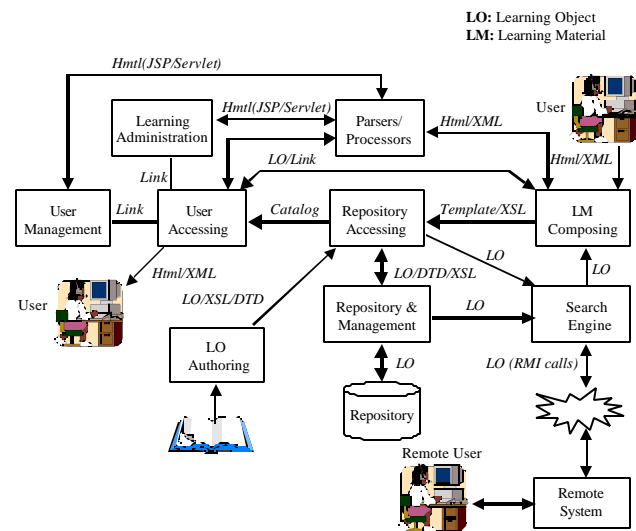


Figure 2. A function model for NCEC system

The Tongji University designed a NCEC function model in 1999 (Figure 2) as the major portion of the gross design. It was based on XML and Java technology following IMS' metadata standard (Anderson et al. 1999). The function model consists of the following seven modules based on the three-subsystem structure:

- *Learning Object (LO) Authoring*
- *User Accessing*
- *User Management*
- *Learning Administration*
- *Learning Material (LM) Composing*
- *RMI (Remote Method Invocation) Server/Search Engine*
- *Repository Accessing*

Course Logical Structure

The course content has a hierarchical structure from top down: discipline, course, textbook (LM) and LO,

where a LO is an elemental pedagogical unit, and a LM is an online textbook dynamically built up with LOs. The online electronic version of a textbook is a LM built upon LOs using a template. The presentation styles of the LM are combinations of related LOs according to predefined templates or user requirements, and translated into HTML by XML processors incorporated in Web servers. Each textbook is allowed more than one static template in the form of XML. The presenting style of the LM is defined by style sheet, XSL (eXtensive Server Pages) in NCEC case. Different XSL files can be used for each LM in order to make it have different presentation-style-supporting means on user browsers, such as one presentation with multimedia support and the other without it may be applied for the same LM.

Course Production

The LO Authoring system provides all required functions for course production. The first step in the course production process is authoring DTD and tags. The DTD gives constraints and validation rules of these tags that are to be used to parse the textbook. Tags can be defined in accordance with each course, i.e., a course has its own set of tags used to tokenize its textbooks, or has its definition based on a discipline that may include several courses. As far as the DTD is concerned, it is better to define one DTD file for each discipline, which is to have the same DTD for all LOs used in different courses.

Once the DTD and tags for a course is ready, a courseware author can start to tokenize a textbook into learning objects by using tags that have been defined. The process is:

- Decompose the text into small and reusable parts called LOs.
- Generate the metadata and their structure for each LO according to LOM standard.
- Set taxonomies and dictionaries of LOM to describe attributes of the LOM elements which are understandable to search engines specified to deal with LOs.

The relationships among LOs are defined by means of XLL (eXtensible Link Language). It is the basis upon which LO hierarchical structure can be established.

Learning Material Delivery

Learning material delivery is supported by *User Accessing*, *LM Composing*, *RMI Server/Search Engine*, and *Repository Accessing*. The User Accessing System provides users with system-accessing interfaces implemented mainly by server pages such as JSP (Java Server Page), Java Servlets and XML processors. Upon receiving a request in the form of XML from the User Accessing System, the LM Composing System will search the cache for the LM, or find a requested template,

or generate a template accordingly. Then it will send serials of requests to the RMI Server/Search Engine System, which will retrieve the required LOs for the LM Composing System. The LM Composing System will generate a LM header from the metadata contained in the LOs. The LM header is parsed into HTML documents to be sent to the user's browser, in accordance with the results of the search engine.

The RMI Server/Search Engine System is implemented with Java RMI protocol. The search engine is used specifically for the retrieval of LOs in the XML form. The Repository Accessing system will be called to search the local repository and remote sites in order.

The Repository Accessing System provides interfaces for accessing of system database tables, caches and directories. It includes several modules used to maintain the repository, especially the databases and catalogs. The repository accessing interfaces encapsulate all database tables, whose inheritances are realized by using DTAL (Data Table Abstraction Layer) (Yang 1999).

Users' Learning Management

Users' Learning Management consists of two subsystems: *User Management* and *Learning Administration*. The User Management System provides functions such as user registration, system logon, user authentication, account services, and so on. When a user accesses the system and wants to browse the protected pages, the user must be authenticated by the system and authorized to the requested contents.

The Learning Administration System allows registered users to obtain requested services such as topic-specific searches, examinations, and curriculum creation which incorporates teachers. It is very important for users to have various kinds of online utilities that enable them to make notes on browsing pages, get help from teachers, join mailing lists and BBS, and retrieve recent interfaces by clicking only a button. Users can also get learning and profession advice from some experienced experts dedicated to the system.

Pilot Courses

A number of pilot courses are being developed for both verifying the NCEC methods and tools and helping the Chinese partners acquire skills in the new methods for the production, delivery and presentation of electronic courses. The pilot courses are carried out as training experiments where both the cost-efficiency of the production methods and the effectiveness of learning in terms of learning outcomes will be assessed. Some of the courses will be provided for training the employees of European-Chinese joint-venture companies. EVITech has developed three pilot NCEC courses in English:

- Introduction to Telecommunications Networks
- Internet Technology

- Electronic Documents and Network Publishing

Chinese partners are developing a number of pilot courses in Chinese. For example, Fujian Economic Information Center is porting its CD-versioned *Confucius* to the Web-based version that can be used as a supplemental material for the Chinese literature course.

This will provide a basic underpinning of the development of Chinese-based electronic courses on the NCEC system. The above programs will form the basis of the training experimentation of the NCEC.

However, we do have to consider how to develop the learning capability of the new target population. This implies that we have to develop a hierarchy of skill delivery. The programs to be presented in China will therefore be delivered in a rather structured manner. We will firstly deliver a set of enabling courses that can be used to build up the community of trainers and learners enabled by the new technologies. We call this approach the *bootstrap model*. We therefore can classify our programs according to the hierarchy given in the Table 1 below:

Table 1. The Bootstrap Model

Level	Courses	Domain
Application Specific	Entrepreneurship Data Business—Call Center	Information technology Technology support areas Biotechnology
Content Development	Learning Applications Development	Quality processes for learning
Basic Level—Enabling Knowledge & Skills	Network use Introduction to the Internet	The application of the Internet in education

Promises and Research Issues

The NCEC project will benefit China and Europe in many ways:

- The NCEC is intended to provide full support to the Continuing Education and Training on the Internet at Shanghai at the first stage. Shanghai is crowded with 13 million people. The relatively smaller area provides a better communication environment for network based education. At the second stage, the NCEC will have the opportunity to be popularized to the whole country. China is populated with more than one billion people. CERNET is being expanded to a body of about 1000 universities in China to service about 400,000 professors and staff members, 100,000 graduate students and 2,200,000 undergraduate students. Following that, CERNET will link many middle schools and primary schools in China in the future to benefit about 180 million students in total. Therefore, CERNET will be the largest education and

research network in the world. In light of the NCEC's experience, China will be able to develop other training systems for different levels of schooling.

- The NCEC will supply a well-tested system for the transfer of training support from Europe to China. It will also provide a clear pattern for the development of collaboration between the training systems of China and the EU. The lessons learned and the systems built will be of significant interest to future EU-CN projects.
- The repository technology being built with the NCEC project will be a direct exploitation of the standards being developed in the USA and the EU, in particular the ARIADNE standards and the developing standards of the IEEE, for the collation and distribution of learning objects. The NCEC has been providing both techniques and experience to the Internet applications in China.

The NCEC's research plan will be focused on two aspects. The first one is its commercialization. This will bring benefits to both Chinese and European partners (Hämäläinen 1996; Hämäläinen et al. 1996). We have proposed and studied a couple of e-commerce-oriented proposals for the NCEC with new business models, trying to capture emerging Internet-based business opportunities. The distance-education market in China is different from the market in other countries in nature. The relevant regulations and Chinese consumer behaviors with specific cultural backgrounds together will challenge the research effort in this direction. The second aspect is technology research. Specifically, knowledge management (Lin et al. 1996) for Chinese information is one of the suggested topics. Conceptualizing metadata in Chinese may lead to organizing textbook knowledge in the way that allows new knowledge discovery and knowledge inference. Therefore, the efficiency of courseware production and modification can be improved. In addition this may provide users a better application interface.

Although the NCEC project is progressing very quickly now, more and more Chinese institutions have reached its pace in last five years in the research and development of distance-education systems. The NCEC project is not, relatively speaking, the largest in funding and scope now. However, its effects are significant and profound, because it is the first distance-education project proposed in China and carried out jointly there by the leading Internet application researchers who are empowered by China's major Internet services and the European institutions who have successful experiences in this field.

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