

The Medium of *Media*:

The Past, Present, and Future of Personal Screens

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INTRODUCTION AND HISTORY

We live in a screen culture. Most Americans rise, labor, and rest to the glow of a screen. In Western culture, screens developed as a means to provide visual entertainment. Now they serve as the common medium that displays nearly all digital media. We work, read, and entertain ourselves facing the screen, from computers to televisions to films and video games. Even traditionally paper-based mediums, like books and newspapers, are increasingly experienced through a screen. Screens have evolved to fit our needs, and our lives have evolved to fit screens. To study the screen is to study the medium of media: the last physical apparatus between our machines and our eyes. In this essay, we examine the screen as a technological object—the display window in which media is projected both on and to—and how screens affect human interaction, society, and development. For the sake of specificity, this essay will focus on personal use of screens: the symbiotic relationship between the average person and the screens they view and manipulate in their daily life. Screens serve as fascinating objects with which to discuss the evolution of digital media.

Since this essay will focus specifically on screens as they are used in a personal capacity, the historical timeline will emphasize the years in which each screen was introduced and assimilated into modern society, and not the exact year it was developed in a laboratory or research facility. Thus, the cinema screen was Americans' first personal experience with a screen. The first cinema screen (not unlike the current movie screen) requires almost no internal technology: it exists only as a physical blank onto which machines project media. But the human reaction to this early screen was profound. People accustomed to watching live performance found themselves seated in the familiar darkness of the theatre, but instead they watched a screen; they viewed, in person, performances that had occurred in the past. Some reacted to their first screened motion picture viewing experience with understandable confusion. In her book *The Virtual Window*, Anne Friedberg describes the film *Uncle Josh at the Moving Picture Show* (1902) as an example of "the spectator's confusion between offscreen and on-screen reality."

As the first short film, *Parisian Danger*, commences, a woman enters the frame of the inset screen and begins to lift her skirts, revealing her legs with high kicks. Uncle Josh applauds and then quickly jumps out of his loge seat, shaking the flimsy boards of the theater set that frames him. As the woman dances in the space of the screen, Uncle Josh remains on stage in the narrow space between his now-abandoned framed loge and the frame of the projection screen. The moving bodies of Josh and his female screen "other" are matched in scale as he mirrors her movements...¹

In Uncle Josh's defense, the screen portrayed in the film was life sized and situated to meet the floor of the stage, giving the illusion that the screen was a continuation of real space.

Through the cinema, American society embraced the screen as a medium to portray virtual images and quickly welcomed the television's small screen into the home. According to the Federal Communications Commission, by 1960 85% of US homes had a television set.² We began to organize our lives around the screen, arranging our furniture for optimum screen viewing and eating our dinners on portable trays. Meanwhile, we still went to movies; the television screen did not and has not replaced the movie theatre, it simply added to our screen time. Until very recently, the television screen utilized a cathode-ray tube system for projecting images. The cathode, a heated filament, emits negative electrons into a vacuum, sending them streaming through a positively charged anode and out to a phosphor-coated screen inside the glass screen of the television. Copper coils at the end of the tube create magnetic fields used to direct the electron beam horizontally and vertically across the phosphor screen, essentially "painting" an image.³ The unwieldy cathode-ray television is still common, but sales are declining as newer televisions, using the LCD (Liquid Crystal Display), LED (Light-Emitting Diode), and plasma screen systems become more affordable.

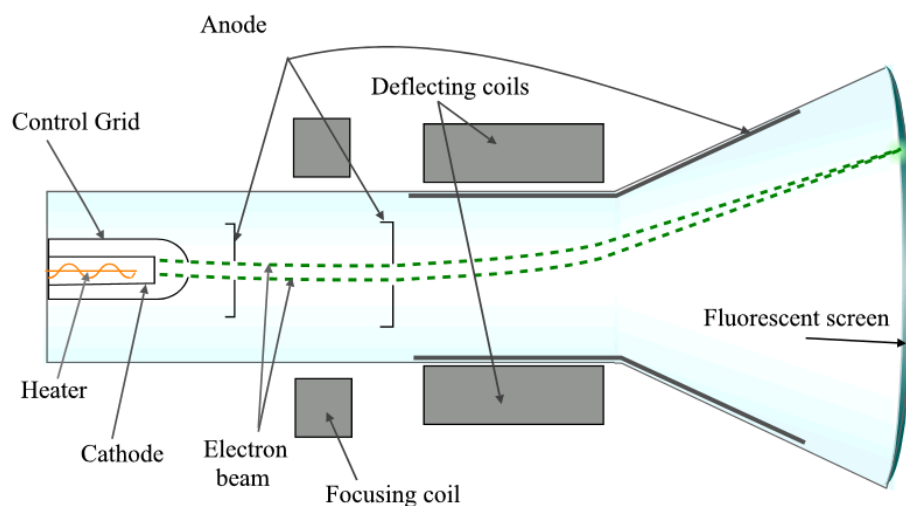


Figure 1: Cathode-Ray Tube. Image labeled for reuse.

Color screen televisions were the norm by 1980, but for the majority of Americans the first computer screens were dichromatic, text-only glass screens which resembled televisions only in shape.⁴ Early personal computers, like the Apple II, which had color graphic capabilities, used the cathode-ray tube system. As computer technology advanced, the need for better screens increased.

Meanwhile, the first laptop, or portable computer, appeared on the market in 1983 using a color LCD display; despite the new screen technology, early laptops were heavy and "portable only in the sense that they could be picked up and carried."⁵ A flurry of development in the 1990's, including

Microsoft's Windows 3.0, CD-ROM equipped computers, and the introduction of the graphically oriented World Wide Web in 1993, transformed the personal computing experience to one entirely dominated by graphics and media. Cumbersome laptops gained popularity as they became lighter. Subsequent advancements in broadband technology made Internet access fast and easy, changing the use protocol for personal computers from processing devices to viewing devices.

In the past few years, homogenization of the television and computer screens occurred as user applications for the two devices overlapped; currently, both television and computer screens employ various versions of flat panel technology, the most common of which are the LCD, LED, and plasma displays. Plasma screens behave similarly to fluorescent lightbulbs, in which electrons pass through a combination of gases trapped between two panels of glass to produce lighted color. LCD screens use liquid crystals illuminated by fluorescent lights positioned behind the screen. LED screens use light emitting diodes, which, when combined with electrons, release photons—the basic unit of light.

MOBILITY AND NEW TECHNOLOGIES

As flatscreens replace cathode-ray screens in most people's homes, the cost to both consumer and environment will dictate which system prevails as best. Research shows that both plasma and LCD screens use significantly more power than their cathode-ray predecessors; a 2006 BBC article found that a 50-inch plasma screen used 400 watts of energy to function, compared to the 28-inch cathode-ray screen's 87 watts.⁶ Manufacturers of LCD screens use nitrogen trifluoride, a greenhouse gas estimated to be "17,000 times more potent than carbon dioxide."⁷ According to Amazon.com, a new 46-inch plasma screen can cost as little as 549 USD; a new LCD costs 989 USD, and an LED screen costs 1,997 USD. As costs for the LCD screen fall, the demand is expected to nearly double by 2012, and as consumers replace the cathode-ray screen with new technology, we have to contemplate where—and how—to dispose of old televisions.⁸ Though still the most expensive for the consumer, the LED screen appears to have a lower environmental impact, using less energy to power and no harmful chemicals. Our relationship with screens in the future will depend in part on our attitude toward their environmental impact.

As humans become more mobile through improvements in transportation, their need for more mobile devices, and the appropriate corresponding screens, increases. Cellular phone use exploded into American society in the mid 1990's and quickly became a major form of communication. Small screens designed to display phone numbers rapidly evolved into color screens able to display images; in less than ten years, mobile phone screens have come to resemble computer screens in terms of media displaying capabilities. What's unique about these new small screens is how we can hold them. Unlike even a laptop computer, the PDA or smartphone fits into our pocket, offering a comparable computing experience without the weight of a laptop computer or the fixed

perspective of a desktop screen. Software developers modified existing touch screen technology to suit these mobile computing devices.

Now the standard for all new screens touch screen technology offers a direct human-screen interaction, shifting the paradigm from one of passive viewing, or remote manipulation through a mouse or remote control, to active and kinetic expression. The three most common systems for touch screens are resistive, capacitive, and surface acoustic wave.⁹ A resistive system is comprised of one conductive and one resistant metallic layer held apart by spacers. An electrical current runs through the two layers and when a user pushes on the screen, the resulting contact changes the electrical field, allowing the computer to determine the exact coordinates of contact. In a capacitive system, the layer containing an electrical charge is situated on the glass; the user's touch absorbs some of the electric charge and the subsequent decrease in charge on the capacitive layer registers with the computer. The computer calculates the location based on the relative difference in charge and relays that information to the driver software. In the surface acoustic wave system (SAW), two transducers (one receiving, one transmitting) on the x and y axis of the monitor's glass plate convey an electrical signal to a reflector on the glass surface. The receiving transducer detects any disturbance in the wave and locates it accordingly and immediately. Each system of touch screen has its benefits and limitations; the surface acoustic wave system, which lacks any metallic layer on the glass, is able to produce the highest quality graphics. Both resistive and surface acoustic systems will respond to any stimuli; the capacitive system relies on a charged stimulus, like the human finger, to detect a touch.

As predecessor to the modern smartphone, the Personal Digital Assistant introduced touch screen technology for personal use. The Palm Pilot, an early PDA, offers insight into both screens and the way we adapt to digital media. The Palm Pilot, using a resistive system, relied on a stylus pen to register contact with the operating system. Since the PDA evolved as a technological equivalent to a personal calendar or notebook, it is no surprise that software developers designed the Palm Pilot to mimic the action of holding a pad of paper and writing notes on it with a pen. Another early PDA, the Apple Newton, was praised in a 2002 *Wired* article for its "handwriting recognition," which users called "unbelievable."¹⁰ Early PDAs acted as digital surrogates for paper and preserved the cultural norm of pen and paper notation.

However, the same *Wired* article ridiculed the Newton's size, calling it "as big as a brick."¹¹ In response to the popularity of handheld data devices, computer programmers developed software for showing optimal internet content on tiny screens. The SSD, or small screen device browser, emerged out of the need to preserve the small handheld screen while improving the quality of web pages. Once quality web pages could be viewed from the handheld device, many smartphones switched from resistive touch screens to capacitive screens. The simple motion of dragging a finger

lightly across the screen to scroll through websites, emails, and contacts has become almost a natural motion for today’s smartphone users. Furthermore, capacitive screens are the only touch screens that function with LED systems, utilized by the newest crop of smartphones including the Apple iPhone4 and Google Android. Both the iPhone4 and the Droid also employ multi-touch screen capabilities only available with the capacitive system.



Figure 2: Smartphone with touch screen technology. Image labeled for reuse.

As of 2010, the most recent incarnation of the personal screen was a hybrid of laptop computer and smartphone and commonly known as a “tablet.” The tablet computer is slim, lightweight, and capable of displaying high quality video and websites. The tablet’s screen ranges in size from 9.7” to 12” and the newest tablets, including the Apple iPad 2, employ capacitive multi-touch screen technology and LED display systems (IPS, Super PLS). The tablet computer typically has very few buttons—the screen comprises the majority of the visible machine. There is no external keyboard or mouse (though attachments are available as supplemental peripherals); instead our fingers are the mouse and the screen our keyboard. The keyboard on the iPad, for instance, appears when the user needs to enter text and then disappears, like touch screen smartphones. Tablet computers are poised to become as popular as laptop computers; in May of 2010, Apple announced that it had sold one million iPads in 28 days.¹² The tablet’s success lies in its ability to provide users with an excellent internet browsing experience, less weight than a laptop computer, and, of course, a crisp, kinetic, and enjoyable screen. Furthermore, at 499 USD for the basic model, the iPad entered the market at the same price range as a basic laptop computer, and as competition in tablet computers increases, we can expect the device’s price to fall or the technology in the devices to advance significantly. Already we are seeing this evolution with the iPad 2, and Honeycomb based devices like the Motorola Xoom and the redesigned Samsung Galaxy Tab 10.1.



Figure 3: Apple iPad. Image copyright Apple Inc. 2010.

As smartphones and PDA's replace notepads with touch screens, the launch of the E-Reader Amazon Kindle in 2007 represents the end of an era for paper-based novels and periodicals. Other E-Readers include Barnes and Noble's Nook and Sony's Reader. The handheld digital device can hold up to 1,500 books in data storage. Users can purchase subscriptions to newspapers and periodicals and, using either a touch screen or buttons, navigate the "page" with considerable ease. Some E-Readers, like the iPad, are backlit, allowing the user to read anything at any time without the need for external artificial light. Other E-Readers truly mimic paper, requiring light to see the words but no electricity to maintain the image.

E-Readers like the Kindle employ a new technology called E-Ink. E-Ink is composed of microcapsules full of millions of positively charged white particles and negatively charged black particles. Electronic signals force either the white or the black particles to the top of the microcapsule and the opposite to the bottom, and thus the capsule appears either black or white. E-Ink is "printed" on plastic sheets connected to a layer of circuitry; the electronic signals come from wireless transmissions.¹³ The growth of E-Readership has led American society to question the future of paper-based newspapers and books; in July of this year, Amazon.com "announced that in the last three months, sales of books for its E-Reader, the Kindle, outnumbered sales of hardcover books."¹⁴ To a certain degree, affection for turning the page and collecting cherished novels will sustain advancements in E-Reader technology. But as the technology improves, the practicality of consuming information through this screen is undeniable. Right now, the Amazon Kindle costs 189USD, and the typical E-Book bestseller costs between 9.99 and 14.99USD.¹⁵ But as E-Books improve, incorporating a

multitude of languages, textbooks, and literatures, the average student may find that purchasing the E-Reader and subsequently downloading E-Books is more cost effective than purchasing the requisite traditional books for each class. Furthermore, research proves that E-Readers are indeed the environmentally friendly choice, generating between 130-168 kg of carbon dioxide from manufacture to use. Compare that to the typical book, which uses 7.5 kg of carbon dioxide from manufacture to use, and a collection of one hundred novels ends up costing the earth 750 kg of CO₂—and represents a fraction of the amount of books storable on the Kindle.¹⁶

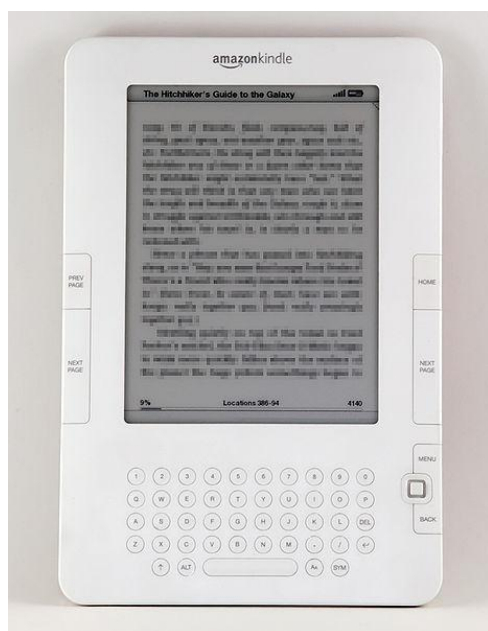


Figure 4: Amazon Kindle. Image labeled for reuse.

According to the 2010 Nielsen Three-Screen Report, American adults spend roughly 40 hours a week in front of the television and computer screen; the report did not include time spent watching media on mobile device screens.¹⁷ At the time of this essay, one of the most hotly debated issues in American society is the potential correlation between “screen time” and health problems such as obesity. The static nature of individual screens, such as television and desktop computers, contributes to hours of sitting, engaging only our eyes and (sometimes) our brains, and rarely our full bodies. As the cost of healthcare rises, and health problems are increasingly attributed to sedentary lifestyles, our relationship with the screen has become destructive. Already, the US government has issued guidelines for limiting screen time for children to two hours or less per day; research has found that American children exceeding this recommendation engage in less physical activity.¹⁸

THE FUTURE

The screens of the future must address this issue and indeed, some technology corporations are already doing so. The Nintendo Wii, a wildly popular game console that interprets a user's movements on the television screen, is an example of how screens will change to incorporate the body as well as the eyes. The Wii uses a wireless remote to translate the users movement into the game; unlike the passive, seated experience of game consoles like the X-Box or Playstation, the Wii experience can be dynamic. On the heels of the Wii, the new Microsoft Kinect uses a combination of camera, motion detector, and software to translate the movements of the user onscreen, without the need for a remote or gear. Furthermore, the Wii Fit Software, which works with a balance board accessory, has turned the screen into a fitness trainer. The Nintendo Wii represents a turning point in our relationship with the screen by proving that interaction trumps aesthetics. Like the touch screen, the Wii compels the user to actively engage with the contents of the screen. And now, the Sony Move and the Microsoft Kinect have taken that movement and level of interaction to new and heightened levels.



Figure 5: A child swings the Wii remote in a game of virtual tennis. Image labeled for reuse.

At a Monterey, California TED conference in 2006, NYU-based research scientist Jeff Han stood in front of a delighted audience and became, physically, one with the screen. Han introduces his newly developed multi-touch screen by using both hands to manipulate a molten lava-lamp like moving image. Later in the presentation, Han shows a map of California, and, as if holding a traditional map, uses both hands to move the image. The screen betrays its digital essence when Han uses both hands to flip the map on its side, revealing a topographical display of the state from eye-level

perspective. "We have so much technology these days that these interfaces should start conforming to us," he says, and then, later, "The interface just disappears. I can switch to different data views."¹⁹ This idea—that interfaces will disappear, and screens will become more intuitive to our physical motions—is prescient. In the upcoming section, we will examine the future of the screen as it transforms from a rigid, glowing rectangle to a thin, malleable plastic; from a framed, remotely-operated monitor to one which will reflect not only the touch of our hands but the movements of our body; and from a technological object to a biological object, as the retina of our eyes becomes the only screen we need.

The multi-touch screen Han debuted at TED 2006 is available, in some incarnations, today. His company, Perceptive Pixel, bills itself as developer of "the most advanced multi-touch solutions in the world."²⁰ But these screens are currently marketed to businesses like medical technology and broadcasting studios, and are prohibitively expensive to the average person, costing between 60,000 and 100,000 USD.²¹ However, smaller devices like the iPad utilize basic multi-touch screens with very little interface. A recent Neilson report found that 23% of time spent on the Internet is for social networking sites, where little more than clicking through photos or reading updates is necessary.²² As accessories to our screen-dominated computers, items like the keyboard and mouse will experience their own transformation. When the average person needs to type more than a password or a comment on a webpage, keyboards will be available as an accessory to plug in. Already, flexible, rollable, waterproof keyboards are for sale, ideally for use with tablet computers.²³ Likewise, since the mouse provides more onscreen precision than a finger, the user will simply plug in the mouse for more accuracy. In the next two years, as multi-touch screens become the norm, our hands will become extensions of our virtual selves. The border between screen and reality blurs as the screen reflects our fingers' movements in real time.

But even with active hands and engaging screens, research shows how attached we are to the physical activities associated with book reading and newspaper reading. A 2008 study by Japanese researchers found that all subjects tended to bend, fold, or flip the pages of books and periodicals. The researchers propose a prototype device that addresses the observed human activity. The device would consist of "(1) an input device with a flexible plastic sheet which encloses both sides of an LCD monitor and (2) bend sensors attached to the sheet, which can detect various bending inputs by the user."²⁴ The prototype would be made out of flexible plastic which would display any bend, fold, or flip of the "page" on the screen, and the LCD monitor would be replaced by plastic E-Paper. In another collaborative research proposal, the authors envision the future of maps as "a networked mobile computing device consisting of a flexible digital touch screen that can be folded up and slipped into the pocket like a piece of paper."²⁵ In the near future, environmental constraints will force paper production to slow dramatically. Most content will continue to move online, like

newspapers and magazines. But our physical inclination to hold and bend these mediums will compel the widespread use of a new screen: E-Paper.

Thin, flexible, and lit by ambient light, E-Paper hybridizes the unique components of computing and viewing for a reading experience similar to a printed paper, yet augmented by Internet access and data storage. This flexible, digital touch screen will provide users with a similar experience as holding a paper map or newspaper. As I mentioned earlier, the Amazon Kindle E-Reader utilizes E-Ink to make print-like displays. However, the Kindle and other E-Readers still rely on rigid hardware behind the E-Ink screen. Future E-Paper will more resemble the aforementioned prototypes. Current limitations on the production and dissemination of E-Paper include costs, content, and lack of manufacturers. The success of E-Paper in replacing periodicals is dependent on a low cost, as it must compete with the fifty-cent newspaper and three dollar magazine. Furthermore, the technology necessary to convert E-Paper from its current rigid incarnation to flexible plastic is not developed enough for inexpensive mass production. When mass production is finally possible, media outfits like national newspapers and periodicals must then find a way to integrate their content into this new medium. In a 2007 interview, a media analyst predicted mass-production of E-Paper by 2012 and disposable E-Paper by 2015.²⁶ Currently, E-Ink "printed" on E-Paper is used in marketing display images and retail signage. The E-Ink Corporation, based in Cambridge, Massachusetts, recently announced its newest display technology, Pearl, which enables "a reading experience most similar to reading text on printed paper," but is "lightweight and eco-friendly... with less eye-strain and longer battery life than an LCD."²⁷ These advancements in screen technology reflect the consumers' demand for more paper-like screens, while incorporating the data storage and wireless capabilities of E-Readers like the Nook and Kindle. Within five years, readers will have the ability to flip, turn, and fold the screen-pages of E-Readers while using their fingers to highlight, drag, and manipulate the images on the screen.



Figure 6: Flexible E-Paper. Image labeled for reuse.

To further examine the future of the screen, let's return to Anne Friedberg's *Virtual Window*. In her conclusion, Friedberg alludes to possibility of the complete disappearance of the screen, evoking images three-dimensional holographs in science fiction adventure such as *Star Wars*. Though Friedberg surmises that "images and data will be 'uploaded' directly, bypassing the eye and the optics of vision," the true potential for the future involves *only* the eye—and no screen or frame.²⁸ No less fantastic but closer to reality is virtual retinal display technology. Virtual retinal display (VRD) technology scans an image onto the human retina similar to the way a cathode-ray tube paints an image on a screen. According to research from the Human Interface Technology lab at the University of Washington, VRD "scans intensity modulated laser light pixels directly onto retina... Unlike CRT monitors, the VRD has no phosphor persistence but depends on the light-gathering properties of the photoreceptors and the temporal integration properties of the visual system."²⁹ To clarify, VRD eliminates the need for a physical screen by utilizing the "screen" of the retina. Instead of screen technology translating the image, VRD relies on the vision system of the human brain. One current project employing VRD technology is an interactive VRD for US Navy pilots, which would "superimpose high luminance color images over the pilot's real world view."³⁰ Another project, called "True 3D Displays," employs VRD technology to improve 3D perception by alleviating the competition in depth cues that naturally occurs when we view virtual 3D images.³¹ We can expect VRD technology to make its way into military operations before becoming available for personal use, but its very existence challenges the current paradigm of screen as a technology apart from our bodies to one in which our bodies provide the only screen we need.

CONCLUSION

In the next decade, expect the screen to change both physically and intrinsically. Sound, motion, and touch detectors will be integrated into the mass of the screen, enabling the screen to interpret human emotion by recognizing the movements and changes in voice tone that correlate to feelings. Since our use protocol for television remains relaxing amusement, the television will continue to be controlled remotely—by integrated sound detectors responsive to the viewer's verbal commands. But unlike the households of the 50's and 60's, we will no longer need to conform our living spaces to the screen—thin and unobtrusive, the screen will conform to us. All standard computer screens will utilize high definition, low-impact, environmentally sound screen technology equipped with invisible cameras, so videoconferencing will be as close to a physical conversation as possible. Mobile screens, like smartphones, tablet computers, and E-Readers will be slim and intuitive, and E-Paper will replace single-use, resource-depleting paper newspapers and paper maps with complex, dynamic touch screens. And, when VRD technology expands into our daily lives, society may again experience an *Uncle Josh* moment—only it will be the disappearance of the screen that leaves us breathless.

Technology advances at such a rapid rate that the need for multiple personal screens may diminish. Functions and capabilities of devices expand and overlap according to user demand. That being said, a deterministic approach to the homogenization of devices—the idea that one machine (and one screen) will rule them all—ignores patterns of human behavior. Whether the individual engages one screen or several will remain personal choice. We can only expect for certain that the screens in the future will engage us more and more intimately, functioning not only as the windows into our machines but as reflections of our lives.

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