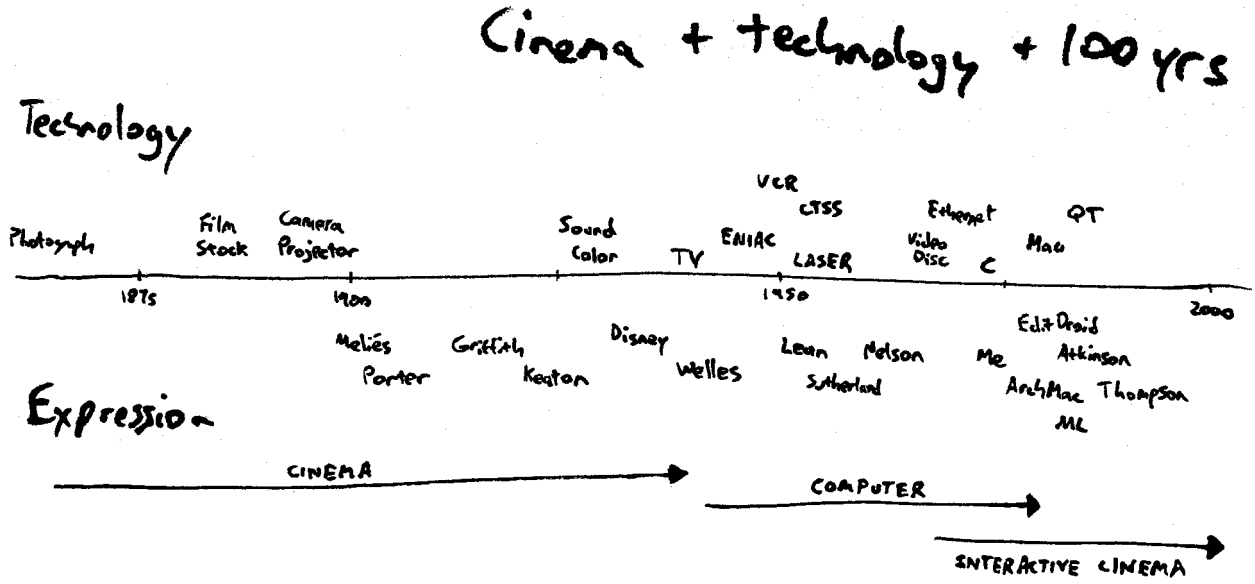
2.0 The evolution of interactive cinema

Interactive Cinema has at its root *cinema*. Cinema—the art of visual storytelling—is inexorably connected to the technology of images and sound. Interactive cinema adds the technology of computation into the mix, inheriting from two traditions, cinema and computers. Glorianna Davenport coined the term "Interactive Cinema" in 1988 as a way to describe the academic endeavor of her research group. Her academic search was to satisfy the "longing of cinema to become something new, something more complex, and something more personal, as if in conversation with an audience."

Figure 2. Timeline of 100 years of cinema and computer. The timeline illustrates the timing of technological innovation with individual expression. Abbreviations: Computer Time-Sharing System (CTSS), QuickTime (QT), Media Lab (ML)



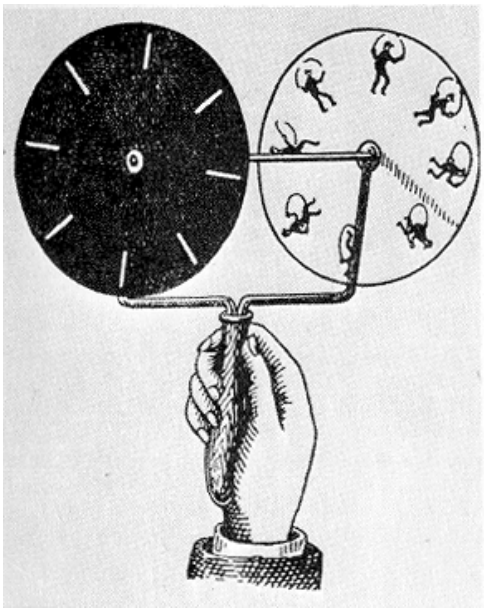
In the 100 years before the group was founded, the two machines which enable interactive cinema was invented, namely the camera and the computer, but they had yet to be combined into a single medium. Cinema was born with the invention of Edison's Kinetoscope in 1891. Filmmakers turned it into a means of expression.

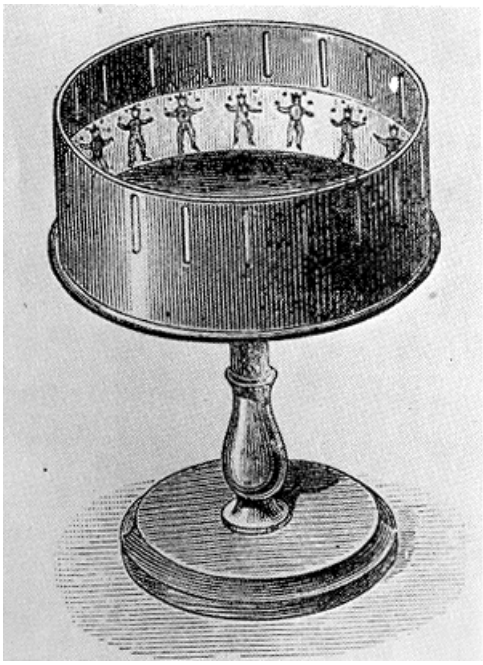
In the 25 years after the camera was invented, Meliés, Edwin S. Porter, D.W. Griffith, Sergei Eisenstein, and Buster Keaton each pushed the expressive use of the film medium to tell their own stories. After the invention of synchronized sound, Orson Welles made his masterpiece *Citizen Kane*—a prime example of using the limits of technology to tell an epic story in black and white. Technicolor enabled Walt Disney to release the first two color cartoons. After technology enables a new form of expression, an artist who understands the conventions of the past and has a vision of the future will tell new kind of story.

In the 25 years after ENIAC—the first electronic computer—Ivan Sutherland expressed his vision of the power of computation by creating *SKETCHPAD*, the first interactive graphical computer interface. As non-linear access to information became possible, Ted Nelson began to implement *Xanadu*, his vision of the ultimate hypertext system that sought to record and cross-reference all human literature.

In this section, I will chronicle the three periods. The evolution of the cinematic medium begins with the invention of the photograph (1850) and ends with Citizen Kane (1941). The development of interactive computing begins with ENIAC (1945) and ends with the Macintosh (1984). The last period is the birth of interactive cinema, which begins with the invention of the optical videodisc (1976) and continues until today. In each period, I describe the enabling technologies of the day and some of the people who expressed themselves in the new medium.

Figure 3. Phenakistoscope and Zoetrope, early motion picture machines





2.1 Cinema and its machines, 1850–1941

> Cinema was born as an independent medium only *after* the cinema machines had been evolved for purposes other than the establishment of such a medium. That is, the invention of the machines preceded any serious consideration of their documentary or aesthetic potential; and this relationship has remained constant throughout the history of film because the cinema at its material base is a technological form—one in which technological innovation precedes the aesthetic impulse (i.e. no artist can express him- or herself in cinema in ways which would *exceed* the technological capabilities of the machines). (Cook 1990)

The film medium's first incarnation was as a light-sensitive emulsion smeared onto a glass plate. For the budding photographer like George Eastman, going outside to take a picture meant bringing a light-tight tent full of glass bottles with you. Eastman pioneered the use of celluloid as a flexible, portable, and highly flammable film base. This advance made possible amateur photography, the moving picture, and many small fires.

The "moving picture" was born of two technologies, mechanical and photographic. After you have film with sprocket holes, then you need a camera to move the film at sixteen frames per second, starting and stopping the film behind a rotating shutter—a difficult mechanical task. Early film cameras had difficulty controlling the inertia of large film reels, which would spin too fast and snap the film passing through the camera. Early movies were shorts that could only last from thirty seconds to two minutes. (Cook 1990)

Figure 4. Muybridge's galloping horse

Thomas Edison's Kinetoscope did not even use a film reel, instead stretching the entire film out on rollers. The first nickelodeon shows were primarily novelty acts that could be brought into a studio and performed in front of a fixed camera.

Figure 6. A shot from a typical nickelodeon film *Parisian Dance*

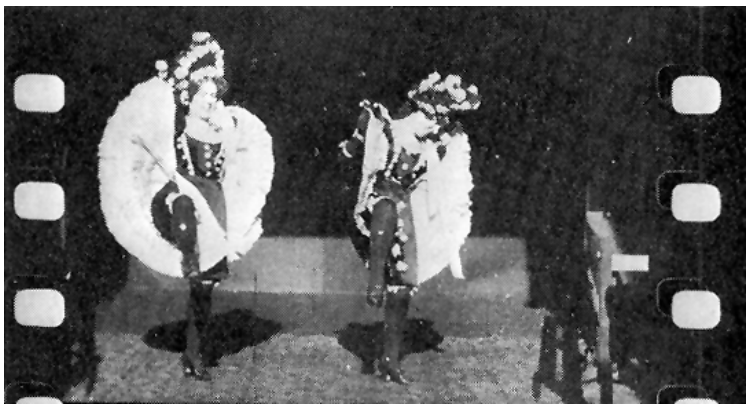
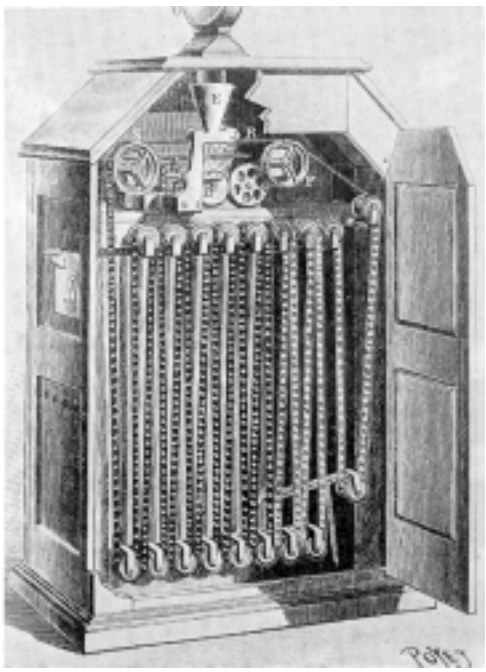


Figure 5. Edison's first projection machine, the Kinetoscope



In 1895, The Lumiére Brothers create the Cinématographe, a single machine which was camera, film printer, and projector, all in one. The hand-cranked camera weighed only 16 pounds making it quite portable. The brothers freed the camera from being fixed inside a studio and began to capture scenes from the world around them.

Figure 8. The first Lumiére film: *La Sorite des ouvriers de l'usine Lumiére* (*Workers Leaving the Lumiére Factory*)

Figure 7. The Cinématographe. The wondrous machine did everything a filmmaker needed as camera, film printer, and projector. Its hand-cranked drive mechanism made it much lighter than Edison's battery-driven camera.

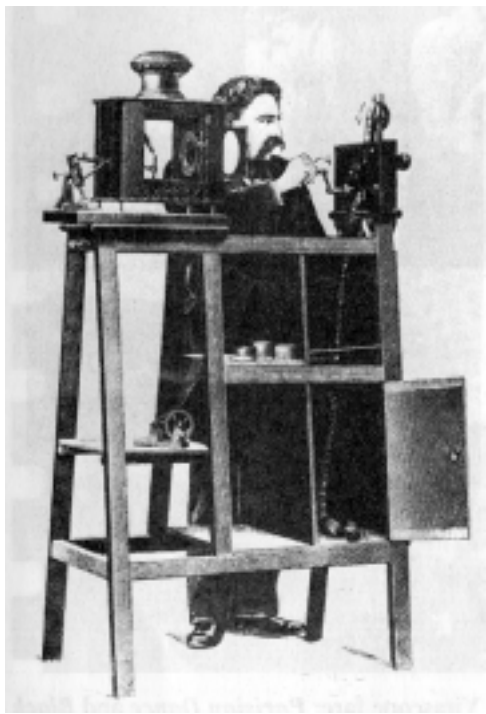
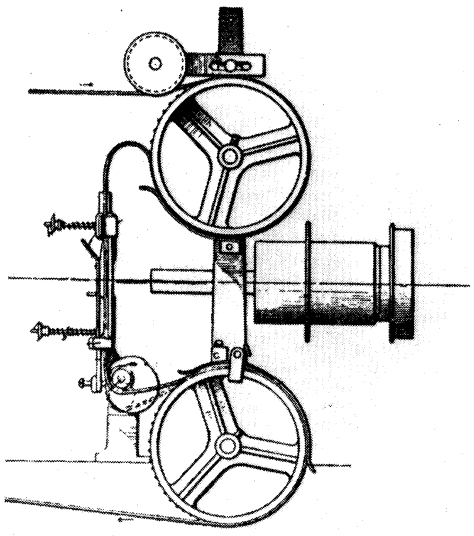


Figure 9. The Latham Loop



In 1901, the Latham Family (Gray, Otway, and father Woodville) discovered that placing a small loop above and below the shutter reduced the stress placed on film passing through projectors and cameras. Cameras and projectors using the Loop could reliably hold 20 minutes of film instead of 120 seconds. This incremental advance in technology made it possible for filmmakers to record and project much longer sequences. Filmmakers began to experiment with longer shots and editing different shots together. The advance in technology allowed filmmakers to extend their narrative language.

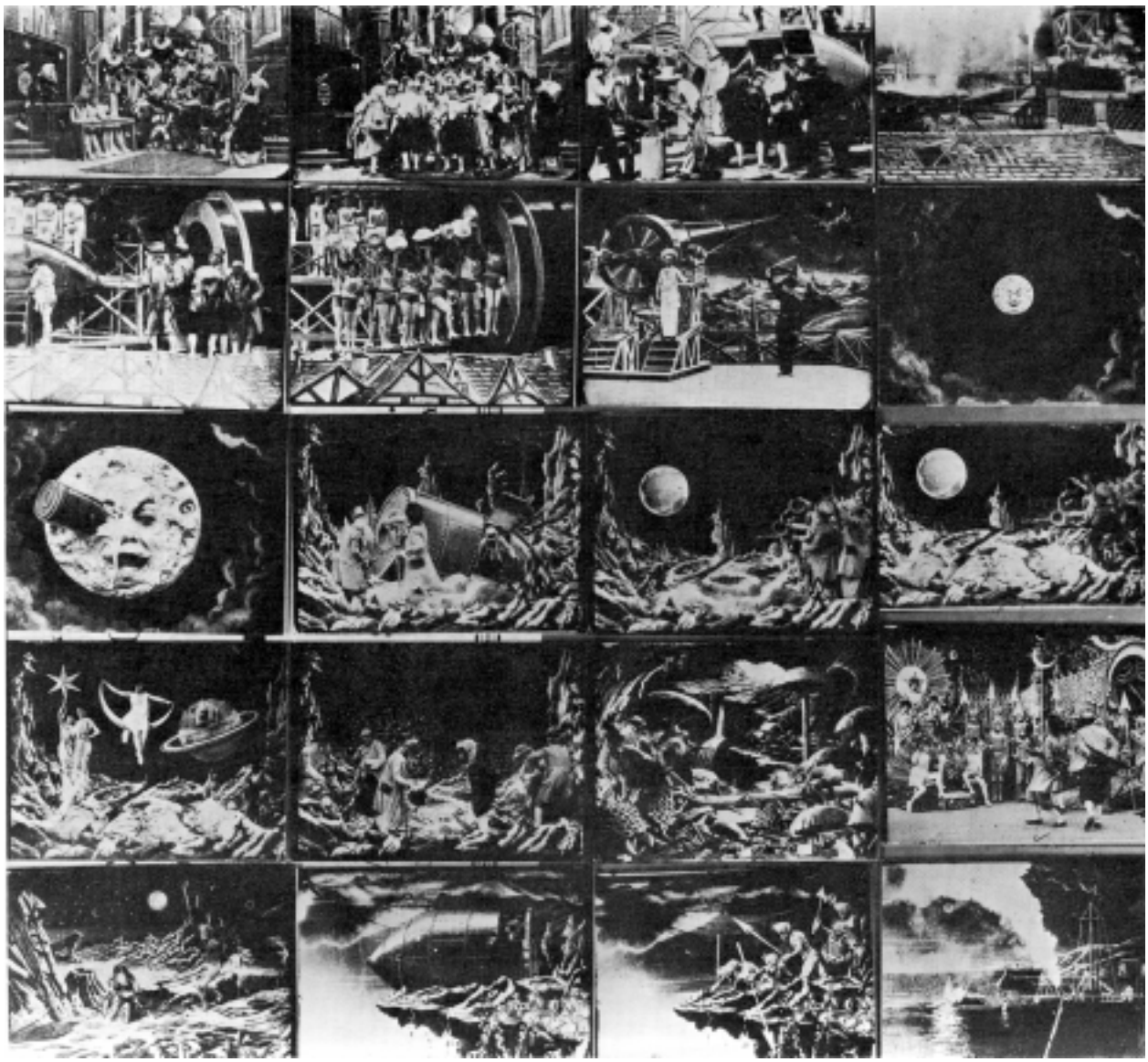
Meliés. The thirty second nickelodeon show *Parisian Dance* soon evolved into George Meliés's ten minute *A Trip to the Moon*. Meliés began to use the technology in a different way, to tell a story. He adapted much of his material from books or plays, such as Jules Verne's *A Trip to the Moon*.

Meliés composed one-shot scenes which he called *tableaux*, e.g. "The flight of the projectile through space" or "The astronomers' escape." The actors, as if on a stage, would begin and finish *tableaux* in continuous shots while Meliés filmed the action as if he were sitting in a theatre house. Meliés spliced each complete scene together into a narrative. Voilá, Cinema! (Cook 1990)

Meliés's films exhibit mastery of the techniques of photography. His films contain camera-trick illusions, clouds of hand-tinted color, and visual transitions like lap dissolves[1] to edit smoothly from scene to scene. Meliés understood how the camera worked mechanically—he had built it from scratch—but not once in 500 films did his camera move during a shot. He fixed the camera in the best seat of his theatre and left it there, to record his stage plays—the proscenium arch[2] just outside the frame. He extended the language of visual storytelling using narrative and editing, but he was entrenched in the traditions of stage and theatre.

(1) Lap Dissolves are an in-camera transition from scene to scene. The camera person closes the iris at the end of a scene, rewinds the film a few seconds, then open the iris slowly while the next scene begins. Today these effects are usually done in post-production either using an optical printer or digitally on a computer.
(2) The proscenium arch is the physical frame which surrounds the theatrical stage. It is the boundary between the real world and the drama on stage. In early films, this arch was often included in the frame to signify that was a play.

Figure 10. *Le Voyage dans d'lune* (*A Trip to the Moon*), dir George Meliés, 825 ft. ~16 minutes



Continuity editing. The film medium would not sit still, and just one year later, Edwin S. Porter would extend the language of both cinematography and editing by releasing *The Great Train Robbery*. Up to this point, film editing was performed as a way of to connect whole actions. If it took the actor two minutes to get dressed, the action was recorded in a two minute scene.

Figure 11. The compression of time

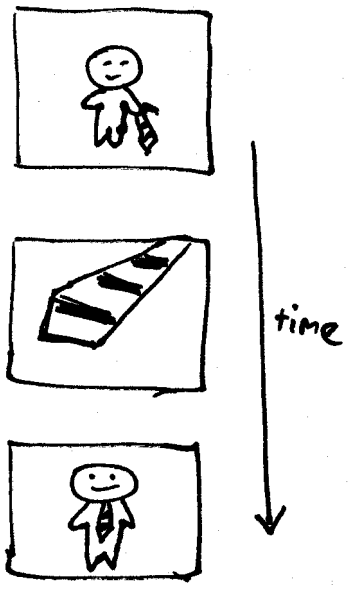
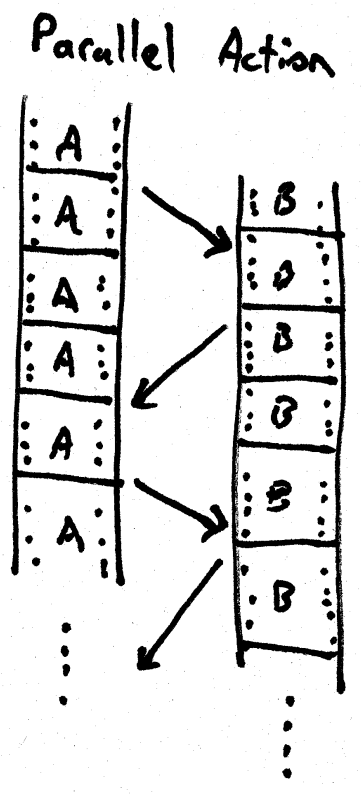


Figure 12. Editing for parallel action



Porter pioneered the editing conventions that today are known as the rules of continuity editing. By cutting scenes before the end of an action, you create an ellipsis in time. An actor can get dressed in two shots, rather than two minutes. Porter's basic element for telling a story was not a *scene* but a shot. He sequenced multiple shots together to compose scene, breaking the one shot-one scene convention of Meliés. (Cook 1990)

The basic underlying assumption of continuity editing is that time is always progressing forward, even if the camera is not present. Porter could portray two actions happening in parallel, by intercutting between them. Editing became part of the process of telling the story.

Because complete actions no longer had to happen in a single shot, Porter experimented with moving the camera closer to actors. He staged his scenes using the depth of the frame, so action would proceed from the background to the foreground. In the Great Train Robbery, he panned the camera to follow the action in the scene, moving the camera during a shot! In later films, he even mounted his camera onto cars and trains. (Cook 1990)

Porter's films had a strong effect on everyone who saw them, especially other filmmakers. Filmmakers delighted by the novelty built on what they had learned. Audiences learned a new visual language. Soon everyone imitated Porter's techniques, which were codified slowly into the conventions we use today. His films destroyed the proscenium arch that constrained films to the staged action of the theatre.

Figure 13. *The Great Train Robbery*, dir Edwin S. Porter, 740 ft. ~12 minutes

Porter had faster film stocks, reliable cameras, and was part of a generation of filmmakers evolving the visual language of cinema. The filmmakers before him saw movies as a way to make photographs come alive, or to record a stage play with special effects, but Porter and filmmakers after him showed the world what was possible.

Figure 14. The Tramp in the machine: *Modern Times*, 1936, 87 minutes, dir Charles Chaplin

The silent masters. The filmmakers who followed—D.W. Griffith, Charlie Chaplin, Buster Keaton—would evolve these narrative techniques to tell their unique bands of stories. D.W. Griffith's controversial epic *Birth of a Nation* (1915) was a mind-numbing 185 minutes with 1154 shots. Charlie Chaplin's Tramp was loved throughout the world.

Twenty years after Porter, Buster Keaton made *Sherlock. Jr.* (1936), his greatest and most self-reflexive film. He plays the part of a poor projectionist who falls asleep during his movies. As part of his dreams, he finds himself stepping into and out of other movies, revealing to the real audience the techniques of the filmmaking, within a movie inside another movie. He was *very* meta.

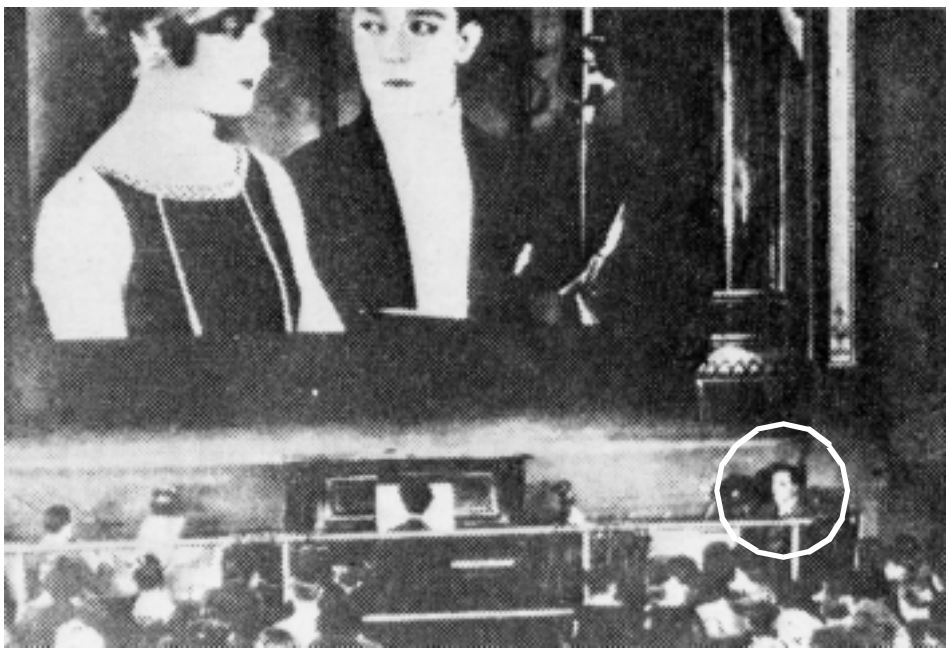


Figure 15. *Sherlock Jr.*, 1945, 45 minutes, dir/editor Buster Keaton. (Keaton is in the circle.) In this scene, he sees his beloved on the screen and jumps *into the movie* to save her from the evil boyfriend.

Sergei Eisenstein defined the language of montage editing in the earth-shattering *Battleship Potemkin* (*Ten Days That Shook the World*) revealing to the world the power of Soviet filmmaking.

Figure 16. The promotion poster for *Battleship Potemkin*, 1925, 75 minutes, writer/dir Sergei Eisenstein. Below, a still from the oft imitated Odessa Steps sequence. I love the design of this poster. Soviet design and filmmaking influenced each other in their search for the best way to motivate the common man to action.

Figure 17. *The Jazz Singer*, 1927, 89 minutes. Al Jolson in black face talks to the audience.

Sound and color. The technologies that followed would enhance the filmmaker's pallet, but would not change it fundamentally. The techniques of continuity editing, fluid camera movement, and montage would all continue to apply to sound and color films. The coming of sound was denounced by studios as a passing fad, hailed by inventors as a way for small towns without orchestras to have movie music, and unappreciated by everyone. *The Jazz Singer* (1927) surprised everyone, even its producers. The star Al Jolson ad-libbed dialogue during the musical numbers, but for the most part, the film was treated like a silent picture. During the sound scenes, audiences were surprised that they were "overhearing" real people having a conversation. They loved it so much, that the worst sound picture would beat the finest silent film at the box office. Within two years, silent movies were dead. (Cook 1990)

In 1932, three MIT graduates perfected the expensive three-strip **Tech**nicolor process. Walt Disney used it first in his color cartoon, *Three Little Pigs*. Color would be adopted slowly because of its prohibitive expense.

Figure 18. Whoa dude, it's coming right at me!

(1) *Citizen Kane*, 1941, 119 minutes, writer/dir Orson Welles, dir of photography Gregg Toland, ASC

In response to black and white television, Hollywood adopted color in the 50s and widescreen CinemaScope in the 60s. Hollywood turned to any technology to stem the tide of viewers flocking to TV, from making 3D "Depthies" to engaging our keen sense of smell with Smell-o-Vision. The first "Smellie" was *The Scent of Mystery*, 1959, 125 minutes. Its advertising slogan did not convince audiences of the narrative value of smell, "First they moved (1895)! Now they smell!" (Holliday 1993)

By this time, audiences had become accustomed to the Hollywood conventions of narrative filmmaking, and the culmination of this style is exemplified *and defied* in Orson Welles's radical first film *Citizen Kane*.

Kane, Charles Foster Kane.

> Right away I want to make a distinction between "commandment" and "convention." Photographically speaking, I understand a commandment to be a rule, axiom, or principle, an incontrovertible fact of photographic procedure which is unchangeable for physical and chemical reasons. On the other hand, a convention, to me, is a usage which has become acceptable through repetition. It is a tradition rather than a rule. With time the convention becomes a commandment, through force of habit. I feel that the limiting effect is both obvious and unfortunate.... Orson Welles was insistent that the story be told most effectively, letting the Hollywood conventions go hang if need be. (Toland 1941)

In *Citizen Kane*, Orson Welles with his Director of Photography Gregg Toland used the latest technology in film stock and super-wide angle lenses to invent a new visual style called deep-focus cinematography. Welles told Toland "the technique of filming should never be evident to the audience" (Toland 1941). By creating a frame with virtually infinite depth of field, the film most closely approximates how the eye sees. Welles staged his scenes in depth and eliminated much of the need for hard cuts, thus allowing the eye to ignore the film mechanism. Welles and Toland used the tools of the day and consciously discarded the common assumptions about how you visually construct a story. In collaboration, they evolved the language of cinema to a new level. The result is a combination of cinematic technology and narrative vision in which technology is used uniquely in service to the narrative. I strive for this same unity of vision and technology in my interactive work.

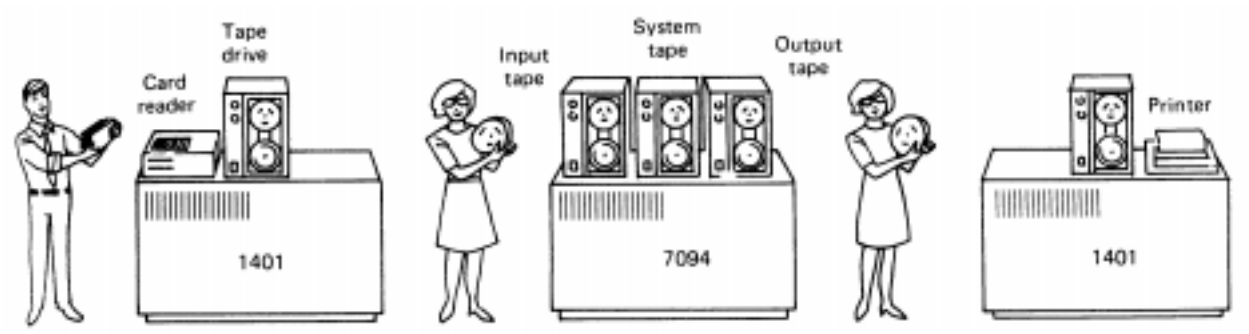
Figure 19. The grandiose Kane (Orson Welles) just before his fall.

2.2 The digital calculating machine

In 1945, fours years after *Citizen Kane*—perhaps the culmination of narrative film—ENIAC the first electronic computer was born. Unreliable, filling several rooms with vacuum tubes, and programmed with banks of switches, its performance rivaled the reliability, memory footprint, and usability of today's Microsoft operating systems.

The first computer systems, like ENIAC, were large, expensive, and completely non-interactive. Programmers wrote their first programs by flipping switches. Later they wrote machine language onto punch cards. These programs were run through the computer as a batch, to minimize idle time between jobs on the expensive computers. However, because programmers did not receive feedback until the batch was completed, a misplaced comma could ruin a whole day's work. (Tanenbaum 1992)

Figure 20. The typical process to program a computer. Man writes card. Woman with glasses carries tapes back and forth between computers. Obviously, some things have changed and, unfortunately, some have not. (Tanenbaum 1992)(!)



The programmer was the only user, and the only input was text. Usually, the only output was text as well...

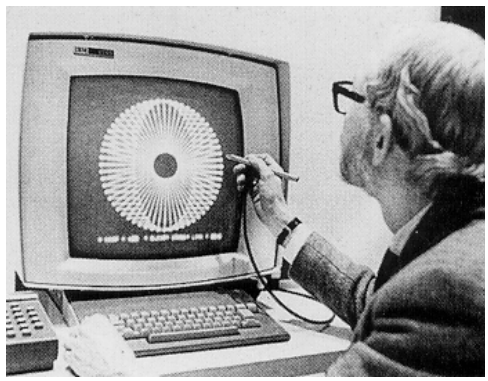
> But one day, the icy clamorous cardprinter room was turned into a whimsical cabaret: a clever young hacker had created a set of punch cards that worked like a piano roll and caused the card reader to chug out a recognizable version of the Marine Corps Hymn: bam-bam-THUMP bam-THUMP bam-THUMP-THUMP-THUMP. All day long, programmers sneaked away from their work to hear the mesmerizing concert. (Murray 1997)

2.3 Interactive computing

Obviously, programmers wanted to have a closer relationship with their machines. In order to provide faster feedback to programmers, MIT built the prototype Computer Time Sharing System (CTSS) in 1962. The system was invented to speed the task of debugging programs. Multiple people could access CTSS at the same time to run and compile programs interactively. Interactive access to a computer was considered wasteful, because a computer is idle for most of the time it takes for a person to type in a program. Making the system available to multiple users reduces the chance that the computer is not being used. CTSS became the model for all modern operating systems, especially UN*X. CTSS was the first step to interactive computing, but the interface to most computers was a teletype machine with a typewritten paper display, not a graphical one. (Tanenbaum 1992)

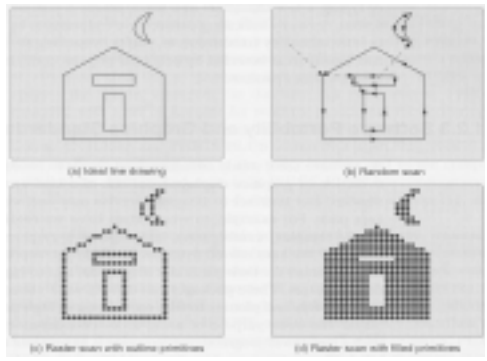
A year later, Ivan Sutherland published his landmark paper, *SKETCHPAD: A Man-Machine Graphical Communication System*. SKETCHPAD is the first graphical user interface to a computer. Completely built out of custom hardware, Sutherland uses a light pen and a vector graphics display to sketch graphics interactively. The vector display uses a "random scan" pattern to trace arbitrary line drawings, however the display is expensive to produce. (Foley 1994)

Figure 21. Sutherland using SKETCHPAD.



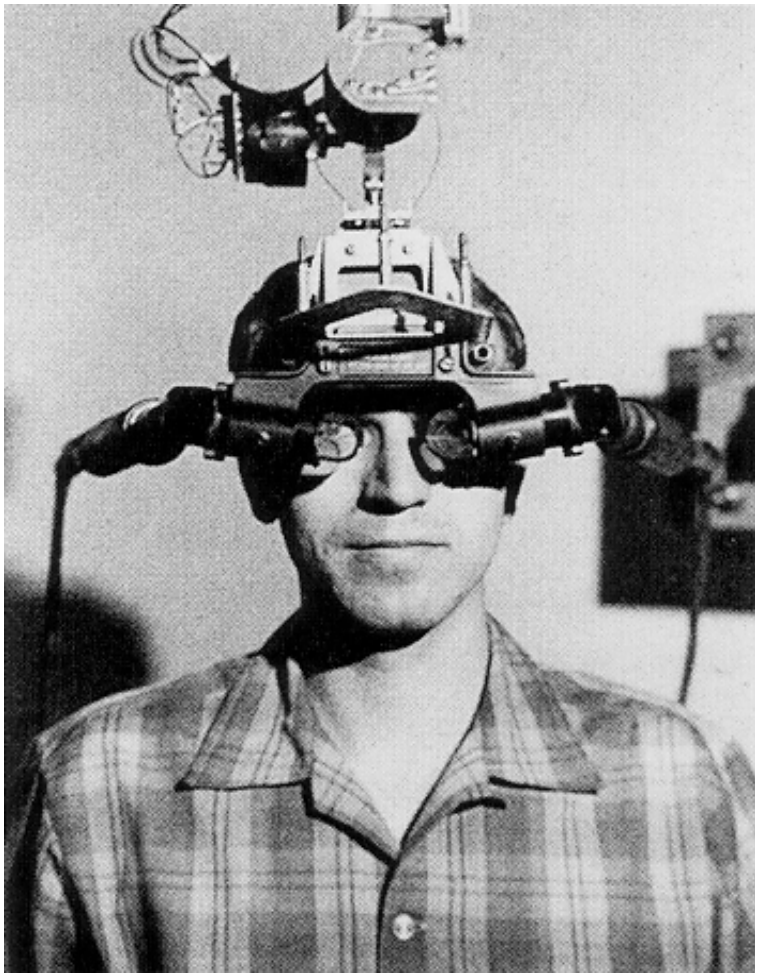
Sutherland's work inspired Xerox PARC and Apple Computer to integrate graphical user interfaces into their operating systems. They would use a much cheaper form of rendering called raster graphics, which divided the screen up into an addressable array of pixels. This "fixed scan" display could be used on televisions, making displays cheap and easy to produce.

Figure 22. The two types of graphic displays



Sutherland was an interface genius, grasping that the power of the computational medium could be used for visual communication. He invented the first 3D headset with a real time visual display. Although few people had access to his work, those who did invented the next generation of computers.

Figure 23. Ivan Sutherland, father of the graphical user interface, had intense vision.



With the invention of hard disks and access to interactive computing, the capacity to access text in a non-linear manner enables Ted Nelson at Brown to begin work on *Xanadu* (1965) during which he coined the term *hypertext*. Nelson's vision was to digitize and store all human knowledge into a single storage medium. Nelson was inspired by Vannevar Bush's original conception of hypertext in his article, "As We May Think," which Bush wrote in 1945! Nelson's vision has never been realized, but he showed a human need for interactive computing.

Figure 24. Bill Atkinson, father of HyperCard.

Hypertext was not available to anyone except programmers until Bill Atkinson at Apple shipped HyperCard (1987). Its built-in scripting language, HyperTalk enabled anyone to write simple programs to access graphics, text, and serial devices, like videodisc players, and it was shipped with *every* Macintosh.

2.4 The birth of interactive cinema

Two things needed to happen for interactive cinema to be born. First, the computer needed a graphical interface and non-linear access to narrative images, like the optical videodisc. Second, someone had to ask the question, "What do computers have to do with video?"

Non-linear editors. In 1982, Montage released their first editing system, and in 1984 LucasFilm released a hybrid videotape/videodisc, non-linear computer editing system called EditDroid. It was a tool for the production of film and video, which used the computer as an intermediate editing medium for the eventual compilation of a film. EditDroid would foreshadow later tools like Avid's MediaComposer and the Media 100.

Nicholas Negroponte forecasted a convergence of broadcast, print, and computation into one medium. (Brand 1987)

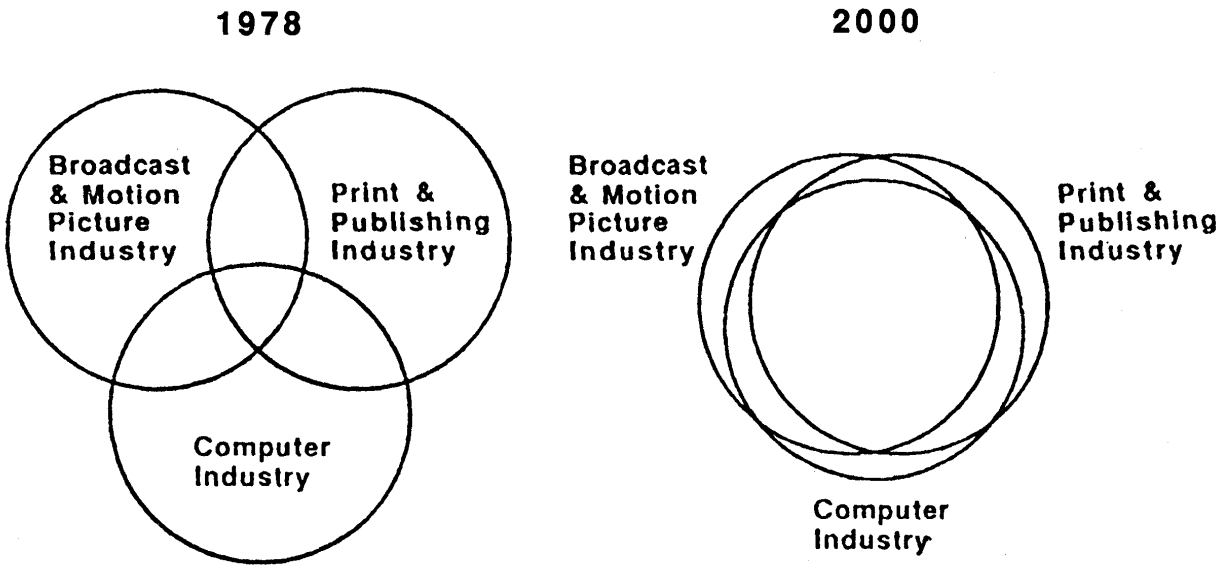


Figure 25. Negroponte's famous circles

At MIT, Glorianna Davenport thought about how she could use the medium to tell more interesting stories, and how would it affect the most lucrative medium of television. Andy Lippman asked, "What is the Television of Tomorrow?"

Figure 26. The Aspen Movie Map

Aspen. MIT's fledgling Architecture Machine Group, led by Nicholas Negroponte, began to answer those questions by building the *Aspen Movie Map*. It illustrated one application of non-linear access to photographic images. The system used optical videodiscs because of their ability to access video non-linearly. Unlike video cassette recorders, the first LaserDisc players also shipped with RS-232 serial ports enabling computer control. *Aspen* was one of the first virtual reality environments. By interacting with a touch screen, viewers could drive and turn onto any street of Aspen, Colorado, in different seasons and different times of day. In places like the Court House, users could go in and experience meeting the Police Chief through short narrative movies. (Brand 1987)

With HyperCard, the Macintosh, and optical videodiscs, anyone could create interactive movies using off the shelf hardware and software. The narrative work shot by Prof. Ricky Leacock and edited by Glorianna Davenport provided the first participation in a new interactive form for these filmmakers. Finally, the computational medium had all the technology it needed to begin telling visual stories, and storytellers searching to extend the language. After Leacock left the Media Lab, Davenport would found the Interactive Cinema Group (1988). Thus interactive cinema was born.

Figure 27. Nicholas Negroponte pondering the future.

2.5 Developing a new expressive medium

> Individually it's difficult for people to imagine a thing that hasn't been invented yet. If you had asked people in 1955 what new kind of toy they wanted, nobody would have said, "a plastic hoop that I can rotate around my hips." And extrapolating from the current interactive entertainment landscape is risky too, because it may give us a future that unconsciously incorporates the limitations of the past (Laurel 1989).

What conclusions should one draw from all this history? The development of a new expressive medium happens in three stages. First, the medium is invented because of an advance in technology: movedble type created the print medium, motion picture cameras enabled cinema, and computers enabled interactive media. The next stage of development is defines an expressive language. Through experimentation, luck, and observation, the practitioners in the new medium begin to learn new techniques of expression. The first forms of expression will inevitably be unsatisfying translations of older media into the new medium. The first films were essentially stage plays acted in front of a camera. Refinements in the technology and the economics of the new medium enable whole new forms of expression. Finally, as the new medium matures, the tools for creating the medium become stable and cheap (relative to the cost at the invention of the medium). At that point, new practitioners of the medium will step in and discard the assumptions of the past and refine the new conventions for the medium.

The computational medium is on the brink of entering into the final period of development. The machines have become stable and accessible. A new generation of computational designers and storytellers are beginning to cast off the assumptions of the old and discover the new.

Figure 28. The future rushing to meet us.