Feeding the Machine for Good: An Intersection of Science & Creativity

Dr. Bill Swartout '70 creates AI systems to inform, educate, and heal

In the 1969-1970 academic year at St. Louis Country Day School, senior Bill Swartout navigated the catwalk in Orthwein Theatre numerous times, setting up lighting rigs for Troubadours and Masque productions such as Abbott and Loesser's *Where's Charley?* and N.F. Simpson's *One Way Pendulum,* pondering if he would pursue filmmaking or computer science after graduation. He ultimately chose computer science, but little did he know that his two interests would finally intersect two decades after landing his first role in the field.

Today, as Chief Technology Officer at the USC Institute for Creative Technologies and a research professor in computer science at the University of Southern California, Swartout is involved in developing artificial intelligence (AI) systems where he focuses on virtual humans, explanation and text generation, knowledge acquisition and representation, intelligent computer-based education, and the development of new AI architectures.

When AI was a mere twinkle in the universe, Swartout entered seventh grade at CDS—immediately impacted by his science teacher, Mr. Fredrickson ("Mr. Fred"), who was highly skilled at engaging students, encouraging critical thinking, and involving them deeply in the subject. Later, it was a spark from Mr. Webb, who formed the first Computer Club where Swartout and his buddy Paul Anagnostopoulos had their first experience in programming computers. Swartout said, "Paul's dad worked in the research department at Monsanto then, and he had access to some computers. So we got to trundle down to Monsanto on the weekends with our little card decks to program the computer. And later, Mary

01/02. Images taken by Swartout of Troubadours and Masque productions in the 1969-1970 academic year

03. A snowy day image taken by Swartout for the CODASCO 1970 yearbook.

Institute got its own computer, and I remember getting permission to go over there and use it. So that was great fun."

At the same time, Swartout was using his creative and technical skills on the lighting and sound crews for Troubadours and Masque productions and as a photographer for *CDS News* and the CODASCO yearbook. "I was involved in many of the dramatic productions in Danforth Chapel where the lights were operated with dimmers with patents from the 1900s, and they would spark when rotated like something out of Frankenstein. When we moved to the "New Theatre" (now Orthwein Theatre), there were catwalks, and you could just go out and change the lights in a more straightforward way." Swartout nurtured his split interests in science and the arts, even creating a few films at CDS, one of which was a student film with his classmates Anagnostopoulos, Harold Bible, and Cappy Grossman about environmental issues. It won first place in a St. Louis area high school film contest. The film led to another project encouraged by CDS faculty member Bob

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"One of the things I learned at Country Day was how to work on projects as a team and what you need to make a team work. The student movie we made was just one example of a year-long project. I looked back at it at the end and said if I knew how hard this would be when I started, I would never have started. All the best things I've done in my life are of that sort, things that seemed really daunting, but if you stuck to it, you got a good result."

BILL SWARTOUT

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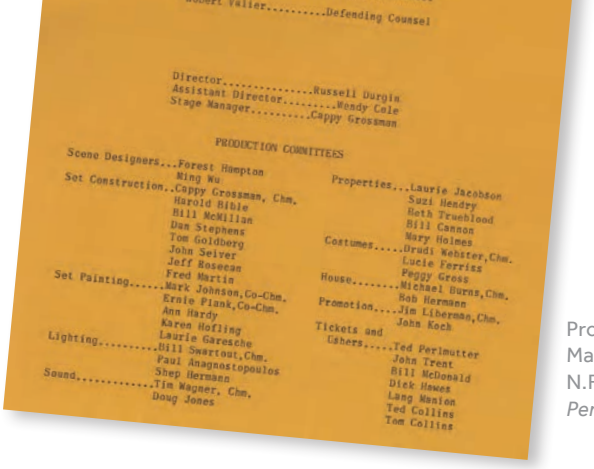
Simpson, who left CDS to work at the Social Health Association of St. Louis. "The organization provided sex education materials to public schools and needed a film to show at school PTA meetings to convince the parents that this was a good idea, so we made a film that demonstrated what material the students will cover in the class and to demystify it for parents. Years later, the organization got back in touch with me for a new copy because they had shown the sprockets off of the first one," he said.

As he approached graduation in 1970, the split interests felt more disparate. He said, "Do I want to become a filmmaker, or do I want to become a computer scientist? There wasn't much mathematics in filmmaking or much creativity in computer science. I remember talking to my dad, and he said in a good midwestern fatherly sort of way, 'Well, Bill, you know, if you go into computer science, you'll probably always have a job.' I was probably a little more talented in computer science, so I went in that direction but remained interested in filmmaking."

After CDS, Swartout attended Stanford and pursued his master's degree and doctorate at the Massachusetts Institute of Technology. Swartout laughed and said, "When I was at Stanford, I kept trying to get into the filmmaking course, and I could never get in because it was only for film majors. So one summer, I volunteered as an assistant cameraman for KETC in St. Louis, which was a lot of fun. And at the same time, I got into the computer science and AI field because it seemed amazing if you could create a computer you could converse with."

Image of Swartout with camera from his 1970 CODASCO yearbook senior page and program from the 1969-70 Troubadours production of Abbott and Loesser's *Where's Charley?*



Director.....Russell Durgin
Assistant Director.....Wendy Cole
Stage Manager.....Cappy Grossman

PRODUCTION COMMITTEES

Scene Designers...Forest Hampton, Ming Wu
Set Construction..Cappy Grossman, Chm., Harold Bible, Bill McMillan, Dan Stephens, Tom Goldberg, John Selver, Jeff Roseman
Set Painting.....Fred Martin, Mark Johnson, Co-Chm., Ernie Plank, Co-Chm., Ann Hardy, Karen Hofling, Laurie Garesche
Lighting.....Bill Swartout, Chm., Paul Anagnostopoulos, Shep Hermann
Sound.....Tim Wagner, Chm., Doug Jones
Properties...Laurie Jacobson, Suzi Hendry, Beth Trueblood, Bill Cannon, Mary Holmes
Costumes.....Drudi Webster, Chm., Lucie Ferriss, Peggy Gross
House.....Michael Burns, Chm., Bob Hermann
Promotion....Jim Liberman, Chm., John Koch
Tickets and Ushers....Ted Perlmutter, John Trent, Bill McDonald, Dick Howes, Lang Wanion, Ted Collins, Tom Collins

Program from the 1969-70 Masque production of N.F. Simpson's *One Way Pendulum*

Stanford also sparked his love affair with California and warm weather, and the brutal winters at MIT sealed the deal. Swartout landed a role at USC working in the Information Sciences Institute, which eventually started an AI division. Swartout became director of that division, grew it, and left to run a new USC entity, the Institute for Creative Technologies (ICT), where he remains more than two decades later. The ICT was established in partnership with the Department of Defense (DoD) to bring together research in advanced technology such as AI, computer graphics, virtual and augmented reality, and the learning sciences to work with creatives from the entertainment industry who know how to create compelling content, to develop the next generation of systems for training and education.

The Birth of Artificial Intelligence

AI at the time of Swartout's graduation was different than today. "Instead of using machine learning that you hear about now, in the latter part of the 70s and early 80s, people used various rule-based architectures: if this condition is met, then take this action, and build from there. Earlier models used logic, having the computer do proofs that were very slow. The next idea on the scene was giving the computer a knowledge base about a particular topic. Then a big area became 'how do you represent knowledge in a computer?' It's like a database but different because it represents principles about the world, giving it a significant leg up in solving problems. Instead of deriving everything from scratch, it knew the answer based on the knowledge within," he said.

Swartout was also involved in the clinical decision-making group at MIT, trying to build AI systems to help physicians with diagnoses or therapies. "We created a system that offers a physician some advice about a patient," said Swartout. "But what's also important is to explain why that advice is a good idea. Which led to the area of knowledge explanation." He added, "The current technology is more of the machine learning / neural net approach, which considers many factors to produce a result. But it takes different activation levels of various things to make it

happen. It's hard to turn that into a natural language explanation, so naturally, people have struggled with it. Until we solve that particular nugget, it will limit the use of the technology because people won't know if they can trust the results they're getting."

The Intersection of Science and Art

In the late 1990s, computers and video games started to look and play really well, and computers were getting much faster. "The military was noticing this and saying that these video games were better than some military simulations that cost millions of dollars and have to run on a computer the size of a refrigerator," Swartout said. So the DoD sponsored a study with the National Research Council to see if there would be something to gain by bringing together people from the entertainment industry, academia, and the military. The study found that to be a promising idea, and the next question was how to make it happen. Ultimately, the DoD determined the best approach would be to set up an institute at a university, which could serve as a meeting ground bringing together technology, the entertainment industry, and the military, giving rise to the ICT.

Swartout was thrilled. "When I heard about this, I was like, 'Sign me up!' My two interests could finally come back together again," he said. "Think about films these days; if you stick around for the credits, they've gotten a lot longer because of all the digital arts involved in filmmaking, and some of the technology we created at the Institute is actually involved in that." For example, his team built a device called a Light Stage, a large geodesic dome with LED lights inside. A person can be filmed under various lighting conditions in the dome, creating a 3D model of the person that can be animated and relit under arbitrary conditions. The ICT team has even won a few Technical Academy Awards for their work. "We've used this for the military and are talking about using it to create personalized avatars for people. So if you're in a simulation with your teammates rehearsing a maneuver, you have teammates that actually look like your real-life colleagues, and we can take into account their other skills like marksmanship, navigation, etc.," he added.

The Light Stage avatar work led to more projects with the military helping veterans and active duty soldiers with Post-Traumatic Stress Disorder (PTSD). Swartout's colleagues tackled the issue by assisting soldiers in reliving the traumatic experience using virtual reality accompanied by a therapist providing a safe context. "It's been found to be as effective as conventional therapy and works on people who have failed it. We had an early group in our study who had failed conventional therapy, and at the end of the ten weeks, around 70 to 80% were no longer considered to have PTSD," Swartout said.

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01. Bill hiking the Yosemite Falls Trail.

02. Bill with wife, Jane, off of St. John's in the Caribbean.

Pinchas Gutter, the first holocaust survivor recorded in the Light Stage.

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Building a Better World

Swartout's pride and joy is a project with the Shoah Foundation, an organization that provides an opportunity for survivors and witnesses of the Holocaust to tell their own stories in audio-visual interviews and make them accessible for research, education, and outreach. "They came to us several years ago and shared that a highlight of going to a holocaust museum is talking to a living holocaust survivor and conversing with them. And the problem is, they're all getting a lot older, and we are the last generation with access to these stories," Swartout said. To preserve the stories, the ICT worked with holocaust museums to develop a list of questions that museum visitors typically ask, and they brought survivors into the lab. Using the Light Stage, the team asked questions and recorded the survivors' answers to create a database of questions and corresponding answers. They recorded 1,700+ responses and fed them into the natural language system on site, forming a predictive model with off-the-shelf speech recognition that provides the best-fit answer. "All this happens very fast, and it works well. When visitors start to feel that they are in a conversation, the AI technology behind it disappears as they engage in the stories being told. It has a real emotional impact on people," said Swartout. This technology has been exhibited at the National Holocaust Museum and is on permanent display at the Holocaust Museum in Skokie, Illinois.

Swartout is also excited about the scalability of this method. The same technology has been used to record military members who are survivors of sexual assault so that the Army can train counselors who treat people who have experienced assault. "The number of people willing to talk about their experiences is fairly small, and one willing to share it publicly is even smaller. But it only takes one to make it available on a larger scale," he said.

In addition to creating virtual avatars for storytelling and advice as mentors, Swartout is on a team starting up a new center on AI and learning to develop AI-based tools to tutor and educate individuals. The center will also develop content to train people on AI and help upskill them for future jobs that will require some AI literacy. He is also co-director of a new Center on Generative AI and Society that USC has just started that will research how generative AI may be used for good.

He said, "You see a lot of doomsday articles that say with ChatGPT, the term paper or college essay is dead. In education, there have been two main approaches to dealing with it. One is to try to detect and discourage when a student is using it. The other is it's here, and we've got to understand it. The analogy that's often drawn is to calculators. When those came out, all of a sudden, math educators panicked, and what happened was that math education changed.

"That's what has to happen here. We are building studies of best practices and other factors and creating a framework to improve a student's critical thinking skills. It's taking an approach I call 'authoring by editing,' creating an initial draft with something like ChatGPT, then looking critically at what's written. Are all the facts correct? Does the argument make sense? Are there other arguments to consider? Then you have to edit what's there and produce something better, and your edits get tracked and classified. And that forms the basis of your evaluation of that assignment. By moving away from grading an artifact, such as an essay, to grading the process, such as the edits that produced it, everything becomes more resistant to cheating and results in a grade that should better reflect the student's thinking. Hopefully, this will improve critical thinking skills from a larger society standpoint, which will be imperative going into the future because so much text will be produced mechanically."

To combat the doomsday feelings, students in today's world must be what Swartout refers to as 'AI literate.' He said, "It doesn't mean you have to know how to program AI, but you need to understand what it can and can't do, where it's going, and what the issues are."

In today's rapidly-changing world, one of the values Swartout employs and thrives on each day at the Institute was formed during his years at CDS: teamwork. He said, "One of the things I learned at Country Day was how to work on projects as a team and what you need to make a team work. The student movie we made was just one example of a year-long project. I looked back at it at the end and said if I knew how hard this would be when I started, I would never have started. All the best things I've done in my life are of that sort, things that seemed really daunting, but if you stuck to it, you got a good result."

Not knowing where his path would lead, Swartout's insatiable curiosity and passion for creativity led to a beautiful blend of work in science and creativity, always with a personal mission to preserve, elevate, and optimize the human experience through technology. Something he could never have imagined while adjusting lighting rigs on the catwalk in Orthwein Theatre.

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SENIOR PROFILE BY RUSS DURGIN, CDS ENGLISH DEPARTMENT

Purity of heart is to will one thing. Concentration in its willing one thing has purity of heart and mind. Only the genius and the saint know these things for sure, but all men have flashed intimations of these things.

Bill Swartout usually works with images of the eye, not images of the word. He creates with the camera lens and with 32 theatre lights as his searching, concentrating eye chisels blue lights on a black stage to render the design and the tone for wild Lear on the heath. Somehow, somewhere, sometime, at least a number of years ago, Bill began to see things differently; and he became curious about what light can do to the mind and feelings of people. For four years the people in the school have quietly become a part of the expanding vision of this concentrating eye.

Quietly and largely unknown—for the light designer, the lighting man, and the photographer work in the dark, often alone, and never in his own lights—Bill has become a master of his art in his passion for perfection. A hundred hours moving ellipsoidals and fresnels, edging areas, sculpting forms of light on the black stage or on the enlarging frame to create wonder: the writer is given a new focus for his work; the actor comes alive; reader and audience see new things or see old things new.

Bill is the last of our lone lighting men; he marks the transition from mad Wyndom to ten lighting workshop boys. In Danforth Chapel, lighting men improvised constantly, playing with inadequate circuitry, tempting fuses to many crises, losing lights, but finally winning in ways that couldn't be done; all off a six dimmer unit and little power.' Nine years of improvising on limitations taught Wyndom Hannaway, Boyd Ostroff, and Bill Swartout the art of juggling lights. And then, this year in the new Theatre in Orthwein Hall, Bill took over a new world, with thirty dimming units, thirty-two lamps, and a two-scene preset light console. Rather than simply delight in the beautiful new system, Bill, trained by limitations for challenge, continued to work intricately, with concentration.

Bill went beyond the self-mastery of knowledge to become a teacher to many students this year. First he worked with Paul Aganostopolous (Aggie) and actor Larry Lawless to wire the lamps and check-out the system; then he cleared Shep Hermann, Larry Reed and Jeff McFarland. This team designed the lighting for the Troubadours and the Masque, and two of them, Junior Larry Reed and Freshman Jeff McFarland, took over the lighting for the plays in the Arts Festival.

Bill also held lighting workshops at which some ten underclassmen learned the fundamentals of theatre lighting. Next year directors and teachers will have some fifteen students to operate the lighting console for English classes or to design and set lamps for productions. The era of the one light man has passed, partly because of the grand learning facility made possible by the devotion of alumni, parents, and friends of the school and by the labors of architects, faculty, and tech men, and partly because of Bill's attitude toward the new facility: that it be a learning situation for as many students as possible.

This is Bill's other excellence: he is a team and project man (and an after-hours man), and he has become a fine teacher. His knowledge and his patience are balanced by his sense of humor and the fun of it all. I still hear his uncat-like tromp on the cat-walk.