# From a Teapot to Toy Story, and Beyond: A Reflection on Utah, Computer Science, and Culture

**Jeffrey R. Yost**

*Abstract: Dave Evans and Ivan Sutherland pioneered computer graphics in the 1960s, then joined forces in 1968 to cultivate and extend a unique center of excellence at the University of Utah and start a company. Under their leadership, the University of Utah's Computer Science (CS) Department, and their company Evans and Sutherland, catalyzed vast research and tools that changed our world—pioneering in virtual reality, object-oriented programming, CAD, simulation, GUI, HCI, and more. Utah CS alumni founded (or co-founded) Atari, Silicon Graphics, Pixar, Adobe, and Netscape. Alums also joined the faculty of Caltech, Utah, Stanford, Carnegie Mellon, and other top CS departments; as well as led at standout industrial labs—from 1970s Xerox PARC to Nvidia today. In this essay, I reflect on two remarkable days (23-24 March 2023) of history-focused symposia of Utah's Kahlert School of Computing.*

Utah is an unparalleled exemplar of how creating a global center of excellence in an emerging specialty of computer science and engineering is possible with government seed funding. It was a special moment when the Advanced Research Project Agency's Information Processing Techniques Office (ARPA, IPTO) awarded the University of Utah $5 million ($43 million in today's dollars) over six years, 1966 to 1972, for a project entitled "Graphical Man-Machine Communication" to launch the field of computer graphics and create a leading center for research and education. Three years earlier IPTO funded "Mathematics and Computation," or Project MAC at MIT, also for six years, 1963 to 1969 (initially $2 million/year, but this grew to over $3 million/year). Given MIT's Whirlwind (a real-time precursor to SAGE) in 1951, launching Lincoln Lab in that same year, and MIT spinoff nonprofit MITRE Corporation, in Bedford, Massachusetts, in 1958, past, major Department of Defense support had helped make MIT a top computing center prior. As such, Project Mac extended core areas of research and made an excellent computer science program far stronger. What was impressive about Utah was IPTO provided a half dozen years of support, far less than half the funds that IPTO awarded to Project MAC, and extremely talented and creative people ran with it and created a center of excellence anew. The Kahlert School has embraced the words of one its most famed and early doctorates (1969), Turing Award winner Alan Kay, "The best way to predict the future is to invent it."

Dave Evans, Ivan Sutherland, other faculty, and graduate students made it happen in Utah. It changed from a program to a department (1973) to a school (2000), and throughout, it has achieved amazing feats. What came through so strongly in hearing talks, panel discussions, and meeting and engaging in conversations with the pioneers over two days in Utah this March, is that the research and development extending from the University of Utah and its alumni, was and is a product of a quite special culture.

The Original Utah Teapot, on display at the Computer History Museum, Mountain View California, photo courtesy of https://www.flickr.com/photos/lifeontheedge/352811902/.

Through the great leadership of Kahlert School of Computing Director Mary Hall, and the tremendous faculty at the school, that core, special culture, with some newer elements and commitments added, thrives today. Utah is one of the leaders in computer science and remains unmatched in graphics within computer science. The Kahlert School of Computing also impacts the world with newer tracks, such as Data Science and Software Development, and possesses a strong commitment to diversity, equity, and inclusion. Joining Hall and Dean of Engineering Richard B. Brown in this commitment to excellence and inclusion, it was also a pleasure to meet Vice President of the Kahlert Foundation, Heather Kahlert. The foundation's support to the school recently led to its naming to become the Kahlert School of Computing, and her family foundation has supported an important initiative on inclusivity within the school, entitled "Programming for All." Also impactful, John and Marcia Price recently made a $50 million donation to the College of Engineering, and their lead gift made the new, $190 million, John and Marcia Price building possible. Opening soon, it will house the Kahlert School of Computing and allow for its rapid expansion of existing and new areas of computing education and research.

Graphical rendering of the new John & Marcia Price Computing & Engineering Building currently being built on the University of Utah's campus in Salt Lake City, photo of placard at event, Jeffrey Yost.

There actually were three events on 23-24 March 2023 held in unison—the full day *50th Anniversary of the Computer Science Department of the University of Utah;* followed on the second day morning *IEEE Milestone Dedication*; and then the afternoon *Graphics Symposium*. The three were complementary, reinforcing and expanding on each other in highly constructive ways. Most of the time, the program focused on looking back, but importantly, it also looked forward. Contributing to both was a fantastic day one keynote by Telle Whitney, past, longtime CEO of the Anita Borg Foundation. Whitney is also co-founder of the Grace Murray Hopper Celebration, as well as of the National Center for Women and Information Technology (NCWIT). Nobody has done more to advance women in computing than Telle Whitney and to carry on the early work of her fellow computer scientist and collaborator Anita Borg.

On day two, consultant and IEEE Milestone Coordinator Brian Berg awarded an IEEE Milestone to the University of Utah Kahlert School of Computing for the department/school's pioneering work in graphics. Berg presented the award to the school's Director, Mary Hall, and the Dean of Engineering, Richard B. Brown.

This prestigious IEEE Milestone Award is an elite designation in technology. In computing, developments such as Bletchley Park Code-breaking; the ENIAC; MIT's Whirlwind Computer (real-time); Moore's Law; UCLA, and the (ARPAnet)/Internet have been awarded IEEE Milestones (which includes a bronze plaque—on day two, a video of Hall and Brown's unveiling of the Utah CS plaque was played). Outside of computing, IEEE Milestones include Samuel Morse and Alfred Vail's "Demonstration of Practical Telegraphy" in 1838; "Thomas Alva Edison's Menlo Park Laboratory" created in 1876; and "Reginald Fessenden Wireless Radio Broadcast" in 1906. In short, it is a major honor and a useful IEEE program commemorating and exploring the past. Brian Berg has added much to the IEEE Milestone program, for more than a dozen years leading many IEEE Milestone efforts in the history of computing, software, and networking for IEEE Region 6, the Western United States.

Hall organized and was Master of Ceremonies for the magnificent day one "50th Anniversary of Computer Science at the University of Utah" symposium. She kicked off the event with an informative historical overview, drawing on the David Evans Papers and other archival materials.

Kahlert School of Computing Director Mary Hall.

**Odd Ducks and Grand Challenges**

ARPA funding was a necessary but not in itself sufficient element to foster Utah leading the way with the computer graphics revolution. Even having two of the most brilliant pioneers in computer graphics—hiring David Evans in 1965 to start the CS program and attracting Ivan Sutherland away from Harvard to join Evans—was not enough. The final, and arguably the most important ingredient, was the environment and culture that Evans set starting with his arrival (leaving the faculty of Cal Berkeley) in the mid-1960s, and that Sutherland contributed to mightily as well with his arrival in 1968.

There were other standout faculty in the early years, including but not limited to William Viavant, who served from 1964 to 1987, and the late Elliott Organick, who contributed to operating systems research and education and related areas of computer science with his nineteen books—including one I have devoured again and again on Multics and its security design (security and privacy are two of my areas of historical and sociological research). Also contributing to first-day events were impactful faculty who joined the department in the 1980s and beyond. They added greatly to the event and showed the breadth of the department in so many areas of computer science—Al Davis, Duane Call, Chuck Seitz, and Rajeev Balasubramonian. Program alum, Kahlert School Research Professor, and Flux Research Team Co-Director Robert Ricci's moderation of a panel with graduates David Andersen of Carnegie Mellon and Cody Cutler from Amazon was especially intriguing in exploring "…Network Research, from ARPANET to Emulab and Beyond."

Alan Kay is among the first and most famed of Utah CS doctoral alums (1969). His quote on inventing the future is fitting given he helped build the office of the future at Xerox PARC in the 1970s. Kay provided leadership in creating windows-oriented graphical user interfaces (GUI) and made major contributions to object-oriented programming (OOP), including his pivotal leadership creating the OOP-optimized

Smalltalk language with Adele Goldberg, Dan Ingalls, and others. Kay's presentation was by video, and focused on Dave Evans, Ivan Sutherland, and the environment of CS at Utah in the 1960s. Another, early and long-famed graduate, Jim Clark, also invented the future in founding Silicon Graphics and later Netscape. He, too, gave a brief and inspired talk on day one—his was in person.

As a social and organizational historian of computing, Utah has long fascinated me, and I have enjoyed the oral histories that have been conducted by past and current colleagues of the organization I am now privileged to direct, The Charles Babbage Institute for Computing, Information, and Culture. Perusing our unparalleled archives on computer graphics (many collections), and reading and re-reading the secondary literature has been a joy—including and especially past CBI Tomash Fellow Jacob Gaboury's stellar, award-winning new book, *Image Objects: An Archeology of Computer Graphics*, and long ago, Founding CBI Director Arthur Norberg and Judy O'Neill's classic *Transforming Computer Technology: Information Processing for the Pentagon, 1962-1986*.

How does an ARPA grant and two extremely gifted scientists create an unparalleled global center of excellence at a state school with a smaller state population (about 30$^{th}$)? How does it succeed in fostering such an organizational culture to attract and cultivate the people to succeed on such a grand scale? Beyond Evan and Sutherland's leadership gifts, high standards, and generosity, I would argue that not being surrounded by an overall, existing elite (Ivy or equivalent like MIT or Stanford) institution was a major plus. It helped facilitate the freedom for the faculty and students to experiment, to take risks, and to think big. That was my belief before traveling to Utah for the two days of events, and it was reinforced by the program, reminiscences, and discussions there.

Evans and Sutherland's entrepreneurial drive shaped the department and pioneering graphics company Evans and Sutherland, but it was not the Silicon Valley style entrepreneurism of moving fast and breaking things. Instead, it was tending to the necessary money and resources side of the equation, and focusing on the nurturing and creative sides, more akin to a metaphor raised at the event several times, to "cultivating a garden." This was a garden that encouraged talented graduate students, faculty, and company team members to grow the next new thing, the code, the tools, and the devices that could have a positive impact on science, knowledge, work, and leisure. Over the two days of meetings, the importance of the physical setting came through as a meaningful factor as well, the mountains and their tremendous beauty, the skiing, the retreats, and the frequent computer science meetings held at the picturesque Alta Lodge.

In starting a new program and seeking a certain culture that was different from other emerging schools in computer science, Evans looked for *outliers* in the graduate students he (and colleagues) admitted to the program. The seeking of "odd ducks," was foundational and essential to the intellectual freethinking, and creative culture that he cultivated with the program from his formation of it in 1965 (the Computer Center launched in 1958 and grew to a staff of 30 people), one of 11 such programs at the time.

In 1968, with Ivan Sutherland's arrival, resigning from his Associate Professorship in Computer Science at Harvard to become a Professor of Computer Science at Utah, and the ARPA IPTO funds, the program really took off. He and Evans were the two top researchers in the new field of graphics—they essentially invented it. Sutherland especially so, with his path-breaking 1963 dissertation on Sketchpad. Sketchpad was a legendary computer graphics program that transformed computer science. It influenced so much—from Human-Computer Interaction (HCI), Computer-Aided Design (CAD), object-oriented programming to GUIs, and virtual reality (VR). He had the additional insight to do a film demo that

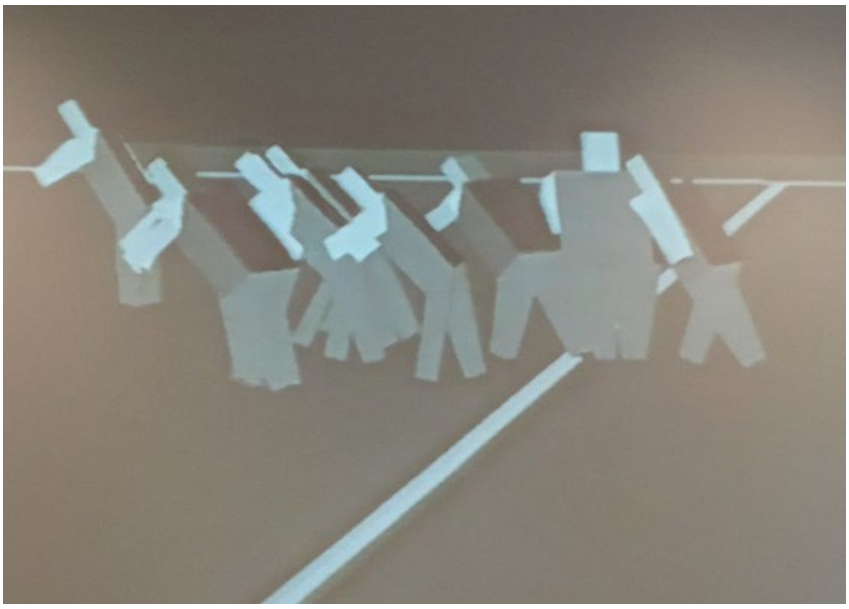
conveyed to the emerging field of computer science that a new major domain within it, graphics, was possible.

As Sutherland reflected during a panel at the event, ARPA IPTO Director J.C.R. Licklider had convened a group of top scientists and military leaders to see Sketchpad and meet with him. Despite his young age Sutherland was essentially a legend shortly after his dissertation. In 1964, Sutherland, only twenty-six years old, followed Founding Director Licklider in taking the reins to become the second ARPA IPTO Director, funding basic research largely at universities that helped transform the new field of computer science in areas such as time-sharing, AI, and other early graphics and networking work. Two of the most important grants in IPTO's history were Project Mac (by Licklider in 1963) to MIT in artificial intelligence and time-sharing (Multics) and the six-year grant (by Robert Taylor in 1966) to the University of Utah in graphics. Other critical 1960s IPTO grants provided the basis of the ARPAnet. Utah has the distinction of being one of the four nodes of the ARPAnet at its launch as a four-node network in 1969.

Given Evans' and Sutherland's immediate respect for each other, their visionary, and entrepreneurial personalities, they became immediate friends and collaborators. And coming together at Utah was also about starting a company. Sutherland reminisced with a smile, whether Evans was to join him in Cambridge, or he was to go to Utah came down to "he [Evans] had seven kids and I just two." It was fortuitous for both scholars, for the field of graphics, for the U, as Utah is affectionately known. It was also beneficial to the company, Evans and Sutherland. The University of Utah likely had greater opportunity for freedom than Sutherland's Harvard, Cambridge, or Boston might have had for the company. Evans and Sutherland cultivated an overlapping family-type environment in both settings and endeavors. For the company, this made it all the easier to retain its talented computer scientists over the long term—good people tend to job-hop more in Silicon Valley and in Boston/Cambridge.

Evans and Sutherland, trailblazing graphics commercially, increasingly brought the technology to the world in a fast-growing range of applications. They attracted a top venture capital firm in Hambrecht and Quist, and their company was soon valued at $50 million. In just ten years, it grew from $10 million in revenue to $100 million in revenue.

As Sutherland conveyed about himself and Evans, and many others at the recent symposia reinforced, at the University of Utah Computer Science Department and at Evans and Sutherland, the two leaders sought to have as flat organizations as possible. Also important to them was assuring the satisfaction of everyone contributing to something larger than themselves. Seeking and solving hard problems was key to the student and employee/researcher's satisfaction. The challenges could add to a sense of common purpose and a closeness of individuals and feeling part of the team. The graduate students became part of Evans' and Sutherland's extended family and they frequently had them to their homes to socialize.



Long before Madden Football in 1988 and photorealistic gaming today, Utah was pioneering on the graphical gridiron, photo of Utah Kahlert School's video loop at the event, photo Jeffrey Yost.

**Early Graphics**

The many images shown at the event exemplified the words of the largely retired set of standout graduates who spoke and participated in its panels. This included showing a costume party photograph of playful attire and big smiles on the faces of faculty and graduate students in the Evans' home. Regarding the company, Evans and Sutherland, there is one data point that goes beyond just the speakers and hints at the broader experience of employees being very positive and a family-like atmosphere, it is the retirement group and its continuing so many years. This sizeable group has a picnic reunion each year, the large numbers of people coming to this event year after year is suggestive of the positive culture of the company over decades.

Is there a potential risk of exaggeration or embellishment of the culture given the people speaking at the event had impressive careers and legendary accomplishments—a selection bias? Certainly, and further research into this culture through oral history, the David Evans Papers, and other archives likely would be fruitful and fascinating. For now, it seemed to me the group was large enough, and the message clear enough from people speaking, often quite emotionally, and always in a way uniquely their own, to get a telling sense of this culture and environment that Sutherland and Evans, the people, and Evans and Sutherland the company, created.

The participants in the event (especially the second day symposium specifically on graphics) were primarily graduate students from the late 1960s and the 1970s (though not exclusively). In the images and the talks there were tremendous accomplishments of alumni from multiple continents. Nonetheless, most were white and male. This was not unique to Utah. Diversity of gender participation and inclusion were challenges across computer science prior to a mid-1980s peak in women majors (reaching 38 percent), as well as from the early 1990s forward to today. Women's participation as CS majors has generally been in the teens to low twenties, and at times the lower teens, apart from the

mid to late 1980s. As such, Telle Whitney's wonderful talk on gender, both historical and prescriptive, and highlighting some incredible women, added so much to the event.

For the remainder of this essay reflection, I will discuss several keynotes and other talks that especially resonated for me regarding University of Utah Computer Science Department/School of Computing culture and carrying of this culture impactfully into the broader world by faculty and alumni. In selecting a handful to discuss, I want to stress that all of the panel discussions and talks were compelling and fascinating, and many I do not highlight in what follows also exemplified the special culture of CS and The Kahlert School of Computing at the University of Utah.

**Impacting the World at Scale: Nvidia, GPUs, and LLMs**

Steve Parker gave a compelling keynote address on "Utah and the Frontiers of Computing." Like a number of doctorates of the program, he later was a professor within it. For the past sixteen years he has been at Nvidia, and he currently serves as Vice President, Professional Graphics at the corporation, which has strategically led in skating to (and inventing and shaping) where the puck is going, rather than where it has been (such as Intel did in stumbling fashion), in microcircuitry—leading the way with Graphical Processing Units. GPUs are central to gaming, an area Nvidia has long served, and the far larger opportunity is that they are now also concentrating on large language models, machine learning, and many application areas. As OpenAI, Microsoft, and Google are seeking to exploit the opportunity for general markets and consumers (in my mind with too little HCI and user experience research and testing of how ChatGPT and Bard might amplify societal biases and extend inequalities, as search has done), Nvidia is focused on enterprise and targeting verticals.

In addition to some wonderful graphics displays Parker and his team did for the presentation, he refreshingly acknowledged the ethical critique with "search" and the importance of research and ethics in getting things right to have a positive impact on the world with large language models, with applications of generative artificial intelligence. A theme throughout was how researchers and leaders at corporations such as himself are "standing on the shoulders of giants" in Evans, Sutherland, and others. This is very much true in both the technical sense and organizational and decision-making sense with stewardship of machine learning out in the world. Parker concluded on a humorous note, with a slide of song lyrics after he asked ChatGPT to "Write a rap song on the history of computer graphics at the University of Utah." To give a brief sense…. Verse 2 (1980s) … "In the eighties, Pixar joined the crew; and they worked on RenderMan, which was something new. It made computer graphics look oh so fine; And it's still used today, it stood the test of time…"

**Gender, Inclusion, and Innovations of Extraordinary Women**

While ethics was a portion of Parker's talk, it was the focus Telle Whitney's excellent keynote address which preceded it on day one. Whitney was an undergraduate at the University of Utah and went through several potential majors before settling on Computer Science (BS 1978). These included Theater, Political Science, and English. She took an Interest Inventory Test and scored exceedingly high in programming. An advocate for her was Professor Richard F. Riesenfeld. Whitney earned her Ph.D. from Caltech in Computer Science working under the legendary Carver Mead, the co-inventor of Very Large-Scale Integration (VLSI), with Xerox PARC's Lynn Conway. Doctorate in hand, by the mid-1980s she went on to technical and managerial positions at semiconductor companies Actel and Malleable Technologies. She also held senior leadership roles at a few tech startups. With her friend, Anita Borg,

she was co-founder of Institute for Women and Technology, which Borg ran until she became terminally ill with brain cancer. In 2002 Whitney, initially temporarily, took over to lead the institute as CEO, which was renamed as the Anita Borg Institute, and later AnitaB.org. She ended up staying and was the CEO and President until she retired from role in 2017. In 1994, Borg and Whitney launched the Grace Hopper Celebration, which that year was a gathering of 500 women, an event for research, socializing (including dance parties), recruiting, and professional support. It has continued to grow steadily and is tremendously impactful to those who attend and to advancing women's access and opportunities in computer science. There is a long way to go, but AnitaB.org, the Grace Hopper Celebration, and NCWIT are powerful and positive forces.

Longtime CEO of AnitaB.org Institute and Co-Founder of the Grace Hopper Celebration Telle Whitney" Image courtesy of Wikimedia Commons.

Whitney spoke about the Anita Borg Institute and its co-founding of the Grace Hopper Celebration that started strong and has only grown since. Participation rates of women in computer science remains a challenge. In the biological sciences there is near gender parity (around 50 percent) women. In computer science, in recent years, numbers have been around 20 percent women at the bachelor's and at the Doctoral degree levels, while a bit higher for Master's, but still under one-third. Women's participation in computer science even lags that of engineering overall. The early part of Whitney's address was on underrepresentation of women historically and today and the very important point that it is both an inequity and to the detriment of computer science, losing out on so much talent and creativity.

The last two-thirds of Whitney's talk was profiling five women and what they are doing in leadership, advocacy, and as role models to advance issues of equity and inclusion for women in computer science. Whitney offered rich cases of all five, I provide brief mention below.

- Cecilia Rodriguez Aragon—Professor of Human Centered Design and Engineering at the University of Washington, who co-invented treap data structure.
- Ashley Mae Conard—Computational biologist who works as a Senior Research at Microsoft Research.

- Aicha Evans—Computer engineer who served as Intel's Chief Strategy Officer. In 2019 she became CEO of Zoox, a self-driving technology firm, and remains CEO of the Division after Amazon acquired Zoox for $1.3 billion.
- Mary Lou Jepsen—CEO of Openwater and co-founder of One Laptop per Child.
- Fei Fei Li—Professor of Computer Science at Stanford who in 2017 started AI4All and Co-Director of the Stanford Institute for Human-Centered Artificial Intelligence.

Whitney began studying CS at Utah, became a standout computer scientist and entrepreneur in industry, and has been an unparalleled leader for women in technology in leading AnitaB.org for fifteen years. Her message is important for all higher education institutions, one insightfully and inspirationally conveyed through biographical cases of these five tremendously accomplished and impactful women.

**Utah and Influencing Corporate Cultures—Evans and Sutherland and Far Beyond**

Dave Evans and Ivan Sutherland, by all accounts of the people on the program and in the audience, created an atypical corporate culture at their company that was analogous to how they built the University of Utah's program/department into a center of excellence. This included seeking driven individuals who were creative and interested in tackling and solving big problems. It also included a non-hierarchical management structure with few layers. This was evident in Robert Schumaker's insightful and engaging presentation. He joined General Electric (GE) in 1960 working on visual simulation systems but ran into dead ends in trying to get customers to contract for his and Rodney Rougelot's work on flight simulators. Without the contractors signing on, GE was not supportive of continuing the work. The two were recruited away by Evans and Sutherland in 1972 and had the freedom and the runway to succeed, and they did mightily for the company. While photos of basic one-story buildings and trailers Schumaker showed of Evans and Sutherland's "campus" may not have been impressive or inviting compared to GE, the environment and support was. Schumaker and Rougelot led work that resulted in selling 1,000 flight simulators to various airlines globally a mere year after joining the more conducive team atmosphere of Evans and Sutherland. Schumaker became Simulation Division President and after two dozen years with the company, Rougelot rose to become President and CEO of Evans and Sutherland in 1994.

The culture that Evans and Sutherland built (at the university and the company) shaped how founders and leaders managed at some of the most influential graphics and software companies in the world. This included at Pixar Animation Studios and Adobe.

Ed Catmull gave one of the most moving talks of the event. It began with his account of his graduate student days. In the doctoral program in its early years, he had classes with Jim Clark, Alan Kay, and John Warnock. Catmull made major advances in computer graphics contour and textual mapping. He went on to do pioneering work in film graphics but ran into difficulty selling the ideas and his early work, that is until Lucasfilm hired him in 1979 and he became Vice President of the Computer Division of Lucasfilm. In 1986 Steve Jobs acquired this division of Lucasfilm, which became Pixar.

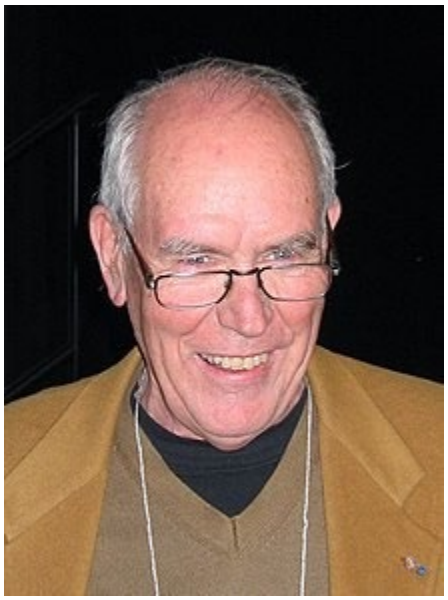
Catmull is a co-founder of Pixar Animation Studios and worked very closely with Jobs. He was emotional in emphasizing writers have the early Steve Jobs, in his first stint at Apple Computer, pegged appropriately (his impatient difficult personality and disrespect of others) but fail to recognize that the experience of being pushed out of Apple changed Jobs. He expressed how the Jobs he worked with in leading Pixar was a changed man (it is not uncommon for journalists writing history to prioritize the

story they want to tell, a sort of truthiness over truth). At Pixar, both prior to and after it was taken over by Disney in 2006, there was a culture of commitment to completing projects and taking the time and putting in the resources to do them right. Catmull articulated how Pixar and Disney had parallel functional departments and units, sometimes benefiting from each other, but had their own culture and identity. This was key to success, and it runs counter to ideas in management with M&A, of integration and eliminating overlap and laying people off to capitalize on efficiency. Catmull stated another key lesson (one taken from Utah) is participation in decision-making and processes and keeping powerful people out of the room or reducing the number of them in the room. These were keys to Pixar's success with *Toy Story* (with the Utah Teacup a part of it of course); *Toy Story II, III,* and *IV; Finding Nemo; Ratatouille;* and its many other creative achievements and blockbuster hits.

**Sutherland Still Future-Focused in His Stellar Presentation**

At various times Ivan Sutherland took the stage on panels, and offered remembrances, interesting anecdotes, perspectives, and historical details. It was this end of the day one keynote that stood out for me. He gave a technical and overview talk on Single Flux Quantum as a wholly new path for the greatest challenges in computing today.

As Sutherland related, the challenges today to extend Moore's Law, inability to continue to add/double components on a chip, or it drastically decelerating, amounts to hitting a "power wall." This is what is limiting computing's future as he sees it. Sutherland gave a powerful and compelling talk advocating for Single Flux Quantum as a path to pursue to address this challenge. It is distinct from both the Moore's Law methods and paradigm as well as from quantum computing. The latter may be a few decades out still and will work for some scientific and engineering purposes, but far from all or even most applications in computing. In Single Flux Quantum, magnetic flux is quantized. Sutherland stated the worst part of semiconductors today are the wires. Single Flux Quantum does not have this problem, further it is fast, digital, and Turing complete. It has some challenges and Sutherland went through each, arguing the payoff could be tremendous and if the US does not do it other nations will.



Ivan Edward Sutherland, photograph from Dick Lyon, on Wikimedia Commons.

To do Single Flux Quantum right, Sutherland advocated for government funding for 1,000 engineers to work on it. He emphasized Utah should be a part of this. In his twenties, in the 1960s, with Sketchpad and Head Mounted Display, Sutherland invented computer graphics, VR, Object-Oriented Programming, and more. Also, in his twenties (mid-twenties at that) he led ARPA's IPTO in skillfully funneling funds to worthy projects that would change computing. At Utah he and David Evans, and their company, were soon beneficiaries of their own IPTO funding, and they did change the world. The impact of their students and former employees is profound and continues. I, like 99 percent plus of the population, do not have the technical understanding to assess Single Quantum Flux, but the case Sutherland made for it seemed deeply researched and informed. More importantly, some of the fraction of one percent who understand it were in the room. The questions after it, from top engineers, were also strong and some quite challenging. Sutherland handled them masterfully. At age 84 Sutherland is doing what he has always done, and it is line with a famed quote of one of his early star students Alan Kay, "the best way to predict the future is to invent it." While Sutherland, by his own acknowledgement, will not likely lead the effort to conclusion given his age, he is seeking to be a policy advocate for it in a highly informed way and doing this in his typical virtuoso fashion. It was moving and resulted in an extended standing ovation from all.

**Bibliography**

[Most of this reflection/review essay is drawn from the presentations at the three events described over the two days put on by the Kahlert School of Computing at the University of Utah, 23-24 March 2023. Below are some books, articles, oral histories, and archives collections that have influenced my thinking on the history of computer graphics.]

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