American Professor

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One of the questions most often asked of me has always been, "How did you get here?" This is an attempt to explain the breadcrumb trail to my life as a professor.

In 2017, I received an IEEE Virtual Reality (VR) Technical Achievement Award "for fundamental work in virtual reality networking, body tracking, and institutionalizing the application of virtual reality." I was asked to put together a talk by the person who invited me to the IEEE VR conference where I was to receive that award. I asked them two questions: 1. what my talk should be about and 2. how long I had to speak. I was told that my talk should be about "How did I get here?" and that I had an hour to present my talk. Therefore, I dived into making this talk about my life and how I became whatever I have become and 77 slides illustrating that life.

The title was inspired by a Google search, which gave me the image shown in Figure 1 on the search page and told me, "People also search for—William R. Cockayne, Bran Ferren, Danny Hillis, and Robert M. Widney." Now, Bill Cockayne is a brilliant former student, so that makes sense. Bran Ferren is the former president of research and development for the Walt Disney Company and president of creative technology for Walt Disney Imagineering, positions I interviewed for in the months from May to September 2000. I mean, who would not want to be director of Imagineering? Bran quit Disney in May 2000 and formed Applied Minds with his business partner, Danny Hillis. Both Bran and Danny are techno superstars whom I have known and followed for years and have always wanted to work with on cool projects, so them being there on the Google search kind of makes sense. Robert Widney is the founder of the University of Southern California (USC), a university where I founded the games program and wrote the operating plan and research agenda for founding USC's Institute for Creative Technologies. Google search knows something about me—hence, the article's title.

ARRIVAL

Well, I got to the IEEE VR 2017 session where I was to speak and receive the award and found that, yes, the session was

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1 h long—but it had four other people in that session, including the chair of the session and three other award winners. I found out that I really had 12 min or so for my talk, not the 60 min I was told (or misunderstood). I gave that talk using all 77 slides; I just sped up my voice to cover everything. No one recorded that session! Therefore, I thought I should perhaps put pen to paper and turn this into something mere mortals could read at their leisure as opposed to hearing it spouted at high velocity from someone who, perhaps, should not have had so much late coffee.

IN THE BEGINNING (1973)

The original idea of the talk was to do a slide for every year from 1973 forward. In 1973, I was attending the University of California, San Diego (UCSD), which is really in La Jolla—a school I chose as it seemed to be the closest UC to the beach. All of my high school friends went to UC Los Angeles or UC Berkeley and chose smart, particular programs. I chose the beach because, in my mind, I have always thought of the ocean as my ancestral home. I selected Revelle College at UCSD because my neighbor told me it was the easiest of the colleges at UCSD. It turns out that was maybe less than fully accurate. I selected my major as mathematics, which I figured I understood reasonably well, and my minor as Spanish literature because I loved languages.

I got to the end of my first year as an undergraduate at UCSD and saw an ad in the paper indicating a professor in the chemistry department was looking for someone who knew how to edit film—I had learned to edit film in a "Fundamentals of Film Production" class at San Fernando Valley State College, a college that was mostly a truck farm where my father bought corn. I met with the professor, Dr. Kent R. Wilson, and he asked me three questions: 1. Was I willing to learn how to program a computer? 2. Was I willing to teach myself computer graphics? and 3. Was I willing to write grant proposals? I said, "Yes, of course," of course.

COMPUTERS AND GRAPHICS

I became a research assistant in the chemistry department and began my computational journey. I am not proud—I learned to program by taking old listings out of the trash, code written by Bill Atkinson, and had the guy at the desk next to me, Bud Tribble, explain to me what was happening. I built a three-ring binder of "programming techniques." I started programming on an IBM 1800 computer (Figure 2) that had a Tektronix storage oscilloscope on it. The 1800 had previously been a shipboard computer for the Scripps Institute of Oceanography. There was a stop-action animation camera that had been used in *Citizen Kane*, so I was told, in front of the Tektronix that had a filter flipper in front of its lens so that we could color the graphics off the storage oscilloscope with red, green, and blue filters. We (Bud, Bill, and I and others) made

FIGURE 1. What the Google search attached to me.

an animated film called *Tainted Sky*. *Tainted Sky* was shown at the 1974 International Computer Film Festival, which I understand to be the first festival that focused on computer animated films. Therefore, I kind of stumbled into this field, and it was great fun to hang around smart and productive creatives.

Yes, I also wrote grant proposals to the National Science Foundation's Student Originated Studies Program and to the Regents of UC and funded the rest of my way through college.

In 1974, the professor I worked for purchased the Evans & Sutherland Picture System One (PS-1)—we got serial number one and connected it to a Digital Equipment Corporation PDP-11. The PS-1 was a calligraphic line drawing system that could draw 5,000 lines per frame before it flickered horribly.

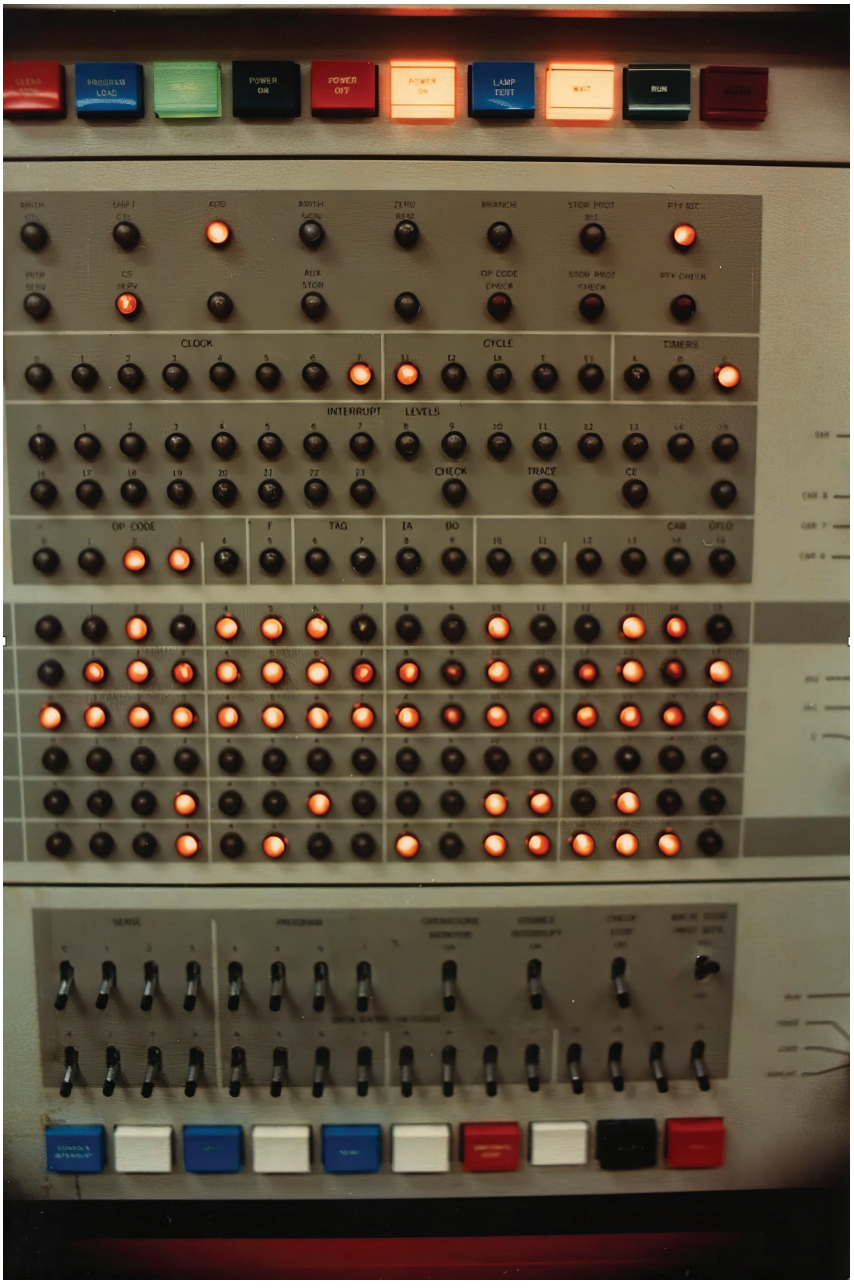

FIGURE 2. The IBM 1800 in all its switchy glory.

On that PS-1, I spent all of my time trying to build real-time animated displays for molecular modeling and quantum chemistry. I had to start by teaching myself quantum chemistry by reading all of the texts in my professor's office—he gave me a key so I could read there at night. In 1974, I started learning Unix.

In 1975, we added a floating-point systems array processor onto the PDP-11. I used it to develop control software for a force-feedback device called the *touchy-feely*. The touchy-feely allowed you to grab a ball connected to a tetrahedron of wires, with the wires connected to stepper motors. The stepper motors were driven by the modeled forces of the molecules being displayed. It was a VR haptic device in 1975. It was pretty cool until the wires snapped occasionally. About 10 years later, in Japan, a device called *Spidar* did about the same thing.

In 1976, I graduated from UCSD with a bachelor's degree in applied mechanics and engineering sciences/bioengineering and the minor in Spanish literature. I applied to a number of graduate schools and selected the University of Massachusetts, Amherst for a Ph.D. program in computer and information sciences. I started working with Andy Barto there and then switched to Victor Lesser, as Victor was closer to what I wanted to work on. I worked on modeling and simulating a large-scale processor similar to the Carnegie Mellon CM*. I built a 500-processor simulator and a molecular simulation that ran on top of that processor simulator and used up the entire graduate school's CPU cycles in my last semester there. I finished an M.S. in computer and information sciences at the end of my fourth semester. Almost all of the classes I took were on computational neuroscience and artificial intelligence (AI)—for the most part, I did not take meaningful courses on the fundamentals of computer science. The Commonwealth of Massachusetts passed a new law in my fourth semester that only allowed

four semesters of teaching assistant support for Ph.D. students.

WASHINGTON UNIVERSITY IN ST. LOUIS

In 1978, I moved to Washington University in St. Louis. I started in a joint Ph.D. program in physiology/biophysics and computer science. I stayed in that program for two years before I dropped out of the physiology/biophysics part. The joint program had me taking 11 units of physiology/biophysics at the medical school in the mornings with the medical students and nine units of computer science in the afternoons. When I entered that joint program, I was told a single Ph.D. dissertation could be written as long as it satisfied both degree programs. Unfortunately, I waited until about the two-year point when I asked the crucial question of each department—I asked the physiology/biophysics faculty what percentage of the dissertation had to be physiology/biophysics, and they said 95%. The computer science department said the same thing: 95% computer science. I dropped out of the physiology/biophysics part and focused on computer science.

At about that time, I started swimming with the St. Louis Masters Swim Club at lunch for 90 min every day and 3 h on Sunday. I still swim almost every day.

At Washington University, I worked in the Computer Systems Laboratory (CSL) designing graphics software to support the lab-designed workstations. The CSL had a research contract to design and build 16 graphics workstations for use by X-ray crystallographers. We used a Texas Instruments TI-980B as the central computer and designed our own graphics hardware. We actually manufactured all 16, and my role was to write the microcode that ran the graphics hardware and the software above that, which allowed computer graphics programs to be written by mere mortals. This turned out to be a lot of fun and some work, but the first eight workstations worked perfectly with my microcode. When we made the ninth workstation, we discovered that one of the integrated circuits we relied on to make the graphics hardware had been discontinued! All of a sudden, we had to put a different integrated circuit into the last eight workstations, which meant the microcode I wrote had to start out by finding out which version of machine was it! So this was fun. I worked for Charles Molnar at CSL, a legend and character in the computing industry since his time as a student at the Massachusetts Institute of Technology.

DISSERTATION

My D.Sc. dissertation was "Algorithm-Directed Architectures for Real-Time Surface Display Generation." With the new ability to create integrated circuits at that time, 1978–1984, what I was trying to do was figure out a way to create a class of surface display generation algorithms that could readily be put into silicon. I looked at 3D contour surface generation from collected 3D arrays of sensor data. The algorithm I created looks kind of like precursor work to the later marching cubes algorithm.[1] Unfortunately, my paper was submitted to the Association for Computing Machinery's (ACM's) *ACM Transactions on Graphics* (*TOG*) in September 1984 and was finally published without any changes in the April 1988 edition of *TOG*—the editor of *TOG* at the time had no explanation as to the delay.[2] My dissertation also looked at how to create 3D surfaces from planar contours.[3] When I look at back, what I was doing with this work was pointing the way toward the requirement for the creation of more general-purpose computational hardware—this was the pre-GPU era, and researchers were thinking about how to generalize the algorithms they were baking into very large-scale integration chips so that something more general, the GPU, could be built.

WORKING: 1978–1983

When I was at Washington University, my dissertation was separate from the work I was actually paid to do. I worked on creating computational algorithms for the conformational analysis of small drug molecules. That work was initially funded by the National Institutes of Health and then SmithKline, the drug company. The work I did was spun off into a start-up called *Tripos Associates*, and the algorithm I developed became part of their Sybyl tool. Seven years after I graduated from Washington University, I received a call from an engineer at Tripos asking me if I remembered the code I had written, as they needed someone to repair a software bug. Unfortunately, I no longer had a copy or memory of what they needed fixed.

When I look at back, what I was doing with this work was pointing the way toward the requirement for the creation of more general-purpose computational hardware.

NAVAL POSTGRADUATE SCHOOL

My dissertation defense was on 23 January 1984, and all went well. I had an invite to attend the unveiling of the Macintosh computer the next day but could not attend. I also was starting as an assistant professor at the Naval Postgraduate School (NPS) on 23 February. I chose NPS because it had the best swimming pool of any of the other schools where I had interviewed. I quit NPS in late 2004 when the two-star rear admiral who headed NPS decided to fill in their swimming pool with

sand. Despite that, I had a good almost 21 years at NPS.

Now, NPS is kind of a strange school—it has U.S. military, U.S. Department of Defense (DoD) civilians, and international partners as students in various master's and Ph.D. programs of interest to the DoD. When I arrived in February 1984, NPS looked like it hadn't hired much in the way of new faculty for something like 17 years. In 1984, things were turning around, and they hired 11 assistant professors. My office ended up being next to Dick Hamming's office, and, every day as I arrived, he would come over, sit in a chair uninvited, and look through new books and papers I had acquired but not yet read. He would then spend 45 min trying to give me guidance on how to be a great researcher and professor. He would then take my brand-new books and reprints and come back the next day having fully annotated almost every page, usually declaring that the book was "bullshit" and that I should not waste my time reading it. So I didn't.

I asked if there were any limitations on consulting, and my dean told me that I could consult for anyone from whom the U.S. government doesn't buy anything.

NPS is in one of the most expensive areas to live in the United States, so immediately I almost couldn't afford to live there. By the way, I started out US$36,000 a year in 1984. I went to my dean in October 1984 and told him, "I can't afford to live here. I'm going to leave." He said, "You can consult! We have permission from the Secretary of the Navy that allows faculty to consult outside at one day per week." (Secretary of the Navy Forrestal? 1947?) I asked if there were any limitations on consulting, and my dean told me that I could consult for anyone from whom the U.S. government (USG) doesn't buy anything. My dean had a great sense of humor! I decided to look for something outside the United States.

About the same time, my Silicon Graphics (SGI) salesman, Marvin Katich, came to visit me. He brought an SGI IRIS-1400 workstation to demo to my class. Now, this is a workstation with a Motorola 68010 processor, running at 10 MHz, and graphics hardware that could render about 500 polygons per frame without a Z-buffer! This was a very slow, very expensive machine—about US$60,000. I purchased one for my lab, as it looked promising. I think it had only 2 MB of memory. I began teaching my computer graphics class at NPS with this machine; the students had to sign up to get time slots of 2 h, and we had people signed up for 19 of 24 h daily.

Marvin Katich came back to me soon after I had the machine and asked me if I was interested in going to Japan to consult. I said, "Yes, of course." He asked me for a rate he could proffer to the companies involved. Now, SGI had sold two machines to Quadrex Corporation in San Jose, CA, USA. Quadrex doubled the price and sold them to Japan Tech Services Corporation in Tokyo, which increased the price. So, I quoted US$1,500 per day for all work and travel days and weekends, plus ¥25,000 in cash on arrival per day for expenses, plus hotels paid directly. Next thing I knew, I had a passport and a business visa for Japan, and I went to Tokyo and then Hitachi-shi to teach the employees of Hitachi-kojo how to use these workstations. I was there for three weeks with the group at Hitachi-kojo that designs nuclear power plants. I worked with them on how to use their workstations to build a CAD system for designing their power plants. I did three trips to Hitachi-shi, the first two to get their engineers up to speed and the third trip to help them figure out computer networking.

The computer networking trip to Hitachi-kojo was to be a class on image synthesis, but, when I got to Hitachi-kojo, they wanted something else. The engineers at Hitachi wanted to connect 16 SGI workstations in a matrix, with their screens aligned so that they could generate a high-resolution image with the synchronized output of the 16 machines. They wanted me to teach them networking. Well, I hadn't prepared anything for a networking class, so I called the SGI hotline collect from Hitachi-shi. I spoke to a great engineer there, Shaun Daredia, and had him read me the source code for the networking from the SGI flight simulator. This was 1987, and I didn't have access to e-mail or a fax machine. I started writing the code down on five different pieces of paper, running out of ink on two pens. I then spent a day putting together the code connecting the 16 machines. It worked great. We put the demo together, and then I flew back to California, bringing a copy of the code I wrote with me. This changed my career, and I spent the next 12 years focusing on how to network large-scale virtual environments and games.

BACK AT NPS

When I returned to NPS from Japan, I met with two of my students, Doug Smith and Dale Streyle. I told them we needed a vehicle simulator to play against the fiber optically guided missle (FOG-M) simulator. We used the networking software I had written in Japan and had this up and running almost immediately. One could drive the tank on the ground as the FOG-M tried to shoot that tank. This was 1987. It became the start of a long line of networked virtual environments. The networking effort grew larger. In 1988, we built the Moving Platform Simulator (MPS) 1, 2, and 3. We generalized what we did and made it so MPS could simulate just about any military vehicle.

In 1989, I began planning a new symposium, the ACM SIGGRAPH Symposium on Interactive 3D Graphics, to be held in 1990 in Snowbird, UT, USA. This came out of the 1986 Workshop on Interactive 3D Graphics held at the University of North Carolina, Chapel Hill. Fred Brooks, Henry Fuchs, Carlo Sequin, and Mary Whitton helped me turn that workshop into the permanent Symposium on Interactive 3D Graphics and Games that is still held today. At the 1990 symposium, my student Dave Pratt and I demoed our NPSNET-1 software, which was a direct descendant of our MPS virtual environment of 1988. We took NPSNET-1 to the 1991 SIGGRAPH Tomorrow's Realities Gallery (TRG) and demoed it on three SGI workstations, one being the SGI VGX, which could fill about 1 million triangles/s with one texture. At the 1991 TRG, I believe we were the only networked virtual environment being shown. A Defense Advanced Research Projects Agency (DARPA) program manager (PM) came by and told us he ought to be funding us for the DARPA Warbreaker Program. We received US$1.4 million per year for three years because we had been able to take our demo to SIGGRAPH and demo it live networked.

We built NPSNET-1, -2, -3 and got NPSNET-3 ready for demo at the 1993 SIGGRAPH TRG. After we were accepted by the conference, we rewrote the entire code and created NPSNET-4. We demoed NPSNET-4 on 60 SGI workstations in our booth at TRG! Our demos were fully networked with a T-1 link to DARPA in Virginia and to the Defense Simulation Internet in San Diego. We did a live demo to the director of DARPA and a video teleconference with the DARPA director from the show floor. We had eight-channel sound at 1,000 W per channel for our missile firings and explosions. Now, we did this demo joint with the Air Force Institute of Technology (AFIT), so we had a large crew of NPS and AFIT military officers to man our booth. We usually had a line of 50–60 people waiting to come into the booth. One day, most of the NPS guys were out of the booth, and I came back to a silent demo and no one in line. The AFIT guys had turned off the sound! The AFIT guys told us that, when they were out on a mission, they were in the sky and didn't hear anything. We turned the sound back on and again had our line of 50 conference attendees waiting to try out NPSNET-4.

THE NATIONAL RESEARCH COUNCIL

In 1992, I was appointed a member of the National Research Council (NRC) committee that put out the report *Virtual Reality—Scientific and Technological Challenges*.[6] The NRC is the operating arm of the National Academy of Sciences. Abraham Lincoln founded the National Academy of Sciences in 1863, with the purpose being to provide sage guidance from scientists and engineers to the USG. The purpose was to let the USG know what research and development areas it should fund with regard to science and technology. I ended up giving some 33 presentations of the results of that study to many governmental agencies and professional societies.

I chaired the NRC committee that put out the study *Modeling and Simulation—Linking Entertainment and Defense*.[7] That NRC report changed the entire DoD toward the usage of games and entertainment technology for its future modeling and simulation systems. From that report, I wrote the operating plan and research agenda that founded USC's Institute for Creative Technologies. In addition, I was asked by the U.S. Army to serve as the principal investigator and development director of the *America's Army* PC game funded by the assistant secretary of the army for manpower and reserve affairs. I took *America's Army* from conception to more than 3 million registered players and, hence, transformed Army recruiting. The creation of the *America's Army* game founded the serious games field.

For the NRC, I have served on committees for the Behavioral and Social Sciences and Education Commission;, Computer Science and Telecommunications Board; Aeronautics and Space Engineering Board; Mathematical Sciences and Their Applications Board; Naval Studies Board; Air Force Studies Board; Army Research Laboratory Technical Assessment Board; Board on Higher Education and Workforce; Board on Behavioral, Cognitive, and Sensory Sciences; Board on Earth Sciences and Resources; and Division of Engineering and Physical Sciences Tiger Standing Committee.

I hold a lifetime appointment as a National Associate of the National Academies, an appointment made by the Council of the National Academy of Sciences in November 2003, awarded in recognition of "extraordinary service" to the National Academies.

1993–1996

On Christmas Eve 1993, I received a call asking if my research group could put together a demo of NPSNET for the director of defense research and engineering, Anita Jones. The demo was slated for 14 February 1994. We were asked to work with two other partners: Sarcos Engineering of Salt Lake City, UT, USA, and the University of Pennsylvania. The demo was to place soldiers into fully instrumented bodysuits on locomotion platforms with instrumented weapons and place graphical avatars of the soldiers and their movements into NPSNET so that people could see the soldiers' movements across the Internet. Why not? We had this up and running on time for the demo—we only had to figure out how to create the new network packets required for the body movements and how to integrate the locomotion platforms and their movements into NPSNET. At this point, no one had ever shown a fully instrumented bodysuited person interacting with other people across the Internet. We did this demo, and it was documented by

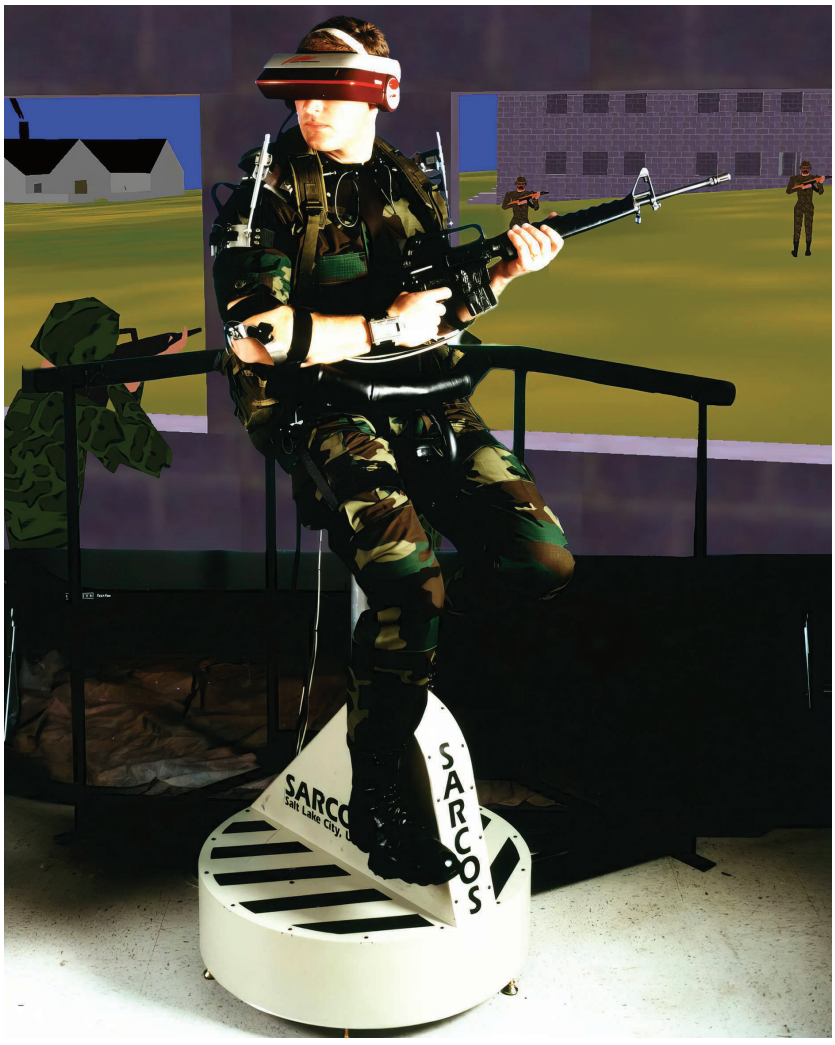

FIGURE 3. The NPSNET iPort demo.

FIGURE 4. The NPSNET Treadport demo.

Pratt et al.[4] We used special forces soldiers in the head-mounted displays (Figure 3)—soldiers who complained that we messed up their aim for several weeks afterward.

In 1995, we demoed NPSNET with a walk-in synthetic environment (Figure 4). The soldier walked on a standard hospital treadmill. The soldier was held by a robot arm so that the soldier could be recentered on the treadmill as he turned right or left. We used three large rear projectors to create a three-walled cave-like environment.

In October 1996, we used a device called the omnidirectional treadmill (ODT), which had two belts of rollers the soldier could walk on for locomotion (Figure 5). The soldier had a safety harness to an overhead gallows, just in case. The ODT generated something like 70–80 dB of continuous noise. That demo was our last funded NPSNET project, as the DoD declared victory with respect to the networking of virtual environments.

THE MOVES INSTITUTE AND MOVES DEGREE PROGRAM

In 1996, I founded the MOVES master's and Ph.D. programs at NPS. *MOVES* stands for "modeling, virtual environments, and simulation." The degree programs were one-third computer science, one-third mathematical modeling from the operations analysis perspective, and one-third new courses on modeling human behaviors. With George Phillips, I helped found the subspecialty in modeling and simulation for the U.S. Navy, the simulation operations functional area (57) for the U.S. Army, and the simulation operations area [Military Occupational Specialty (MOS-9625)] for the U.S. Marine Corps.

The MOVES Institute I founded in 2000 by taking the remaining NPSNET Research Group funding and faculty—we had about US$4 million of research money to start and grew to 71 faculty and staff and about US$19 million in research funding by 2004.

ENTERTAINMENT INDUSTRY CONSULTING: 1997–1999

In 1997, the NRC study I chaired issued a report, *Modeling and Simulation—Linking Entertainment and Defense* (Figure 6). My consulting moved from Japan to various entertainment groups. From January through September 1997, I worked as a consultant to Paramount with the *Star Trek Voyager* creative team. The goal was to develop a piece of software called the *Story Drive Engine*—in modern times, this would be done with machine learning. The goal was to take the story bible of *Star Trek* and put it into a machine learning system that could help writers produce the next episode of *Voyager*. The project turned out to be way too early. Today, you might be able to do this with ChatGPT, and we should try. My time at Paramount was great fun—they gave me a driver who would take me to/from Los Angeles International Airport (LAX) by picking me up at the LAX gate. My name was at the gate at Paramount, and I could walk around and visit the streets of New York and other adventures. I had a great time!

The year 1998 was the height of the Internet boom. It became impossible to keep technical people inside the USG, as everyone wanted to work in industry for a chance at becoming an instant billionaire. I was an advisor for Muse3d, which was trying to create a web browser you could read while moving around inside a 3D virtual environment. I became an advisor for SpiritChannel.com, whose CEO was Isaac Tigrett. Isaac was the cofounder of the Hard Rock Café and the founder of the House of Blues and now was trying to create an online channel for the sayings and teachings of the Dalai Lama. All of our meetings were in New York City (NYC) at the Trump Tower, where Isaac lived. This project did not last long, as there was not much venture capital money in that space, but driving around NYC in limos was great fun.

From 1996 through 1999, I cowrote a book with Sandeep Singhal, *Networked Virtual Environments—Design and Implementation* (Figure 7). In 1995, the Defense Modeling and Simulation Office ceased funding research on work in networked environments, and Sandeep and I decided to take 12 years of our efforts and put them into archival form. Sandeep was a student of David Cheriton at Stanford when I first met him in 1994, and drafting a text with him was a great joy. That text became the guidebook for the creation of application layer infrastructures for networked games.

FIGURE 5. The NPSNET ODT demo.

2000–2004

In May through October 2004, I did multiple interviews to be CTO for the Walt Disney Corporation and director of Disney Imagineering. This was very exciting, and I really wanted the position! My understanding is they only interviewed three people. I ended up being the number one candidate according to the headhunter, but Disney had a chief scientist, Eric Haseltine, whom they made CTO. It turned out to be a good thing, though, as I started the *America's Army* project in May 2000, just as that first interview was happening at Disney.

AMERICA'S ARMY: 1999–2004

I am not going to talk much about the *America's Army* game, as one of my recent articles in *IEEE Computer* covered that game's development and operation in good detail.[5] Basically, I built a game development studio inside NPS's MOVES Institute. We shipped the game on time on the 4 July 2002 and additional levels almost every 90 days after that until March 2004, when

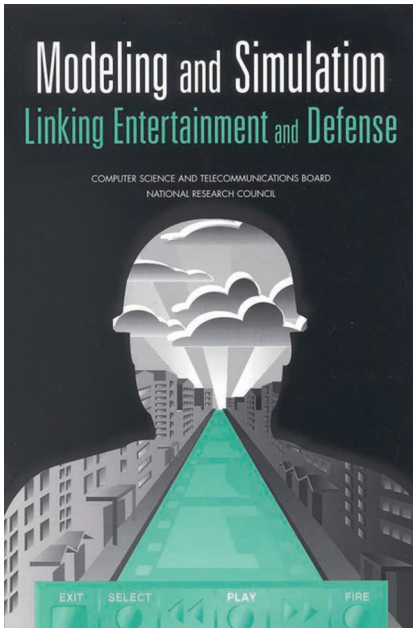

FIGURE 6. The NRC study *Modeling and Simulation—Linking Entertainment and Defense*.[6]

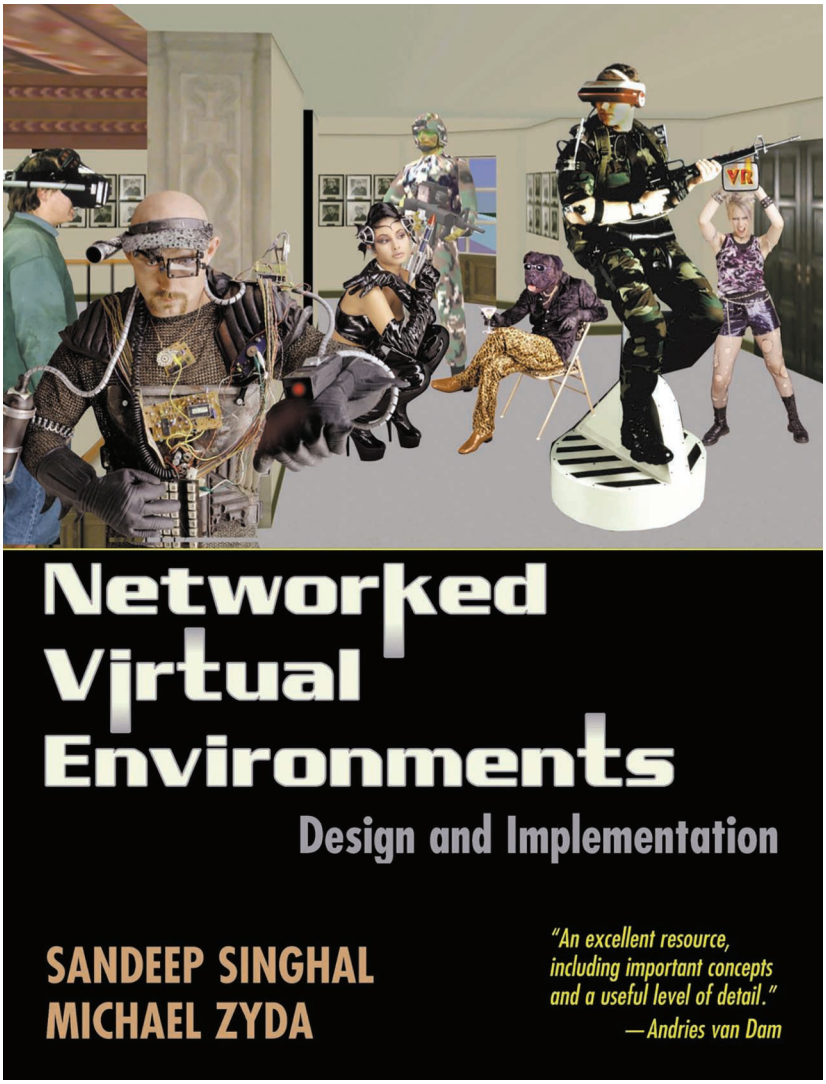

FIGURE 7. Singhal and Zyda's *Networked Virtual Environments*.[7]

the Army PM for the project decided he would rather produce the game himself in an abandoned warehouse at Fort Ord. At the time that decision was made, *America's Army* was one of the top five played online games and had a vibrant development team of 26. With the move to the warehouse and change in management, the development team went to a remaining six people in one day. It then took the PM five years to ship the next version of the game—that new development team was fired the day the game went online, and the game crashed the next day with no one remaining to get the game back up. Not my problem.

USC GAMEPIPE LABORATORY: 2005–2019

With the abrupt closure of the *America's Army* game project at NPS and the decision of the NPS superintendent to fill in their beautiful swimming pool with sand, I decided to call up USC's dean of engineering to ask him to make me a position at USC where I could found the games program in a laboratory called the USC GamePipe Laboratory. I designed the B.S. in computer science (games) and the M.S. in computer science (game development) as well as the year-long advanced game projects course that I made joint with the USC School of Cinematic Arts Interactive Media Program's B.A. and M.F.A. in interactive media design. I ran this program from 2005 to May 2019, placing 4,000 graduates into positions in the games and computing industries. The program was a rocking success and became rated the number one program in the world almost every year over the last decade.

AWARDS

At NPS and USC, I received many awards, and these are presented as a list as opposed to being squashed into a paragraph:

- In 2002, I received the Pioneer Certificate from the Modeling and Simulation Professional Certification Commission, along with 26 other pioneers.
- In 2003, the MOVES Institute was a finalist for Best Technology Organization along with IBM and the Sony PlayStation 2 Group.
- In November 2003, I was given a lifetime appointment as a National Associate of the National Academies, an appointment made by the Council of the National Academy of Sciences in November 2003, awarded in recognition of "extraordinary service" to the National Academies.
- My students put together a game called *Trainer* that became the grand prize winner in Michelle Obama's White House competition in September 2010. *Trainer* won best game and best overall in the contest.
- On 13 March 2022, I became an inaugural member of the IEEE Visualization and Graphics Technical Committee Virtual Reality Academy.
- On 6 June 2021, I was made a fellow of the Asia-Pacific AI Association.
- On 13 January 2021, I was promoted to ACM fellow "for contributions to game design, game

COMMENTS?

If you have comments about this article, or topics or references I should have cited or you want to rant back to me on why what I say is nonsense, I want to hear. Every time we finish one of these columns, and it goes to print, what I'm going to do is get it up online and maybe point to it at my Facebook (mikezyda) and my LinkedIn (mikezyda) pages so that I can receive comments from you. Maybe we'll react to some of those comments in future columns or online to enlighten you in real time! This is the "Games" column. You have a wonderful day.

and virtual reality networking, and body tracking."

- On 11 February 2020, the National Academy of Inventors elected me as a senior member for "success in patents, licensing, and commercialization" and for producing "technologies that have brought, or aspire to bring, real impact on the welfare of society." In May 2017, I was appointed a member of the National Academy of Inventors in recognition of advanced technological development and innovation, as issued by the U.S. Patent and Trademark Office.
- In August 2019, I was appointed a distinguished collaborator for the Stanford Human Perception Laboratory affiliated with the Institute for Human-Centered AI.
- In November 2018, I was promoted to IEEE Fellow with the citation "for contributions to game design and networking."
- In March 2017, I was awarded the IEEE Virtual Reality Technical Achievement Award "for fundamental work in virtual reality networking, body tracking, and institutionalizing the application of VR."

That last bullet point is where the question about my career started. I need to wrap this up before I put you to sleep.

EXPERT WITNESS

I have been expert witness for 58 game and computing companies, mostly for patent litigation but some for purported intellectual property theft. I was an expert for Meta and Mark Zuckerberg in the *Federal Trade Commission (FTC) v. Meta* case brought by the FTC. These cases have helped me understand how to write patents that can survive litigation, and now I understand the arcane merger guidelines perpetrated by the FTC.

START-UPS

I have been advisor to more than 20 start-ups in the games and computing technologies industry. Start-ups are where American innovation goes for commercialization. Start-ups are important, and universities that haven't figured this out never make the top 10. The best list of which start-ups is on my LinkedIn page.

SWIMMING

As stated before, I started swimming in graduate school seven days a week, usually 2,000 yd or 2,000 m, depending on the length of the pool. This is about 35 mi per month for the last 42 years. It clears my head and makes my day great! I swim before my first meeting every day.

The purpose of this column was to provide an understanding to the reader of the answer to the question, "How did I get there?" in abbreviated form. This may help the reader understand some of the path taken by one professor, knowing full well that every professor has such a story. Have a great day!

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