

***Scan of the Fields of Distance Education
and Simulation Technology***

***Prepared for:
The Kauffman Center for Entrepreneurial Leadership***

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I. Executive Summary

Distance Education

The following is very brief executive summary of critical key points from the detailed environmental scan of distance education:

- **Overview of the expanse of the market**

An estimated 1 million students are taking courses on the Internet, and that number is expected to reach 2.2 million by 2002

Distance education has become viable because: there is an increased reliance on knowledge-based information, rapid change has become the rule, information access will be improved through shared resources, networking and inter-organizational partnerships and it provides greater access to experts.

- **Overview of the tools of distance education**

Much of the focus of current distance learning technology incorporates satellite, broadcasting and the Internet. However, other forms have been and continue to be used. They tend to be benchmarked as either interactive or non-interactive. Tools include videoconferencing, satellite uplinks and broadcast uplinks.

- **Overview of distance education players**

In this field, the market players tend to fall into one of three categories, with some inbreeding and crossover. They include:

Primary and secondary education (K-12) - At the elementary and middle school levels, distance learning usually takes the form of curriculum enrichment modules and ongoing telecommunications projects. At the secondary level, distance learning becomes critical for smaller, rural districts and under-served urban school districts by offering some state or federally funded courses the schools would otherwise not be able to offer.

Corporate/professional training - In 2000, companies spent more than \$1 billion on e-learning systems and the International Data Corporation predicts that market will grow to \$11 billion by 2003. The majority of corporate continuing education is arranged through partnerships between colleges/universities and corporations. This is the fastest growing area of distance education, and with its partnerships with institutions of higher education, it is likely to promote growth at the higher education level as well.

Higher and continuing education — The term distance learning is almost exclusively used in reference to degreed and non-degreed program coursework associated with college and universities. Almost every major national and international college offers some form of coursework — whether

in part or as a whole — via the Internet or other modes of distance learning. The growing trend in this area is partnerships between universities and partnership with corporations.

- **Overview of design issues in distance education**

Coursework design in the field of distance education especially with online courses, is a growing area of interest for academics. This tends to relate directly to an understanding of how students learn and ongoing research of how humans interact with media resources in general. Issues brought to task include:

Interactivity — Without connectivity to the teacher and other students, a student will tend to lose interest and drop out.

Active learning — Students must be able to understand the medium, the message and its meaning to learn effectively

Visual imagery — With high-tech graphics, can a student distinguish the root of the material from the edutaining junk?

Effective communication — Communication at the distance level lies in understanding the intended user

- **Overview of challenges of distance education**

The primary issues that tend to resurface in addressing the incorporation of distance education into existing standards for learning and teaching include:

Overcoming the stigma that distance education is not real learning

Understanding the idea that content, not technology, must always be the driving force behind online education

Training teachers must involve not just teaching the technology, but how the technology affects learning.

Understanding equity of access addresses more than socioeconomic issues. It also tends to enfold issues of globalization, an deeper understanding of what ratio is truly needed and how that access reaches students on a full-time level.

Redefining institutions roles in the areas of support and student/faculty services, which tend to expand with the added technology and outreach, not diminish

Understanding the need for institutions to carefully redefine their own identity and contexts.

Understanding that increased use of multimedia equipment will tend to have a sociological impact on students lifestyles.

Melding head-based activities with the physical nature of interacting with multimedia equipment

Balancing the influx of corporate and business ideology into academic settings

- **Overview of expert recommendations from the field**

The players in the field — both academic and corporate — offer specific recommendations to carry along when entering a distance education project. They include:

Those who tend to know the content best should be involved in program development

Material tends to be best delivered in small bits.

Ownership of educational materials tends to be not just an issue of institution relations, but for one of copyright as well

Solitary work tends to be more effective when blended with classroom interaction

The best leaders tend to be trained appropriately in e-learning, educational theory and technology

Introducing new information and levels of coursework tends to require some level of information management

Distance education tends to encourage lifelong learners

Simulation technology tends to help drive experiential learning and can be used to determine prior to implementation the effectiveness of some distance education programs

Best results in any educational or training exercise tends to vary instructional approaches.

Communication protocols tend to provide clear boundaries and rules for students new to the discipline

Rehearsal tends to be a key component for educators in presenting effective distance education classes.

(Appendices at the end of the scan provide lists, information and hyperlinks to distance education vendors, products and services, professional associations and organizations, research centers and universities and Websites.)

Simulation Technology

The following is a very brief executive summary of critical key points from the detailed environmental scan of simulation technology:

- **Overview of the simulation market and its terminology**
 - The term simulation technology generally refers to the introduction of discrete or continuous event modeling software into a particular business or training process in order to generate information prior to developing and working with the system itself.
 - The term simulation itself, however, can refer to any kind of role play or generation of a model of something else.
 - Simulation technology started with the military and flight simulators and has begun to expand to almost every sector of commerce, including academia, finance, engineering, natural resource exploration, control systems, manufacturing and insurance.

- **Overview of market roles of simulation technology**

Simulation tends to have the ability to adapt to the necessities of a certain sector or market. However, the overarching roles it plays tend to remain constant. They include:

- Helping to support decision making
 - Creating visual predictions
 - Assessing roles of market expansion for products and services
 - Involving training and time issues into assessments
 - Reducing cost and increasing efficiency
 - Assessing and diagnosing a products performance
 - Improving the general processes involved in the scope of the simulation model
-
- **Overview of problems and pitfalls in simulation modeling**

Unlike distance education, the pitfalls of simulation tend to involve more specific design and probability issues over issues of human interaction and learning. These issues include:

The tendency to fail to define a clear set of goals

The tendency to fail to communicate with clients and vendors

A general lack of knowledge about the methodology and mathematical principles

The tendency to over-detail the model unnecessarily

The tendency to collect wrong system data and the failure to prepare proper output analysis

A misuse or overuse of animation

- **Overview of the relationships between vendor, products and users**

The tools for simulation should tend to meet certain requirements, including:

Provide benchmark figures for comparing the status quo to future processes

Allow you to explore alternative approaches

Help to determine the best way to use resources

Show where to eliminate tasks that add no value

It appears necessary that vendors establish ongoing relationships with the end users, and continue to update the products as necessary. Conversely, it appears users should commit to the product only after fully researching its history, its capabilities and its compatibility to existing hardware and software

A sample list of vendors and their products is provided.

(Appendices at the end of the scan provide lists, information and hyperlinks to simulations organizations in the areas of academic, corporate, government, professional and others).

II. Distance Education

Overview and History

Steve W. Gilbert heads the Technology Projects at the American Association for Higher Education in Washington D.C. Four years ago, according to *The Chronicle of Higher Education*, he created an e-mail list, AAHESGIT, that shares daily messages about computer technology in higher education. Gilbert is invited to speak or advise at hundreds of campuses each year.

Gilbert distrusts two types of people: those who talk a lot about the future and those who overhype distance education without doing their homework. Gilbert mediates the Technology Project s Teaching, Learning and Technology Roundtable program. Learning in distance-education classes, he says, often requires more discipline than many students can muster — especially undergraduates. And supporting the classes takes more work and more manpower than expected.¹

According to the *New York Times*, the for-profit education market grew to \$105 billion in 2000, up from \$42 billion in 1995. It is expected to reach \$170 billion by 2005.² Distance learning and advances in Internet technology are two of highest profile vehicles of advancement in the education and training.

In 2000, a panel of researchers from George Washington University, led by William Halal, professor of management, released The GWU Forecast of Emerging Technologies. The group used environmental scanning of emerging technologies to estimate what year the technology advance will occur. The group predicted distance learning to be fully incorporated into the education and training marketplaces by 2010, along with a string of multimedia interconnectivity technologies that are predicted to explode in the first decade of the 21st century.³

According to the Teletraining Institute (www.teletrain.com), distance education emerged as a viable and efficient educational medium for several reasons:⁴

- Future education and training endeavours will be increasingly knowledge-based as the amount of information available continues to explode
- Rapid change appears to be the rule and not the exception
- Information access will be improved through shared resources, networking and inter-organizational partnerships
- It provides access to experts and personnel in remote locations and network-dispersed groups

Distance learning has existed since the 19th century, when farmers used correspondence courses to bone up on plowing techniques. As television and radio broadcasting emerged, distance education evolved to media through extension services at universities and colleges, especially land-grant universities. Microwave and satellite uplinks brought the teachers to remote location via television monitors, but the courses still relied on the postal service for exchanging written content. It is only recently with the explosion of Internet and software technologies that educators and businesses have begun to understand the depth of possibility embedded in distance learning.

According to PBS online, an estimated 1 million students are currently taking distance learning classes via the Internet, and the International Data Corporation expects enrollment for college courses online will reach 2.2 million by 2002.⁵

A. The Distance Education Tools

Much of the focus of current distance learning technology incorporates satellite, broadcasting and the Internet. However, other forms have been and continue to be used. They tend to be benchmarked as either interactive or non-interactive.⁶ They include:

Interactive

- *Audioconference* — Training through telephone connection. Audio only.
- *Audiographics* — Computer and phone linkage, with participants responding to trainer via speakerphone while observing computer screen training. They respond with a writing whiteboard linked to the computer.
- *Videoconferencing* — Cameras, microphones and televisions transmit images and audio. Participants can see and hear each other.
- *Computer conference* — Training via email or the Internet. Materials sent to participants online. They respond via one- or two-way online discussions.
- *Two-way satellite/microwave* — Program delivered via satellite or microwave link, with television cameras at trainers and participants ends so there is a two-way video and audio. Similar to videoconferencing, but different equipment
- *Desktop videoconferencing* — Same as videoconferencing but participants sit at a computer with camera and microphone attached. Can see and hear trainer and participants.
- *One-way satellite with keypad* — Delivered via satellite using an electronic keypad as a response tool for participants. Answers are displayed on a TV screen at all sites.
- *Voicemail* — Trainer sends out material in advance, then asks participants to leave responses on voicemail. Can also be set up so participants can hear each other's responses.
- *Virtual reality* — Participants placed in a realistic situation to learn a new skill where they must respond verbally, visually, and kinesthetically. Involves computer simulation of some type.

Non-Interactive

- *One-way satellite/microwave feed* — Delivered via satellite or microwave link where participants watch then respond via phone, fax or e-mail.
- *Cable/broadcast television* — Same as one-way satellite, but with cable television. Instructor teaches from a TV station. Material is sent out in advance and participants respond via fax, e-mail or telephone.
- *Radio* — Courses broadcast via radio with participants responding by mail or phone.

- *Printed materials* —The oldest distance learning technology: sending printed material with the course lesson. Participants mail responses back. Trainer gives feedback via mail or telephone.
- *Audiotape* — Mailed out with recorded course. Participants respond via telephone, fax or e-mail or make an audiotape of their own.
- *Computer disk/CD-ROM/Laser disk* - Mailed out with courses. Participants respond via telephone, fax, e-mail or computer disk.
- *Videotape* - Mailed out with courses. Participants respond via telephone, fax or e-mail.

B. What is Distance Education?

The term distance learning or distance education is used for a great variety of programs, providers, audiences, and media. According to the *International Journal of Educational Telecommunications*, traits that tend to be consistent in all areas are:

- 1) Separation of teacher and learner in space and/or time
- 2) Volitional control of learning by the student rather than the distant instructor
- 3) Noncontiguous communication between the student and the instructor, either in print or in some form of technology.⁷

Distance teachers appear to have a slightly different role than traditional classroom teachers. They facilitate learning instead of communicating a fixed body of knowledge. Desmond Keegan's theory of distance education indicates that distance education recreates the teaching-learning interaction and reintegrates it back into the instructional process. Distance learning tends to increase the amount of interactivity between teachers and students, and can integrate a virtual community of students, teachers and researchers throughout the world.

C. Why Distance Education?

Tom Kelly, vice president of worldwide training for Cisco Systems, cites a half dozen reasons — besides the inevitability factor — for why distance education, in both the corporate and academic structures, will evolve a critical role in training and education.⁸

- It enables companies/schools to reach more employees/students at a lower cost
- It reduces training backlogs
- It increases access to subject matter experts
- It makes training more flexible
- It increases access to alternative instructional resources
- It is adaptable to most traditional training approaches

The ideal distance learning program will combine the highest levels of active learning, interactivity, effective communication and visual imagery, tied into efficient, flexible and more cost-effective options for educators and students.

D. Who Uses Distance Learning?

There tends to be three distinct kinds of end users of distance learning:

- Primary/secondary education (K-12)
- Corporate or business training
- Higher education or continuing education (through universities, colleges or training institutes)

Primary and Secondary (K-12)

Typically, distance learning is associated with adult education, either as a form of continuing/higher education or corporate and business training. However, with the increase of technology in K-12 schools, some aspects of distance learning are expanding to the younger students. At the elementary and middle school levels, distance learning usually takes the form of curriculum enrichment modules and ongoing telecommunications projects. At the secondary level, distance learning becomes critical for smaller, rural districts and under-served urban school districts by offering some state or federally funded courses the schools would otherwise not be able to offer (e.g., advanced placement, foreign language, and vocational classes).

Corporate/Professional Training

With a market for education and corporate-training services reaching \$900 billion, according to March 12, 2001 *Wall Street Journal* estimates, companies are looking to make money by touching all corners of the education market. In 2000, companies spent more than \$1 billion on e-learning systems and the International Data Corporations predicts that market will grow to \$11 billion by 2003.

In the field of adult education, the market indicates that universities and colleges absorb the bulk of distance education distribution. A few corporations, including Cisco Systems and Walt Disney, have developed and opened their own training and educational facilities, but the majority of corporate continuing education is arranged through partnerships between colleges/universities and corporations. NYUOnline, a for-profit e-learning company owned by New York University, draws on the university's faculty and courses, working with the corporate training material, to create tailor-made, Web-based program of study for employees.⁹ Berger Funds, a Denver-based mutual fund concern, has invested in DeVry, a for-profit degree-granting enterprise for corporate training.

Other examples of such partnerships include:

- *Army University Access Online* — PricewaterhouseCoopers, a technology outsourcing company, won the U.S. Army's contract to form comprehensive distance learning coursework to soldiers all over the world. PricewaterhouseCoopers will act as integrator of the site, with 10 companies and 29 colleges, initially, working together. The colleges and universities span a diverse mix of educational opportunities but all have some experience working with the military. They include:
 - Anne Arundel Community College — Arnold, Md.
 - Florida State University — Tallahassee, Fla.
 - Indiana University — Bloomington, Ind.
 - Kansas State University — Manhattan, Kan.
 - Northwest Missouri State University — Maryville
 - Embry-Riddle Aeronautical University — Daytona Beach, Fla.
 - Baker College — Flint, Mich.
 - North Carolina A&T State University — Greensboro, N.C.
 - Penn State's World Campus (*see above*) — Philadelphia
 - University of Texas — Arlington
 - University of Washington — Seattle¹⁰

- *World Bank* — According to the Dec. 8, 2000 issue of *The Chronicle of Higher Education*, the World Bank spent more than \$20 million since 1997 to get its distance-education program started. There are more than 40 distance-learning centers globally. The mission of the Global Distance EducationNet is to focus on skills that community leaders and government workers can use to improve their countries' economies. It uses cameras, satellite equipment, and computers with Internet capabilities. No degrees are offered, only certificates of completion.¹¹

- *Apollo Group, Inc* — According to *The Wall Street Journal*, this Phoenix-based education-holding company is serving students over the Web through the University of Phoenix Online. The decade-old institution offers programs through distance learning in accounting, administrations, business, education, management, marketing, nursing/healthcare and technology.¹²

- *General Motors* — This company has recently hired Saba Software, Inc. to develop its online learning for its 65,000 employees

- *Coca-Cola Corp and Microsoft.* —SkillSoft won agreements with The Coca-Cola Company and Microsoft Ltd. to supply Web-based soft skills training to their respective employees. The agreement with Microsoft Ltd., based in Reading, England, applies to U.K. employees over the next two years. The Coca-Cola agreement covers the company's Middle East and North Africa operations for three years.
- *Electronic Data Systems Corp* —Last summer a \$150 million strategic alliance was inked between Electronic Data Systems Corp., of Plano, Texas, and e-learning provider DigitalThink Inc., of San Francisco, under which EDS promises to deliver \$100 million in revenue to DigitalThink over the next five years.
- *Domino s Pizza, LLC* —The popular pizza chain uses Centra Software Inc.'s e-learning product to put employee training over the Internet. Says Paul Messink, director of intranet development at Domino s: We can integrate the interface with our intranets and extranets and really take advantage of the Web as a viable business tool. ¹³

Research conducted by *The Chronicle of Higher Education* in Corporate-College Partnerships: A Best Practice Survey indicates that the success of corporate universities is having a double-edged effect on traditional universities. On the one hand, the increase in these corporate institutions indicates that learning is now viewed as a lifelong commitment. Higher education takes in more than \$740 billion a year, more than 10 percent of the gross domestic product, and corporation no longer see continuing education as a cost to cut but an investment to attract the best work force. As a result, corporate education and training programs represent a big opportunity for higher-education institutions. ¹⁴

Higher and Continuing Education

For the most part, however, it is clear that the terminology distance learning usually refers in the majority to an e-based, Internet-fused presentation of traditional undergraduate and post-graduate studies. Land-grant universities such as the University of Wisconsin with established extension services that used broadcasting, satellite and microwave uplink services are now expanded to Web-based course platforms. Universities are opening distance learning centers and creating integrated coursework and entire academic programs available totally or in part via the Internet. *The Chronicle of Higher Education* has been tracking developments and reports on new issues and situations weekly. They include:

- *Penn State University* —The Department of Distance Education is divided into three program-delivery units:

- World Campus — Primarily technologically-based, these courses are offered on a semester basis and provide convenient educational opportunities for advancing adult learners professionally.
- Independent Learning — 150 individual courses that can be taken for general interest or to complete a degree program. Students work one-on-one with the instructors and can register at any time. They are primarily print-based.
- Distributed Learning — On-site training for professional development for corporations, associations and organizations. The programs include a Master's in Engineering in Acoustics, Master of Education in Elementary Education, and Certificate in Logistics and Supply Chain Management. These programs utilize interactive videoconferencing and Internet communications.¹⁵
- *University of Michigan* — Part of Universitas 21, a network of 18 universities in 10 countries, the school is working with Thomson Learning. The vendor will create course design, testing, assessment and student-database management for courses taken through affiliation between the 18 universities.¹⁶
- *Babson College* — Internationally recognized for providing programs in entrepreneurship, Babson College announced in February its selection of Centra, a live, interactive virtual classroom software to power the Internet-based Executive Education program. The program will use a hybrid approach, combining self-paced learning, classroom work, and live, Internet-based sessions to home or office PCs.¹⁷
- *State University of New York* — The institution will offer SkillSoft courses to its faculty and staff members at its western campuses. Topics of instruction include conflict resolution, budgeting, and recognizing and handling sexual harassment cases.¹⁸
- *The George Washington University* — Instead of going to the tech market for software, this institution created its own distance education course platform and software, Prometheus. Now the university is selling the platform and courseware to other distance learning facilities, including the *United States Open University*, the sister institution to the United Kingdom's *Open University*.¹⁹ GWU offers complete programs online, including an accelerated Master Degree in Tourism Administration, a Master of Arts in Educational Technology Leadership, a Master of Science in Project Management and a Master of Science in Health Sciences (Clinical Leadership).
- *University of Washington* — Beginning this month, the Institute of Electrical and Electronic Engineers receives access to coursework from this institution. Topics include Web administration and programming.²⁰
- *University of Oxford, Yale University, Princeton University, Stanford University* — These four most prestigious institutions are allied to offer distance learning courses to alumni, each providing several million dollars in initial dowry for the project. Stanford reports it is creating two courses in classics for the alliance to offer to alumni and families of students.²¹

- *Arizona Board of Regents* — Oracle Corporation designed and integrated the Arizona state university system's online education component, Arizona Regents University. The project combines courses from the three state universities and may add courses from other universities, including Harvard and Columbia. Programs and certifications are available in parks and recreation management, tourism, hospitality, engineering, educational technology, and business administration, among others.
- *Duke University* — In May of last year, the Duke University Academic Council approved a policy that sets rules for faculty members' ownership of online courses. The council also addressed issues of conflicts of interest for professors providing course material for other institutions.²² Duke incorporates distance learning into its MBA programs in the Fuqua School of Business and in the Center for Instructional Technology & Distance Learning in the School of Nursing
- *San Diego State University* — In the same month, San Diego State set up a similar list of rules requiring the following provisions:
 - Professors must oversee distance-education courses.
 - Students must have substantial, personal and timely interaction with faculty and classmates.
 - An agreement must be established between faculty and university for who owns the course, before it begins.
 - There must be assurance of access of resources and services for students.
 - Part-time instructors must not replace full-time professors.²³

Through the Interwork Institute Center for Distance Learning at San Diego State, the university offers degrees, certificates and credentials via distance and distributed learning to individuals nationally and internationally. The programs included rehabilitation counseling, vocational education, education leadership and others, and are accredited by nationally recognized organizations and institutions such as the Western Association of Schools and Colleges (WASC).

- *University of North Texas* — In 1998, this university established the Distributed Learning Center as a service to assist faculty with the development and delivery of distributed learning. The Center combines technology resources with expert consultation and personnel, in an effort to provide faculty with a one-stop guide to technology-based courses. Programs offered through distance learning include: hospitality, computer education, library science, gerontology, community service, and behavior analysis.

UNT pays its professors up to 8 percent in tuition royalties for the use of their materials when other instructors teach the courses via distance education.²⁴ Since the fall of 1999, UNT's distance-education enrollments and course selections have tripled.

- *Massachusetts Institute of Technology* — *The New York Times* reported April 4, 2001 that M.I.T. plans to announce a 10-year initiative to create public Web sites for almost all of its 2,000 courses, posting course content such as lecture notes, problem sets, syllabuses, simulations and video lectures. Participation in the \$100 million program is voluntary for professors, but all courses will have a posted site. The OpenCourseWare plan, said faculty chairman Steven Lerman, is more appealing to faculty than selling content for profit. The Institute wants to focus on finding ways to disseminate it as broadly as possible.²⁵ M.I.T.'s plan differs from other Internet initiatives in that the institute will make no effort to offer for-credit courses online. The course materials are offered as ingredients in learning that can be combined with teacher/student involvement at high school and universities worldwide.
- *University of California* —The university system is building a new campus at Merced and is already using distance-education technology to offer courses at distributed-learning centers in Central California. For Merced, the cities with centers form a line down the 250-mile stretch of the San Joaquin Valley. The university's coverage area will reach poorer and more spread out California residents who traditionally have less access to the other U. of C. campuses. Merced is planned as a full-scale research university.²⁶

The university system is also contributing to the revitalized California Virtual University (formerly the California Virtual Campus) which lists over 3,100 distance-education courses offered by public and private colleges throughout the state.²⁷

- *University of Maryland University College* — Maryland spent more than \$1 million on its online MBA program, which was primarily to buy the program's technological infrastructure and create an assessment team to monitor the performance and satisfaction of students and faculty members. They cancelled a distance program in engineering management at one point, however, because it was not financially viable.²⁸

UMUC offers online undergraduate and graduate courses in areas including: accounting, communications, business, education, environmental management, humanities, paralegal studies, psychology and software engineering.

- *Salish Kootenai College* — Located on the Flathead Indian Reservation in Western Montana, this college is offering online courses for Native Americans across the United States. The college emphasizes service rather than profit, and embeds collaboration traditions into course design. With an \$800,000 grant from the Kellogg Foundation and \$200,000 from the Alfred P. Sloan Foundation, the college's goal is to connect not to the students' homes but to reach them through central locations such as tribal governance offices, community centers and schools.²⁹

E. Designing Distance Education

In the process of creating curriculum for distance learning, according to Sherry, consideration must be made for the goals, needs and characteristics of the students and teachers, in addition to content requirements and technical constraints. Provisions must be made for ongoing course updates to keep the subject matter relevant. The design of a successful distance education system incorporates the following:

- ***Interactivity***

Interaction in distance learning implies not just work between the student and the instructor, but activities that involve students together, and students within the learning environment. Interactivity, Sherry says, represents the connectivity the students feel with the distance teacher, the local teachers, aides, facilitators and their peers.

Without connectivity, distance learning denigrates into the old correspondence model of independent study. The student becomes autonomous and isolated, procrastinates and eventually drops out.³⁰

- ***Active Learning***

According to J.R. Savery and T.M. Duffy's *Problem Based Learning*, the mental effort that a student will invest in a learning task depends on the student's perception of two things:

- 1) the relevance of both the medium and the message
- 2) the student's ability to make something meaningful out of the material presented.³¹

Students, Savery and Duffy say, must feel a sense of ownership to the learning goals in order to connect fully with the learning process. For that reason, consideration must be made as to which form of distance learning technology provides students with the most immediate connection to the learning goal. This may include lessons for students on the best way to process the content from a particular mode of instruction.

- ***Visual Imagery***

The power of visual imagery appears to consistently motivate and captivate students, but also, according to a study by D. Ravitch,³² can focus students' attention on the entertaining features of the presentation. He refers to this as *edutaining*, a phenomenon that can distort the curriculum. In addition, too many powerful images, presented in short units, may result in oversimplification of the material. Students require guidance in learning to distinguish the *junk* from the quality information, judging its reliability or bias, and understanding how the technology itself shapes the information it carries.³³

- ***Effective Communication***

According to Sherry, if you want the learner to construct an idea similar to the teacher's, this must begin with understanding the intended user and recognizing each student has a unique outlook, different from the designers'. The key to good instructional design lies in the image presented.

F. Problems and Challenges of Distance Education

Researchers and academics tend to agree that the field of distance education is rife with pitfalls and mines. Even the most prestigious universities such as Harvard and New York University continue to meet with obstacles along the way.

The greatest obstacles to distance learning at these levels are inequity of access, which tend to become a policy problem as much as technology problem, and the possibility of social disenfranchisement of students who lack discipline and time management skills.³⁴

Distance learners need also to be separated by their goals, their learning styles, the support available to them and the factors that are most likely to influence their success. Other challenges are outlined below:

- ***Overcoming Stigma***

Glenn R. Jones, founder of the Arizona-based Jones International University, faced ridicule and suspicion since his university received the first-ever accreditation of a virtual institution. He says that the real bottleneck for online education is cultural.

What needs to be overcome is not bandwidth or Internet access, but resistance to the idea of online learning.

- ***Technology doesn't do anything***

According to The Gaston Caperton-Seymour Papert platform Vision for Education, (1999) one of the most common misunderstandings in developing distance learning programs is the focus on the technology. Without appropriate, interactive and stimulating course content, the technology is useless.

Technology gives *people* the *opportunity* to create new, high-expectation learning environments. Technology doesn't *do* anything. People do. Statistics that lump together technology implementation across the board only prove that throwing a lot of computers into an otherwise unchanged school will leave you with an unchanged school.³⁵

- ***Training teachers on educational issues of technology, not just technology***

The cost of retraining teachers for distance education, according to Caperton-Papert, should be attributed to the needs of the future world, not to technology. Each day the cost of failing to anticipate and address these needs grows as schools pour out students prepared for a bygone world.

Teachers will have to make the transition and this will have a cost. The issue is not about technical training, but about helping teachers address serious educational issues that have nothing to do with technology.

- ***Equity of Access***

Despite the exploding expansion of the Internet and computer technologies, the ratio of computers to students in most public schools is still 3:1 or greater. Few students of lower socioeconomic status have computers in the home.

Caroline Soeborg Ohlsen, chief creative officer of Cell Network and CEO of MouseHouse, also notes in *Fast Company* that the increasing globalization that technology makes possible may also expand the rift between first- and third-world nations. We have an obligation to learn from the lessons of the past, she says. We have to consider and be prepared to deal with the unintended consequences of our actions. What really troubles me is the fact that the technological revolution is not proceeding at a synchronous speed around the globe and, in many ways, is creating an enormous gap between the new-economy countries and the no-economy countries.

Equity, according to Caperton and Papert, is not the only, or even the best, reason for 1:1 ratio of computers to students. The real lesson, they say, comes by imagining how differently a student develops their passions and interests in careers and hobbies when they have full-time access. The innovations only hint at the wholly transformative effect the introduction of (computers will have) on the dissemination of knowledge.³⁶

- ***Redefining the roles of academic and institutional support and services***

With students miles away from the campus, the vision of distance learning tends to include some relief from administration and the services provided by traditional, campus-based academic institutions. In fact, institutions offering distance education can expect increases in the need for support services and access to administration as well as the possibility of having to completely rethink and reorganize the institutional system. The isolating tendency of distance learning elicits the philosophical question of how can the community of college life be replicated over the Internet and other multimedia resources used in distance learning?

Of the five fundamentals of an effective program, outlined by Spodick, four of these require timely bi-directional communication.

- Contact between the student and the instructor
- Active learning through writing out answers
- Timely feedback to the instructor on students' comprehension
- Time feedback to students on work done
- Opportunity for students to make revisions to work done and learn from their mistakes³⁷

- ***Changing Institutional Contexts***

The directive to educate more people with limited or declining resources, and without lowering standards will lead to increased competitiveness in the distance education market along with demands for increasing faculty, staff and student productivity. This will tend to push an increased need for institutional collaboration and resource sharing and the need to develop new markets offering unique educational experiences. This means institutions will need to explore carefully their resources, target audience and institutional philosophy in order to focus on what best fits their mission and goals.³⁸

- ***Sociological Impact***

Academics and faith-based leaders consider the impact of increased technological interfacing and decreased human interactions upon the spiritual and emotional psyche as a critical issue that should be addressed.

The New Economy, as I see it, says Rabbi Irwin Kiila, president of the National Jewish Center for Learning and Leadership, is part of a larger context in which we are redefining what it means to be human. There is the possibility that in our haste to push technological and economic growth to their fullest potential, we ll end up falling behind in spiritual and psychological growth.³⁹

- ***E-learning melds learning and doing***

According to Estee Solomon Grey, chief e-learning officer for InterWise, Inc., the push for experiential learning in most business and academic fields (of which the majority requires computer literacy) enters new level through distance learning and the introduction of simulation technology to a growing field of academic and training programs. This means a shift in methodology and theory of practice will become necessary for educators.

As we work with the Web, she says, learning moves from knowledge as matter to knowledge as practice.⁴⁰

- ***Applying business roles to academic settings***

There tends to be a conversion factor when applying the ideas developed by corporations for training to academic settings where education — not just profit — is the ultimate bottom line. The commercialization of academic research has already brought universities and industry in close partnership. Distance education at public and private schools, with its portended cost-effectiveness and ability to reach the masses, tends to further blur the distinction between the university as a cultivator of minds versus profit-generating tool. David Noble, professor at York University, revisits the history of distance education in his cautionary work *Digital Diploma Mills*. He refers to the high-tech advances in distance learning as more a rerun than a revolution.

Then as now, distance education has always been not so much technology-driven as profit-driven, whatever the mode of delivery. The common denominator

linking the two episodes is not technology but the pursuit of profit in the guise and name of higher education.⁴¹

Noble heralds the necessity of interpersonal (not merely interactive) relationships between people, noting that whenever people recall their educational experiences they tend to remember above all not courses or subjects or information but people who changed their minds or their lives.⁴² Meanwhile, Cisco System's Kelly recognizes the classroom experience as useful but not efficient. Learning, he says, is about one thing: the time-critical value of information.

The main benefit of the classroom is human interaction — make new friends, strengthen relationships, that sort of thing. That's enormously important. But the classroom is not about acquiring knowledge. The classroom cannot address business issues. If you have to teach 100 people about one topic, you can train 25 people in a classroom at a time and repeat the course four times. But if you have to train 3,000 people every 60 days on a new product, or on a new technology, or on a new market — there's no way that the classroom can work. There's no way to scale.⁴³

Noble's cautionary stance and Kelly's gung-ho confidence complete a stark contrast and illustrate the ideals of the two sides of the argument: quality versus quantity.

Katherine Gehl, director of information technologies for Chicago Public Schools, represents the middle ground with her consideration about the technological advances of distance learning.

My concern is that we won't take full advantage of our opportunities. In the private sector, market forces drive change. We can't automatically assume that change will happen naturally and efficiently in the public sector.⁴⁴

These challenges only begin to skim the surface of the dozens of concerns expressed over the course of research and experimentation with the newer forms of distance education. Educational outcomes, for example, are only recently beginning to be addressed and studied. The excitement of the new technology, paired with the expense of training and time required to get a system up and running have, to a certain extent, overshadowed the realities of assessment of the strategies. Since the popularity and freedom of the Internet and its related technologies are incomparable to any other development in recent educational history, the evaluation of its use and development will tend to exert itself as an ongoing process.

G. Considerations/Recommendations from the Distance Learning Field

Every player has a unique situation that makes varying solutions more common. However, some key concepts come up repeatedly. The current players in the field of distance education — whether they are business owners or academics — have identified through experience some conclusions for creating and maintaining effective technology-based education programs.

- *Let people with the knowledge of the content take part in developing it.* Cisco's Kelly cautions that the vendors and consortia that provide the technology cannot and should not be expected to contribute to the actual content of each course.

In most organizations, the training group doesn't just deliver the content, it develops it as well. We've gone in a totally different direction. We believe the most up-to-date knowledge exists right at the source.⁴⁵

- *Deliver training material in small, manageable bits.* We work in a world of limited attention spans, unlimited demands on people's time and endless multitasking, says Cisco's Kelly. Learning programs have to reflect these realities.
- *Under copyright law, ownership follows authorship.* According to David Noble, author of *Digital Diploma Mills*, it is important to remember that course materials are the property of the teaching faculty and staff who developed them.

For faculty and their organizations it is a struggle not only over proprietary control of course materials per se but also over their academic role, their autonomy and integrity, their future employment, and the future of quality education, Noble says. In the wake of the online education gold rush, many have begun to wonder, will the content of education be shaped by scholars and educators or by media businessmen, by the dictates of experienced pedagogy or a quick profit?⁴⁶

Institutions should prepare to address with faculty issues of ownership of the curriculum and develop a clear system for retaining rights to the curriculum, especially programs disseminated via the Internet, which can be easily copied and reused without the input of the faculty member who created them.

- *Find a way to blend solitary work on the web with real classroom interaction.* The best solutions are blended solutions. Effective learning, says Sherry, requires both knowledge of learner styles and advance preparation on the part of teacher and site facilitator. If a teacher recognizes the existence of alternate learning styles, and attempts to make a match between these modes and the content learned, he can develop a local instructional theory (which) has greater prospect of success than a general instructional theory.⁴⁷
- *Appoint the appropriately trained leaders.* No matter what the content, the technology will always demand a leader with the expertise to create the best

curriculum format and to handle the inevitable complications. One real problem with e-learning is that traditional training people are in charge of it, Kelly says. You've got people who have spent 20 years in lecture-lab environments, and now they're deploying e-learning. No wonder it doesn't work!

Kelly suggests that institutions will save time and thus, money, if they assign the task of creating the technology environment to the experts. The faculty and trainers need to play a role in supplying the content and deciding.

- *Invest in Knowledge Management* — Institutions can expect to increase staff and faculty in order to manage the new education dissemination. This staff's mission is to supervise the flow of information to and from students and teachers.

The need for e-learning systems that are substantive as well as integrated into business processes points to the big breakthrough in learning today: knowledge management, the delivery of exactly the right information to exactly the right people who need it, when they need it, says March Rosenberg, principal, Diamond Technology Partners, Inc. and author of *E-learning: Strategies for Delivering Knowledge in the Digital Age*. With that model, the Web becomes more like a library than like a classroom. You can use whatever helps you learn: courses, articles, collaboration tools like e-mail.

- *Think in terms of retaining students for a lifetime* — Eliot Masie, president of the Masie Center, an international think tank for issues of education and technology, reminds us that higher education is the only business that conducts a ceremony for firing customers.

Rather than offering learning that has an end point, MBA (and other) programs could transform learning into something continuous. Educational institutions that survive will move from the Industrial Age event model to a model that turns students into members of a network — a network that keeps them engaged over the course of their life.⁴⁸

- *Incorporate simulations when appropriate* to drive experiential learning and to force students/trainees to use what they have learned at a level that offers tangible results. Bill Ellet, partner and editor of *Training Media Review*, says that simulations are powerful because they are suspenseful; they show rather than tell.

Simulations force you to make decisions — and then show you the consequences of those decisions. You can view scenes online, you make decisions, and then you watch how those decisions work. The effects of your decisions are cumulative, just as they are in real life.

Simulators are interactive computer programs that mimic real world complex systems such as the economy or corporate behavior; and as such they are among the most powerful, effective and popular training tools available on the Web. Virtually all of today's distance education systems are Web-based, which makes the industry very

sensitive to online trends, and so simulators and simulation technology have become prominent topics in distance education programs and marketing. Simulators are very useful training aids and are indeed particularly well suited to the Web-centric world of distance education. However, they have nothing to do with distance education per se; simulators are but one tool among many, and work as well in the classroom as online from 1,500 miles away.

- *Vary instructional approaches and formats* — What is true for the classroom also carries over to distance education. Donna Abernathy, associate editor of *Training and Development*, says stimulating the students' minds requires varying levels of interaction, group work and individual study. Technology of distance learning offers new options, such as simulation and online experts, while reducing or eliminating things like face-to-face small group exercises and immediate follow-up.

Teletraining lends itself to creative formats, such as team teaching, brainstorming and role play. You get the best results by mixing several styles.

The discussion of learning styles figures into this aspect of distance education. In both the academic and training fields, the consensus tends to be not to have a heavy reliance on any one learning tool.

- *Create and incorporate communication protocols, i.e. netiquette* — The trainer may want provide clear instructions in advance on how the interaction and activities will take place via distance learning. In a classroom, a student knows he or she must raise a hand and be called upon before they speak. Distance learning is a new area for almost everyone involved. Ground rules tend to provide boundaries that can offer some comfort for students and instructors alike, making the transition to virtual classroom easier and more productive.
- *Educators should rehearse* — In distance learning, the technology surpasses and trumps chalkboards, overheads, and even Power Point. The teacher/trainer should become comfortable with the format before jumping in to a session. Some training professionals have described distance learning as training in the dark because of the lack of visual and sometimes auditory cues, says Donna Abernathy, associate editor of *Training and Development*. Instructors should expect that they will feel uncomfortable at first with response time and the level of interaction they have with their students.

H. What is the Future of Distance Education?

Technology is the tool, not the teacher. A shift in the teaching system that makes room for distance education, according to Caperton and Papert, is about giving more attention to solving educational problems of the school as it should be versus the school that it is.

The conversation about technology in schools is trapped in the wrong subject. The talk is all about does the technology work as a fix for the old. It ought to be about developing and choosing between visions of how this immensely powerful technology can support the invention of powerful new forms of learning to serve levels of expectation higher than anything imagined in the past. ⁴⁹

Appendix A

Distance Education Vendors, Products, and Services

Educational Organizations and Services

[Access Wisconsin](#)

Access Wisconsin's mission is to promote the development of an advanced telecommunications infrastructure and to provide a telecommunications services.

[ALLEGRA Learning Solutions, LLC](#)

ALLEGRA Learning Solutions develops distance education courses for vocational, baccalaureate, and master's level curricula as well as professional continuing education programs for health care professionals.

[ASI: Amelia Systems, Inc.](#)

Amelia Systems is an information-technology consulting firm whose customer service ranges from applications development to networking to project management.

[Assessments4Kids](#)

Offering parents' activities that can get their child motivated to learn, and tracking tools to help them focus on their child's strengths and help them in any weak areas they might have.

[Cisco Systems, Inc.](#)

The [Cisco Education Network](#) describes CISCO's education programs, upcoming events, and the use of the Internet in schools.

[CollegeLearning.com](#)

The International Center for Distance Learning, through its website, CollegeLearning.com, is a one-stop clearinghouse for anyone wishing to take a distance learning course from any university around the world.

[COLLEGIS](#)

Specific services include data center management, developing and implementing strategic and tactical plans, designing and implementing network solutions, expanding the use of technology for instructional purposes, and developing technology migration strategies to help clients achieve the maximum return on their technology investment through multi-year partnerships.

[Computer Curriculum Corporation](#)

Computer Curriculum Corporation (CCC) provides software and services for the educational community.

[Convene.com](#)

Creating customized online education solutions for colleges, universities, businesses, and training organizations since 1993. Convene has the expertise, technology and resources to handle everything necessary to successfully build a client's online program and then support it with virtual campus creation, network services, faculty training, customer development, hosting, and an around the clock helpdesk.

[Convergent Media Systems](#)

Includes the Interactive Distance Learning package with real-time remote interactivity, multimedia support materials available on demand to the presenter,

viewer interactive keypads with built-in microphone and training and develop program content.

[DigitalThink](#)

DigitalThink provides Web-based training courses for programmers, developers, system administrators and end users. DigitalThink's courses offer Continuing Educational Units, in a collaborative learning environment of students, tutors and instructors.

[The EDEN Project](#)

The EDEN Project, Electronic Distributed Education Network uses leading edge technology to meet the evolving needs of learners. By fostering the flow of creative energy in a collaborative environment, EDEN designs, develops and implements educational materials and technical solutions.

[Education Course Advisory Service Worldwide](#)

Independent service assisting students in finding courses at universities and colleges across the UK and internationally.

[FirstClass](#)

Open e-mail and Internet collaboration software that helps students and faculty at colleges and universities worldwide collaborate and participate in distance learning.

[GeoLearning, Inc.](#)

Provider of computer-based training solutions for business. Offers over a thousand technical and soft-skill courses in a variety of subject areas.

[Infonautics Inc.](#)

Provides online reference services and information technology products. Electric Library is a complete online research library with search engine, built-in dictionary, spell checker, and thesaurus.

[Knowledge Connection Corporation](#)

Knowledge Connection Corporation is a partnership organization of small and large corporations and educators, established in 1995 to foster development of a Distance Learnware industry. It encourages collaborative projects among telecommunications companies, developers of educational software, and educators with expertise in interactive learning techniques.

[Online Conservatory](#)

Using the Internet a student and an Online Music School teacher can come together once a week for a private piano lesson. Students learn from distant teachers almost as if they are sitting in the same room together by using software called NetSessions.

[Online Learning.Net](#)

Helping adult learners around the world access the best in educational resources

[Petersons Education and Career Center - Distance Learning](#)

The Education & Career Center offers features to expand knowledge and communicate with educational institutions.

[Question Mark Testing and Surveying](#)

Question Mark enables teachers and trainers to write, administer and mark tests using computers and the World Wide Web.

[Training and Seminar Locators \(TASL\)](#)

Searchable database of events, services, products and providers for business and industry.

[Tutor 2000](#)

An online tutor referral service helping tutors and students find each other over the Internet. Sponsored by the National Tutoring Association of America.

[Curriculum Software](#)

[A.D.A.M. Software Inc.](#)

Creates, publishes, and markets multimedia software based on human anatomy. A.D.A.M. (Animated Dissection of Anatomy for Medicine) is a multimedia system for Windows and Macintosh computers, which promotes interactive learning via a comprehensive simulation of human anatomy.

[Ars Nova Software](#)

Music training software. Practica Musica 3 is a comprehensive tutor for music theory and ear training.

[Casady & Greene Inc.](#)

Provides easy to use solutions with its Eddy Award winning utility, Conflict Catcher and the new Simplified Office Solutions suite of products: K.I.S.S., and Spell Catcher. K.I.S.S. (Keep It Simple Spreadsheet) shows numerical calculation in a clear and easy-to-understand format. Spell Catcher offers spell checking, thesaurus, and shorthand glossary globally in any application as well as the Internet.

[Charles River Media, Inc.](#)

Publishes books and software for educational training and computing professionals.

[Computer Curriculum Corporation](#)

Computer Curriculum Corporation (CCC) provides software and services for the educational community.

[Davis Instruments](#)

Manufactures weather stations that are designed to be accurate and easy-to-use with a range of features all at affordable prices. Complete your weather station by adding the optional rain gauge and Weatherlink software for IBM or Macintosh.

[Dover Software](#)

Designed for small to medium size training programs, this software contains tools to create and manage an online campus complete with course content, online quizzes, text based student records, and grade reports.

[E-education](#)

Jones e-education(tm) Inc. online course software delivers Internet education tools that empower colleges, universities, and corporations to offer online education. e-education's cost-effective software, used in the delivery and management of online courses, supports higher education administrators, faculty and students as well as corporate training and development programs.

[Falcon Software, Inc.](#)

Educational science software in chemistry, environmental science and electronics.

[Logicus Inc.](#)

The learning materials developed by Logicus recognize the differences in learning abilities and styles of students. Products address students' intuitive and the analytical learning potential.

[Microsoft](#)

Microsoft offers a wide range of products and services for business and personal use designed to take advantage of the full power of personal computing.

[Peregrine Publishers](#)

Working in partnership with leading educators to create teaching and learning resources for higher education and secondary school curricula. Unique teams of faculty have created The Biology Place, The Chemistry Place, and The Psychology Place, subscription Web sites.

[Presence Corp.](#)

Question Mark is a powerful tool for computerizing quizzes, tests, assessments and surveys. Used worldwide by corporations, colleges, universities and K-12 schools to test and assess their employees and students using computers.

[Science Academy Software](#)

Science Academy Software produces and distributes educational software, instructional materials and technology.

[SocratEase](#)

SocratEase is an easy to use e-learning solution. Build your own e-training portal that educates, tests, tracks and provides detailed reports for employees and students. Visit their site and download a free two-user version of SocratEase.

[Theorix](#)

a delivery and management system for self-paced and collaborative learning, knowledge management, including performance support. 100 % multilingual user interface designed for e-learning portals.

[TopClass](#)

TopClass server software from WBT Systems is a virtual classroom environment. It manages student collaboration and the delivery of interactive, customizable courseware from a standard web browser. A free copy called TopClass Lite is available to download from the site.

[Ucompass.com, Inc.](#)

Provides the products and services necessary to deliver state-of-the-art online course experiences including software, hardware, training and content development services.

[UOL, Publishing, Inc.](#)

UOL Publishing, Inc. is a publisher of interactive, Web-based courseware delivered through the Internet or corporate intranets to the education and training market.

Multimedia

[Adobe Systems](#)

Develops, markets and supports computer software products and technologies that enable users to create, display, print and communicate electronic documents.

[AIMS Multimedia](#)

AIMS produces and distributes educational and training programs, core-curriculum videos, CD-ROM, laserdisc, and CD-interactive programs.

[Asymetrix Corp.](#)

Supplier of easy-to-use Internet authoring and development tools for distributed learning, Web publishing, Internet application, and database development.

[ConferTech International, Inc.](#)

ConferTech International, Inc., is a dedicated multimedia teleconferencing company marketing equipment and services worldwide.

[Copeland Wilson & Associates \(CWA\) Education Web](#)

Copeland Wilson & Associates are producers of online, broadcast and non-broadcast resources for education.

[Corel Systems Corp.](#)

Produces CorelDRAW 5, a product that combines the graphics power of CorelDRAW and the advanced publishing capabilities of Corel VENTURA 5 within an integrated user interface.

[Creation Engine](#)

Offers academic discounts on multimedia, graphics, and Web development software to schools, faculty, and students.

[DataBeam](#)

DataBeam develops and markets multimedia communications technology.

DataBeam's products range from application software to servers to developer toolkits for the Internet and dial-up networks, including products such as FarSite and the neT.120 Conference Server.

[TCM Internet Services](#)

TCM specializes in integrating the new technologies of the information age into business processes particularly in the area of Human Resources.

[University Video Communications](#)

Provides video and CD-ROM lectures and tutorials featuring the leaders in computing and information technology

Mathematics, Statistics, and Visualization

[Fortner Research Corp.](#)

Publishes Math77, a portable library of FORTRAN subroutines for use in numerical computation.

[LearningSpace](#)

LearningSpace is Lotus' technology for creating and delivering education and training. It combines the anytime, anywhere convenience distance learning with the face-to-face classroom benefits of a rich, collaborative, instructor-facilitated environment.

[LPA \(Logic Programming Associates Ltd.\)](#)

Leading supplier of advanced software development tools for Windows, Macintosh, and MS-DOS machines.

[Research Systems Inc.](#)

Developer of multi-platform data analysis and scientific visualization software.

[Soft Warehouse Inc](#)

DERIVE for Windows is a new version of its well-established symbolic mathematics software system.

[SPSS Inc.](#)

Company focuses on four higher education areas: Administration research, Social Science research (grant based), Medical research, and Instruction (particularly in Business schools, Education, and Social Science).

[Synergy Software](#)

Produces KaleidaGraph and VersaTerm. KaleidaGraph, available for Macintosh and Windows, has the capacity to transform complex data into functional graphical displays. VersaTerm for Macintosh provides a toolbar interface that lets users access Internet mail, news, FTP file transfers, and three directory clients.

[Waterloo Maple Software](#)

Offers a number of mathematical programs.

[Wolfram Research](#)

Provides students with a fully integrated environment for technical computing.

Hardware

[Apple Computer, Inc.](#)

Apple develops, manufactures, licenses and markets solutions, products, technologies and services for business, education, consumer, entertainment, scientific and engineering and government customers.

[Chaparral Communications, Inc.](#)

Chaparral provides products used in commercial and residential satellite reception systems worldwide.

[Compaq Computer Corp.](#)

Provider of PCs and servers to the education marketplace. The company partners with independent software providers and leading education resellers nationwide to supply educators and students in K-12 and higher education institutions with complete PC solutions.

[Hitachi \(HSC\) Canada Inc., Multimedia Division](#)

Products include Computer Monitors, PC TVs, Digital Boards, Handheld PCs, LCD Projectors, Video Printers, Cameras and MPEG Cameras.

IBM

- [Higher Education](#)

IBM Global Campus combines advanced technologies, network computing solutions, applications, consulting and services tailored to enable colleges and universities to expand their offerings to new groups of students.

- [K-12 Solutions](#)

IBM K-12 Education site offers news, solutions, technical information, and a Teachers Corner.

Networking Solutions

[ADC Telecommunications](#)

ADC is a supplier of transmission and networking systems for telecommunications, cable television, broadcast, wireless and enterprise networks.

[AE Business Solutions](#)

AE Business Solutions provides advanced client/server and systems integration solutions for companies throughout the Midwest.

[Ameritech](#)

In addition to providing Illinois, Indiana, Michigan, Ohio and Wisconsin with local telephone service, Ameritech offers cellular, long distance, paging, cable TV, security monitoring, electronic commerce, managed services and wireless data communications for much of the U.S. and many parts of Europe.

[ARNATECH](#)

ARNATECH specializes in all aspects of K-12 educational networking, from phone and data wiring to installation of high-speed routers and switches.

[AT&T](#)

[The AT&T Learning Network](#) provides the latest technology to schools and communities, as well as support and information on how to plan for and use technology effectively.

[British Telecommunications \(BT\)](#)

BT.COM includes information about BT, its Internet access program, information about BT products and details of the research being conducted at the BT Laboratories.

[3Com Corp.](#)

A broad range of award winning LAN/WAN solutions from Ethernet and Token Ring to the newer high-speed technologies like FDDI, Fast Ethernet, and ATM for all levels of education.

[Dascom Systems, Inc.](#)

Dascom Systems is a systems integration firm specializing in videoconferencing and distance education technology. Dascom offers both packaged and custom classroom, boardroom, and networking systems.

[Executone Information Systems, Inc](#)

Executone designs, markets and supports a comprehensive line of communications products and services for Computer Telephony, Call Center Management, and Healthcare Communications.

[Fiber Options Inc.](#)

Manufactures state-of-the-art, fiber-optic, transmission system links for enhanced transmission of voice, video, and data, including systems that combine voice, video, and data transmission custom configured to meet the needs of individual users.

[FTP Software, Inc.](#)

FTP Software, Inc. provides open, secure, managed IP client and server network applications, along with services, that allow customers to access host and server-based information, regardless of computer hardware, operating system, or physical location.

[GTE](#)

GTE is made up of many business units located throughout the United States, with operations that extend throughout the world. GTE'S [Distance Learning Solutions](#) includes implementing the appropriate technology and the latest distance learning conventions.

[IBM](#)

- [Higher Education](#)
IBM Global Campus combines advanced technologies, network computing solutions, applications, consulting and services tailored to enable colleges and universities to expand their offerings to new groups of students.
- [K-12 Solutions](#)

IBM K-12 Education site offers news, solutions, technical information, and a Teachers Corner.

[Lucent Technologies](#)

Lucent Technologies designs, builds and delivers a wide range of public and private networks, communications systems and software, consumer and business telephone systems and microelectronics components. Bell Laboratories is the research and development arm for the company. [Center for Excellence in Distance Learning](#) provides information on state of the art distance learning technologies and applications.

[MCI](#)

- [networkMCI](#)
networkMCI Conferencing audioconferencing, videoconferencing and document conferencing services

[NEC America, Inc](#)

NEC America, Inc., an affiliate of NEC Corporation, develops, manufactures and markets communications products and software for public and private networks, including digital key telephone and PBX systems; ATM switching systems; PCS equipment; cellular telephones; pagers; facsimile equipment; videoconferencing equipment; fiber optic transmission systems; data communications products; digital microwave radio, satellite communications and network management systems.

[Nortel \(Northern Telecom\)](#)

Nortel works with customers in more than 150 countries to design, build and integrate their communications products and advanced digital networks. Nortel's [Distance Learning](#) turnkey solutions include hardware and software, such as video codecs, ATM access multiplexers, data ports, transmission equipment, control, cabinets & racks, power supplies, cables & connectors, room preparation and integration, installation, training, and service.

[Newbridge Networks](#)

Designs, manufactures, and services a family of networking products and systems that deliver multimedia communications to schools, corporate customers, and service providers.

[Pacific Bell Network](#)

[Pacific Bell Knowledge Network Explorer](#) offers a wide spectrum of products, services and programs to educators including the Pacific Bell Education First initiative of helping schools and libraries connect to the information superhighway.

[Paragon Furniture Inc.](#)

Presents innovative concepts in classroom and library furniture.

[Power On Software](#)

Develops computer laboratory management software.

[Shiva Corp.](#)

Provides colleges and universities throughout North America with high-quality, affordable remote access solutions.

[SoftArc](#)

Has released its new FirstClass Intranet Server (FCIS). Now an entire organization can connect, collaborate, and publish on the Internet without needing a full-time Web Master or a complex mix of hardware and software.

[Sprint Communications Company](#)

- [Sprint Videoconferencing](#)

Sprint works closely with the industry's most stable and respected suppliers of videoconferencing technology and equipment.

[Sun Microsystems, Inc.](#)

Sun Microsystems provides hardware, software and services for establishing enterprise-wide, network solutions, offering products from the Java smartcards to SPARC supercomputers.

Video Presentation Products

[ACT Teleconferencing](#)

ACT Teleconferencing provides audio, video and data conferencing products and services.

[Alpha Video](#)

Alpha Video specializes in the sale, rental, service and training of digital, non-linear, and desktop video editing systems.

[Ameritech](#)

In addition to providing local telephone service, Ameritech offers cellular, long distance, paging, cable TV, security monitoring, electronic commerce, managed services and wireless data communications for much of the U.S. and many parts of Europe.

[Apollo Presentation Products](#)

Worldwide manufacturer and distributor of a complete line of products for presentation needs, from overhead projector, LCD panels, and slide and data/video projectors, to screens, easels, lamps, laminating equipment, laser pointers, and AV furniture.

[ASK](#)

Multimedia presentation products - LCD projectors, panels, and monitors.

[AT&T](#)

[The AT&T Learning Network](#) provides technologies to schools and communities, as well as support and information on how to plan for and use technology effectively.

[Boxlight Corporation](#)

A supplier of LCD projection and presentation products. Offering technological teaching tools to replace the use of transparencies and slides, Boxlight carries a full range of panel and projector LCD systems.

[Canon USA, Inc. Visual Communication Systems Division](#)

Manufactures, markets, and distributes a complete line of electronic imaging and video conferencing products.

[Chisholm](#)

Designs LCD panels and electronic writing products, which are sold through a worldwide network of audio-visual dealers.

[Compunetix](#)

Compunetix, Inc. designs, manufactures, markets, installs, operates, and supports high-performance digital teleconferencing systems.

[DAVIS North America](#)

Produces video presentation products.

[Dukane Corp.](#)

Offers audiovisual products that deliver computer generated graphics and video.

[Eastman Kodak Co.](#)

Provides a variety of video presentation solutions. An example of the company's education offerings is the Kodak Education Technology Grant Program, which awards winners digital cameras, CD media, thermal dye sublimation printers, and film scanners.

[ELMO Company Ltd.](#)

A worldwide manufacturer of electronic imaging equipment. ELMO also offers a complete line of CCTV equipment.

[Evans Associates](#)

Evans Associates of Thiensville, Wis., specializes in the worldwide application of video, voice, and data networking.

[Force, Incorporated](#)

Force, Incorporated manufactures fiber optic video, audio, and data links as well as fiber optic test equipment for datacom and telecom industries and the military.

[Gentner Communications Corporation](#)

Gentner Communications Corporation develops and manufactures audio solutions for the broadcast, teleconferencing, and assistive listening markets. Gentner's mission is to help build synergistic relationships between people who are geographically separated by providing customers with total audio solutions.

[GTE](#)

GTE is made up of many business units located throughout the United States, with operations that extend throughout the world. GTE'S [Distance Learning Solutions](#) includes implementing the appropriate technology and the latest distance learning conventions.

[Hitachi](#)

A global electronic company that markets and manufactures a wide range of products, including computers, semiconductors, consumer products, and power and industrial equipment.

[IBM](#)

- [Higher Education](#)
IBM Global Campus combines advanced technologies, network computing solutions, applications, consulting and services tailored to enable colleges and universities to expand their offerings to new groups of students.
- [K-12 Solutions](#)
IBM K-12 Education site offers news, solutions, technical information, and a Teachers Corner.

[Instructional Networks Inc.](#)

Instructional Networks is an international design and development firm specializing in instructional media and technologies, designing data, voice, and video networks for learning and collaboration.

[JVC Professional Products Co.](#)

Offers an array of video products from VCRs to visual presenters.

[MentorPoint Distance Learning Center](#)

Live desktop data conferencing solutions for distance learning and distance selling.

[MultiLink](#)

MultiLink's audioconferencing products are used by commercial, education, government and service provider organizations for applications including: business meetings, shareholder services, public relations, project management, focus groups, teletraining, distance learning and crisis management.

[PictureTel](#)

PictureTel Corporation develops, manufactures and markets a full range of videoconferencing solutions. PictureTel also markets network conferencing servers and a comprehensive portfolio of enterprise-wide services, providing videoconferencing solutions to customers in distance learning, health care, financial services and manufacturing industries.

[Proxima Corp.](#)

Offers an array of video presentation products.

[Polycom, Inc](#)

Polycom, Inc. develops, manufactures and markets audioconferencing and dataconferencing products that facilitate meetings at a distance.

[Shure Brothers Incorporated](#)

Shure offers consumer and professional products to meet a variety of audio applications: from phonograph cartridges to stage performance microphones to mixers to teleconferencing products

[SMART Technologies Inc.](#)

Provides touch sensitive whiteboards and interactive communications software for use in computer-based meetings, education, presentations, and training.

[TeleSpan: A Bulletin on Teleconferencing](#)

Elliot Gold founded TeleSpan in 1981 as a publishing and consulting company in the area of teleconferencing.

[Videonics](#)

Manufactures a full line of digital video editing products designed to provide the advanced features required for any video project.

[VSI Enterprises, Inc.](#)

VSI designs, manufactures, markets and supports an array of videoconferencing products, along with integrated telecommunications software and services including product applications designed for use in distance education.

[VStream](#)

VStream provides video-on-demand and audio-on-demand services to corporations worldwide. VStream collects, digitally encodes and stores the company's media content from various sources such as videotape, audio or videoconference and satellite reception.

[VTEL](#)

VTEL's digital visual communication systems are deployed in corporations, healthcare facilities, educational institutions, and government operations around the globe. VTEL technology is utilized for distance education.

Appendix B

Distance Education Professional Associations and Organizations

- [Association for Telecommunications Professionals in Higher Education \(ACUTA\)](#)
ACUTA is a member-driven organization dedicated to the enhancement of teaching, learning, research, and public (community) service by providing leadership in the application of telecommunications technology for higher education.
- [ADEC Distance Learning Consortium](#)
ADEC is a national consortium of state universities and land grant institutions providing high quality and economic distance education programs and services via the latest and most appropriate information technologies.
- [Adult Literacy and Technology Network \(ALT\)](#)
The Adult Literacy & Technology Network is a national effort dedicated to finding solutions for using technology to enhance adult literacy.
- [American Association for Higher Education \(AAHE\)](#)
The American Association for Higher Education is a national organization of more than 8,500 individuals dedicated to improving the quality of American higher education. AAHE's members -- faculty, administrators, and students from all sectors, as well as policymakers and leaders from foundations, government, and business -- believe that higher education should play a more central role in national life and that our institutions can and must become more effective.
- [American Center for the Study of Distance Education \(ACSDE\)](#)
The American Center for the Study of Distance Education (ACSDE), established in 1988 in the College of Education, seeks to promote distance education research, study, scholarship, and teaching and to serve as a clearinghouse for the dissemination of knowledge about distance education.
- [Annenberg/CPB Project](#)
Working to make a quality college education more accessible to the American public, the Project is the only national effort at the forefront of an innovative movement in higher education to apply new developments in information and telecommunications technologies to teaching and learning.
- [Association for the Advancement of Computing in Education \(AACE\)](#)
AACE (founded in 1981) is an international, educational, and professional organization dedicated to the advancement of the knowledge, theory, and quality of learning and teaching at all levels with information technology.
- [Association for Applied Interactive Multimedia \(AAIM\)](#)
AAIM was created to support professionals using and developing multimedia. From modest beginnings five years ago the organization has grown to include professionals from: business & industry, higher education, K-12 education, military, medicine, hardware and software producers and manufacturers, suppliers, state, local and federal government. AAIM conducts at least one major conference a year for the purpose of bringing together practicing

multimedia professionals, and those considering using multimedia and related activities. While the focus is on multimedia, papers and seminars on a wide variety of related technologies are presented.

- [Association for Computer Professionals in Education, Inc. \(ACPE\)](#)
A nonprofit organization serving Oregon and Washington
- [Association for Computing Machinery \(ACM\)](#)
ACM (founded 1947) is an international scientific and educational organization dedicated to advancing the art, science, engineering, and application of information technology, serving both professional and public interests by fostering the open interchange of information and by promoting the highest professional and ethical standards.
- [Association for Educational Communications & Technology \(AECT\)](#)
The mission of the Association for Educational Communications and Technology is to provide leadership in educational communications and technology by linking professionals holding a common interest in the use of educational technology and its application to the learning process.
- [Association for Learning Technology \(ALT\)](#)
ALT aims to promote good practice in the use and development of learning technologies in higher education, facilitate interchange between practitioners, developers, researchers and policy makers in higher education and industry, and represent the membership in areas of policy such as infrastructure provision and resource allocation.
- [Association for Media and Technology in Education in Canada \(AMTEC\)](#)
The Association for Media and Technology in Education in Canada (AMTEC) is Canada's national association for educational media and technology professionals. As an organization, AMTEC provides national leadership through annual conferences, publications, workshops, media festivals, and awards. AMTEC responds to media and technology issues at the international, national, provincial, and local levels. AMTEC also maintains linkages with other organizations with similar interest.
- [Australasian Teleconferencing Association \(ATA\)](#)
The Australasian Teleconferencing Association is an independent organization involved in promoting the development and application of interactive telecommunication in the interest of its members.
- [Australian Society for Computers in Learning In Tertiary Education \(ASCILITE\)](#)
- [Canadian Association for Distance Education / Association canadienne de l'education a distance \(CADE / L'ACED\)](#)
Established in 1983, CADE is a national association of professionals committed to excellence in the provision of distance education in Canada.
- [Center for Distance Learning Research \(CDLR\)](#)
The mission of the Center for Distance Learning Research at Texas A&M University is to provide timely and appropriate information on the development, application and maintenance of information technology systems.
- [Center for Educational Leadership and Technology \(CELT\)](#)

CELT is a non-profit educational service agency whose primary mission is to integrate technology with current education reforms and research.

- [Coalition for Networked Information \(CNI\)](#)
The Coalition for Networked Information was founded in March 1990 with a mission to help realize the promise of high performance networks and computers for the advancement of scholarship and the enrichment of intellectual productivity. The Coalition is a partnership of the Association of Research Libraries, CAUSE, and EDUCOM.
- [Commonwealth of Learning](#)
The purpose of The Commonwealth of Learning is to create and widen access to education and to improve its quality, utilizing distance education techniques and associated communications technologies to meet the particular requirements of member countries. The agency's programs and activities aim to strengthen member countries' capacities to develop the human resources required for their economic and social advancement and are carried out in collaboration with Governments, relevant agencies, universities, colleges and other educational and training establishments among whom it also seeks to promote co-operative endeavours.
- [Computer-Using Educators \(CUE\)](#)
CUE is the oldest and largest organization in the United States dedicated to learning, teaching and technology. CUE is a not-for-profit educational corporation registered in California.
- [Consortium of College and University Media Centers](#)
CCUMC is a dynamic organization whose mission is to improve teaching and learning through the effective use of media/instructional technology services in higher education. The over 400 members represent all sizes of institutions in higher education that provide media/instructional technology-related support services, as well as companies providing relating products.
- [Consortium for School Networking \(CoSN\)](#)
The purpose for which the Consortium for School Networking is organized is to advocate access to, and facilitate the evolution of, national and international electronic networks as resources to K-12 educators and students. Using these interconnected networks, the Consortium will support educational goals by advocating equitable, low-cost, user-friendly access to communications services and information resources, and by stimulating collaborations among K-12 educators and students, post-secondary researchers and scholars, and other individuals and groups concerned with K-12 education.
- [Corporation for Research & Educational Networking \(CREN\)](#)
CREN: serving education, research, and the rest of the Internet community with software and services. CREN's focus is on supporting educational outreach, worldwide collaboration, and easy access to information resources throughout the network.
- [Distance Education and Training Council \(DETC\)](#)
The Distance Education and Training Council (formerly the National Home Study Council) is a non profit educational association located in Washington, D.C. DETC serves as a clearinghouse of information about the distance

study/correspondence field and sponsors a nationally recognized accrediting agency called the Accrediting Commission of the Distance Education and Training Council.

- [The Education Coalition - Distributed Learning Systems and Services](#)
The Education Coalition (TEC) is a not-for-profit educational organization, created in 1993 to serve the needs of the business and education communities. The web site provides information and resources on distance education and educational technology for teachers and learners at all levels.
- [Educause](#)
EDUCAUSE focuses on the management and use of computational, network, and information resources in support of higher education's missions of scholarship, instruction, service, and administration.
- [EuroPACE 2000](#)
EuroPACE 2000, the Professional and Academic Channel for Europe 2000, is a trans-European network of universities, and through them their partners in education and training (private companies, regional and professional organizations, public authorities) that wants to demonstrate and develop the potential of telematics for the European universities of the future.
- [European Association of Distance Teaching Universities \(EADTU\)](#)
EADTU is a strategic level organization whose mission includes: to promote and support the creation of a European network for higher-level distance education.
- [European Distance Education Network \(EDEN\)](#)
EDEN was formally established in May 1991 following the first pan-European conference in Budapest in 1990. Its aim is to foster developments in distance education through the provision of a platform for co-operation and collaboration between a wide range of institutions, networks and individuals concerned with distance education in Europe.
- [Florida Distance Learning Network \(FDLN\)](#)
The Florida Distance Learning Network seeks to improve student learning and achievement through new instructional techniques and strategies that increase access to distance learning in the most cost-effective ways.
- [The Global Alliance for Transnational Education \(GATE\)](#)
GATE is a global alliance of corporations, governments and institutions of higher education dedicated to assuring the quality of higher education and training which cross national borders.
- [Information Network of the Society for Information Technology and Teacher Education \(InSITE\)](#)
The Society for Information Technology and Teacher Education is an international association of teacher educators who are interested in the creation and dissemination of knowledge about the use of information technology in teacher education.
- [Institute for the Transfer of Technology to Education \(ITTE\)](#)
A program of the National School Boards Association. ITTE works actively with school districts across North America that are exploring creative ways to

teach and learn with technology. Our district participants are large and small, are in cities, small towns and rural areas, and are economically diverse.

- [Inter-American Distance Education Consortium](#)
Composed of a vast network of individuals and institutions throughout North, Central, and South America, conjoining resources and expertise to redefine educational partnerships in the 21st century.
- [International Centre for Distance Learning \(ICDL\)](#)
The International Centre for Distance Learning (ICDL) is a documentation center specializing in collecting and disseminating information on distance education worldwide. Supported by the national Distance Learning Council, ICDL offers its members guidelines, newsletters, workshops, and conferences.
- [International Interactive Communications Society](#)
The IICS is the premier worldwide non-profit organization for interactive media professionals. Dedicated to the advancement of interactive arts and technologies since 1983, members of the IICS include professionals involved in the rapidly-integrating digital "convergence" industries: multimedia, computing, telecommunications, education, mass media, consumer electronics, publishing and entertainment, among others. The IICS is unique in the broad spectrum of media issues we address, and for the talent, information, networking and educational resources we provide to our international membership.
- [International Multimedia Teleconferencing Consortium \(IMTC\)](#)
The mission of the IMTC is to bring together all organizations involved in the development of interactive, multimedia teleconferencing products and services to help create and promote the adoption of industry-wide interoperability standards.
- [International Society for Technology in Education \(ISTE\)](#)
A nonprofit professional organization dedicated to the improvement of education through computer-based technology.
- [International Teleconferencing Association \(ITCA\)](#)
ITCA is a professional association linking users, providers, strategists, educators, learners, managers and employees that use teleconferencing, telecollaborative and distance education technologies.
- [International Television Association \(ITVA\)](#)
ITVA serves the needs of accomplished visual communicators who work in corporate, organizational, and independent settings.
- [International University Consortium \(IUC\)](#)
Developing and Sharing Distance Education Courses
- [Internet Society](#)
The Internet Society is a non-governmental International organization for global cooperation and coordination for the Internet and its internetworking technologies and applications.
- [LearnNet](#)
LearnNet is about important Federal Communications Commission (FCC) policy and education initiatives.
- [Mid-Atlantic Network for Teaching Learning Enterprises \(MANTLE\)](#)

The Mid-Atlantic Network for Teaching Learning Enterprises was created to build a forum for sharing and disseminating knowledge about distance education. A particular focus of the organization is promoting the professional development of educators engaged in this type of instruction in the mid-Atlantic region.

- [National Council for Educational Technology \(NCET\)](#)
The National Council for Educational Technology (NCET) evaluates, promotes, and supports the effective use of information technology to enhance learning and raise educational standards.
- [National ITFS Association](#)
The Instructional Television Fixed Service (ITFS) is a band of twenty (20) television channels available to be licensed by the FCC to local credit granting educational institutions.
- [Network for Ontario Distance Educators \(NODE\)](#)
The NODE/R_DO (the Network for Ontario Distance Educators/Le Réseau d'éducation distance de l'Ontario) is a network linking post-secondary course and program developers, faculty, administrators and learners interested in technologically-mediated teaching and learning. Our prime focus is on the needs and interests of post-secondary distance educators and learners, but NODE activities reflect the fact that these needs and interests are shared by more and more faculty, administrators and learners as communications and information technologies are integrated into post-secondary learning.
- [New Media Centers](#)
New Media Centers is a non-profit, 501(c)(3) organization helping institutions of higher education enhance teaching and learning through the use of new media. Bringing together pioneers in the new media field from academia and industry, NMC creates a collaborative network of institutions and corporations serving as a catalyst to integrate new media into education.
- [Norwegian Association for Distance Education \(NADE\)](#)
The Norwegian Association for Distance Education (NADE) was founded in 1968. The organization has since played an active part in the development of distance education in Norway.
- [Open and Distance Learning Association of Australia](#)
The Open and Distance Learning Association of Australia (ODLAA) is a professional association of members interested in the practice and administration of distance education and open learning. It is a non-profit organization managed by an Executive Committee of members operating in a voluntary capacity.
- [Society for Applied Learning Technology \(SALT\)](#)
Founded in 1972, membership in the Society is oriented to professionals whose work requires knowledge and communication in the field of instructional technology. It is a professional society, designed for individual membership participation with classes of membership keyed to the interest and experience of the individual. The Society provides a means to enhance the knowledge and job performance of an individual by participating in Society sponsored meetings, and through receiving Society sponsored publications. It

enables one to achieve knowledge for work in the field of applied learning technology by association with other professionals in conferences sponsored by the Society.

- [TLT Group](#)
The TLT Group, a nonprofit corporation, is the Teaching, Learning, and Technology Affiliate of AAHE. Its mission is to provide materials and services that motivate and enable institutions to improve teaching and learning with technology, while helping them cope with continual change.
- [United States Distance Learning Association \(USDLA\)](#)
The United States Distance Learning Association is a non-profit association formed in 1987 by Patrick Portway, Dr. Smith Holt of Oklahoma State University and Dr. Ralph Mills of California State University. The association's purpose is to promote the development and application of distance learning for education and training. The constituents we serve include K through 12 education, higher education, continuing education, corporate training, and military and government training.
- [Universities and Colleges Information Systems Association \(UCISA\)](#)
UCISA represents the whole of higher education in the provision and development of academic, management and administrative information systems, providing a network of contacts and a powerful lobbying voice.
- [University Continuing Education Association \(UCEA\)](#)
Founded in 1915, the University Continuing Education Association (formerly the National University Continuing Education Association) is among the oldest college and university associations, and the principal organization for continuing higher education in the United States. The Association assists institutions of higher learning in expanding access to higher education through a wide array of educational programs and services, while providing national leadership in support of policies that advance workforce and professional development. Since its inception, UCEA has been committed to making higher education available to everyone, while striving to ensure that programs and services address societal needs and economic trends.
- [Web-Based Training Information Center \(WBT\)](#)
The Web-Based Training Information Center is a non-profit resource for individuals and organizations interested in developing and delivering training using Web technology. The intent of this site is to share non-proprietary information, stimulate creative ideas, and link to interesting training sites around the world. No product or service is offered at this site.
- [Western Cooperative for Educational Telecommunications](#)
The Western Cooperative for Educational Telecommunications is a membership-based organization open to providers and users of educational telecommunications. Established in 1989 by the Western Interstate Commission for Higher Education (WICHE), the Western Cooperative facilitates resource sharing, information sharing, and policy advocacy in the use of educational technologies and telecommunications. Members come from higher education, non-profit organizations, K-12 schools, and corporations located in 26 states, Canada, Malaysia, and Mexico. The Western Cooperative

has emerged as a leader in educational telecommunications policy development through its on-going work in a variety of projects.

- [World Association for Online Education \(WAOE\)](#)
An international professional organization concerned with online pedagogy. WAOE offers membership services relevant to educators concerned with teaching online, public services for international society, and collaboration with other educational organizations functioning in cyberspace.

Appendix C

Distance Education Research Centers and Universities

- Brown University Scholarly Technology Group
Computing and Information Services
Brown University
<http://www.stg.brown.edu/>

The Brown University Scholarly Technology Group (STG) supports the development and use of advanced information technology in academic research, teaching, and scholarly communication. STG pursues this mission by exploring new technologies and practices, developing specialized tools and techniques, and providing consulting and project management services to academic projects. . . . The common theme of STG projects is their exploration of the technologies of electronic learning, collaboration, and dissemination, particularly with respect to interactivity, flexible high-performance use of structured data, and integration with disciplinary and pedagogical methodologies. The effective creation and deployment of academic information technology requires a thorough-going critical engagement with the theory and practice of the disciplines that the technology is serving. Only with this sort of substantive connection with disciplinary practice can technology and methodology evolve in concert and genuine methodological innovation be achieved. [Web page]

- CoVis: Learning Through Collaborative Visualization Project
Learning Sciences Program
The School of Education & Social Policy, Northwestern University
<http://www.covis.nwu.edu/>

The Learning Through Collaborative Visualization (CoVis) Project is thousands of students, over a hundred teachers, and dozens of researchers and scientists working to improve science education in middle and high schools. They do this by approaching the learning of science more like the doing of science, and by employing a broad range of communication and collaboration technologies. [Web page]

- Knowledge Media Institute (KMi)
The Open University, Milton Keynes, United Kingdom.
<http://kmi.open.ac.uk/kmi-research/> <http://kmi.open.ac.uk/>

Major research teams at the Open University, working in related areas of learning applications of new technologies, joined forces in mid-1995 to create the Knowledge Media Institute (KMi). We share a belief that our future depends on understanding and sharing knowledge, and we therefore aim to define the future of life-long learning by harnessing and shaping the technologies that underpin it. Our interests include knowledge systems, multimedia enabling technologies for disabled people, advanced telematics, virtual classrooms, customizable authoring tools, virtual science laboratories, intelligent agents, and "training on demand." [Web page]

- Learning Technology Dissemination Initiative (LTDI)
Institute for Computer-Based Learning
Heriot-Watt University, Edinburgh, Scotland
<http://www.icbl.hw.ac.uk/ltdi/index.html>

The Learning Technology Dissemination Initiative is a project funded by the Scottish Higher Education Funding Council to promote the use of learning technology and computer based learning materials in SHEFC funded Higher Education Institutions. The emphasis of our support is on educational issues and pedagogy, and the implementation and integration of learning technology rather than technical and programming aspects. [Web page]

- Yale Center for Advanced Instructional Media (CAIM)
Yale University
http://info.med.yale.edu/caim/C_HOME.HTML

Founded in 1987, the Yale Center for Advanced Instructional Media (CAIM) develops innovative educational and communications programs. Through C/AIM, Yale University has become a leading developer of multimedia education and computer-based training programs [<http://info.med.yale.edu/caim/caim/projects/projects.html>]. CAIM is a recognized leader in information design, digital document design, medical illustration, and interface design for electronic publications and networked information systems. [Web page]

Appendix D

Distance Education Sites

(Recommended by *The Chronicle of Higher Education*)

- American Distance Education Consortium — www.adec.edu
- ADEC is an international consortium of state universities and land grant institutions providing high quality and economic distance education programs and services via the latest and most appropriate information technologies. Primary emphasis is on programs relating to: distance education and technology, food and agriculture, youth and families, community and economic development, environment and natural resources, and nutrition and health.
- Distance Education and Training Council — www.detc.org
- The Distance Education and Training Council (formerly the National Home Study Council) is a nonprofit educational association located in Washington, D.C. DETC serves as a clearinghouse of information about the distance study/correspondence field and sponsors a nationally recognized accrediting agency called the Accrediting Commission of the Distance Education and Training Council.
- Distance Education at a Glance — www.uidaho.edu/evo/distglan.html
- Barry Willis, the associate dean for outreach and the engineering outreach staff at the University of Idaho, wrote a series of guides highlighting information detailed in his books, *Distance Education - Strategies and Tools* and *Distance Education - A Practical Guide*.
- Distance Education Clearinghouse Conference Database www.uwex.edu/disted/conf/
- The Distance Education Clearinghouse Conference Database lists worldwide conferences, workshops, seminars and other events of interest to distance education and related fields.
- Hungry Minds (formerly IDG Books Worldwide) — www.hungryminds.com
Hungry Minds, Inc. is a leading global knowledge company with a portfolio of technology, business, consumer and how-to brands, computer-based learning tools, Web sites and Internet e-services. Hungry Minds' best-selling brands include For Dummies[®], Betty Crocker[®], Bible, CliffsNotes(tm), Frommer's[®], the Unofficial Guide[®], Visual(tm), Weight Watchers[®] and Webster's New World(tm). Hungry Minds is also the publisher of AOL Press(tm), Hewlett-Packard Press(tm), Netscape Press(tm) and Novell Press(tm). Hungry Minds has more than 4,000 active titles in 39 languages. Hungry Minds owns the websites as well as Web-based products and services that extend our brands online including www.cliffsnotes.com, www.dummies.com and www.frommers.com. Additionally, www.hungrymindsuniversity.com a web-site leading the way in e-learning provides

more than 17,000 online courses and learning experiences from trusted academic names, such as UC Berkley, New York University and University of Maryland.

- United States Distance Learning Association —www.usdla.org

The United States Distance Learning Association is a nonprofit organization formed in 1987. The association's purpose is to promote the development and application of distance learning for education and training. The constituents we serve include Pre-K through grade 12 education, higher education, home school education, continuing education, corporate training, military and government training, and telemedicine.

- Web Based Learning Resources Library —www.outreach.utk.edu/weblearning

The University of Tennessee Outreach and Continuing Education program has compiled this well-researched, extensive directory of information, services providers and resources for educators about distance education.

- World Lecture Hall —www.utexas.edu/world/lecture

Created by the University of Texas, World Lecture Hall publishes links to pages created by faculty worldwide who are using the Web to deliver course materials in any language

III. Simulation Technology

Introduction

The Oxford English Dictionary describes simulation as:

The technique of imitating the behaviour of some situation or system (economic, Mechanical, etc.) by means of an analogous model, situation or apparatus, either to gain information more conveniently or to train personnel.

Simulation does not necessarily imply expensive computer platforms such as flight simulators. Simulation is a broad term that includes everything for role playing to computer games to low fidelity simulations that provide an effective medium for training and assessment.⁵⁰

The term simulation technology generally refers to the introduction of discrete or continuous event modeling software into a particular business or training process in order to generate information prior to developing and working with the system itself.

James Swain, professor and chair of the Department of Industrial Systems and Engineering and Engineering at the University of Alabama-Huntsville, says that with simulation models, we are free to imagine how an existing system might perform if altered, or imagine, and explicitly visualize, how a new system might behave before the prototype is even completed.⁵¹

The goal of most simulation software is to assist in making a decision through information analysis and exchange. The software operates by the construction of an explicit trajectory or realization of a process. Each replication only provides a single sample, Swain notes, so accuracy is improved through repetition. When joined with animated outputs, it can be used for analysis, validation and training. Software applications currently available tend to serve the following primary markets:

- Academics/Education/Training
- Business process/Marketing/Consumer goods
- Chemicals/Oil and mineral exploration
- Control systems (traffic, transportation, communication protocols, airport logistics)
- Energy/Utilities
- Engineering (Industrial, software, etc.)

- Environmental Studies
- Financing/Investing/Economics
- Human and artificial collective behavior
- Insurance
- Manufacturing/Warehousing and distribution
- Medical /Pharmaceutical/Hospital process
- Military/Defense/Aerospace
- Networking
- Website development/E-Commerce

The primary strength of simulation says Alan Christie of Carnegie Mellon University's Software Engineering Institute (SEI), is [it] can be applied in many critical areas and enables one to address issues before these issues become problems.

Simulation is more than just a technology, as it forces one to think in global terms, about system behavior, and about the fact that systems are more than the sum of their components.⁵²

From the emergence of simulation technology in the 1960s through the end of the 80s, a simulation could only be developed through a textual coding model. Since the early 1990s, graphical simulation tools have become available. According to Christie, these tools:

- Allow rapid model development through the use of drag-and-drop building blocks, graphical element linking and syntactic constraints on how elements are linked;
- Are less error prone;
- Require significantly less training; and
- Are easier to understand, reason about and communicate to non-technical staff.

Development of simulation tools has shifted away from construction of syntactically correct models to a focus on the models' semantic validity and accuracy of their numerical drivers. The marketplace for these software programs has tended to become more diverse and less expensive, with some less customized tools costing from \$500 to \$1000.⁵³

In order to characterize simulation, it is useful to understand how it compares to the fields of computer graphics/animation and virtual reality, since, according to Paul Fishwick, associate professor of computer and information sciences at the University of Florida, these fields have much in common with simulation.

- *Computer graphics* is the computational study of light and its effect on geometric objects. The focus is to create meaning through rendered images.
- *Animation* is the use of computer graphics to generate a sequence of frames which, when passed before your eyes very quickly, produce the illusion of continuous motion.
- *Virtual reality* is focused on immersive human-computer interactions using devices such as head-mounted displays and data gloves.
- *Simulation*, on the other hand, is best understood as the engine that drives the graphics and virtual reality technologies. Simulation is the infrastructure necessary for other fields, which can be measured through face validation (how good it looks) and through non-visual confirmation of mathematical validation of the model.⁵⁴

Simulation technology emerged in the 1960s with the U.S. military development of flight simulators. Other fields tended to gravitate to the development of this new technology, and are considered the pioneers of simulation. They include.

- ***Military Training*** - In 1998, Jacques Gansler, undersecretary of defense (Acquisition and Technology) stated that the U.S. government is committed to reforming the acquisition system and recognize that an essential tool for accomplishing that reform will be modeling and simulation.⁵⁵

Flight simulator technology is the original simulation technology and since its development and success, the Department of Defense has committed itself to using simulation in every area of acquisition. That means that prior to purchasing any major new system or product (investments that often cost taxpayers millions), it creates simulation models to determine if the product or system will work, and do so efficiently.

- ***Medical Training*** - According to the Journal of the American Medical Association, four areas of high-tech simulations are being used to further educated both students and practitioners:
 - Laparoscopic techniques
 - Cardiovascular disease simulator
 - Multimedia computer systems, including patient-centered, case-based programs
 - Anesthesia simulator

These systems help to address the problem of poor skills training and proficiency, and may provide a method for physicians to become self-directed, lifelong learners.⁵⁶

Medical simulators generally function to allow the student to acquire clinical skills and medical information. A good simulator, according to Gary Meller of MedSim

USA, allows the student to learn skills in a shorter time, a lower risk to themselves and patients and in a practical or realistic manner. Simulators, Meller notes, are only a rough approximation of reality, so there is a real danger of creating oversimplified clinical images or practice situations. Newer simulators evaluate a trade-off between several alternatives, enabling the trainer and trainee to understand their impact on future directions. This helps to avoid black and white thinking, Meller says, which does not represent reality.

A useful feature of this analysis is that it can clarify the risks and benefits inherent in what may appear to be a simple decision.⁵⁷

- ***Computer Technologies***

As a result of advancements in computer science, simulation programs have grown larger and more complex since their beginning. Computer technology leverages technologies from other areas of science to create the models used in computer-based simulation.

- ***Entertainment***

Arcade games, computer games, board wargames, and role playing games all require the creation of a consistent model of an imaginary world and devices for interacting with that world. These simulations often appear very similar to training simulations, but differ in that their purpose is entertainment rather than practice for real-world events. According to the *Encyclopedia of Computer Science*, this fact allows game developers the freedom to modify the laws of physics and other behaviors, rather than accurately capturing their real world equivalents.⁵⁸

A. Why do Simulation?

Fishwick at the University of Florida says that there are many modeling systems that do not require simulation involvement. Simulation, he continues, is often essential in the following case:

- If the model is very complex, with many variable and interacting components
- If the underlying variables relationships are nonlinear
- If the model contains random variates
- If the model s output is to be visual, as in 3-D computerized animation.⁵⁹

In the science and entertainment sectors, simulation and virtual reality will dominate development over the next decade, Fishwick says.

B. The Roles of Simulation

Simulation technology is expanding exponentially daily, and finding acceptance in dozens of new sectors. From industrial analysis to market research to environmental and behavioral training modules, simulation fills many common roles across the spectrum.

- ***Decision Making***

According to James Swain, professor and chair of ISEEM departments at University of Alabama-Huntsville, simulation technology is about building models with the goal of assisting in making a decision. These tools are being positioned as modeling tools within a general decision-making framework. Many products also include tools for data analysis for both input and output. These products contrast with standard analytical models because their accuracy can be improved through repetition and because the simulation can be joined to animated outputs, used for validation, analysis and training.⁶⁰

- ***Visualization***

Visualization adds impact to simulation output and generally enhances the credibility of the model for both the technical and the non-technical audience, Swain says. Almost all simulation software has some level of animation, and now developers are combining simulation with virtual reality to enhance exploration. In the corporate world, simulation is increasingly commonplace. For Intel, simulation is no longer a luxury but a necessity for proper analysis to support good decisions. And the Department of Defense, Swain continues, anticipates that simulation will be used for all aspects of the acquisition cycle from design evaluation and operation to manufacturing and tactical doctrine and training.⁶¹

- ***Market Expansion***

According to the market study *3D Visualization and Simulation*, presented August 2000 by Jon Peddie Associates (JPA), this market will triple in size over the next five years - growing from \$8.1 billion at the end of 2000 to \$24.8 billion by 2005. Key drivers of the growth include:

- The continued shift to more cost-effective computing platforms such as Microsoft's Windows NT
- The growth of off-the-shelf, 3-D visualization packages
- The emergence of new 3-D VizSim sectors, such as enterprise visualization.

JPA also tends to predict the industry and business segments to lead the pack in terms of annual growth, catching up with already established defense, design and engineering and medical segments. In the expanding financial services sector in particular, the explosion of the volume of data encountered will drive managers to find better tools for information management and decision analysis.⁶²

- ***Time and Training***

Simulation has the power to present a wide variety of relevant situations within a compressed time period.

Averill M. Law, a simulation consultant and Ph.D. in industrial engineering and operations research from the University of California-Berkeley, has taught for 17 years and more than 325 simulation short courses. He says that one of the best benefits of simulation modeling is it eliminates the risk of unforeseen bottlenecks, underutilization or overutilization of resources, and failure to meet specified system requirements.⁶³

In developing simulation education programs and coursework, Law recommends the following:

- A focus on methodology rather than how to use a particular simulation package.
- An extensive period (at least 3 weeks at an upper level undergraduate or graduate level course) teaching the fundamentals of the particular simulation package.

- ***Efficiency and Cost Effectiveness***

According to the *McKinsey Quarterly*, the application of simulation software to modeling is already cutting development time and cost, but its future holds even greater promise.⁶⁴ One of the primary roles of simulation is to reduce the costs incurred in creating and testing and retooling an entire system. According to Meller at MedSim USA, Inc., the pricing consideration is essential to the development effort, because of the constraints it places on the budget. There is normal conflict between engineering and marketing on the issue of price, Meller says. The higher the price, the more comprehensive the product can be. With a lower price, however, more units may be sold.⁶⁵

- ***Assessment and Diagnosing Performance***

The Teaching Skills Enhancement System (TSES) product distributed by Applied Simulation Consultants, for example, diagnoses performance strengths and weaknesses, helping to focus training on true areas of need. TSES provides focused training by allowing teachers to perform an objective confidential self-assessment of their classroom teaching skills.⁶⁶

- ***Process Improvement***

Traditionally, operational experience is necessary to improve new or revised processes, an often risky and expensive process. According to Christie, simulation can provide considerable insights into how a process will work, prior to its implementation. In this way, processes can be pre-tested and buy-in is more likely

obtained by management. Subjective criticism is less likely, since quantitative simulation of validated models can produce specific and credible answers to hostile questions. For this reason, simulation, Christie says, can be useful in analyzing product lines. Using software that accumulates the cost associated with processing at each stage can provide detailed product cost predictions and, in turn, affect product line strategies.⁶⁷

C. Pitfalls of Simulation Modeling

On his website, (www.averill-law.com), simulation consultant Averill Law outlines what he calls 10 Critical Pitfalls to Simulation Modeling. They are: ⁶⁸

1. Failure to have a well-defined set of objectives at the beginning of the simulation study — Make a list of specific questions that the model is to address, Law says, and a list of performance measure to be used for evaluating efficacy.
2. Failure to communicate with the client or decision-maker on a regular basis — This is essential, Law says, to ensuring that the correct problem is solved.
3. Lack of knowledge of simulation methodology and probability and statistics — The simulation analyst, Law says, must not only be trained to use the package, but be knowledgeable in the methodology of validating a model, selecting input probability distributions, etc.
4. Inappropriate level of model detail — Start with a moderately detailed model, Law says, because modeling each aspect of the system will seldom be required to make effective decisions.
5. Failure to collect good system data — Despite time constraints, if working with an existing system, Law says it is important to collect data on key system random variables.
6. The belief that easy-to-use simulation packages require lower levels of technical competence — Even with easy-to-use simulation packages, some level of programming will be required. Also, Law says, the modeler needs technical competence to collect and analyze data and to manage the overall simulation project.
7. Misuse of animation — Animation, Law says, is useful in communicating to the decision-makers, but my not be a reliable measure of whether the model is valid. Rely on statistical procedures.
8. Replacing a probability distribution by its mean — Take care, Law says, not to represent a source of system randomness by the perceived mean value rather than its corresponding probability distribution.
9. Using an inappropriate probability distribution — For the same reasons as above, Law says, it is necessary to model each source of randomness by an appropriate distribution.
10. Failure to perform a proper output-data analysis — Finally, Law recommends that confidence intervals be constructed for important measurements.

In examining the use of simulation modeling in a social context, Nigel Gilbert, professor of sociology at the Centre for Research on Social Simulation at the UK s University of Surrey, hypothesizes that computer simulation is not just a new method to add to the social researcher's armory, but a new way of thinking about society, and especially social processes. His concludes that:

- Simple patterns of repeated individual action can lead to extremely complex social institutions.
- It is impossible, in principle, to predict the outcomes of some social changes.
- Even when there are powerful processes tending to convert a population to a consensus view, minorities may persist.
- Members' misperception and misbelief can be functional for groups and societies.⁶⁹

Although these conclusions seem related only to sociological simulations, it is important to note that every simulation involves artificial reproduction of some level of human involvement, and in that sense, it is critical to remain aware of the possibilities created merely by human impulse.

D. Vendors and Their Tools

According to Bob Diamond, founder of Imagine That, Inc., a good modeling tool is flexible enough to fit a specific project, company or industry. It should also:

- Provide benchmark figures for comparing the status quo to future processes
- Allow you to explore alternative approaches
- Help to determine the best way to use resources
- Show where to eliminate tasks that add no value⁷⁰

Like most software and hardware acquisitions, the user should expect to maintain an ongoing relationship with the vendors. Products will evolve, Swain says, and new versions become available. The vendor can also be a source of support and information about products and services. Vendors often provide clients with newsletters, mass e-mailings to user groups and annual user conferences that can nurture contacts and also provide users with an opportunity to learn from each other.⁷¹

The ARC Advisory Group concluded that the market for process simulation and optimization software and services alone exceeded \$319 million in 1999 and that figure should expand to \$575 million by 2004. These figures apply only to the software and accompanying services market. Simulation is more than that, it involves statistics, market analysis, business consulting, data mining, science and education, to name a few. The availability and continuation of globalization is permitting developers to create more complex and reliable simulations. As the New Economy fuels change and traditional markets and new markets are rising at an overwhelming pace, prudently designed and executed simulation models offer possibilities for significant reduction of uncertainty.

The simulation market has a variety of services and providers. Some companies offer distinct services, while others tend to blend several different areas. These services include:

- Building software applications for simulation purposes
- Using applications to design or represent environments
- Using environments to analyze simulated events
- Offering training on how to use simulation systems
- Offering maintenance and updates of simulated systems
- Offering advice and consulting services based on simulation-based analysis⁷²

In his fifth biennial survey of simulation software for discrete event systems and related products, Swain summarizes product features, as provided by the vendors. Swain does not review the products but presents a sampling of available software and its uses. It includes:⁷³

- **@RISK 4.0** — *by Palisade Corporation*, for new product development and launch, production siting, real options and investment analysis in the markets of finance, investing, pharmaceuticals, insurance, oil and mineral exploration utilities and engineering.
- **AnyLogic 4.0** — *by XJ Technologies* for communication protocols, mobile networks, traffic, control of physical processes, robotics, human and artificial collective behavior in the markets of telecom, networking, control systems, education and military
- **APS Virtual Planning** — *by Frontstep, Inc* for manufacturing plant design, capacity analysis, scheduling, material handling, continuous improvement in the markets of discrete parts manufacturing
- **Arena** — *by Rockwell Software*, for business process simulation, call center simulation, manufacturing simulation, supply chain simulation, logistics and warehousing in the markets of manufacturing, customer service, business process, call center, supply chain and logistics.
- **Aspova** — *by Production Modeling Corporation*, for high-speed production schedulings in the markets of electric/electronic automotive, metal, non-metal, machinery, customer goods, medical, chemical.
- **AutoMod** — *by Brooks Automation, AutoSimulations Division* for simulation and emulation in the markets of manufacturing, material handling, warehousing and distribution, and automotive.
- **Awe Sim** — *by Frontstep, Inc.* for general purpose, logistics, finance, transportation, communications, manufacturing, staffing, healthcare and systems design for the markets of general-purpose simulations and simulation education.
- **C Library** — *by Numerical Algorithms Group (NAG)*, for manufacturing, marketing, scheduling finance and supply chain management in the same markets.
- **CB Predictor** — *by Decisioneering, Inc.* for project-likely revenue figures and cash flows, forecast product or service demand and project future sales in the markets of finance, manufacturing, health care, pharmaceutical and environmental assessment.
- **Crystal Ball 2000 Professional Edit** - *by Decisioneering, Inc.* for business planning and analysis, cost/benefit analysis, risk management, petroleum exploration, portfolio optimization, and project management in the markets of financial services and planning, oil and gas, pharmaceuticals, telecom, manufacturing, energy and utilities.

- **DecisionPro** — by *Vanguard Software Corporation*, for business financial modeling, process optimization, and decision making in the markets of management consulting, oil and gas, manufacturing and legal.
- **DecisionScript** — by *Vanguard Software Corporation*, for Web-based financial planning, online sales assistance, management reporting, and portfolio simulation in the markets of financial services and Web site development.
- **DecisionTools Suite** — by *Palisade Corporation*, for new product development and launch, production siting, real options and investment evaluation in the markets of finance, investing, pharmaceuticals, natural resources exploration, and engineering.
- **emodel** — by *ProModel Corporation*, for bandwidth, delivery process optimization, fulfillment, process improvement, and capacity analysis in the e-commerce market.
- **ExpertFit** — by *Averill M. Law and Associates*, for fitting probability distributions to data for simulation and other applications in the markets of manufacturing, defense, transportation, services, health care, universities and call centers.
- **Extend** — by *Imagine That, Inc.*, for engineering design, operations research, scientific analysis, custom programming, and general purpose continuous model building in the markets of science, engineering, electronics, education, healthcare, environmental studies and defense/aerospace.
- **Extend + BPR** — by *Imagine That, Inc.* for process modeling, activity-based costing, workflow, cycle time, strategic analysis and technology insertion analysis in the markets of business, government, telecommunications, banking, education, healthcare and financial.
- **Extend + Industry** — by *Imagine That, Inc.*, for industrial modeling, throughput analysis, de-bottlenecking, and synchronous flow management in the markets of discrete, batch and continuous manufacturing, materials handling and government/military.
- **Extend + Manufacturing** — by *Imagine That, Inc.*, for industrial and commercial modeling, JIT, queuing, costing, logistics, and throughput analysis in the markets of materials handling, networking, manufacturing, transportation, government/military and service industries.
- **Extend Suite/Industry Suite** — by *Imagine That, Inc.*, for business, industrial and commercial modeling, queuing, manufacturing and costing analysis in the markets of engineering, science, manufacturing, business, government/military, networks, transportation, materials handling and education.
- **Factory Explorer** — by *Wright Williams and Kelly*, for capital equipment and capacity planning in the markets of semiconductors (fab, assembly/test), disk

drives (record heads, media), solar panels and other discrete manufacturing or assembly.

- **Fortran Library** — *by Numerical Algorithms Group (NAG)*, for manufacturing, marketing, scheduling, finance, supply chain and management in the markets of the same.
- **GAUSS** — *by Aptech Systems, Inc.* for all types of numerical analysis in the markets of economics, engineering and finance.
- **GPSS/H** — *by Wolverine Software Corporation*, for material handling/manufacturing, transportation and mining in general purpose markets.
- **GPSS for Windows** — *by Minutemen Software*, for general-purpose simulation in the markets of manufacturing, networks and communications, transportation, healthcare and warehousing.
- **iGrafx Process 2000** — *by Microgrfx, Inc.* to communicate about processes, reduce cycle times and costs, eliminate bottlenecks, understand capacity constraints and redeploy limited resources in the markets of small to large corporations, consulting and integration service provides and government organizations.
- **iGrafx Process for Six Sigma** — *by Micrografx, Inc.* for Six Sigma projects to reduce cycle times and costs, eliminate bottlenecks, reduce defects, understand capacity constraints and optimize critical quality variables in the market of Six Sigma champions, master black belts, black belts and green belts.
- **MAST** — *by CMS Research* for manufacturing operations, factory flow models, cell design, FMS design and operation and automated cells in all machine tool industry and all types of manufacturing.
- **MedModel** — *by ProModel Corporation* for faculty design, capacity analysis, what-if scenarios and scheduling in the healthcare market.
- **micro-GPSS (Web GPSS)** — *by Ingolf Stahl* for general-purpose discrete events simulation in the educational markets of business and engineering.
- **Parallel Library** — *by Numerical Algorithms Group (NAG)* for manufacturing, marketing, scheduling, finance and supply chain management.
- **PASION Simulation System** — *Stanislaw Raczynski*, for general purpose simulation, supporting discrete and continuous simulation, queuing models, bond- and signal-flow graphs, ODE, animation and source code generators in the market of academics, dynamic system design, mass-servicing models queuing and manufacturing.
- **ProModel** — *by ProModel Corporation* for capacity analysis, supply chain, material handling and process improvement in the manufacturing market.
- **Proof Animation** — *Wolverine Software Corporation*, for the material handling/manufacturing, transportation and mining markets.

- **QUEST** — *by DELMIA Corporation* for process flow simulation and analysis, manufacturing, material handling, and discrete material flow analysis in the markets of manufacturing, materials handling, warehousing and distribution.
- **RISKOptimizer** — *by Palisade Corporation*, for new product development and launch, production siting, real options and investment evaluation in the markets of finance, investing, insurance, pharmaceuticals, oil and mineral exploration, utilities, and engineering.
- **ServiceModel** — *by ProModel Corporation* for service organizations, airlines, finance, amusement parks, call centers, capacity analysis, staffing scheduling and optimization of process in the service markets
- **SIGMA** — *by Custom Simulation*, for customized discrete event simulations.
- **Simprocess** - *by CACI Products Company*, for process change, management ERP, customer service, supply chain/transportation logistics, call center, procurement process, and electronic document management (EDM) in the markets of insurance, defense, telecommunications, consulting, finance , transportation and government.
- **Simsript II.5** — *by CACI Products Company* for building large, complex, high-fidelity discrete event simulation models with 2-D graphics and built-in animations in the markets of military theater-level simulations, telecommunications, factory simulations and hospital processes.
- **SIMUL8** — *by Visual8 Corporation*, for capacity planning, plant design, work flow improvement, and business process re-engineering in the markets of manufacturing, steel industry, call centers, healthcare, supply chain, and work flow modeling.
- **SLX** — *by Wolverine Software Corporation* for material handling/manufacturing, transportation and mining.
- **SMP Library** — *by Numerical Algorithms Group (NAG)*, for manufacturing, marketing, scheduling, finance and supply chain management.
- **Stat:Fit** — *by Geer Mountain Software Corporation*, for fitting input data to analytical distributions, automatically fitting continuous and discrete distributions and translating fitted distribution into specific forms for simulation software in the markets of simulation, reliability, quality and finance.
- **Taylor Enterprise Dynamics** — *by F&H Simulation*, for manufacturing, distribution, warehousing, order picking, semiconductor, PABS, mining, data flow, airport logistics and finance in the markets of manufacturing, material handling, semiconductor plants, and airport logistics.
- **Visual Simulation Environment** — *by Orca Computer, Inc.*, for an integrated development and execution environment for discrete-event general-purpose, object-oriented, picture-based, component-based visual modeling and simulations applications for general-purpose discrete-event modeling and simulation markets.

- **Witness** — *by Lanner Group, Inc.*, for simulation discrete event, manufacturing planning, resource utilization, supply chain logistics and facilities layout in the markets of service/manufacturing, automotive, food/drug, consumer, computers and communications.

Although this is by no means an exhaustive list, the above sample offers a clear picture of the products and vendors available and their capabilities in simulating.

E. The Future of Simulation

Yale professor Eugene Shapiro will present *The Evolution of Computing Technology and the Art of Simulation* at the Eurosim Congress in June in the Netherlands. He states that effective simulation of a complex structure is in many respects analogous to the creation of a large, multi-dimensional tapestry wherein there are many intertwined threads. The threads of future development in simulation have shifted, he says, away from perfecting the nuts and bolts to an artistic level. Those threads of the future include:

- Downward scaling of silicon-based MOS transistor devices
- The challenge of culture integration
- The emergence of philosophic differences in methodology
- Asking *what is reality?* in terms of the creation and use of devices in virtual reality
- Looking at the possibility of life after silicon.⁷⁴

Simulation allows the analysis of a system's capabilities, capacities, and behaviors without requiring the construction of or experimentation with the real system. Since it is extremely expensive to experiment with an entire factory to determine its best configuration, a simulation of the factory can be extremely valuable. There are also systems, like nuclear reactions and warfare, which are too dangerous to carry out for the sake of analysis, but which can be usefully analyzed through simulation.

Appendix E

Simulation Organizations

(Note: All underlined text is hyperlinked via Microsoft Word.)

Academic

- **Arizona Center for Integrative Modeling & Simulation** (College of Engineering & Mines/University of Arizona)
- **Australian Society for Operations Research**
- Modeling and Simulation at the **Applied Physics Laboratory** (The Johns Hopkins University)
- **The Bond Graph Compendium** (Cellier/University of Arizona)
- Bulgarian Academy of Sciences
 - **Institute of Control and System Research (ICSR)**
- **Distributed Simulation: Concepts and Applications** {**Barry A. Sohl**/California State University at Long Beach}
- **Distributed Simulation Systems (DSS)** {at Georgia Tech}
- **Economy Simulation Forum**
- **GMD/FIRST Institute for Computer Architecture and Software Technology**
- **Systems Analysis and Simulation Department**
- **Institute for Simulation and Graphics (ISG)** University of Magdeburg / Germany
- **Institute of Simulation and Training (IST)** - University of Central Florida
 - **Modeling, Simulation, & Training Service Center**
- **McLeod Institute of Simulation Sciences (MISS)** (established by the Society for Computer Simulation at California State University — Chico)
 - **MISS Center at the Universidad Panamericana (UP) in Mexico City**
- **Modeling and Simulation of Ethnic and Social Processes** (Omsk State University/Russia)
- Mississippi State University
 - **Simulation and Advanced Computation Laboratory**

- Naval Postgraduate School (NPS)
 - [**MOVES - Modeling, Virtual Environments, and Simulation Academic Group**](#)
- [**Operations Research and System Theory**](#) (University of Passau, Germany)
- [**Project for Simulation of Social Behaviour**](#)
- RMIT University, Melbourne Australia
 - [**Master of Engineering in Simulation Technology**](#)
- Scalable Software Library Technology Initiative (sponsored by DARPA/ITO)
 - [**Scalable Parallel Random Number Generators Library for Parallel Monte Carlo Computations**](#)_(University of Illinois)
- Universidad de Buenos Aires, Argentina
 - [**Cell-Based Discrete Event Simulation**](#)
 - [**related courses**](#)
- University of Central Florida
 - [**Institute for Simulation and Training \(IST\)**](#)
 - [**Training and Simulation Technology Consortium \(TSTC\)**](#)

Corporate

- [**AAI Corporation's Simulation Systems HomePage**](#)
- [**MCC International**](#)
- [**MITRE**](#)
 - [**Information Systems and Technology Division**](#)
 - [**Web-Based Simulation Support Homepage**](#)
 - Modeling and Simulation Technical Center
 - [**Aggregate Level Simulation Protocol Project \(ALSP\) Center**](#)
 - [**ALSP Homepage**](#)
- [**MITRETEK**](#)
- [**Motion Plc.**](#) (high-fidelity full motion simulation)
- [**OPNETWORK Conferences**](#)_(OPNET user group annual meeting)
- [**SimCentral**](#) - The Modeling and Simulation Information Network, a fee-based website by ISTI

- [TOMASWEB](#) - Tools for Object-oriented Modeling And Simulation [free process-approach software]
- [WITNESS Simulation User Association \(WSUA\)](#)

Governmental

- [Defense Modeling, Simulation, Tactical Technology Information Analysis Center](#) (DMSTTIAC)
- [Defense Modeling and Simulation Office](#) (DMSO)
 - [DoD Modeling and Simulation Education Project](#)
 - [Modeling and Simulation Information Analysis Center](#) (MSIAC)
- [HLA HomePage](#) (DoD High Level Architecture)
- [JMASS](#) Simulation Support Environment
- [Joint Advanced Distributed Simulation Joint Test Force](#)
- [JSIMS](#) (Joint Simulation System)
 - [ASST](#) - Advanced Simulation Technology Thrust
- [Modeling and Simulation Information Analysis Center](#) (MSIAC)
- [NASA](#) (National Aeronautics and Space Administration, USA)
 - [NASA Langley Research Center - Systems Development Branch](#)
 - [Flight Simulation Facilities](#) (most extensive simulator research facilities are in the U.S.)
 - [NASA Lewis Research Center - Flight Simulation](#)
 - [NASA Software Independent Verification & Validation \(IVV\) Facility](#)
- [Terrain Modeling Project Office \(TMPO\)](#)
- [U.S. Air Force Agency for Modeling and Simulation](#) (AFAMS)
 - [Air Force Modeling and Simulation Resource Repository](#) (AFMSRR)
 - [Institute for Simulation and Training \(IST\)](#)
 - [U.S. Air Force Modeling and Simulation Education and Training](#) (AFMSET)
- U.S. Army Simulation Training & Instrumentation Command - [STRICOM](#)
 - [Warfighter's Simulation](#)
- [U.S. Army Armament Research Development & Engineering Center \(ARDEC\) - Distributed Interactive Simulation](#)
- U.S. Army

- [Institute for Creative Technologies \(ICT\)](#)
- [U.S. Army Modeling and Simulation Office \(AMSO\)](#)
 - [Army Model & Simulation Resource Repository \(MSRR\)](#)
 - Simulation and Modeling for Acquisition, Requirements and Training (SMART)
- [U.S. Army National Simulation Center](#) (Fort Leavenworth, Kansas)
- U.S. Army Tank-Automotive and Armaments Command (TACOM)
 - [Tank/Automotive Research, Development and Engineering Center \(TARDEC\)](#)
 - [Simulation Throughout the Life Cycle \(SimTLC\)](#)
- U.S. Marine Corps Program Office
 - Joint Simulation System Joint Program Office
- U.S. Naval Air Warfare Center
 - [Training Systems Division](#)
- [Virginia Modeling, Analysis, and Simulation Center](#) (VMASC)

Professional

- [American Statistical Association](#)
- [ACM](#)
 - [Crossroads](#) (The ACM Student Magazine)
 - [ACM SIGAPP](#) (Special Interest Group on Applied Computing)
 - [ACM SIGCHI](#) (Special Interest Group on Computer-Human Interaction)
 - [ACM Transactions on Computer-Human Interaction](#)
 - [ACM SIG3C](#) (Special Interest Group on Computing in Community Colleges)
 - [ACM SIGCSE](#) (Special Interest Group on Computer Science Education)
 - [ACM SIGCSE sponsored Conferences](#)
 - [ACM SIGCUE](#) (Special Interest Group on Computer Uses in Education)
 - [ACM SIGCUE sponsored Conferences](#)
 - [ACM SIGGRAPH](#) (Special Interest Group on Computer Graphics)
 - [ACM SIGSIM](#) (ACM Special Interest Group on Simulation)
 - [Call-for-Papers List](#)
 - [Interactive Related Simulation Links](#)
 - [List Of All Simulation-Related Conferences !](#)
 - [Simulation Digest](#) {Newsletter}
 - [SIGSIM's Online Catalog](#) (books, proceedings, videos)
 - [SIGSIM's Newsletters and Publications](#)

- [ACM TOMACS](#) (*Transactions on Modeling and Computer Simulation*)
- [ASEE](#) (American Society for Engineering Education)
 - [Computers in Education Journal](#)
 - [Journal of Engineering Education](#)
 - [PRISM Magazine](#)
- [Association of Business Simulation and Experiential Learning](#) (ABSEL)
- [Centre for Research on Simulation in the Social Sciences \(CRESS\)](#)
- [Chinese Association for System Simulation \(CASS\)](#)
- Computing in Science and Engineering
 - [Computer Simulation Columns](#) (*on a periodic basis*)
- [Computer Simulation: Modeling and Analysis \(CSMA\)](#) An International Electronic Journal
- [Discrete Event Dynamic Systems: Theory and Applications](#) (Journal)
- [Dutch Benelux Simulation Society \(DBSS\)](#)
- [Environmental Modelling and Software Journal](#)
- [EuroSim](#) (the Federation of European Simulation Societies)
 - [SNE - Simulation News Europe](#)
 - [SIMPRA](#) - the scientific journal of EUROSIM
 - [ARGE SIM](#) - a nonprofit working group providing the infra structure for the administration of EUROSIM and other activities in the area of modeling and simulation
 - [Dutch Benelux Simulation Society \(DBSS\)](#)
 - [Italian Society for Computer Simulation \(ISCS\)](#)
 - [United Kingdom Simulation Society](#) (UKSIM)
- [Federation of European Simulation Societies](#) (see also EuroSim)
- [The Historical Simulation Boardgamers Society of Japan](#) (HisSim Japan)
- [INFORMS](#) (Institute for Operations Research and Management Science)
 - [INFORMS Forum on Education](#) (INFORMED)
 - [INFORMS College on Simulation](#) (INFORMS/CS)
 - [Military Operations Research Society](#) (MORS)
 - [SIMVAL'99](#) (Simulation Validation Workshop)
 - [ORMS Today](#)

- [IEEE](#)
 - [IEEE Computer Graphics and Applications Magazine](#) (CGA)
 - [IEEE Education Society](#) (EDSOC)
 - [Frontiers in Education \(FIE\) Conference Clearinghouse](#)
 - [IEEE Transactions on Education](#)
 - [IEEE Potentials](#) (IEEE Student Magazine)
 - [IEEE Systems, Man, and Cybernetics Society](#) (SMC)
 - [International Conference on Systems, Man, and Cybernetics](#)
 - [IEEE Transactions on Systems, Man, and Cybernetics](#)
 - [IEEE TCSIM](#) (Technical Committee on Simulation)
 - [IEEE Transactions on Parallel and Distributed Systems](#) (TPDS)
 - [IEEE Transactions on Visualization and Computer Graphics](#) (TVCG)
 - [IEEE Working Group on Hybrid Dynamic Systems](#)
- [Institute of Industrial Engineers](#) (IIE)
 - [IIE Book Catalog](#)
 - [IIE Solutions Magazine](#)
 - [IIE/Systems Modeling Student Simulation Competition](#)
 - [IIE Transactions](#)
- [IMACS](#) - Institute for Mathematics And Computers in Simulation or The International Association for Mathematics and Computers in Simulation
 - [IMACS Events](#)
 - [Mathematics and Computers in Simulation Journal](#)
- [International Conference on Health Sciences Simulation](#)
- [International Marine Simulator Forum \(IMSF\)](#)
- [International Journal of Computer Research](#)
- International Journal in Computer Simulation - ceased publication in 1997
 - [Volume 1](#)
 - [Volume 2](#)
 - [Volume 3](#)
 - [Volume 4](#)
 - [Volume 6](#)
- [International Simulation and Gaming Association](#) (ISGA)
 - [Australian Simulation and Games Association](#) (OzSGA)
 - [Japan Association of Simulation and Gaming](#) (JASAG)
 - [North American Simulation and Gaming](#) (NASAGA)
 - [Societa Italiana dei Giochi di Simulazione](#) (SIGIS)
 - [ISAGA Conferences](#)
 - [ISAGA Conference Proceedings](#)

- [International Society for Technology in Education \(ISTE\)](#)
 - [ISTE Book Catalog](#)
 - [ISTE Update](#)
 - [Journal of Research on Computing in Education](#)
 - [Learning and Leading & Technology](#)
- [Italian Society for Computer Simulation \(ISCS\)](#)
- [Japan Society for Simulation Technology \(JSST\)](#)
- [Journal of Artificial Societies and Social Simulation \(JASSS\)](#)
- [Journal of Systems Analysis Modelling Simulation](#) (Gordon and Breach Science Publishers)
- [Mathematics and Computers in Simulation](#) (Transactions of the International Association for Mathematics and Computers in Simulation [IMACS])
- [Modelica Design & Users Group](#)
- [Modeling and Simulation Society of Australia Inc. \(MSSA\)](#)
- [The National Association of Space Simulating Educators \(NASSE\)](#)
- [National Center for Simulation \(NCS\)](#) Orlando, Florida USA
 - [member organizations](#)
- [National Education Computing Conference \(NECC\)](#)
- [National Training Systems Association \(NTSA\)](#)
- [NovaSim LLC](#) (general simulation and SIMUL8[®] certified training)
- [Object Management Group \(OMG\)](#)
 - Special Interest Group on Distributed Simulation
- [Operations Research Society](#)
- [The Polish Society for Computer Simulation](#)
- [SimResource](#): Global Resource for Simulations
- [simsoc](#) (mailing list to discuss computer simulation in the social sciences)

- [*Simulation & Gaming: An International Journal of Theory, Practice, and Research*](#) {Journal from Sage Publishers
 - [Simulation/Gaming Exchange \(SGX\)](#)
 - [International Simulation and Gaming Association \(ISGA\)](#)
- [Simulation in Europe](#) (ESPRIT Basic Research Working Group)
- [Simulation Industry Association of Australia \(SIAA\)](#)
- [Simulation Practice and Theory](#) (SIMPRA)
- [Simulation Interoperability Standards Organization \(SISO\)](#)
- [Simulation Stream HomePage](#) (Operations Research Society/Brunel University)
- [Simulation Study Group](#) (Operations Research Society/Brunel University)
- [Society for Computer Simulation \(SCS\) - International](#) the international, multidisciplinary forum dedicated to research, development and applications of simulation
 - [*SIMULATION*](#) - The Journal of The Society for Computer Simulation
 - [*TRANSACTIONS*](#) of the Society for Computer Simulation (SCS)
 - [SCS Publications Catalogue](#)
 - [McLeod Institute of Simulation Sciences \(MISS\)](#) (established by the Society for Computer Simulation at California State University - Chico)
 - [Society for Computer Simulation International - European Council](#)
 - [Liophant Simulation Club](#) {Chapter of SCS-International-Europe}
- [SPIE](#) -The International Society for Optical Engineering (sponsors several conferences a year which include simulation)
- [System Dynamics Society](#)
 - [The Systems Dynamic Review](#)
- [UK Simulation Society](#)
- [UK Simulation Interoperability Working Group \(SIWG\)](#)
- [VIS-SIM.ORG Visual Simulation Portal](#)
- [Winter Simulation Conference](#) (annual event in December)

Others

- [SSFNET.org](#) - Scalable Simulation Framework: a clearinghouse for information about the latest tools for scalable high-performance network modeling,

simulation, and analysis

- [Michigan Simulation Users Group \(MSUG\)](#)
 - [Simulation Product Show Down](#)

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