SBC TOWN: COST-EFFICIENT TRAINING IN A VIRTUAL URBAN ENVIRONMENT

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ABSTRACT

This paper focuses on the development of a virtual reality-based training application that strongly suggests virtual reality is a viable mechanism for cost-efficiently delivering technical training. The focus is on the development of SBC Town, a virtual city that EDS built for Southwestern Bell, and argue that its strengths are readily transferable to a broad array of other virtual-reality based training applications. We specifically argue that VR provides a robust learning experience that simultaneously delivers multiple layers of instruction, from subject-matter content to related subjects, such as logic and problem-solving. The application creates a city and its telecommunications infrastructure and is designed to teach service technicians how to locate problems, or faults, in telecommunications circuits. Students use a mouse to drive through the city, climb poles, splice cable, open crossboxes, descend into manholes, and use virtual tools to zero in on circuit glitches. The system allows users to focus exclusively on learning to find circuit problems. Southwestern Bell is spared the cost of sending technicians to remote training facilities, and technicians can continue their daily responsibilities while refining their fault-locating skills. The SBC application models the way its target systems and environments behave in the real world. It reproduces in virtual space the actual behavior of urban communications circuits. Unlike many virtual environments, SBC Town isn't a place for users to passively examine things. They act on circuits, which, in turn, respond. This interactivity ensures a constant and realistic dynamism between student and virtual world. The SBC Town application's uniqueness lies in the complexity of its elements, their interactions, and the faithfulness with which those elements' virtual behaviors reproduce a realistic version of the real thing in a virtual space.

ABOUT THE AUTHOR

Jill Scheppler is an advanced systems engineer at EDS and is a member of the virtual reality team which was responsible for creating the SBC Town training application for the SBC Center for Learning. Jill has been with EDS over twelve years, developing and supporting manufacturing and insurance applications, delivering lecture-style instruction in the C and C++ programming languages, providing human factors expertise, and now, helping EDS develop and deploy virtual reality technology. She holds a B.S. in psychology from Iowa State University, an M.S. in psychology and a Ph.D. in psychology from the University of Florida.

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INTRODUCTION

Virtual reality (VR) is the experience of multisensory artificial environments that retain enough features of the real world to be perceived as "reality." An environment is considered virtual if it is modeled in three-dimensional (3D) space, and if it offers real-time interactivity. VR's interactivity, in particular, makes it suitable technology for a variety of business applications. A virtual world behaves realistically, affording the freedom to test scenarios and try things that otherwise could not or would not, be feasible.

For example, in a VR data visualization application, budget numbers can be manipulated and the results displayed and experienced within a 3D balance sheet. In a VR architectural design application, different materials can be substituted, then viewed in a variety of lighting conditions. In a VR manufacturing application, an assembly line work flow can be rerouted and the results observed in virtual space before refitting the plant floor.

As a human acts in a virtual setting, the environment responds and changes. Features of the virtual environment can be interacted with to simulate their expected counterparts in the real world.

VR provides immediate strategic business benefits. Costs may be controlled more effectively. The product-development budget can be decreased by prototyping in virtual space, and training expenses may be lessened by using VR applications to teach workers new skills. VR also affords effective risk management by allowing employees to learn new procedures with no risk to themselves, coworkers, customers, or property.

For business, modeling in virtual reality offers unprecedented power to imagine without constraints; to safely practice dangerous or risky procedures, to experiment freely without overrunning the budget, to get work done faster and transform ideas into marketplace realities sooner.

VR is an affordable and scalable technology. Some of the most effective and practical VR applications run on personal computers or workstations.

SBC S TRAINING NEED

The leaders of Southwestern Bell and its parent company, SBC, realize that help can't come too quickly when customers' telephone circuits are out-of-service. People and businesses depend on those circuits for a multitude of reasons: World Wide Web connections, fax, videoconferencing, paging, voice and electronic mail, home-security services and, of course, telephones.

Thus, there's a lot to lose when circuits are out, and telecommunications providers know that customers have little tolerance for service interruptions, especially in a hypercompetitive telecommunications market. Customers have more provider choices than ever before, and they evaluate providers' services by their connectivity's quality and reliability.

Traditionally, Southwestern Bell service technicians, whose whole focus is circuit quality and reliability, train at warehouse facilities where they climb poles, scrutinize fault-containing cable, and use electronic test equipment to pinpoint circuit problems. Centralized training at physical facilities is expensive. The cost of transportation, lodging, and food mounts up, plus, remote training takes service personnel away from helping customers.

The situation was deemed ripe for a VR training application; thus, the subject-matter experts at the SBC Center for Learning and EDS' virtual reality team in Plano, Texas, collaborated to create SBC Town, the VR application that faithfully models the way its target systems and environments behave in the real world by accurately reproducing in virtual space the telephonic and electrical behavior or urban communications circuits. SBC has a tradition of embracing the best available methods to give technicians the training they need to fix service problems as quickly as possible; thus, they were eager to

embrace VR as an emerging technology suitable for delivering efficient and effective training.

Keeping telephone circuits functioning is one of the highest priorities for Southwestern Bell and SBC. By investing in the virtual city, SBC laid the groundwork to begin combining virtual reality-based training with the traditional remote-site experience familiar to generations of service technicians. SBC sought to harness emerging virtual reality technology to enhance Southwestern Bell's service technicians' skills at finding problems that occasionally arise in telephone cable.

THE APPLICATION

EDS' SBC Town is one of the most ambitious commercial virtual reality applications ever built. It simulates the elements of a city's telecommunications infrastructure, replicating what technicians encounter in the real world.

The Town features eight scenarios that give students simulated work tickets describing a customer's trouble. Students must navigate through SBC Town's downtown and residential areas to find faults by using what they learned in their introductory Netscape-based tutorials, the information in their virtual work tickets, and the tools in their virtual tool boxes.

Those tools include the CTC 9925BLT test equipment, the lollipop, the banana probe, snips, and scotch lock. SBC Town simulates the behavior of each tool.

As they use their virtual tools to search for each scenario's fault—short, cross, tip-ground, ring-ground, open on one side, open on two sides, power influence, or combination—students must access splices, crossboxes, terminals, buried pedestals, manholes, and overhead cable. Technicians actually isolate virtual cable segments and test their reasoning about the source of a circuit's problem.

Given the importance of workplace safety, the application provides tips on dealing with traffic and other safety threats, such as noxious gases in manholes, failing to close a manhole cover, or failing to place safety cones around the work area.

The application monitors how efficiently students actually locate faults, by giving them a virtual bankroll at the beginning of each scenario. If the student exceeds resources, the application intervenes. Students' decisions are captured, and the application compares their solutions to the preferred ones. Students may study full-screen, narrated animated tutorials that explain the ideal way to locate each fault. Each preferred solution drives students to the pertinent test locations and demonstrates the work they should do there. Students can then go back and practice the scenarios themselves.

On the application's front end are Netscape-based tutorials implemented with HTML, Java applets, JavaScripts, and PERL scripts, that teach the fault-location and basic-electricity concepts that students need once they enter SBC Town. This use of Netscape as a common interface to both the front-end tutorials and the application's virtual reality centerpiece is a unique SBC Town feature.

The EDS development team created SBC Town using Division's VDI scripting language and dVISE, Division's interactive, virtual world simulation and authoring tool, as well as the C programming language. Integrating Division and Netscape gives students seamless access to the entire application, making it easier to use and fully place the technologies in the service of the application's learning objectives.

Virtual reality calls for collaboration of people from multiple disciplines having varied skills. A VR project team is likely to include people whose expertise lies in programming, graphics design, systems integration, systems development, educational course design, and science.

Accordingly, the Southwestern Bell and EDS team included people who brought with them a broad range of skills:

- an understanding of telephony circuits and fault location
- 3-D modeling using Autodesk's 3-D Studio
- a command of Netscape, HTML, Java, JavaScript, and PERL Script
- familiarity with Silicon Graphics hardware and the IRIX operating system
- command of Division virtual reality software
- C programming experience
- online training-course development

The team paired Division and Netscape software with Silicon Graphics hardware to create SBC Town and simulate the CTC Corp.'s 9925BLT circuit-testing equipment.

The application includes more than 70,000 lines of Division VDI code, more than 14,000 lines of C code, 300 classes of objects, and several thousand instances of objects.

The application's blending of media—audio, virtual reality, and interactivity—provide students a much more robust and engaging learning experience than is possible through lecture-style instruction in traditional classrooms. Rather than static exercises and dull explanations of highly technical concepts, students get a rich, compelling exposure to fault locating that places them at the center of the learning action.

The application's powerful use of sight, sound, and interaction also makes it possible to convey multiple layers of instruction. Whereas classroom-bound students may hear lectures that sequentially cover multiple topics, students using the virtual reality application concurrently learn technical concepts and skills, logic and problem solving, environmental issues, and safety practices, as well as cost control. The application does it all in a context where students are active participants in their learning, not passive recipients of someone's instruction.

The complexity of SBC Town's elements, their interactions, and the faithfulness with which those elements' virtual behaviors reproduce the real thing in a virtual space all combine to make the application unique.

The complexity permits technicians to learn the most crucial fault-detection behaviors in a realistic virtual environment. SBC Town differs from many other VR applications because of the complex behaviors that it implements. Virtual environments that don't include that level of interactivity present fewer design and technical challenges than a truly interactive virtual world where the environment changes depending on what users actually do there.

SBC Town is full of possible interactions. Some of the interactions are part of the correct way to test for faults under specific conditions. But most of the possible interactions are wrong; if students choose them, they need enough information to understand their mistakes and how to avoid them next time.

Nimbly managing all of a virtual environment's elements and their interaction points is essential to building optimally effective VR applications—ones that capture enough of the real world's complexity to be truly effective.

The EDS team's VR programmers were concerned to realistically construct the behaviors that service technicians must execute to do their jobs. They built the city from the ground up, proceeding through each of the environments' elements all the way to telephone circuits and the equipment that technicians use to find faults.

The fundamental requirement was to capture enough of the interactive complexity of the telephony circuits and the tools and behaviors that technicians use to test them, in order to teach fault location.

Some of the crucial elements that students interact with in SBC Town include:

- the CTC 9925BLT test set and other virtual tools such as the lollipop and banana probe
- strapping, in other words, connecting different cable pairs for test purposes
- removing and replacing jumpers, heat coils, and drops, to take them on and off
- 9925BLT terminal connections
- pairs: the telephone cables themselves
- terminals: the points of access to the cables
- faults: problems with telephone circuits that inhibit or impede service

All of these elements interact in innumerable different ways. In all, SBC Town includes more than 3,000 different situations; for each situation, there are up to 68 data elements.

SBC S DEPLOYMENT OF SBC TOWN

SBC conducted a six-workstation pilot in Kansas City, Missouri. One group of students, chosen at random, learned outside plant fault locating using SBC Town. Another group took the traditional lecture and lab version of the course. SBC found that the students learning via VR learned as much in the ten hours it took them to complete SBC Town's Netscape-based tutorial and eight virtual reality scenarios, as did the students who took the three-day lecture-style instruction course.

SBC hopes to realize training-related savings. Having determined through parallel testing that technicians who use SBC Town receive more efficiently-delivered training, SBC will use the VR application to leverage these benefits and to help determine VR's potential to augment conventional training in other areas.

VR technology is ideally suited to help students learn about the properties and behavior of technologies under various conditions that cannot easily be brought into a conventional classroom.

In SBC Town, for example, the virtual environment allows students to run a noise test on a "live" circuit. That's impossible in the classroom, where instructors can't simulate high voltage.

In addition, students learn how to conserve resources by striving to use the fastest, most effective method for finding circuit faults. If they choose sub-optimal fault-location strategies, they risk exceeding their allotted resources.

The virtual environment provides an ideal way to encourage resource consciousness by making it an integral part of fault-location methodology.

As virtual training expands, customers' service is likely to benefit from the application's rigorous, state-of-the-art training, as well as the integration of training with service technicians' daily work. On-site training at technicians' home work locations means service personnel stay on the job helping customers while they use SBC Town to hone their fault-location skills at their own pace and convenience.

The technology's role, though, is likely to expand beyond fault-location training in telecommunications providers' repertoire of service quality and continuity tools.

VR S POTENTIAL AS A TECHNICAL-TRAINING DELIVERY MECHANISM

Training is crucial to any organization's competitive edge, be it corporate, government, or military. It can be expensive, and many training situations are hazardous or require risking valuable assets.

Traditional training takes people away from their work, and travel expenses mount.

Virtual reality can be a viable alternative. Its benefits, many of which SBC expects to reap, include:

- empowered employees, because students learn by exploring the virtual world as individuals,
- a more engaging learning experience, because VR involves more of the senses and is especially powerful at leveraging visual perception,
- better situation awareness,
- performing high risk skills successfully and safely and then transferring those skills to the real world,
- and improved training at reduced cost.

Better training at a lower cost, with less time away from work are just some of the competitive advantages available from the commercial application of virtual reality technology.

MILITARY APPLICATIONS

VR Training is a must for today's high tech military forces. VR technology allows the soldier/sailor/airman/marine to be immersed into a near real world environment that will allow him/her to train both efficiently and effectively. The VR application as demonstrated in the SBC Town Project has a direct relationship to support the multiple needs of our military forces. VR can be used to support the military in such areas as training, tactics development, mission rehearsal, real time military operations, and After Action Reviews (AARS). The tools are here today and the leveraged use of commercial VR technology can only help achieve a cost efficient well trained military force.