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Web-CCAT: a Collaborative Learning Environment for Geographically Distributed Information Technology Students and Working Professionals

Donna Dufner
University of Nebraska at Omaha, dufner@mail.unomaha.edu

Ojoung Kwon
University of Illinois at Springfield, kwon@uis.edu

Rassule Hadidi
University of Illinois at Springfield, rhadi1@uis.edu

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A COLLABORATIVE LEARNING ENVIRONMENT FOR GEOGRAPHICALLY DISTRIBUTED INFORMATION TECHNOLOGY STUDENTS AND WORKING PROFESSIONALS

Donna Dufner
Ojoung Kwon
Rassule Hadidi
Department of Management Information Systems, College of Business and Management
University of Illinois at Springfield

dufner@uis.edu, kwon@uis.edu, hadidi@uis.edu

EDUCATION

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Department of Management Information Systems, College of Business and Management
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ABSTRACT

This paper describes the underlying concepts, architecture, and design of a Web-enabled CyberCollaboratory (Web-CCAT) for geographically distributed information systems students and working professionals. The primary objectives for Web-CCAT are (1) to provide the opportunity to participate in and enjoy the benefits of cooperative learning without having to coordinate meeting times or come to campus; and (2) to provide a more technologically enriched collaborative environment than is possible in a traditional face-to-face classroom.

To meet these objectives, multi-user, collaborative software tools and procedures were designed for use in the asynchronous mode of communication. Web-CCAT is implemented as a tool kit of commercially available applications coupled with software developed at the University of Illinois at Springfield. The system became operational in January 1999.

I. INTRODUCTION

The faculty of the Management Information Systems (MIS) program at the University of Illinois at Springfield (UIS) encourages collaborative student projects in many of the traditional graduate MIS courses. Cooperative or collaborative learning experiences have a long history of positive outcomes. Previous research shows that students who have the opportunity for collaborative learning experiences develop better analytical skills, evaluate readings more thoughtfully, and feel more of a sense of belonging [Turoff, 1995; Bligh, 1972; Kulik and Kulik, 1979; Wagner et al., 1992]. Collaborative learning in and of itself is an effective method for promoting learning [Kimber, 1994]. Learning is a social process [Hiltz, 1995b] and group learning is more effective than individual learning [Alavi et al., 1995; Brown and Palincsar, 1989; Hiltz, 1995b; Vygotsky, 1978].

Providing collaborative learning opportunities for both traditional (face-to-face) and online students can be difficult. Traditional students need to coordinate and attend meetings outside regularly scheduled class times. Geographically distributed students in online programs must rely exclusively on technology to communicate and collaborate.

Students can collaborate using e-mail or computer mediated conferencing (CMC) systems to support their group work and to communicate with one another. However, groups distributed in space and time have serious coordination problems [Dufner et al., 1994; Dufner et al., 1995]. CMC systems and e-mail provide limited structures for coordinating asynchronous collaboration.

This paper describes our efforts to design and implement a Web-based CyberCollaboratory for asynchronous use by student groups and working professionals. The CyberCollaboratory, known as Web-CCAT was developed to

provide the tools, processes, and structures for enhanced asynchronous collaboration among both our online and traditional students.

II. FOUNDATIONS

As a land grant institution, one of the University of Illinois' strategic objectives is to deliver "affordable education of internationally recognized stature to undergraduate, graduate and professional students" [Stukel, 1997]. To achieve this objective it is necessary to deliver educational opportunities to students in the small towns and rural farming communities; to working professionals; and to the housebound; as well as to those who are able to come to the university.

The students in the graduate MIS program at UIS are among the working professionals who are often those most hard pressed to attend traditional face-to-face classes. These individuals hold responsible, professional positions and frequently have families as well. Many must travel extensively or work erratic schedules. Their jobs often require that they miss class or take a semester off. As a result of our students' needs and the University of Illinois' mission, the faculty of the MIS program decided to deliver the entire MIS program in the asynchronous mode of communication via the Web. The immediate issue facing the MIS department was how to deliver media rich, high quality educational opportunities via the Web that are equivalent or perhaps better than face-to-face classes for the geographically and temporally distributed students.

Delivering *collaborative* educational opportunities (such as group project work or group case analyses) to both our traditional and online students using the asynchronous mode of communication via the web was also of great interest to us. Asynchronous group support tools can be used by individual group members from the location of choice such as home or office, and at the times preferred.

The benefits of asynchronous collaboration include more than just convenience. The asynchronous mode of communication may be better in some ways than face-to-face communication. In the asynchronous mode of

communication students have time to reflect and think about a problem. Additional research can be conducted and more alternatives can be explored because these meetings take place over an extended period of time. Asynchronous decision making processes are less prone to "pressure to closure" [Hoffman, 1979; Dufner et al., 1994; Hiltz, 1994; Hiltz, 1995b] which may prevent students from exploring enough alternatives for adequate problem solving. Asynchronous technologies can also enrich learning and working experiences by providing an opportunity for people to interact more directly with one another outside of the classroom, to learn about new technologies, and to enjoy the interaction of a goal-oriented team [Hiltz, 1994].

In addition to the social benefits of collaborative learning, there are clear educational advantages to using asynchronous technologies. Students are reported to perform better using these technologies. The test scores of groups of students using asynchronous technologies such as GDSS, Conferencing, Virtual Classrooms™, and Hypermedia Virtual Classrooms™ were significantly higher than those not using these environments and tools [Alavi, 1994; Rana et al., 1996; Hiltz, 1994; Hiltz, 1995a; Hiltz, 1995b; Turoff, 1995].

However, when group process structures and methods for coordination are absent from collaborative technologies such as CMC systems, group members may lag behind or drop out of the collaborative efforts altogether. From previous research we know simple structures such as a meeting agenda, voting tools or facilitation can help a group to achieve a specific goal such as consensus in a decision making process. Groups without these simple structures frequently flounder [Dufner et al., 1994].

Many of the process support and structuring methods used for Web-CCAT, the task support, and the task structuring methods are based on the work of Nunamaker and his colleagues at the University of Arizona; Hiltz and Turoff at the New Jersey Institute of Technology (NJIT); and Gallupe, DeSanctis, and Dickson while at the University of Minnesota [Bostrum et al., 1992]. The GDSS Tools and task structures were influenced by the research and design work conducted at NJIT, Minnesota, and Arizona.

III. WEB-CCAT ARCHITECTURE AND DESIGN STRATEGY

Given the need for group coordination for successful and satisfying group collaboration the CyberCollaboratory needed

- tools (artifacts),
- process structures (e.g. agenda),
- process support (e.g. group memory, anonymity), and
- task structure and task support (e.g. CASE, project management software, GDSS tools).

Hiltz et al. [1991] discusses three primary methods for coordination of asynchronous groups. These are:

- an agenda or some set of directions or instructions,
- a facilitator or leader, and
- GDSS tools such as those embedded within GroupSystems, Electronic Information and Exchange System 2 (EIES2) or Software Aided Meeting Management (SAMM).

Project management software, computer aided software engineering (CASE) tools and GDSS tools are the main environments within Web-CCAT. A facilitator module was also developed.

After tool selection was completed, the next challenge was to make these tools usable in the asynchronous mode of communication and accessible via the Web. Lotus Notes was selected as our groupware or CMC system platform. The Notes platform is Web enabled using the Domino front-end that is supplied by IBM. An agenda can easily be embedded within the Lotus Notes platform.

IV. THE WEB-CCAT TOOL KIT

The architecture of Web-CCAT is shown in Figure 1. It includes:

- Lotus Notes for group support,
- systems analysis and design tools,

- project management tools, and

- group decision support tools.

Figure 1. Web-CCAT Software Architecture. [Dufner, Kwon, and Hadidi 1998]
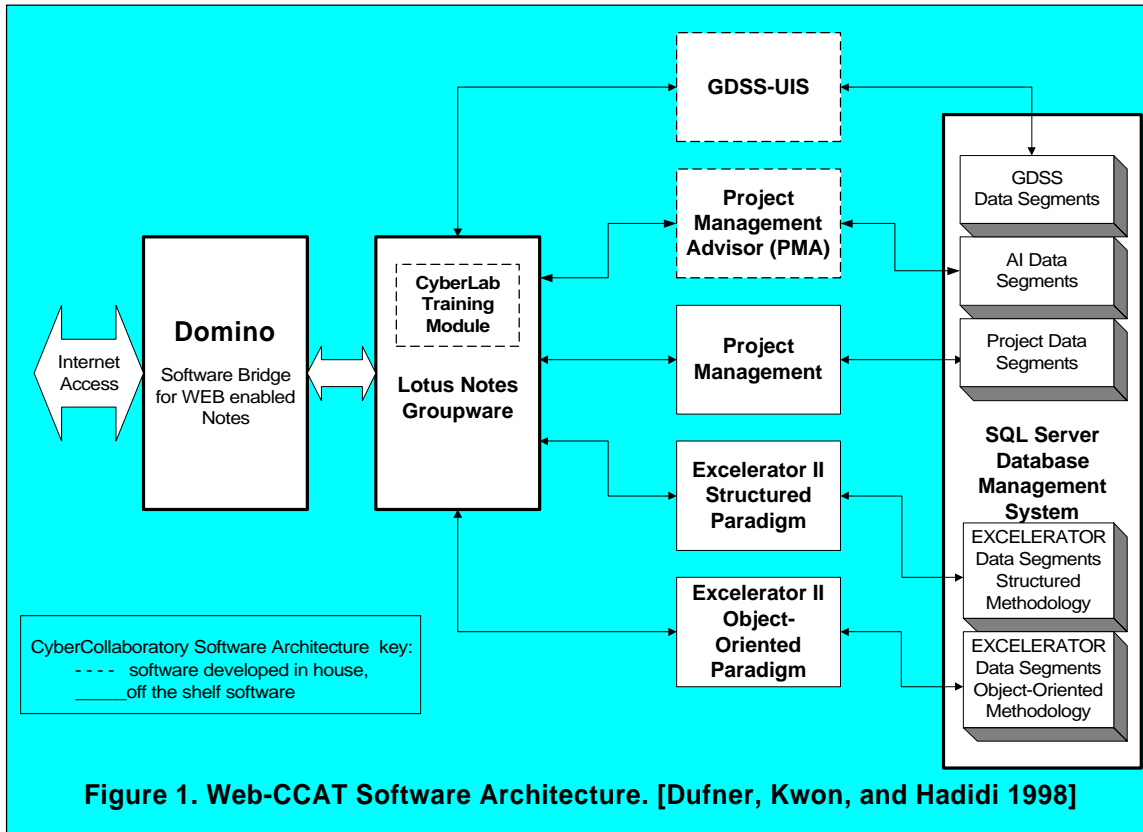
Figure 1. Web-CCAT Software Architecture. [Dufner et al., 1998]

Web-CCAT is tailorable [Turoff et al., 1988]. Alternative group communication structures such as:

- electronic mail,

- conferencing, and

- real-time chat.

are provided. Alternative methods for organizing, tracking and integrating the stored data such as multilevel linked indexing and data storage based on tool usage are also being provided. The interface can be tailored to reflect the tool environment required by a collaborative group.

Web-CCAT is also designed to be adaptively structured [Poole and DeSanctis, 1992] to meet the needs of a variety of task groups. The software is managed by a group administrator or facilitator who can select the team tools from Web-CCAT's setup screen by simply pointing at the desired menu item and clicking the left mouse button. For example, a software design and analysis task might require the use of the GDSS tools, word processing, E-mail, conferencing, and CASE as shown in Figure 2.
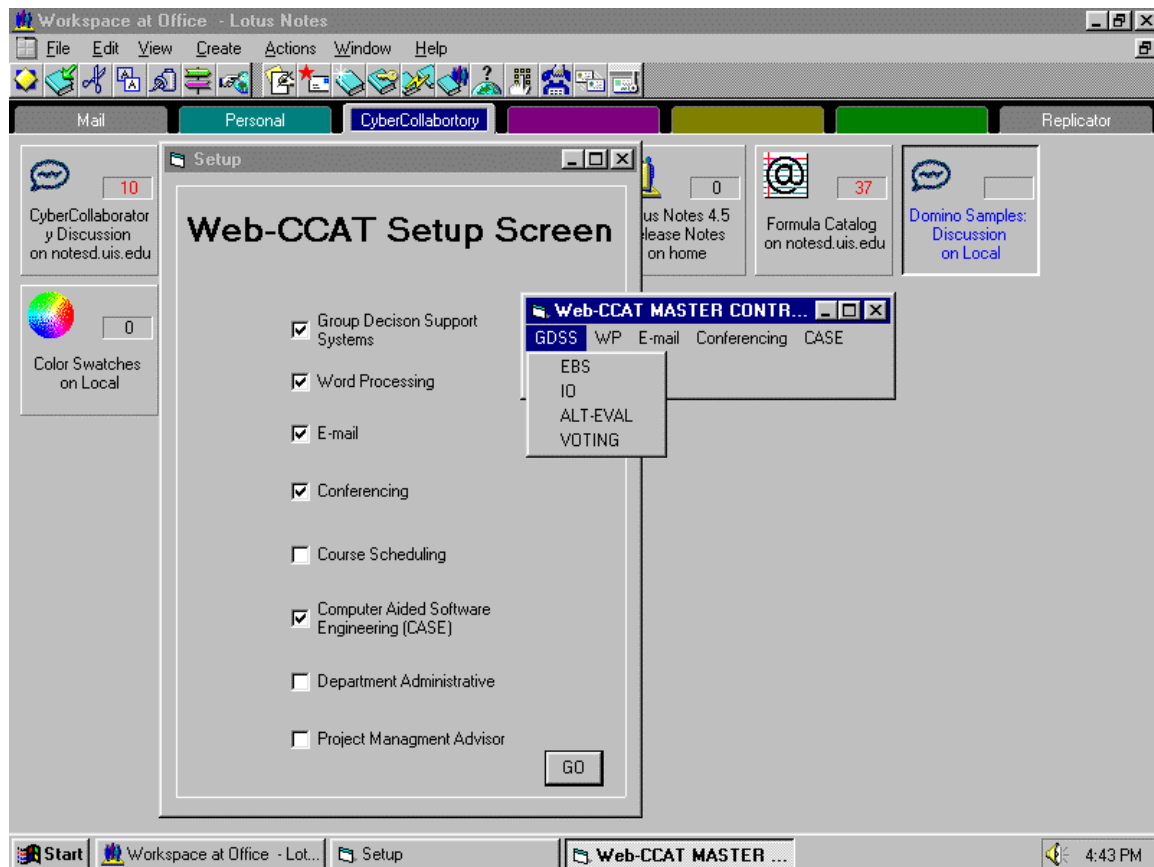

Figure 2: Web-CCAT Setup Menu and Floating Tool Bar [Dufner et al., 1998]

Web-CCAT is invoked once inside the Lotus Notes environment. The Setup Screen with the list of available tools floats on top of the Lotus Notes interface. Once the tools are selected, the environment (Notes and the selected software extensions) is dynamically configured and a customized floating tool bar

of applications, the Web-CCAT Master Control for that specific group, is presented as shown in [Figure 2](#).

V. THE WEB-CCAT ENVIRONMENTS: TOOL SELECTION AND IMPLEMENTATION

". . . collaboration is not just conversation, it is joint activity around certain artifacts." [Row, 1997]   In this instance the artifacts are the tools in the CyberCollaboratory.

Our initial focus was to create an architecture for an asynchronous team environment by embedding appropriate software tools in a groupware platform. Tools were selected based on their potential use by the students.

The current Web-CCAT design consists of three sub-environments;

- Asynchronous Systems Analysis and Design Environment (ASADE),
- GDSS Environment, and
- Project Management Environment.

The three environments, together with Real Time Chat and group conferencing, are described in the following subsections.

A COLLABORATIVE WEB-ENABLED ASYNCHRONOUS SYSTEMS ANALYSIS AND DESIGN ENVIRONMENT (ASADE)

Systems analysis and design is often a group activity performed by a number of individuals, the design team. The design process consists of tasks performed serially by individual team members, punctuated by face-to-face design team (group) meetings. With Web-enabled CASE tools that can be used by a group asynchronously, design activities become a more genuinely collaborative function. Asynchronous systems analysis and design enables a project team to act in concert where members are distributed in time and space. Team members can accomplish a shared objective with a reduced need for face-to-face meetings.

For example, the decision to include the multi-user CASE tools (Excelerator^{TM} II shown in Figure 1) was in direct response to:

> (1) the nature of systems analysis and design course which we teach in our program, and

> (2) the importance of CASE in producing quality software products.

In practice, systems analysis and design is not a solitary effort, but is a collaborative task often requiring software design and development teams to spend up to 70% of their time communicating and working with other team members [DeMarco and Listner, 1987]. The rationale for CASE is explored further in Sidebar 1.

Traditionally, CASE tools are implemented in three ways:

- as centralized, host-based applications accessible through PCs or terminals,
- as distributed, stand-alone applications resident on a PC, or
- as LAN-based client/server applications.

The ASADE environment extends traditional CASE implementation architectures to a fourth type of implementation environment as shown in Figure 3, a Web-enabled asynchronous collaborative environment. This fourth type of implementation extends the three traditional methods of implementation as follows:

- the CASE tools are multi-user,
- the CASE tools are Web-enabled and can be accessed through the Internet using a standard Web browser and a PC from any remote location where there is Internet access,
- and the CASE tools can be used in asynchronous mode from the location of the user's choice and at the time of preference without regard for temporal or geographical limitations.

SIDEBAR 1. ADVANTAGES OF CASE TOOLS FOR WEB-CCAT

CASE tools can and do improve software quality, developer productivity, and user satisfaction when adopted and used [Chmura and Crockett, 1995; Iivari, 1996; Vessey and Sravanapudi, 1995; Semich, 1994; Martin and McClure, 1988]. The reason CASE tools are not widely used is because designing software using CASE tools requires specialized training both in the use of the tools and in a well-defined development methodology.

Academic programs often provide training in development methodologies such as the Life Cycle but not in the use of CASE tools. Even when CASE tools are provided, students must schedule time to come to campus to use the technology. Asynchronous CASE tools provided through the Web eliminate one hurdle to adoption, accessibility. Students have the opportunity to work with these systems before leaving the university.

While the research shows that CASE tools can be useful in the development and maintenance of software, the results can be disappointing if training in the use of these tools is not provided. Chmura and Crocket [1995] reported that with the *proper* use of CASE tools, developers could realize significant improvements in productivity and quality of software systems. CASE tool success, however, is heavily dependent on training in the use of the tools coupled with training in systems development methodologies. Without adequate training the CASE tool will probably be abandoned [Chmura and Crocket, 1995]. Iivari [1996] also mentioned that the quality and quantity of training in the use of the CASE tool is the key to their continued usage.

The empirical literature shows the use of a well-defined methodology coupled with the use of CASE is critical to the delivery of maintainable and reusable software. Many studies support the usefulness of CASE tools [Chmura and Crockett, 1995; Iivari, 1996; Vessey and Sravanapudi, 1995; Semich, 1994]. If CASE tools are used with the right expectations and training, they are more likely to generate increased productivity and more easily maintained software.

The ultimate outcomes expected from the use of the Web-based, collaborative CASE environment are:

- increased productivity,
- flexibility,
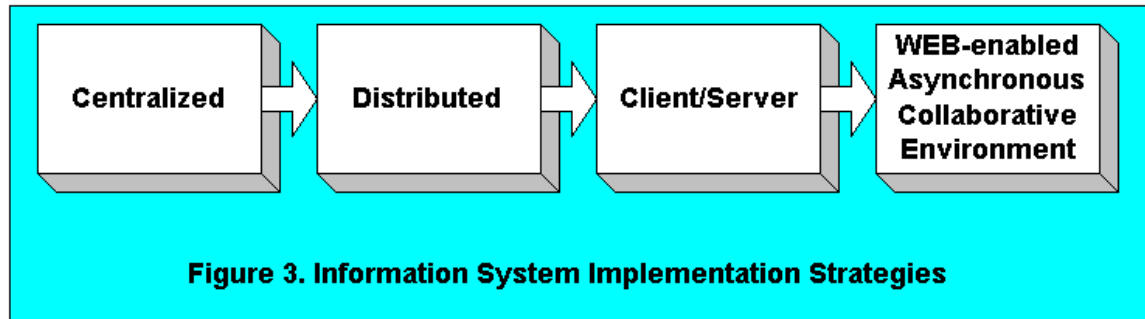- richness, and
- team satisfaction.

Figure 3. Information System Implementation Strategies

The CASE environment is designed to support both the structured and object-oriented methodologies. ASADE was under development when this paper was published in March 1999. For educational purposes these CASE tools can be used for group project assignments incorporated into either a traditional, face-to-face pedagogy or a distance learning pedagogy. Class time is not sacrificed when incorporating the use of the tools in student project work.

THE GDSS ENVIRONMENT

Work on the GDSS environment at UIS began in 1993. As has been true at most other institutions, our system was initially designed for a face-to-face (same time and same place) decision room meeting environment. A software grant from Microsoft including MS-Visual Basic 1.0, MS-Access 1.0, and Windows for Work-groups (WFW 3.11) was used in developing the Phase I system.

The first GDSS at UIS, developed over a period of two years, included five tools: Session Manager, Electronic Brainstorming, Idea Organizer, Voting, and Alternatives Evaluator (see Sidebar 2). The software was tested and operated in a computer lab on campus. Because of the high costs of building a decision room, we decided not to require one in the second phase.

The necessary modifications to make the software capable of handling the distributed, synchronous mode of communication were made in 1995. Using the campus LAN and WAN connections, group members no longer were required to

meet in the same place. The meeting agenda could be distributed via e-mail and members could log in to the system from their computers or from the computer laboratory. Facilitation and meeting coordination were still required.

SIDEBAR 2. GDSS-UIS MODULES

Electronic Brainstorming provides a platform for generating and posting related ideas. The Public Screen contains all of the ideas transmitted by the group members. Individual group members may select public or private messages, and upload or download any of them by using the GUI cut and paste options and the original message will be preserved on the Public Screen.

The group uses the *Idea Organizer* tool to organize a list of ideas generated during an electronic brainstorming session. Ideas can be easily edited, duplicates can be deleted, and similar ideas can be consolidated.

Five *voting* methods are provided in the voting tool. These are:

- Vote for One Item,
- Vote Yes or No,
- Voting by Rating Items,
- Voting by Ranking Items, and
- Voting by Bids.

To vote, each member is presented with the list of ideas generated from a previous electronic brainstorming or idea organizer session. Prior to group voting a facilitator or individual group member specifies the voting method. Regardless of which voting method is used, GDSS-UIS tabulates votes automatically as each member votes.

The *Alternatives Evaluation* tool enables members to create their own evaluation criteria and then use them. For example, a group is trying to generate alternative places for a new factory location. The criteria, which will be used in making the decision, such as land price, transportation, and raw material sources are listed. The group members have four methods for weighting the criteria including equal weight, direct input of priorities, pair-wise comparison, and the ELECTRE [Changkong and Haimes, 1983] method.

In 1996, when the MIS program began the design work for Web-CCAT, the GDSS was included as an important component of the asynchronous tool kit for group coordination and process control. Integration of the GDSS into the

Notes platform provided decision groups with asynchronous GDSS and with the full functionality of a robust CMC system. The evolution of the GDSS-UIS is shown in Table 1. The three levels of GDSS in Table 1 are explained in DeSanctis and Gallupe [1987].

Table 1. Plan and Status of GDSS Project at UIS

Phase I (1993-1995)	• **Face-to-Face (Same Time & Same Place) Meeting Environment** • Level 1 GDSS • Decision Room • GDSS, E-mail
Phase II (1995-1996)	• **Distributed Synchronous (Same Time but Different Place)** • Level 1 GDSS • LAN-based • GDSS, E-mail
Phase III (1997-present)	• **Distributed Asynchronous (Different Time & Different Place)** • Level 2 GDSS • Web-based • CyberCollaboratory including GDSS, E-mail, Discussion Group, Project Management, ASADE
Phase IV (Future Direction)	• **Intelligent Distributed Asynchronous** • Level 3 GDSS • Web-based • Intelligent Facilitation Agent (Self-Facilitation)

The GDSS environment can be chauffeured or not as a group chooses. The facilitator module for Web-CCAT can be used to open and close access to tools, creating a sequential structure for group decision processes.

PROJECT MANAGEMENT ENVIRONMENT

Less than 20% of all software applications development projects are completed within budget. Approximately 1/3 are abandoned before completion, costing over 80 billion dollars a year [Bicknell, 1995; Robert, 1997]. On average, projects that are completed are over budget with scaled down functionality [James, 1997]. Even though politics, lack of leadership, and misunderstanding

between the user and the developer also contribute, project failures are reported to be a result of ignoring basic project management principles such as planning, cost estimation, and risk assessment [Bicknell, 1995]. Consequently, project management skills are important practical skills for MIS students and working professionals.

The project management environment of the Web-CCAT tool kit consists of two sub-components:

- a project management plan tool, and
- a project management advisor tool.

The project plan tool provides access to Microsoft Project databases through the Web via Lotus Notes. Collaborative groups may view and discuss project plans.

View only access was provided for project control and to meet the licensing restrictions of Microsoft (each client side computer must own a copy of Microsoft Project). Plan changes and modifications must be controlled. Uncontrolled updates, deletions, and additions to a project plan can result in chaos. Therefore one member, the facilitator or designated leader, of a work group will be permitted to modify the project plan. This person must also have an installed copy of Microsoft Project on his or her PC. Other group members do not need to own copies of Microsoft Project.

An expert system module, Project Management Advisor (PMA), is being built for analyzing project plans. PMA will issue alerts to potential problems, analyze the causes of delay, and provide suggestions for corrective measures. This module is described in Sidebar 3.

For a project to succeed a well-defined project plan is essential [Button, 1996]. The purpose of a project plan is to eliminate delays and the associated cost overruns [Aoude, 1996]. However, traditional project management software tools based on deterministic optimization algorithms focus on schedule variance based on historical data [Aoude, 1996]. These tools are not able to forecast project control problems that may affect project completion dates. Nor are they able to analyze the causes of delays and the corrective measures required.

SIDEBAR 3. THE EXPERT SYSTEM PROJECT MANAGEMENT MODULE

The PMA expert system being developed is designed to provide guidance in the form of alerts and advice for the project management team. The alerts can be grouped into two categories.

1. The first set of alerts is based on the initial project plan. The plan information is initially analyzed for problems such as missing task dependencies, end dates that are artificially linked to fixed dates, tasks with no resource scheduling, tasks that are more that 40 hours, tasks with no slack time allocated, etc.
2. Thereafter, periodic PMA analyses of the data will be conducted during the life of the applications development project. The ongoing project plan evaluation will include looking for project modifications that may place the project in jeopardy, such as changes in end dates; total amount of effort; tasks that have been added or deleted from the project; or changes in the estimated effort.

We believe the use of PMA to evaluate project plans will prove to be an effective teaching tool for working professionals and for students. The initial field study, discussed in more detail in Section 4, shows PMA successfully detects project plan anomalies and suggests the correct remedies. The identification of plan anomalies and the suggestion of remedies are expected to help students to learn better project management skills. The integration of Microsoft Project databases and PMA into the Web-CCAT environment enables asynchronous groups to manage tasks collaboratively and make more informed decisions using the expert knowledge codified in the knowledge base. In addition to providing an asynchronous project management training environment for students, the groupware/project planning combination is expected to facilitate group (user group and development team) planning and project control as well as project quality and timeliness.

The expert judgment embedded in the knowledge base can be used to offer remedies to potential problems, in addition to flagging potential problems for an existing plan. A high level of training in the use of appropriate project management tools, proficiency in the use of the tools, and experience are required to develop workable project plans and to deliver software in a timely and cost effective manner. Often project managers lack the required training and expertise. An expert system tool is used to fill in for a project manager's lack of skill and experience.

Some planning systems incorporate historical data from completed projects for use as the basis for planning [Harrell, 1996]. However, these methods lack the predictive value of an expert system, which contains the judgment of an expert project manager embedded within its knowledge base.

ADDITIONAL FUNCTIONALITY (Real Time Chat And Group Conferencing)

Real-time Chat (RTC) is designed to support synchronous group discussion in a dispersed environment (at the same time but in different locations). This tool can be used in two different modes: anonymous or onymous. Each mode has different benefits and a group can choose the best mode to use before a session starts. Any group member can add sub-sessions at any time. Members can open multiple windows to track multiple RTC sessions. Before the meeting starts, the group needs to decide total session time, anonymous or onymous mode, and maximum number of sub-sessions allowed.

Group conferencing and discussion is done through Lotus Notes. Users can participate in any ongoing discussion groups or they can start a new discussion group by clicking the "New Topic" button. This tool is designed to be used in asynchronous mode. For real-time group discussion, Real-time Chat is used. To maintain each group's confidentiality, only users who belong to the group can access the contents of each session.

VI. DESIGN ISSUES

Asynchronous group support issues and problems include:

- technical and social coordination,
- group output version control,
- security,
- testing for asynchronous operation, and
- training.

This section describes the design issues experienced while developing the Web-CCAT environments.

TECHNICAL AND SOCIAL COORDINATION

The technical coordination issues for Web-CCAT involve standard software development issues such as flow of control, multi-user access,

database management and security management. The asynchronous mode of communication is also plagued by social coordination problems because many of the means for coordination used by face-to-face groups are missing [Hiltz et al., 1991].

Previous research [Dufner et al., 1995; Hiltz et al., 1991; Smith and Vanacek, 1989] shows asynchronous group members are often frustrated by

- delays between questions and responses,
- members who participate infrequently or drop out altogether,
- splintering discussions, and
- lack of focus.

Groups often wait for absentee members to respond or conversely try to deal with the occasional and often disruptive communication from members who participate infrequently.

In response to unexpected comments, those who have been working in step with their group will often express confusion by asking questions such as, "Didn't we already discuss that?" or "I'm confused, where are we" [Dufner et al., 1994]. The end result can be confusion and interrupted group processes.

To compensate for the lack of coordination structures available to asynchronous groups, we built software tools and embedded these in the group support environment. Hiltz et al. [1991] speculated that even voting routines, for example, might be designed to close after a specified period of time thus helping the active group participants to move forward in the decision or task process.

Thus the voting and other related GDSS tools are designed to be opened and closed one at a time. For example the EBS tool can not be opened for group use at the same time as the voting tool. Each group is constrained for each decision process to the use of one tool at a time. The ability to open and close tools is expected to help keep a group on track and moving through the decision process. Infrequent participants will be less able to enter a discussion and inadvertently introduce subjects that have already been addressed by the group.

At this point in time, the opening and closing of tools requires the intervention of a facilitator. In the future we hope to develop intelligent agents to perform the following work: session control, session monitoring, meeting profile management, and group members assistance.

GROUP OUTPUT VERSION CONTROL

To manage asynchronous work, a group should have to deal only with a single copy of a document, project plan, or graphic at any point in time. To achieve this goal, CASE generated diagrams and documents are made read-only once designs are firm. Updating is performed by one individual based on consensus and discussion. Project management software is used to generate reports without modification of the central plan. A group's movement through a decision process is managed by locking activities (such as voting) until preliminary work (such as brainstorming) is completed.

SECURITY

Security mechanisms are a concern in any Internet environment. The Lotus Domino Server offers authentication through the use of a user ID and password. Additional security is offered by eliminating direct access to the SQL RDBMS by remote team members and other individuals to whom access has not

been granted. Users involved in the performance of group work do not need access to the database directly to perform their tasks.

In addition, initial entry to the Web-CCAT environment is gained through the use of a secure web server. The initial entry server uses the secure hypertext transmission protocol (SHTTP).

The JAVA applications used within the Web-CCAT environment are considered relatively secure, given the current architecture of Lotus Notes and Domino. These applications are not of use to any individual without appropriate access to the Domino Server platforms. So far, the security requirements of this environment are met by the above constraints.

SOFTWARE TESTING

Testing the newer Web-based applications that can be used collaboratively and in any of four modes of communication (face-to-face; distributed synchronous; distributed asynchronous; distributed asynchronous and face-to-face combined) is challenging. The software may be virtually bug free from a developmental perspective and, at the same time, be unusable by an asynchronous team because of social coordination issues. For technical software testing, the steps in Table 2 were followed.

Table 2. Six Steps for Technical Asynchronous Testing [Werries et al., 1999]

Step one	select a sequencing constraint notation
Step two	develop a set of validity constraints based on the program specifications
Step three	perform non-deterministic testing on the system
Step four	generate additional sequence of events from the program
Step five	perform deterministic testing on the system
Step six	perform regression testing after the errors have been corrected

Testing for asynchronous, collaborative *usability* is another issue. For example, to establish whether the software tools work to reduce user frustration with delays and absentee group members we need to test user satisfaction in addition to the operational or functional effectiveness of structures. Validated, reliable questionnaires and protocol analyses will be used on an ongoing basis to determine whether the process losses that occur in the asynchronous mode of communication are reduced with the use of the cybercollaboratory tools. These two methods of testing help us identify errors and design problems that impact collaborative, asynchronous usability such as "perceived" unnatural lags between questions and feedback, unnatural flows in work processes, and cognitive dissonance experienced by the users [Hiltz et al., 1991].

ASYNCHRONOUS TRAINING

In the future, Web-CCAT will have an interactive training module that can be used remotely. Asynchronous and remote training solves the problems of requiring remote students to schedule and attend on-campus training meetings.

Online training has many inherent benefits such as 24 hours, 7 days a week availability; self-paced learning; and training aimed at the user's immediate needs. The training is designed following the cafeteria or Montessori style of selection and education. The user (student) selects the training desired at any specific moment. This self-initiation method of delivering the training through the demonstration of each of the developed modules is expected to increase the understanding and the confidence of the users and bring about adoption of the asynchronous technologies provided through Web-CCAT.

VIII. CONCLUSIONS AND FUTURE DIRECTIONS

This paper is a report on work in progress. Major components of Web-CCAT are complete and are in field-testing. Although much has been accomplished, much still remains to be done. We presented the entire program to show the final configuration that we expect to have available for our students. The status of Web-CCAT components is presented in Table 3.

Table 3. Status Web-CCAT Components

Tools	Stage
GDSS (Web-enabled and Asynchronous)	Field testing
Group Discussions and Real-time Chat	Field testing
PMA (Initial & Ongoing Analysis)	Field testing
PMA (Risk Analysis, Earned Value Analysis, and User Participation Analysis)	Development
ASADE (CASE tool support)	Development
Online Registration & Administration System	Development
Knowledge Management, Intelligent Search Engine, and Intelligent E-mail & FAQ Filter	Planning

A series of controlled experiments is planned to begin in 1999. The experimental design consists of two factors: The Presence or Absence of the CyberCollaboratory, and Traditional or Online Course Delivery as shown in Table 4.

Table 4. Quasi-Experimental Factors

	Factor I: Presence or Absence of the CyberCollaboratory	
Factor II: Traditional or Online Course Delivery	Traditional With CyberCollaboratory	Traditional Without CyberCollaboratory
	Online With CyberCollaboratory	Online Without CyberCollaboratory

The design is quasi-experimental because students cannot be assigned randomly to classes. Students self-select, deciding which courses to take. Also classes differ in content and focus, and students come to each course with diverse backgrounds.

A year-long pilot application of Web-CCAT will begin in Spring 1999 at the Division of Oral Health (DOH) in the Illinois Department of Public Health (IDPH). This application uses Virtual Meeting System (a tailored version of Web-CCAT) to meet the DOH's needs for group communication, information sharing, and decision-making. The DOH has a central office in Springfield, Illinois and seven regional offices throughout the state. The DOH lost many regional staff members due to budget cuts over the last five years. Because of the size of each region, the distance between the regional offices, and the wide area covered by each region, providing adequate service to the clients at each regional office became virtually impossible [Janssen, 1997]. In 1997, the regional staff spent approximately 80% of its time in travel and meetings alone [Janssen, 1997]. The pilot use of VMS is expected to reduce travel time without sacrificing social interactions, trust, motivation and quality of services provided.

While we think a web-enabled, asynchronous, and robust meeting environment such as Web-CCAT can be used to improve productivity and *quality* in the public and private sectors; as educators, we are particularly interested in the implications of Web-CCAT in academic settings. The importance of lifelong active learning such as that made possible through the richness of the Web compared to more traditional passive learning is emphasized in a number of studies [Alavi, 1994; Bok, 1986; Boyer, 1987]. The Internet and the Web can provide a media rich, active learning environment and serve as a highly effective foundation for a Collaboratory [Barua et al., 1995]. Web-CCAT is well aligned to address the concerns expressed by President Stukel's vision statement for the next century.

"The students of the next decade, their parents and their employers all will expect a technologically sophisticated learning environment. To the extent that we can both continue to create technological advances and

integrate them quickly into our curricula and programs, we can enhance the quality of our students' educational experiences even as we extend the breadth and depth of our research enterprise."

<div align="right">James Stukel [1997], President, University of Illinois</div>

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APPENDIX

MIS-ONLINE PROGRAM

The MIS-OnLine Program was offered for the first time in January 1999 at UIS. It provides an affordable and accessible new model for delivering education to busy IS professionals and students who are geographically dispersed. We expect the asynchronous technologies will enable a rich educational experience to be delivered to the students at the time and location of their choice rather than having the students travel to the university. Web-CCAT, coupled with the online program structures at UIS, creates a virtual learning space that provides a continuous, cooperative, and asynchronous teaching/learning environment as described by Leidner and Jarvenpaa [1995]. Delivery of education using the asynchronous virtual learning space model is expected to save time as well as effectively provide educational opportunities for remote students [Leidner and Jarvenpaa, 1995].

REFERENCES

Alavi, M. (1994) "Computer-Mediated Collaborative Learning: An Empirical Evaluation" *MIS Quarterly* (18)2, pp.159-174.

Alavi, M., B.F. Wheeler, and J.S. Valacich (1995) "Using IT to Reengineer Business Education: An Exploratory Investigation of Collaborative Telelearning", *MIS Quarterly* (10)3, pp. 293-312.

Aoude, H. (1996) "Computerized Construction Delay Management System", Unpublished Ph.D. Dissertation, Polytechnic University, Brooklyn, N.Y.

Barua, A., R. Chellappa, and A.B. Whinston (1995) "Creating a Collaboratory in Cyberspace: Theoretical Foundation and Implementation", *Journal of Organizational Computing* (5)4, pp. 417-442.

Bicknell, D. (July 6, 1995) "The Politics of Failure", *Computer Weekly*, p. 28.

Bligh, D.A. (1972) *What's the Use of Lectures?,* Harmondsworth, England: Penguin.

Bok, D. (1986) *Higher Learning*, Cambridge, MA: Harvard University Press.

Bostrum, R.P., R.T. Watson, and S.T. Kinney, (ed.) (1992) *Computer Augmented Teamwork: a Guided Tour*, New York: Van Nostrand Reinhold.

Boyer, E.L. (1987) "Toward School-College Collaboration", *Thought and Action* (3)2, pp. 7-18.

Brown, A.L. and A.M. Palincsar (1989) "Guided Cooperative Learning and Individual Knowledge Acquisition" In L. B. Resnick (Ed.) *Knowing and Learning: Essays in Honor of Robert Gaser,* Hillsdale, NJ: Erlbaum, pp. 393-451.

Button, K. (May 2, 1996) "Thou Shalt Not.…" *Computer Weekly*, p. 32.

Changkong, V. and Y. Haimes (1983) *Multiobjective Decision Making*, New York: North-Holland.

Chmura, A. and H.D. Crockett (1995) "Point-Counterpoint: What's the Proper Role for Case Tools?", *IEEE Software (*12)2, pp. 18 -19.

DeMarco, T. and T. Listner (1987) *Peopleware,* NewYork: Dorset House.

DeSanctis, G. and R.B. Gallupe (1987) "A Foundation for the Study of Group Decision Support Systems", *Management Science* (33)5, pp. 589-609.

Dufner, D.K., S.R. Hiltz, and M. Turoff (1994) "Distributed Group Support: A Preliminary Analysis of the Effects of the Use of Voting Tools and Sequential Procedures", In Proceedings of the *27th Annual Hawaii International Conference on System Sciences (HICSS)*, Los Alamitos, CA.: IEEE Computer Society Press, Vol. III, pp.114-123.

Dufner, D.K. et al. (1995) "Distributed Group Support: The Effects of Voting Tools on Group Perceptions of Media Richness", *Group Decision and Negotiation Journal*, Kluwer Academic Publishers, 4, pp. 235-250.

Dufner, D. K., O. Kwon, and R. Hadidi (1998) "Development and Implementation of a Web-enabled CyberCollaboratory for Asynchronous Teams: Web-CCAT", In Proceedings of the *31st Annual Hawaii International Conference on System Sciences (HICSS)*, Los Alamitos, CA: IEEE Computer Society Press, Vol. III, pp. 330-339.

Harrell, C. (1996) "Heuristic Planning Makes the Past Current", *Electronic Design*, (4)15, pp. 83-86.

Hiltz, S.R. (1994) *The Virtual Classroom: Learning Without Limits via Computer Networks*, Norwood, NJ: Ablex Publishing Corp.

Hiltz, S.R. (1995a) "Impacts of College-Level Courses via Asynchronous Learning Networks: Focus on Students", In *Proceedings of the Sloan Conference on Asynchronous Learning Networks*, October 9-10, Philadelphia, PA.

Hiltz, S.R. (1995b) "Teaching in a Virtual Classroom™", In *Proceedings of the 1995 International Conference on Computer Assisted Instruction* (ICCAI'95), National Chiao Tung University, Hsinchu, Taiwan, March 7-10, Association for the Advancement of Computing in Education, pp. 185-198.

Hiltz, S.R., et al. (1991) "Distributed Group Support Systems: Social Dynamics and Design Dilemmas", *Journal of Organizational Computing* (2)1, pp. 135-159.

Hoffman. L.R. (1979) "Applying Experimental Research on Group Problem Solving to Organizations", *The Journal of Applied Behavioral Science* (15)3, pp. 375-390.

Iivari, J. (1966) "Why are CASE Tools not used?", *Communications of the ACM,* (39)10, pp. 94-103.

James, G. (1997) "IT Fiascoes and How to Avoid Them", *Datamation,* (43)11, p. 84.

Janssen, J. (1997) Personal Communication with Maria Kwon, Division of Oral Health of the Illinois Department of Public Health, Springfield, IL.

Kimber, D. (1994) "Collaborative Learning in Management Education: Issues, Benefits, Problems and Solutions: A Literature Review", In *Proceedings of the Australian and New Zealand Academy of Management Conference*, New Zealand.

Kulik, J.A. and C.L. Kulik (1979) "College Teaching", in Peterson and Walberg (eds.) *Research on Teaching: Concepts, Findings and Implications*, Berkeley, CA: McCutcheon.

Leidner, D. and S. Jarvenpaa (1995) "The Use of Information Technology to Enhance Management School Education: a Theoretical View", *MIS Quarterly*, (9)3, pp. 265 -291.

Martin, J. and C. McClure (1988) *Structured Techniques: The Basis for CASE*, Englewood Cliffs: Prentice Hall.

Poole, M.S., and G. DeSanctis (1992) "Microlevel Structuration in Computer-Supported Group Decision Making", *Human Communication Research* (19)1, pp. 5-49.

Rana, A.R. et al. (1996) "From Virtual Classroom to Hypermedia Virtual Classroom", In *Proceedings of the Americas Conference on Information Systems*, Phoenix, AIS, pp. 832-834.

Robert, D.W. (1997) "Creating An Environment For Project Success", *Information Systems Management* (Winter), pp. 73-77.

Row, H. (1997) "The Joys of Togetherness", *Webmaster* (June), pp. 44-48.

Semich, J.W. (1994) "Client/Server CASE: Oxymoron or Essential", *Datamation*, (9)1, pp. 67-80.

Smith, J. and M.T. Vanacek (1989) "A Nonsimultaneous computer conference as a component of group decision support systems", In Proceedings of the 22nd *Annual Hawaii International Conference on System Sciences (HICSS)*, Los Alamitos, CA: IEEE Computer Society Press, Vol. III, pp. 370-377.

Stukel, J. (1997) Personal Communication to the University of Illinois at Springfield, Campus Senate, Springfield, IL.

Turoff, M. et al. (1988) "The TEIES Design and Objectives: Computer-Mediated Communication and Tailorability", In Proceedings of the 21st *Annual Hawaii International Conference on Systems Sciences (HICSS),* Los Alamitos, CA: IEEE Computer Society Press, Vol. III, pp. 158-168.

Turoff, M. (1995) "Designing a Virtual Classroom™", In *Proceedings of the 1995 International Conference on Computer Assisted Instruction* (ICCAI'95), National

Chiao Tung University, Hsinchu, Taiwan, Association for the Advancement of Computing in Education, March 7-10, pp.245-262.

Vessey, I. and A.J. Sravanapudi (1995) "CASE Tools as Collaborative Support Technologies", *Communications of the ACM* (38)1, pp. 83-95.

Vygotsky, L.S. (1978) *Mind in Society: The Development of Higher Psychological Process,* Cambridge, MA: Harvard University Press.

Wagner, R.J. et al. (1992) "Enhancing Teaching Effectiveness Using Experiential Techniques: Model Development and Empirical Evaluation", In *Proceedings of the Annual Meeting of the Midwest Region of the Academy of Management*, St. Charles, IL, April 22-25, pp 116-122.

Werries, K. et al. 1999 "A Cybercollaboratory Testing Methodology", In *Proceedings of the Annual Meeting of the Midwest DSI*, Springfield, IL, April 22-24, forthcoming.

LIST OF ACRONYMS

AE	Alternative Evaluation tool in GDSS-UIS
ALN	Asynchronous Learning Network
ASADE	Asynchronous Systems Analysis and Design Environment
CASE	Computer Aided Software Engineering
CMC	Computer Mediated Conferencing
DOH	Division of Oral Heal in IDPH
EBS	Electronic Brain-Storming tool in GDSS-UIS
EIES2	Electronic Information and Exchange System 2
EV	Electronic Voting tool in GDSS-UIS
GDSS	Group Decision Support Systems
IDPH	Illinois Department of Public Health
IO	Idea Organization tool in GDSS-UIS
IS	Information Systems
LAN	Local Area Network
MIS	Management Information Systems

NJIT	New Jersey Institute of Technology
PMA	Project Management Advisor
RDBMS	Relational Data Base Management Systems
RTC	Real Time Chat
SAMM	Software Aided Meeting Management
SHTTP	Secure HyperText Transmission Protocol
SM	Session Management tool in GDSS-UIS
SQL	Sequential Query Language
UIS	University of Illinois at Springfield
VMS	Virtual Meeting System
WAN	Wide Area Network
Web-CCAT	Web-enabled CyberCollaboratory

LIST OF HYPERLINKS

A large number of the products and people discussed in this paper are available through on-line hyperlinks. The following is a list of these links. Selecting them will result in direct connection to their World Wide Web sites. These links were active and correct on March 1, 1999. They are not guaranteed to be correct after that date.

Department of Management Information Systems, College of Business and Management, University of Illinois at Springfield

Donna Dufner

IBM

Illinois Department of Public Health (IDPH)

Lotus Domino Server

Lotus Notes

MIS On-Line Program

New Jersey Institute of Technology

[Rassule Hadidi](#)

[Ojoung Kwon](#)

[James Stuckel](#)

[University of Arizona](#)

[University of Illinois](#)

[University of Minnesota](#)

ABOUT THE AUTHORS

Donna Dufner is an Assistant Professor in the Department of Management Information Systems at the University of Illinois at Springfield. She received her Ph.D. from Rutgers University in Management (Computer and Information Science) in 1995; an MS, in Computer and Information Science from The New Jersey Institute of Technology; and an MBA from the University of Chicago. Dr. Dufner has over 12 years of industry experience in telecommunications, and information systems design, development and implementation for major corporations such as AT&T, Chemical Bank Corp., ARDIS (a joint venture of IBM and Motorola), and Bell Atlantic Nynex. Dr. Dufner's research interests are Web-enabled technologies and asynchronous group support systems. Her research has been published in The Journal of Group Decision and Negotiation, The Journal of Organizational Computing, and in a variety of conference proceedings. A referee for IEEE Computer, she has been listed as a referee whose dedication, quality of work, and expertise in reviewing articles submitted for publication exceeds the standards of IEEE (1998). She is listed in Who's Who in the World and in Who's Who in America. In 1998 Dr. Dufner was named a University Scholar, the highest honor awarded by the University of Illinois.

Ojoung Kwon is an associate professor in the Department of Management Information Systems at the University of Illinois at Springfield. He has a BS and an MS in electronics engineering and an MBA in management information systems. He received his Ph.D. in management science and artificial intelligence (AI) from the University of Alabama in 1991. He worked for the

Artificial Intelligence Laboratory and the Alabama Productivity Center for five years and has conducted various projects with a number of organizations, including AT&T, General Motors, Alabama Power Company, Amdahl Communications, and Ballistic Missile Commander (MICOM). His research interests are in the areas of collaborative technologies, intelligent software agents, intelligent project management support systems, neural network applications, and knowledge base management systems. His research has been published in <u>Expert Systems: The International Journal of Knowledge Engineering</u>, <u>International Journal of Production Research</u>, and <u>Interfaces</u> and in a variety of conference proceedings. He is listed in Who's Who in the World and in Who's Who in America.

Rassule Hadidi is a Professor and Chair of the Department of Management Information Systems at the University of Illinois at Springfield. He earned a Ph.D. (1981) in Operations Research from the University of Missouri-Columbia and completed (1988) the AACSB sponsored post-doctoral studies in MIS at Indiana University. His research interests are Electronic Commerce, Management of End User Computing, and MIS Curriculum Development and Quality Assessment. Prior to joining UIS, he worked for five years on several Health Care Delivery Information Systems projects at the Health Services Research Center/Health Care Technology Center of the University of Missouri-Columbia. Starting in 1986 Dr. Hadidi initiated and developed the MIS program at UIS. Over the last three years, he has received several major grants to develop Internet and Web-based interactive graduate level MIS courses and an online MS degree in MIS. He initiated and directed the development and implementation of the MIS-OnLine degree for the University of Illinois, which was offered for the first time in the spring of 1999.