Globalization and Nano Science are Shifting the Education Paradigm

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ABSTRACT

Advances in microscopy and optical lenses have opened a 'window to nature' that allows us to see how the building blocks of our world interact at the atomic level. This scale of science inquiry encompasses all the sciences and demands collaboration between physics, chemistry, biology, engineering and information technology, as well as the talents of simulation and modeling software technicians. All future science, technology and engineering careers will require an expanded knowledge base in the various applications of nanotechnology for manufacturing. As globalization in the marketplace advances the outdated education from the industrial age is not sufficient to meet the needs of the current generation who will face a very different future. China, Singapore and Taiwan have realized this shift and have developed nano science curriculum for grades 1-12. The United States has lagged behind as they continue to study how children learn and do not understand why all children need to be informed of scientific advances. This dynamic stasis will hamper an entire generation, which will be lacking proficiency to participate in the global workplace. Introducing nano scale science in grades K-12 requires innovative immersive learning environments as our children are already defined as 'digital natives' in recent global studies of ages 4-16. Preparation for a very different future is the responsibility of our leaders in government and education. Technology solutions are available and teamwork and collaboration between nations will create a path to success for the next generation. Do we understand the imperative for action and do we have the passion to pursue the task?

Key Words, Immersive, Virtual, Reality, Learning, Environments, Nanoscience, Interactive

INTRODUCTION

The world has moved beyond our limited education proficiency standards and industrial age teaching methods. Globalization of all cultures has shifted the needs of the standard education paradigm and demands that our leaders review these outdated modes of knowledge transfer by rote memorization with innovative platforms that enhance and stimulate both the instructor and the student. Our responsibility as elders and leaders in our society is to discern the serious systemic problems and restore the wonder and creativity of learning via virtual environments that can be accessed globally. This presentation has been developed to look at various solutions to shift the education paradigm for inclusion of every child that will also align with the efforts of the $100 laptop project sponsored by the United Nations. We have moved forward rapidly from an Industrial age to an Information and Technology age without addressing this shift in our global classrooms. The NanoTechnology Group Inc believes that collaboration to resolve education issues will expand the knowledge base so that all children can understand the world they will inherit.

1. IMMERSIVE LEARNING ENVIRONMENTS

The ultimate goal is an Immersive Virtual Learning Environment with adaptive knowledge engines built with ubiquitous (AI) artificial intelligence to house interactive curriculum that responds to a student's skill level. The system should have interactive capabilities to eliminate testing and rote memorization while challenging students to learn new creative thinking skills for the problems encountered in their virtual sessions online promoting learning anytime/anywhere as the classrooms of the future.

1.1 Virtual classrooms for Immersive experiential learning
Virtual classrooms can be filmed with Virtual Reality cameras worn by students in university research labs to create a real-time immersive lab experience online. Filming from a young students' perspective in a Virtual Reality room draws the online participants into the immersive lesson as they become part of the experience.

1.2 Iowa State has the most realistic Virtual Reality Room in the world

Figure 1. Jared Knutzon, an Iowa State University graduate student in human computer interaction, demonstrates how Iowa State's C6 virtual reality room can control the military's unmanned aerial vehicles. Credit: Iowa State University's Virtual Reality Applications Center

More than $4 million in equipment upgrades will shine 100 million pixels on Iowa State University's six-sided virtual reality room. That's twice the number of pixels lighting up any virtual reality room in the world and 16 times the pixels now projected on Iowa State's C6, a 10-foot by 10-foot virtual reality room that surrounds users with computer-generated 3-D images enabling the production of virtual reality at the highest resolution on the planet**.**

Iowa State's C6 opened in June 2000 as the country's first six-sided virtual reality room designed to immerse users in images and sound. The graphics and projection technology that made such immersion possible hasn't been updated since the C6 opened. The difference between the equipment currently in the C6 and the updated technology installed last summer, "is like putting on your glasses in the morning," said James Oliver, the director of Iowa State's Virtual Reality Applications Center (1) and a professor of mechanical engineering. Mark Bryden, an associate professor of mechanical engineering, has used virtual reality to develop engineering tools that help engineers make better decisions. He said this C6 upgrade will allow more realistic images capable of transmitting more information providing more concise and precise information to engineers as they make critical decisions**.** The new equipment, a Hewlett-Packard computer featuring 96 graphics processing units, 24 Sony digital projectors, an eight-channel audio system and ultrasonic motion tracking technology, will be installed by Fakespace Systems Inc. of Marshalltown. The project is supported by a U.S. Department of Defense appropriation through the Air Force Office of Scientific Research. A grand opening celebration was planned for the spring of 2007. These facilities would be ideal for filming virtual classroom lessons with young students in the future to take the first step towards true immersive education platforms.

1.3 CyberWalk - Unconstrained Walking in Virtual Worlds

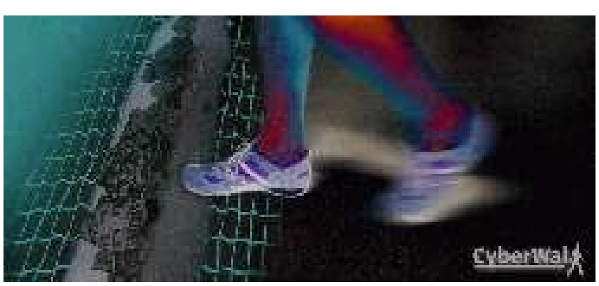

Figure 2. Walking without restriction in virtual worlds is still a challenge for science and technology. Image: CyberWalk

The next step in Immersive Environments will be CyberWalk, which is a European project for the development of a new platform for walking in virtual worlds. The development of a walking platform which will allow unconstrained movement in virtual worlds is the goal of the project, initiated by scientists of the Max Planck Institute for Biological Cybernetics in Tuebingen, Germany, together with their colleagues from the Technical University Munich, the Swiss Federal Institute of Technology, Zurich, Switzerland and the University Roma, Italy. The platform will

serve as a tool to study human spatial cognition and movement in space, but later will also allow visits to historical sites or help improve training for athletes in virtual environments. The CyberWalk project is supported by the European Union with 1.7 million Euro for the duration of three years. (2) For the creation of so-called "virtual worlds", towns, scenes and situations are reconstructed as lifelike as possible in the form of three dimensional programs. These virtual scenes are presented to the viewer via a projection screen or specialized glasses equipped with small projectors. In contrast to passively viewing a film, the audience can move within and interact with the virtual environment. As soon as the viewer turns to the right, for example, they will see the same virtual scene but from another visual angle, as in our natural environment. The aim is to create virtual worlds capable of providing the sensory experience of actually existing within them. This is the beginning of fully immersive experiences involving all the senses. To achieve this goal, detailed knowledge of how humans perceive and behave in their natural environment is required. Human perception and cognition are very precise operations, responding, for instance, very sensitively if together with a particular rotation of the body and the environmental image does not "move" at the same angular velocity. If the coordination of the two is less than perfect, then the behavior of the person in the virtual environment changes, possibly resulting in vertigo or indisposition.

1.4 But what are the benefits of virtual worlds?

Industry is already employing virtual worlds to create and visualizing new car models, in architecture, and in rehabilitation, as well as research on human cognition. Virtual worlds allow for controlled and independent changes of all experimental parameters in precisely defined steps and are therefore, an appropriate environment for studying complex human behavior patterns under quasi-natural conditions. The CyberWalk Project plans to develop a completely new virtual walking environment, which enables subjects to actively and unrestrictedly move through virtual worlds in different directions. The first application may be the creation of a walk through the ancient Persian city of Sagalassos.

The core of the CyberWalk walking environment will be the aptly-named CyberCarpet. At this stage of the project it is envisioned as a platform approximately five meter diameter, consisting of thousands of small, loosely pivoted spheres similar to oversized ball-bearings**.** The spheres are propelled by a treadmill mounted on a turntable. In this way it will be possible to transport a person walking on the CyberCarpet back to the centre of the platform without them noticing. The CyberCarpet will be developed in close collaboration between the Department Cognitive and Computational Psychophysics (Prof. Heinrich Bülthoff) of the Max Planck Institute for Biological Cybernetics in Tuebingen, and the Institute for Applied Mechanics (Prof. Heinz Ulbrich) of the Technical University of Munich. The Munich scientists will develop the prototype and construct the final version of the platform. To ensure that walking on the platform will, indeed, feel completely natural, they will receive guidelines from the Max Planck Institute's scientists so that the platform can be tailored to human behavior and perception patterns. A central factor in this will be the effects of forces arising from the platform's acceleration on human perception and action.

Other partners in the project are scientists of the Institute for Technology and Electrical Engineering (Prof. Luc van Gool) of the Eidgenössische Hochschule Zurich. Their task will be to create a control signal for the platform from visual records of the walking subject because without such a system, subjects would simply fall over the edge of the platform after about three steps without this control. In this task the Zurich scientists will receive support from the Informatics Department of the University of Rome (Prof. Alessandro De Luca), where appropriate software for movement control will be developed, and from the Institute of Automatic Control Engineering and Autonomous Systems (Prof. Martin Buss) at the Technical University of Munich with its expertise in the area of optimized controlled engineering of robotic systems. Management partner in the project is the Agency for Research Funding AFWO GmbH Tuebingen (Dr. Friederike Wolf-Oberhollenzer).

Dr. Marc Ernst, project scientific leader at the Max-Planck Institute for Biological Cybernetics, is convinced that once we have made it possible to walk naturally in virtual worlds, the CyberWalk walking environment will have many potential applications in medical therapy, the training of athletes, in museums and in architecture. It will also have applications that advance immersive education experiences.

2. IMMERSIVE ENVIRONMENTS FOR MUSEUMS AND HOLOGRAPHIC DISPLAYS

The National Science Foundation recently funded a large consortium of museums to develop exhibits for informal learning of nanoscience for the public. Many new avenues of technology are available that would allow them to create outstanding interactive immersive displays. Virtual reality is now available to artists for about $3,000.

Figure 3. Student in virtual room.

Software to create this art can also be secured free-of-charge from the University of Illinois at Urbana-Champaign, where researchers at the Integrated Systems Laboratory under the direction of Hank Kaczmarski have created a portable virtual reality set-up developed specifically for artists. The open-source technology, known as Syzygy, is downloadable from the university. (3) In 1992, three virtual reality pioneers, Dan Sandin, Tom DeFanti and Carolina Cruz-Neira, created the prototypical large-scale virtual environment known as Cave Automatic Virtual Environment, at the university's Chicago campus. The new project is titled: CANVAS and though the effects are slightly less encompassing than those of its forebears, the CANVAS experience is nonetheless transforming, at a fraction of the cost. With as few as two projectors ($1,000 each) fitted with polarizing filters ($300 each), an up-to-date desktop computer, three rear projection screens (optional) and the Syzygy program, artists can take the next step and develop interactive exhibits for museums, creating the next level of virtual immersive experience. All the public needs is a pair of passive stereo glasses ($1) or datagloves ($20).

2.1 Japanese 'device art' brings technology to life

Figure 4. A visitor is about to touch a Japanese virtual piece, 'Kronos Projector,' to distort the image

The works of art along the Japanese aisle at the International Conference on Virtual Reality in Laval, western France are not the sort you find protected behind glass. On the contrary, it is up to the spectator to bring them to life. "Please touch", the signs read. "Virtual reality opens up a whole new space, where the work of art becomes dynamic", where "the artist is no longer unique", explains Alain Grumbach, a virtual reality specialist who teaches computer science at the national school of telecommunications in Paris. (4)

Figure 5. A visitor is about to touch a Japanese virtual piece, 'Please touch the screen,' simulating a layer of water

The effect is almost magical. It is an odd sensation dipping a wooden spoon into an empty bowl and watching it splash around in clear water on the adjacent screen ("Wet-Free Water" by the Nara institute of science and technology, Japan).

2.2 Japanese Device Uses Laser Plasma to Display 3D Images in the Air

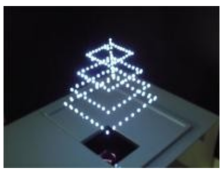

Figure 6. A 3D-object displayed using a 3D-image spatial drawing device. Credit: National Institute of Advanced Industrial Science and Technology.

A collaboration of the Japanese National Institute of Advanced Industrial Science and Technology (AIST), Keio University and Burton Inc., has produced a device to display "real 3D images" consisting of dot arrays in empty space. Many previous displays in 3D have been virtual images on 2D planes that appear as 3D due to human binocular disparity. However, the limitations of our visual field and the physical discomfort caused by wrongly identifying virtual images combine to make these displays less than perfect. The new device uses the plasma emission phenomenon near the focal point of focused laser light. By controlling the position of the focal point in the direction of the x-, y-, and z-axes, real 3D-images in air (3D-space) can be displayed.

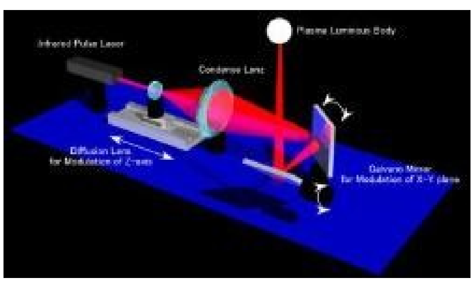

Figure. 7 Overview of the 3D-image spatial drawing device. Credit: National Institute of Advanced Industrial Science and Technology.

Our living space and the objects within it are three-dimensional but, while 3D imaging is well documented on the Internet, we don't see "real 3D-images" on our computer screens because our monitors are unable to display them.   Keio University and Burton Inc., noticed that when laser beams are strongly focused air plasma emission can only be induced near the focal point so they experimented by fabricating a device to display 2D-images in the air. The images are constructed from dot arrays produced by a technique combining a laser light source and galvanometric mirrors. To form 3D-images in the air, the scanning of the focal point in the depth direction along the laser optical axis is essential. However, to achieve this, the quality of the laser and the technique for varying the position of the focal point must be improved. This explains why we do not yet have the technology to display 3D images.

By modifying the 2D image device with a linear motor system and a high-quality and high-brightness infrared pulse, the AIST, Keio University and Burton Inc., created a spatial display of "real 3D images" consisting of dot arrays. The linear motor system can vary the position of the laser focal point by high-speed scanning of a lens set on the motor orbit. Incorporation of this system makes the image scanning in the direction of the z-axis possible. Conventional galvanometric mirrors are used for scanning in the x and y axis directions.

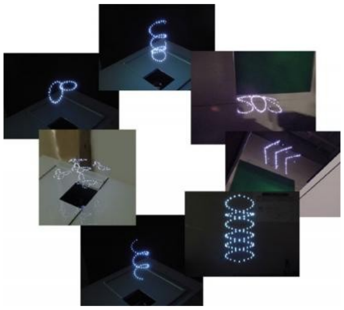

Figure 8.Various 2D and 3D objects drawn by the display device. Credit: National Institute of Advanced Industrial Science and Technology

The high-quality and high–brightness infrared pulsed laser (repetition frequency of pulse: approximately 100 Hz), enables plasma production to be more precisely controlled, resulting in brighter and higher contrast image drawing. Furthermore, the distance between the device and drawing points can be extended by several meters.

The emission time of the laser pulse light is approximately a nanosecond (10-9 sec). The device uses one pulse for each dot. The human eye will recognize the after-image effect of plasma emission from displays up to 100 dot/sec. By synchronizing these pulses and controlling them with software, the device can draw any 3D objects in air. There are many advantages of using this device to develop virtual holographic nanoscale museum displays of the atoms for students and adults. The displays could also be filmed and developed into a virtual classroom setting that visually teaches the atomic scale.

3. SURVEYS PROVE STUDENTS ARE MORE DIGITALLY ADVANCED

A new survey of teachers and instructors at the high school and post-secondary levels has found that students who excel in the use of information and communications technology (ICT) are driving change in classroom instruction. The study was carried out by Certiport Inc., (5) a provider of technology training, certification, and assessment solutions, and the Education Development Center Inc. (EDC), an international nonprofit organization that researches and implements best practices in health and learning in 50 countries. The survey of 444 teachers and instructors was conducted in 382 Certiport testing centers over a seven-day period. Power Users, as defined by EDC, are the savviest of the "digital natives," a demographic of 10- to 15-year-old students who have grown up with digital technology as a part of their everyday lives.

According to EDC, these students have technical acumen beyond any previous generation. They are characterized by their ability to "leverage the internet to the highest degree conceivable" and are energized by technology well past the point of most digital "immigrants"--that is, older learners forced to adapt from the analog age. This group is in tune with skills that are needed for success in the 21st century, exhibiting many of the collaborative learning, analytical thinking, and problem-solving interests that are sought by today's employers.

Power Users exhibit engineer-level thinking that we don't normally expect students to have until they enter post-secondary engineering programs. Among the survey's findings: Sixty-nine percent of respondents believe Power Users influence what is being taught in the classroom and sixty-six percent said they influence teaching methods. According to the survey, forty-eight percent of respondents said Power Users exhibit helpful behavior and fifty-five percent said these students facilitate the learning of other students. Teachers, meanwhile, are pairing these students with other, less technically advanced classmates in hopes that they will assume more of a leadership role and are encouraging them to share their breadth of knowledge with their peers. The study also found that more than four in five teachers (84 percent) believe Power Users have positively influenced their own learning and knowledge of ICT. A synopsis of the report is available at the EDC web site, along with other materials related to the four-year Power User study. (6) This phenomena sets the stage for Team Teaching as a component in the future of education globally.

3.1 Study shows 4-year-old pre-school students think like scientists

Scientific studies show that children think like scientists as revealed in another study with pre-school children who are convinced that perplexing and unpredictable events can be explained, according to an MIT brain researcher. The way kids play and explore suggests that children believe cause-and-effect relationships in the world are governed by fundamental laws rather than by mysterious forces, claimed Laura E. Schulz, assistant professor of cognitive science and co-author of the study "God Does Not Play Dice: Causal Determinism and Preschoolers' Causal Inferences." (7) Schulz and her colleague, Jessica Sommerville of the University of Washington, tested 144 preschoolers to look at whether children believe causes always produce effects. If a child believes causes produce effects deterministically, then whenever causes appear to work only some of the time, children should think some necessary cause is missing or an inhibitory cause is present.

In one part of the study, the experimenters showed children that a switch made a toy with a metal ring light up. Half the children saw the switch work all the time; half saw that the switch only lit the ring toy some of the time. The experimenters also showed the children that removing the ring stopped the toy from lighting up. The experimenters kept the switch, gave the toy to the children and asked the children to stop the toy from lighting up.

If the switch always worked, children removed the ring. If the switch only worked some of the time, children could have removed the ring but they didn't--they assumed that the experimenter had some additional sneaky way of stopping the effect. Children did something completely new: they picked up an object that had been hidden in the experimenter's hand (a squeezable keychain flashlight) and used that to try to stop the toy. That is, the children didn't just accept that the switch might work only some of the time. They looked for an explanation. This is the first study that looks at how probabilistic evidence affects children's reasoning about unobserved causes. This research suggests that preschoolers actually have quite abstract beliefs about causal relationships. Many educational experts and funding agencies have determined that young children cannot grasp the concepts of science as a subject and have consistently denied that all children need to learn about nanoscale science. Therefore, most schools in the United States do not introduce science as a subject until grades 3 or 4. Teaching young children "how the world works" at the nanoscale in the early grades would stimulate a curiosity for learning that would increase as they matured. Visual elements in educational materials have been proven effective in nanoscale science museum exhibits that could be introduced as virtual experiences online for all ages.

3.2 More Nursery School Children Going Online

Before they can even read, almost one in four children in nursery school are learning a skill that some adults have yet to master: using the Internet. Some 23 percent of children in nursery school - kids age 3, 4 or 5 - have gone online, according to the U.S. Education Department. By kindergarten, 32 percent have used the Internet, typically under adult supervision. The numbers underscore a trend in which the largest group of new users of the Internet are kids 2-to 5-years old. At school and home, children are viewing Web sites with interactive stories and animated lessons that teach letters, numbers and rhymes.

"Young students don't differentiate between the face-to-face world and the Internet world," said Susan Patrick, who oversees technology for the department. "They were born into the age of the Internet. They see it as part of the continuum of the way life is today." At a preschool age, children need some grown-up help to get online, said Francie Alexander, chief academic officer for children's book publisher Scholastic Inc. One of their favorite computer activities is writing an e-mail to a grandparent, said Alexander, author of a children's guide to the Internet. "It's great for letter recognition," she said. "Everybody likes to get mail and little kids don't have great tolerance for waiting. So the whole idea that they can write grandma and get an e-mail back a half-hour later saying, 'I got your note', they love that."

Scholastic has a section of its Web site designed just for children who go online to read, write and play with "Clifford the Big Red Dog." PBS Kids Online has more than a dozen educational Web sites for preschool children, including "Sesame Street" and "Barney and Friends." Overall computer use, too, is becoming more common among the youngest learners. Department figures show that two-thirds of nursery school children and 80 percent of kindergartners have used computers.

At the Arnold & Porter Children's Center in Washington, 4- and 5-year-olds have the option to spend time on a computer, working in small teams. They learn basic problem-solving and hand-eye coordination, but the social component of working with classmates on computer exercises is just as important, said Sally D'Italia, director of the center that a law firm offers for its employees. "It helps them become more relaxed, more adventurous, and more willing to take risks as they learn," she said. "With adults, we're still afraid that we're going to blow up the computer. You never know if you're going to push the wrong button and lose all your data."

Virtually all U.S. schools are connected to the Internet, numbering about one computer for every five students, the government reports. Many older students are often far ahead of their teachers in computer literacy and they realize their younger siblings are gaining on them.

4. GAMING AS GLOBAL EDUCATIONAL PLATFORMS IN THE FUTURE

More than 100 colleges and universities in North America, up from less than a dozen five years ago, now offer some form of video game studies. Randy Pausch, co-director of the Entertainment Technology Center at Carnegie Mellon University, which offers a master's degree in entertainment technology, adds that gaming studies have a sneaky side: They attract students to computer science. Meanwhile, on the literary front, some scholars have come up with a fancy name for their discipline: ludology, from the Latin ludus (game). Topics range from game philology to the study of virtual economies in EverQuest, a popular online MORPG. (Massive Online Role Playing Game) Academic video-game departments are also cranking out workers for hundreds of video game studios. "The school system can turn out our worker bees," says Jason Della Rocca, executive director of the International Game Developers Association. (8)

At the Summit on Educational Gaming, sponsored by the Federation of American Scientists, a statement was made that video games have the potential to improve learning in the United States and keep the nation at the forefront of global competition. Educators and cognitive scientists joined forces with software marketers and designers to discuss the possibilities of merging digital gaming into the education of what some described as our increasingly attention-deficient society. The average teenage male spends approximately 316 hours playing video games each year. The hope is that by producing content in a medium already familiar to, and welcomed by students, more of them will be able and willing to master basic knowledge and skills.

Mike Zyda, director of the University of Southern California's GamePipe Laboratory, even sees video games taking on a much more active "teacher" role. GamePipe, an R&D laboratory for interactive games and their practical applications, is currently collaborating with a private company on a piece of technology that would do just that. The plan is for a non-invasive sensor that can monitor a player's brain activity in order to gauge the rate of learning, the modality of learning and the person's emotional state. Once this information is processed, the software would tailor the game's activity to best fit the comprehension methods and speed to which the player seems to respond best.

Learning to leverage the enormous popularity of video games to help students excel was the core purpose of a Serious Gaming Conference event also held in 2005, in Washington, D.C. The Federation of American Scientists (FAS) Summit on Video Gaming wanted to demonstrate the pedagogical value of gaming technology, often viewed with skepticism by generations of educators who did not grow up in the digital age. The FAS event focused on the theory behind using video games in the school curriculum and looked at how to use gaming curricula to engage students and improve their performance.

Educators need tools and standards to create games quickly at low cost, said Barbara Olds, a division director for research, evaluation, and communication in the education and human resources directorate of the National Science Foundation. Educators also need an infrastructure for the collection of data and a way to analyze the effectiveness of these games in teaching content. They also require better coordination between virtual and real activities, she continued. “Better research on motivation would not only help K-12 educators transform young people into better students in the short term, but it also would help today's students become lifelong learners,” she said. "The negative effects of games also must be studied," Olds acknowledged, asking, "What about some games that reinforce gender and cultural biases? Do the preferred metaphors used in games communicate across cultures in a way that helps to reduce the digital divide?"

Olds discussed the importance of immersion and engagement on learner motivation. Picking up on a point raised by Cannon-Bowers, she cited the hypothesis that players might take more away from a game if they are immersed in the game's narrative. The summit ended with two panel discussions on innovation in gaming, one of which focused on the challenges to innovation in the education and training markets. In closing, Eugene Hickok, deputy education secretary during President George W. Bush's first term, said nearly every institution has undergone profound change as a result of the transition to digital communications in the late 20th and early 21st centuries. "The only social institution that has not changed," Hickok said, "is education. It is still based on an industrial model, but [it] needs to make the transition to the digital age. I'm encouraging you to help start a revolution. Most markets don't change unless they have to."

There’s nothing shocking about the use of computer gaming in classrooms, of course. The goal has been to replace the earlier "drill-and-practice" methods of interactive learning with a new generation of pedagogical tools for all educational levels and in subjects ranging from science, mathematics, and engineering to social sciences and humanities. One of the seminal programs in the field was MIT's Games-To-Teach Project. Since 2001 MIT has developed more than a dozen interactive and Web-based games with names like "Replicate," "Biohazard," and "Revolution."

Some even see games and gaming technology as the key to keeping U.S. workers competitive in the world marketplace. One of those is the The Digital Media Collaboratory, one of several technology laboratories at the University of Texas at Austin's IC^2 Institute that works with partners from the public and private sectors to develop computer games that can be used by schools, businesses and governments. Austin is home to several of the largest online gaming companies and the decision to start the laboratory grew out of the institute's successful use of simulations to train welfare recipients.

A pilot program was created in 1998 called EnterTech, a 45-hour training simulation that taught 44 entry-level job skills through digital role playing. The results stunned everyone. Of the 238 participants, two-thirds of the group either found work or enrolled in continuing-education programs. Those who worked received a $1.06 average increase in salary. Bolstered by that success, the group began tailoring programs for different organizations. Versions of EnterTech have since been used in the Dallas Independent School District, the University of Texas, at-risk community schools in Waco, Texas, and adult learning centers and welfare offices throughout the state.

Despite the success of programs like EnterTech, the video-game industry hasn't been proactive with schools. Educational game sales make up only 7 percent of the software market for console games and computer titles haven't generated enough sales to be ranked, according to the Entertainment Software Association. Many commercial titles only offer drill-and-practice lessons, which some experts believe defeats the purpose of using video games. However, games won't be the magic bullet that saves education. Even EnterTech, with all its success only adds depth to lessons taught during the 15 hours of teacher-directed discussion. "The 'e' in e-learning stands for enhanced," said Randy Heinrichs, Microsoft Research group product manager. "What we do is create environments where students can practice what the teachers are telling them."

4.1 Learning with role playing interactive games

Figure 9. NanoMission Educational game

The theory is being tested by PlayGen, a game developer in the U.K. The writers and concept design artists have a passion to develop interactive role playing educational video games that can be played online or on a PC in the classroom. A second phase is planned for the development of massive multi-player online role playing education games (MMORG) for global participation. PlayGen has agreed to partner on our team to answer a solicitation for development of an educational MMORG from NASA. Budgetary issues delayed the release and we are hopeful for a re-issue in the near future which will stimulate the introduction of nanoscience concepts and technology for space travel. What most educators don't realize is that a player can learn difficult subject material within the game if the game is fun. Therefore, we intend to keep the fun of playing while retaining learning as our ultimate goal.

Marketing a role-playing game set in space-time of the future generates many opportunities to introduce nanoscience for space applications and robotics lessons as an educational platform. Our story development team understands how to "lure the students into learning new material", stimulating their desire to solve issues within the game while challenging them with opportunities to learn math and science and make morally significant behavioral decisions as they move among future civilizations and create settlements on planets and stars in distant galaxies.

There will always be small battles within the storyline, but rewards for intelligent, positive, scientifically-oriented decisions can be built into the game, rather than just vaporizing the planet. Role-playing games encourage interaction among the players and promote loyalty and honorable behaviors as they travel through space to colonize or save a world from destruction. The game will be an excellent learning tool for this generation, which may very well be the first to colonize other planets in their lifetime. As we move towards becoming a global society that places value on learning anytime and anywhere, massive multiplayer online role-playing games creating virtual worlds and virtual experiences will become the immersive education tools of the future. Since the solicitation from NASA will only partially fund this endeavor, we are seeking interest from other nations to participate with input and financial support. Development of a MMORG requires $6-10 million U.S. and the current level of funding in the solicitation is planned at $3 million, therefore, collaboration and partnering becomes a necessity.

5. CURRENT SOLUTIONS USING SIMULATION AND MODELING SOFTWARE

Our organization is constantly searching for solutions to provide more visual elements to include in the curriculum development for students to understand and work at the atomic scale of science. Most of the simulation programs are designed for the university level research students and professors. Some of the programs we have found are at the pre-launch testing phase, while others are ready for commercialization. All of the companies are offering large discounts and/or free trial offers for education and government use of the software.

5.1 Summer School CAD program for nanomodeling

A major collaborative breakthrough introducing nanomodeling to advanced high school students in California was announced in July 2006. This effort involved two of our members, Mark Sims from Nanorex (10) and Professor James M. Tour from Rice University, along with COSMOS instructor Miguel F. Aznar, director of education for the Foresight Nanotech Institute. Students who reported for the Nanotechnology and Robotics class at the California State Summer School for Mathematics and Science (COSMOS) (11) on July 9, 2006 at UC Santa Cruz began testing NanoEngineer-1, the first computer-aided design (CAD) program for the nanotech age. NanoEngineer-1's 3-D, interactive environment and molecular physics engine enables the students to invent and test new kinds of molecular machines and devices, designed atom by atom exactly to their specifications.

Nanorex was founded on the premise that in addition to teaching young people the fundamentals of chemical, biological and mechanical engineering at the nanoscale, this next generation of nanotech innovators will also need to 'see' how nature's fundamental building blocks can come together in new ways.

Two other virtual teachers joined NanoEngineer-1 in the COSMOS classroom. The NanoKids and "nanocar," both born in the laboratory of Rice University nanotech researcher James M. Tour, took on new life as students' modeled and animated them. The NanoKids (12) are characters, based on actual anthropomorphic molecules synthesized in the laboratory and will help students and teachers visualize molecular-scale science in a way that is fun and easy to understand.

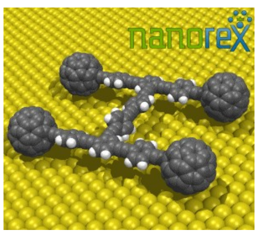

Figure 10. The world's first single-molecule car (photo) comes complete with chassis, axles and four buckyball wheels.

In a kind of reverse CAD process, students used NanoEngineer-1 to model the nanocar and learn how to animate it to move across a gold surface, illustrating the same phenomena demonstrated in Tour's lab. NanoEngineer-1 also helped students model and simulate nanomechanical bearings, gears, molecular machine assemblies and other molecular structures.

"Students have never before been this close to actually building things atom by atom", said COSMOS instructor Miguel F. Aznar, director of education for the Foresight Nanotech Institute. "Using NanoEngineer-1, is the first time we've been able to give high school students hands-on practice with nanotechnology structures. It makes nanotechnology tangible, connecting it to the science they've studied."

5.2 Academic Outreach Program

Another member of our group,Nanorex, is offering academic institutions interested in using nanomechanical engineering software the opportunity to test the beta version in their classrooms. University professors who are developing a nanoengineering course can use nanoENGINEER-1 to apply textbook theory in an educational setting. Inquiries by email at info@nanorex.com are being accepted to apply for the Academic Outreach Program. Assistance is also available in developing new nanoengineering course syllabus that includes workbook exercises to teach students the process of designing, modeling and simulating nanomechanical devices. Request permission to Download (13) the test copy of the software.

5.3 Visualization tools for K-12 Classrooms

The only tool that is appropriate for developing K-12 education at this time is from our esteemed member, Nano Science Instruments. (14) They are the distributor in the United States and Canada for Nanosurf, the original developer of desktop scanners for education based in Switzerland. The recently released new model has many affordable options and is known for the ease-of-use by teachers, students and outreach program.

The EasyScan 2 allows one to acquire a system which is a highly functional multiple mode AFM/STM package. It may be configured to need, and options added later. The Swiss-made system is manufactured near IBM Zurich, the birthplace of the STM and provides high quality, precision machining, and a smart easy-to-use design for teaching or research where large STM and

AFM microscopes are not practical or within budget for most classrooms. The website also features downloads for curriculum development tools, a list of outreach programs, an animation gallery and a quarterly newsletter with articles on the success of educational outreach programs for those considering the purchase of these tools.

Figure 11, Figure 12. New hand-held EasyScan 2

Mark Flowers, President of Nanoscience Instruments is dedicated to education and recognizes the importance of teaching nano science in the primary grades. I have included the animations from his gallery in many of my presentations around the world to encourage governments to initiate programs for K-12 curriculum in all development plans for funding nano science education. Young students respond to these animated visual elements that illustrate the atomic surfaces of graphite, platinum and other elements that are part of the underlying structure of matter. The ability to scan recognizable natural objects such as the skin on their hand, a fingernail, or a strand of hair for observation and understand that "size does matter" in science will leave a lasting impression and create more desire to explore science as they mature.

The Windows applications on their website were written by Dr. Joe Griffith. Administrators and teachers can test these programs to develop expanded modules (15) for their current science curriculum. This product was developed to enhance current curriculum in universities or K-12 education programs as a visual tool for expanding the knowledge base of our students while introducing them to science lab research experiences at an early age.

5.4 Immersive online lab experiences are being expanded to include K-12 students

Professor B. Ramakrishna has become a major global partner with Taiwan and India through the facilitation of the relationships by our organization. As he presents the evolution of nanotechnology education at Arizona State University for the Taiwan collaboration, their leadership in electron microscopy became apparent with the establishment of the John Cowley Center for High resolution electron microscopy in 1970, making them among the first to 'see' atoms and 'bonds'.

Figure 13. Photo: Prof. B. Ramakrishna gives presentation

Nobel Laureate H. Rohrer, co-inventor of the STM at IBM in Switzerland was a visiting professor at ASU since 1993 and served as the Chair of the Advisory Board on the INVSEE project. Concerning nanoscience and technology he stated, "In education for the nanoscale, students need to learn to work at the nanometer scale. This opens completely new dimensions on how we will approach and solve many problems in the future as we enter the nanometer age."

Through this project they soon discovered that the information delivery rates between reading/hearing were at 100 bits/second versus seeing the visual information which had increased the rates to 200 million bits/second. This discovery contributes to the success of the INVSEE program as they found that students who only receive information by hearing/lectures FORGET details, if they process information that has visual elements, they REMEMBER the details, and if they interactively do the experiment in the online nano-lab, they will UNDERSTAND the details.

Between 2002-2004 the ARRIVE project to adapt and adopt INVSEE's resources with collaborating partners at UW Madison, Cornell University, Maricopa Community College and Western Arizona College started the process of expansion and sharing.

A central theme that ties the modules together is that the structure, properties, processing, and performance parameters of a material are intimately linked at all levels of scale. The interactive INVSEE modules provide:

- Reinforcement of key concepts and fundamental principles that are taught in science, math and engineering curricula.
- Prospective users learn the methodologies of experimental design and remote SPM instrumentation on the web.
- Students gain a deeper understanding of research. The modules challenge and encourage potential users to formulate original experiments.

A series of web-based educational modules center around a common theme of understanding and manipulation of our natural and man made material worlds. The module topics rely heavily on interactive, discovery-based learning activities to introduce or reinforce the user to key fundamental and applied material concepts within a material class or discipline as well as various material classes and disciplines over a wide range in length scale. These modules were developed as free resources with funding provided by the National Science Foundation for teachers and students around the world. Teachers and students may access the Gallery, Modules, SPM live, Workshops, and Links. (16) The project will expand in the coming years to include nano-lab experiments for younger students in grades K-12 in the United States along with planning workshops in Taiwan (17) for their nano education programs scheduled as a continuing collaborative effort for K-12 education between our countries. Collaboration rather than competition between countries is imperative as globalization in the marketplace increases. Every child will need a comprehensive global education including an understanding of nanoscience and technology for their future. As a global partner, ASU has an outstanding track record and is a willing partner in expanding these important relationships with countries around the world who have an interest in collaboration for nano science education.

6. CONCLUSIONS

The paradigm shift to total Immersive learning platforms will take at least another decade for administrative and government acceptance. Many of the programs will start as informal education platforms and then move into outreach for assessments and evaluation. Meanwhile, our children will find the resources that interest them online and continue their current expansion of learning through digital media edutainment platforms. They are not waiting for permission to learn!

References:

(1) Source: Iowa State University

(2)The European Commission is supporting the Cyberwalk project for the duration of three years with 1.74 million Euro, the Max-Planck Institute for Biological Cybernetics will receive funding of about 450,000 Euro.

(3) www.isl.uiuc.edu.

(4) New York Times: Author Michael Rush is the director of the Rose Art Museum at Brandeis University and the author of "Video Art" (Thames & Hudson, 2003) and "New Media in Art" (Thames & Hudson World of Art, 2005).

(5) Certiport Inc..http://www.certiport.com

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