Workforce Development: Creating and Implementing CD-based Simulations

Elizabeth A. Mathias
SCANS 2000 NSF Project
Johns Hopkins University

Randall Poe
President,
Vision Place.com LLC

Abstract

Johns Hopkins University's, SCANS 2000 researchers set out to change how students learn in ways that would make classrooms seem more like work settings where learning must be applied. Faculty teams, advisors from major employers, and a multimedia production company helped researchers convert representative real world problems faced by employees into case studies on interactive CDs. This article describes the process of technology-based development and how students benefit.

BACKGROUND: THE SCANS PROJECT

In, 1991, the Secretary of Labor and the Secretary's Commission on Achieving Necessary Skills (SCANS) announced completion of an initial examination of changes in the world of work and the implications of these changes for learning. In preparing the report, the Commission spent 12 months talking to business owners, employees, people who manage employees, and union officials. The message was the same across the country and in every kind of job: good jobs depend on people who could put knowledge to work. New workers must be creative and responsible problem solvers and have skills and knowledge on which employees can build. The Commission was dismayed to report that more than half of young people leave school without the knowledge or foundation required to find and hold a good job. This they attributed to the fact that globalization of commerce and industry and the explosive growth of technology use have barely been reflected in school curricula that should prepare people for work.

The Commission verified workplace know-how as having two elements: competencies and a foundation (see sidebar). Drawing on cognitive science, the commission recommended that the most effective way of learning the competencies is "in context"; that is, placing learning objectives within a real environment rather than insisting that students first learn in the abstract what they will be expect to apply. The Commission further recommended that the competencies and foundation skills be taught in an integrated fashion to reflect the workplace contexts in which they are applied.

The National Science Foundation Advanced Technological Education program helped fund a research project at the Johns Hopkins University's SCANS/2000 Program Center whose goal was to improve the education of community college technician students. We proposed to create curricular tools for teachers to use in their mathematics, science, engineering, technology, and communication courses that would help their students master the SCANS skills. These curriculum tools took the form of case studies representative of real world work problems delivered through technology on CDs. The case study approach encouraged the integration of knowledge that students would need to solve the problems and the collaborative work suggested by the Commission finding that working in teams was a very important competency. [1]

Faculty teams at five community colleges assisted the Johns Hopkins research team in designing and testing the SCANS-based CD learning modules. Those colleges were: Hagerstown (Maryland), South Seattle (Washington), and Northern Essex Community Colleges (Massachusetts), the New Hampshire Technical Education System, and Modesto Junior College (California). The pilot colleges and others implemented the modules in more than 19 different courses in college classrooms nationally. We estimate that the modules have been used at more than 40 colleges.

Workplace Know-How

The know-how identified by SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. These include:

Competencies—effective workers can productively use:

- Resources—allocating time, money, materials, space, and staff;
- Interpersonal Skills—working on teams, teaching others, serving customers, leading, negotiating and working well with people from culturally diverse backgrounds;
- Information—acquiring and evaluating date, organizing and maintaining files, interpreting and communicating, and using computers to process information.
- Systems—understanding social, organizational, and technological systems, monitoring and correcting performance, and designing or improving systems;
- Technology—selecting equipment and tools, applying technology to specific tasks, and maintaining and troubleshooting technologies.

The Foundation—competence requires:

- Basic Skills—reading, writing, arithmetic and mathematics, speaking, and listening;
- Thinking Skills—thinking creatively, making decision, solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning;
- Personal Qualities—individual responsibility, self-esteem, sociability, self-management, and integrity.

Screen I

MOTIVATION

The case study approach

The designed scenarios were based on real world work problems faced by employees. The case studies were selected and designed with the assistance of advisors from industry, and as much as possible they include elements of actual case studies

In a typical SCANS simulated case study, students are given a task or a problem to solve. They are also provided with various background information and data relevant to the problem, along with some reference material all of which is included on the CD. Students are expected to research the problem using the material provided and any other research avenues that are appropriate, including use of the worldwide web. They propose a solution to the problem and defend it in a presentation to their class.

Electronic case studies

Although the problem statement and materials described above could be provided in paper form, we decided that the SCANS objectives were best served by using electronic media (CD) as the presentation tool. We use the medium to actually simulate a work environment rather than provide the student with a static text description of the problem. A well-designed electronic case study should be more than simply a textbook with graphics and sound. The CD allows us to add a number of new dimensions to the case study:

Simulate Reality: By using graphics, audio and information gathering metaphors (see Design) to make the simulation as realistic as possible, the student doesn't just read a description of the workplace, but actually experiences it.

Employers want employees who have job experience, but it is difficult for students to gain useful experience during the college years. A well-designed simulation actually gives the students experience.

Assessment Capability: In order for the simulated work experience to have credence with employers, it is critically important that specific job performance be documentable. The SCANS competencies provide a set of standards by which job performance can be measured. SCANS/2000 assessment instruments, developed and tested with faculty and students, are now incorporated into the electronic curricula.

Tamper-proof Curricula: The CD technology offers a tamper proof venue for curriculum presentation. The essential content of the exercises remains consistent in all classrooms, while leaving the faculty free to use their own creativity and skills in implementation.

Student-driven: The navigation of the CD is designed so that not only the pace, but also the order of presentation of the material is left to the student. This forces the student to use much more initiative and thought in problem solving, than in a paper-based setting where they know everything they need is within a few printed pages.

Information Resources: The storage capacity of a CD makes it convenient to include large amounts of information. This lets us include useful reference material to supplement the problem. The CD uses a "bookshelf" metaphor to include text-heavy materials. Interactive tutorials are used to provide just-in-time learning for topics specific to the case study problem. For instance, one module, designed for use in a physics classroom, teaches the student basic meteorology. This is material that would not ordinarily be included in a physics curriculum, but might very well be required for a new employee to learn on the job.

DESIGN

Having decided the design goals to be accomplished in our electronic case studies, the next problem was how to design the CD to actually realize these goals.

The most important element of the design philosophy was that the problems should be "real". This does not mean that we used three-dimensional virtual reality to make locations appear realistic. On the contrary, media were deliberately low-cost (e.g., still images, limited use of video, and use of available voices instead of professional actors) so that resources could be spent on other aspects of the production: the problem design and the "metaphors".

We were very careful to make the problems as authentic as possible. One aspect of problems encountered in life, as opposed to those in a textbook, is that there is not necessarily a single "right" answer. We also made a decision to leave the order of events in the hands of students as much as possible. Multimedia presentations can be thought of as divided into a series of screens, organized hierarchically, along with some mechanism for moving or navigating from screen to screen. In a strictly linear presentation,

Screen II

the screens are presented in a prescribed order. Most computer based training (CBT) applications take this approach, organizing screens into an outline and giving the user some means for stepping through the outline and for viewing one's progress as one completes lessons.

In our workplace simulations, we replace the "screen" with the metaphor of "offices." At the top level of the hierarchy are sets of rooms representing offices in the virtual company. One of these offices belongs to the student, who is given the role of a junior employee at the company. The lesson outline is replaced with a metaphor of a floor plan. Unlike classic CBT, there is no implied order in this metaphor. The student is free to explore offices in any order they choose.

Physical metaphors are similarly used throughout the modules. Information within the rooms is contained within objects within the room. With few exceptions, the student is again free to explore these objects. Depending on the nature of the information, it could be given in the form of audio spoken by a character, papers in a file cabinet or on a bulletin board, reference books on a bookshelf, a program on a "computer" within the virtual office, or any other metaphor that makes sense within the environment. Changes in the cursor indicate that an object contains useful information and should be examined.

IMPLEMENTATION

After the first SCANS modules were completed, they were tested in pilot classrooms. Feedback received after the initial experience led to some changes in design. One change involved the free exploration concept described in the previous section. Some students, particularly traditional community college students who had recently graduated high school and never held a full-time job, had difficulty with the amount of independence offered. These students felt lost without some sort of explicit guidance.

We added two new metaphors to the CDs to address this problem. One was a checklist, in the form of a "To-do" list, which could be pulled up at any time to obtain a list of tasks. The To-do list could also be used to automatically check off tasks as the student completed them. However, consulting the list is completely optional, and it is kept for reference information only. The student's freedom to explore rooms in any order was still retained.

The other metaphor we added to provide some guidance was the introduction of a "mentor" character. This character can be used in many ways to provide suggestions anywhere the content might require additional direction.

Other changes involved the timing and duration of the SCANS material. The SCANS modules were integrated into courses commonly taken as part of a technology curriculum. Originally, we planned on concentrating the case study module into nine hours of class time over two or three weeks. Some faculty found that the CD modules worked best spread across most of their course and offered in smaller increments per week. This approach gave students the time they needed to work together to research and solve the problems and to put together their report and presentations. Faculty continue to experiment with integration of the modules. Some designed new courses around them.

RESULTS

The electronic case studies proved to be an exciting education experience for both students and faculty. At first students thought it was just a game (indeed, role-playing games were studied as models for the interactive design); but they soon realized that serious information was presented in a new way. The more they worked on the module and the longer they talked with their peers about the problem, the more most students became engaged. A physics professor at Northern Essex Community College tells of being hailed in the cafeteria and while walking across campus. It seemed that wherever his students were, they were talking about their problem. He claims students even worked during their Holiday.

Sustained activity seemed to encourage creative problem solving. We observed students inventing tools to demonstrate their problem solutions, finding solutions not previously considered by the faculty creators, and becoming involved doing in-depth research in areas far removed from the discipline base.

Faculty using this technology found they needed to teach differently. They became learning facilitators, a change that was a difficult transition for many. Some faculty accustomed to classroom control and content delivery rejected using the CD modules. Others found ways to deal with change. One faculty member said: "As a teacher, I needed to become comfortable saying 'I don't know' when asked a question." Another faculty member helped students deal with ambiguity by taking part in the role-play, answering questions in the role of various characters portrayed on the CD. Another teacher simply told the students to make assumptions and work from those.

Indeed, we learned that the ambiguity was useful as a teaching and learning tool. Faculty required students to make assumptions and defend decisions thereby challenging them to research and solve problems. Then too, students reported increased subject mastery when they were required to defend decisions and persuade others. These processes forced students to clarify their thinking and hone their presentation skills.

An external evaluator from the American Institute for Research described as "impressive that students have demonstrated relatively high levels of SCANS competencies…following implementation of the present exercises." He reported that the CD case study provides the opportunity for students to manifest high levels of skill attainment, and for instructors to focus on, observe and document those skills. His survey analysis revealed that students pointed to gains in critical thinking and decision making, evaluating different courses of action within a larger context, working in teams, learning to gather and analyze information, and giving presentations to describe their findings and defend their decisions. Over 82% of the participating students reported that the module taught concepts or skills that they would not otherwise have learned in the class.[2]

We found faculty could say more about what students learned when they observed the students' behaviors when solving the problems. Typically, the course grade has the most meaning to the academic establishment. Now, faculty can attest to the mastery of many new skills or skills not normally learned in their class. Teachers told us of students who were not necessarily academic stars, assuming team leadership roles and excelling in the business settings presented by the CDs.

Because solving case study problems on CD is active learning, students are more likely to remember the lessons. CDs create such complex, yet believable; scenarios that we believe students will remember what they learned in virtual environments long after the course completion. In fact, another SCANS research project (Baltimore Learning Community Technology Challenge Project) using similarly designed interactive CD modules with Baltimore high school students found long lasting effects over three years. Eighty-seven percent (87%) of students in that study continued their mathematics studies to take and pass Algebra II, while only 12 non-program students, half of the comparison group, took and passed this higher level mathematics. Results were similar for English I, II, and III. All program students and all but one non-program student passed English I. All the students passed English II. However, while all but one program student passed English III, only 9 non-program students (38%) passed English III. Table I and II at right, taken from the external evaluator's Final Evaluation Report[3] illustrate the impact on Grade Point Average and Student Attendance.

The CD's provided realistic experiences that allowed students to function in teams with structured roles and assignments. This peer contact had many benefits such as increased motivation, interest, and even, we believe, lower course attrition and increased program retention. Hagerstown Community College (HCC)

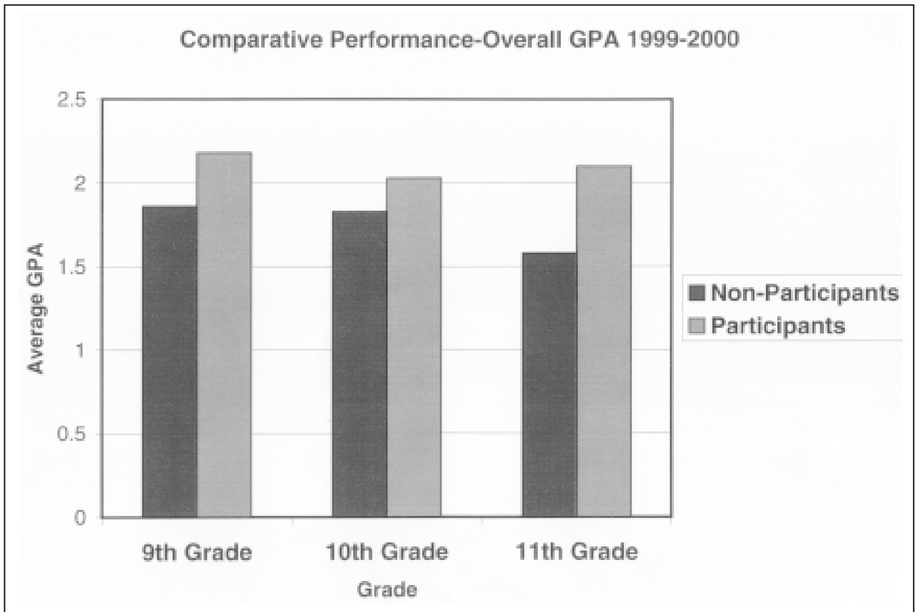


Table I

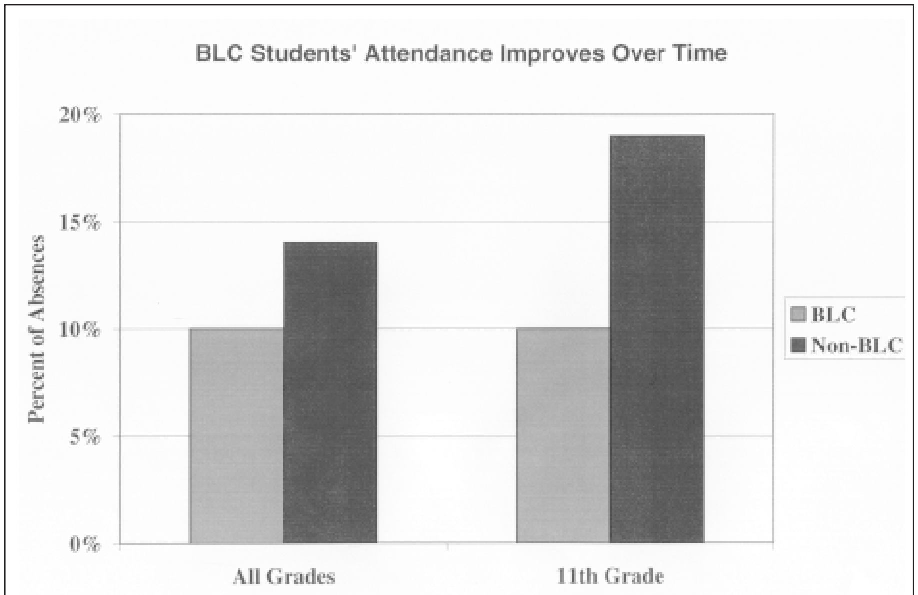


Table II

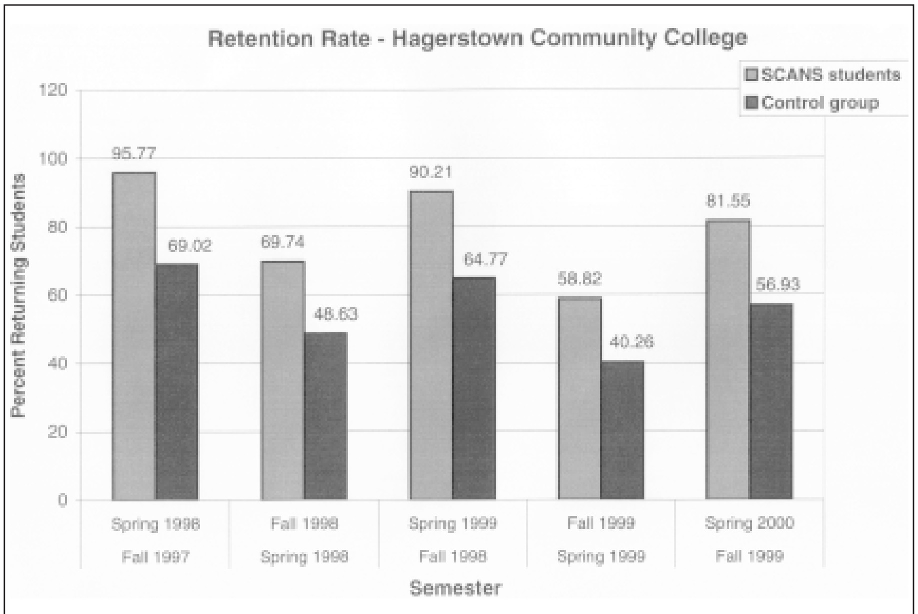


Table III

found students who took courses where the CDs were used tended to stay in college and advance toward program completion. HCC compared the academic retention rate of 251 students who used the CD learning modules with 1221 students who did not and found, on average, a 42% higher retention rate. Table III on the next page presents the data in graphical format (Mathias [4])

Anecdotally, community college teachers experienced in integrating the CD simulations into their coursework reported the following at a March 2001 meeting at Johns Hopkins University:

❑ Module use proved so successful in enhancing critical thinking skills that an entire course was re-structured to place the CD experience as its centerpiece (Charles Padron, Nashville Technical Institute).

❑ Students who used the *Building a Problem Solving Team* module were so proficient in team problem solving that other students who had not used the CD asked for the experience (Casey Chaney, Ivy Technical College in Terre Haute).

❑ Faculty members observing the reactions of students using the CD modules requested training to prepare to use the CDs in their classrooms (Bill Morton, Southern Maryland Community College).

❑ A student aid assisting an instructor by coaching students in a course using a CD changed her academic major and aspires to become a teacher herself (Cheyanne Lewis, Hagerstown Community College).

DISCUSSION

The utility of the simulated case studies for academic learning can be seen in the assessment results cited above. Researchers found that process skills practiced through the CD module experience were not documented in any formal way by academic institutions. Yet, these skills were identified by the SCANS Commission as being those necessary for workers to succeed in high paying jobs. Consequently, we are currently developing an electronic Career Transcript, a brief and academically verified version of a resume to record student achievements.

SCANS researchers estimate a June 2001 completion of the electronic Career Transcript as part of a nationwide data base that can be made accessible to employers. By using a standardized, electronically based curriculum, and a set of standardized assessment tools, competencies can be assessed in the SCANS-based classroom in the same way as in the workplace. Thus, the high-demand skills that the student demonstrates in these modules: decision making, problem solving, working in teams etc. can be incorporated in the student's resume exactly as if they had learned the skills through actual job experience. Experienced faculty will validate the Career Transcript entries making them comparable to the academic transcript.

Although the current study deals with simulated case studies, we found all the principles described above apply as well to actual case studies. Implementing as simulated work-environments tremendously increases the teaching value of case studies. We are encouraged by data that appears to indicate substantial benefits to learners on a number of parameters important to academic institutions.

END NOTES

Appendix: Anatomy of a CD Production

Multimedia presentations such as the CD courses described here are a blend of media (graphics, animations, video, and audio) and programming, industries with very different approaches to production. A successful multimedia production needs to borrow techniques from both industries.

The first step is "Pre-production." Pre-production involves all of the design work, including writing of scripts and development of content. During this design phase, content experts are working with writers, instructional designers, and representatives from the programming and media development teams. Together they decide how to capture the desired content, what the learning goals are and how to achieve them, and develop the overall story line. This first phase might end in a *design document*, which summarizes all the major design philosophies.

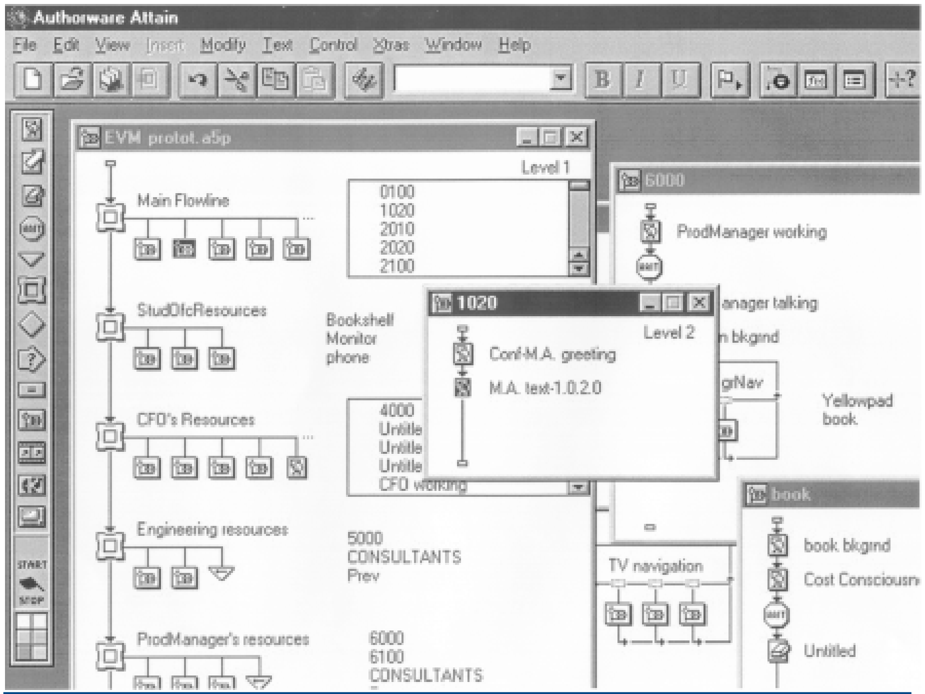
The overall design is then refined, making decisions on characters and their roles, content of tutorials and quizzes, decisions on how user input is tracked and reported, and what metaphors to use. The relationship between screens also needs to be decided, and how the user gets from screen to screen. Dialog is written for the characters, including dialog in reaction to various events or user choices. This next stage of design usually results in a *script* (which documents not only audio but the relations between screens and the interaction available on each screen). It is also convenient to produce a *storyboard*, which illustrates the screens along with the script.

In traditional media, the storyboard is a very detailed document capturing final decisions on practically all aspects of production, including separate camera angles of the same action. In multimedia the design is a much more flexible thing, and the storyboard is less detailed. Instead, we use the storyboard to develop a *rapid prototype*, which then goes through an initial period of user testing.

Well-designed software should be intuitive, and it is only through pilot testing with users that one can see where their intuition leads them. It is a truism in the software industry that users will never use a product in the manner in which it was anticipated, which is why it is so important to observe the product actually being used.

After "Prototype Testing," the product will go through a period of redesign. Interactions that were difficult or unclear can be modified; content can be added where users expressed the need for additional instruction, etc. The result of this redesign phase is a *final script*, which is the guide for the Production phase. This is the most expensive part of the process, involving the largest part of the team, typically working for several months. In this stage, the final graphics are being drawn or animated, audio and video are recorded, digitized and the flow of the piece programmed. (We used Macromedia Authorware™ for the programming).

Finally, as in software development, the nearly finished piece enters a period of "User Acceptance" testing. In this phase, which involves a much larger set of users than the "Prototype Testing," the piece is extensively tested in as many different configurations as possible to uncover possible bugs or errors in design. Small changes might be made in programming and media to address issues that are uncovered, but typically it is not feasible to make major changes at this late stage. Finally, the design is stabilized and the *product* is released.



Screen III

Dr. Elizabeth Mathias is co-Principal Investigator for a National Science Foundation project awarded to the SCANS Center, Johns Hopkins University. She worked with Arnold Packer, Senior Fellow at JHU, his staff, and faculty members from many community colleges to develop and classroom-test the case studies. She is Professor Emerita from Anne Arundel Community College in Arnold, Maryland were she served as a faculty member, Division Chair and Dean of Career and Technical Education. She recently presented the CDs at the International Conference on Life-long Learning in Beijing, China.

not available

Mr. Poe is a software engineer and computer programmer who worked at the Johns Hopkins Physic Laboratory. He was instrumental in the module programming and also helped to develop curricula and resources available on the CD particularly in the area of project management. He worked with SWEP to professionalize the CD versions now available for classroom use.

REFERENCES

1 *What Work Requires of Schools: A SCANS Report for America 2000* (1991). Secretary's Commission on Achieving Necessary Skills. Department of Labor. Pgs. V-IX.

2 Gold, Norm. *Associate Degree in Manufacturing Technology: Three-Year Report* (1998) (Unpublished report to the National Science Foundation). American Institute for Research. Pgs. 2-6.

3 Gold, Norm *The Technology Literacy Challenge The Baltimore Initiative: Integrating School and Work on the Information Highway* (Report to the United States Department of Education). American Institute for Research. 2001.

4 Mathias, Elizabeth. Retention/Graduation study Hagerstown Community College (Unpublished study). July 2000.

Partial support for this work was provided by the National Science Foundation; Advanced Technological Education Program through DUE grant #9850249.

Note: Seven SCANS Virtual Workplace Simulations are now in publication by South Western Educational Publishing. Comprehensive User Manuals and Facilitator Guides accompany the CDs to provide meaningful exercises for learners and suggestions to instructors for maximizing the CD experience. Visit WWW.scans2000.swep.com to learn more and see examples of the content.