A Brief History of Entertainment Technologies

This paper reviews the history of entertainment technologies from the early days of film and television to the present, in order to provide some perspective into the future trajectories of technology and entertainment.

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ABSTRACT | No prediction of the future can be done without a good understanding of its history. This paper takes us through the history of entertainment technologies from the beginning of the 19th Century to the current time. We trace the paths taken by two particular content types—motion pictures and television—and along the way, examine several other forces that eventually come together at the beginning of the 21st century to forge a new digital economy for the coming future.

KEYWORDS | Automatic content recognition (ACR); digital economy; film and television history; high-definition TV (HDTV); Internet; online piracy; social TV

I. INTRODUCTION

In 2009, the chip giant Intel issued a prediction that by the year 2015, there would be 12 billion connected devices worldwide, delivering 500 billion hours of TV and other video content to viewers. Based on the World Bank projection, there will be more than 7 billion people in 2015 to use these 12 billion devices. That works out to be 1.7 connected devices, delivering 71.4 hour of video content to every man, woman, and child on this planet just three short years from now. Most of us know that it has not always been this way: pervasive displays, ubiquitous connectivity, content anytime, anywhere, any device. So how did we get here?

To understand the forces that have come together to shape the future trajectories of technology and entertainment, one must first look at the past from which these forces have been forged. This paper will take a brief look at the history of entertainment technologies, from the early days of film and television to our present time.

II. PREDIGITAL AGE

Technology has always been a big part of the entertainment content world. Entertainment technologies, it can be said, started with Thomas Edison's first phonograph machine in 1877. The technology showed the world that sound can be "recorded" and "played back"—indeed the original *packaged media*. Decades later, a technology invented for telecommunication, namely radiotelegraphy, found new use in entertainment radio broadcast services. Note that the original intent of telecommunication was to allow a point-to-point radio link for communication purposes. The early pioneers of broadcast radio saw the benefit of the technology in providing one-way information, including entertainment content, to a large audience. When combined with prerecorded music (vinyl records, magnetic tapes, and later on CD and other digital recording media), broadcast radio led the way to mass media for entertainment.

History shows us that technologies created for a particular application often became "usurped" by other unintended applications. Occasionally, the unintended use of a technology can spawn a new industry larger than anyone thought possible.

We will review here two major entertainment content types: motion pictures and television.

A. Motion Pictures

Motion pictures first appeared commercially at the end of the 19th century: there were many experiments and attempts to commercialize the technology on both sides of the Atlantic. The Frenchman Louis Lumiere invented the motion picture camera in 1895, and Thomas Edison invented the Vitascope projector in 1896.

The early motion pictures did not have sound, nor did they have color. These early films were mostly single scene, with no stagecraft of any kind. Clearly, this period saw not only the birth of modern motion pictures technology, but also the beginning of the creative arts of storytelling using moving pictures.

Moviemakers soon had more tools at their disposal. By 1925, sound was slowly added to motion pictures. Initially, only music scores, rather than dialogues, were used. In 1928, the film *Lights of New York* introduced the audience to dialogues throughout the film, ushering in the age of the "talkies."

Color took considerably longer to come to the moving pictures. While the theory of color film was understood—indeed the first feature-length color film was produced in 1918—there were many difficulties, both technical as well as commercial, facing the industry as it worked to bring color to the silver screen. The industry had to overcome the difficulty of developing an economical, workable, and reliable color processing method. Even as late as the mid-1950s, most of the films were still in black and white rather than color.

Over this same period of time, as film production technology was used more and more, innovations sprung up to meet new found needs, from mounting gears to allow for camera panning, to better understanding and control of lighting, to the art and science of exposure, and understanding and control of the perception of motion and, hence, time. Other techniques, such as crosscutting to convey events taking place at different locations but at the same time, laid the ground work for an entirely new and rich school of storytelling methods that are unique to the medium of film.

Most of these techniques and their resultant effects quickly added to the palate from which creative storytellers draw upon as ideas and tools, which in turn led to newer sets of needs and requirements for the technologists. Such symbiotic relationship would prove to be an invaluable source of energy to propel the film entertainment technology well into the 21st century.

B. Television

Modern television first took shape in the form of electronic television, first demonstrated by Philo Taylor Farnsworth in 1927, a year before the first "talkie" picture, *Lights of New York*, debuted. At that time, there were electromechanical television systems being used. In fact, the BBC's first public television service in 1936 used an electromechanical television system of Baird. Three years later, in 1939, RCA televised the opening of the New York World's Fair, and the era of electronic television had arrived. RCA's president, David Sarnoff, eventually built up an empire with the television broadcast station NBC and the RCA television receivers. One of the first entertainment television programs was the 1939 televised baseball game between Princeton University and Columbia University, shot with a mobile unit.

In the years between Farnsworth's 1927 first demonstration of an electronic television, and the eventual 1939 RCA televised baseball game, there was plenty of wrangling and drama between Farnsworth and RCA over patent disputes. There were three prominent electronic television systems being developed over this period: Farnsworth's Image Dissectors, RCA's Iconoscope, and Shoenberg's Emitron. American and European companies such as RCA, BBC, EMI, and Telefunken were battling for the nascent television markets. It must be noted that the television systems, while differing on the image capturing mechanism, were all relying on a transmitter-to-receiver model in which images captured on the transmit end would be synchronously replicated at the cathode ray tube (CRT) on the receivers. This early coupling of the entertainment content creation technology to the entertainment content consumption technology sealed the bond between broadcast television and consumer television receivers.

As early as 1932, BBC started its television broadcast service using both Baird electromechanical and Marconi's electronic television systems. Not long after that, the British government selected the Marconi/EMI system. By the time World War II started, many in the country were already regular viewers of the BBC television service.

Earlier, in March 1929, RCA, under David Sarnoff, began daily television broadcast from its New York City station, W2XBS (which later became WNBC). Several other radio stations across the country, using incompatible television systems, soon began television broadcast services as well. These early television systems were nothing like the analog National Television System Committee (NTSC) system that many of us grew up with. Instead, these were televisions with no more than 100 scan lines. Still, the technology continued to improve. By the time RCA broadcast the opening of the 1939 World's Fair, the television system afforded viewers more than 400 scan lines.

In May 2, 1941, the U.S. Federal Communications Commission (FCC) formally adopted the NTSC television standards, cementing the technical standard for television for decades to come. The FCC's decision also had a profound effect in the nascent television industry by ushering in the era of mass electronic media.

Over the next few decades, especially starting with the end of World War II, The United States saw a ground swell of television shows as the TV content industry took off. Countries worldwide, including in Asia, Europe, and South America, all followed suit with the adoption of national television standards, heralding in the era of mass electronic media for the first time in human history.

As viewers increasingly took to television, the industry began to experiment with various formats for different shows. Unlike motion pictures, which remain largely a storytelling medium, television began to transform into a mixture of information dispensary and traditional variety shows, both of which did not fit the motion picture format well.

Another aspect that separates film from television is the gradual but relentless movement by television toward nonstop broadcast programming. Programmers developed a new set of skills to cater to not only the demographics of the audience, but also the time-of-day variation, hence, the morning shows' hours, to the daytime soaps, to the evening "prime time" programming. These program schedules grew out of an increasingly profound understanding of the viewing audience, helped in turn by the emergence of TV audience measurement.

By the early 1960s, television had become the go-to source of information, including entertainment information, for most Americans. Over the next two decades, new distribution technologies, including cable and satellite, became increasingly prominent as the preferred means of TV distribution in the country. Part of the success of these cable/satellite distribution networks was due to the ability of the underlying technology to support far more "channels" of TV programs. For the moment, more was better, and consumers embraced the new technology wholeheartedly.

In 1979, the Japanese state broadcaster, NHK, developed an analog high-definition system known as Multiple Sub-Nyquist Sampling Encoding (MUSE). It was the first time since 1941 that consumer television would have a significant increase in video quality. While it was clear to the developers that the new high-definition TV (HDTV) would be a welcome to consumers, there was a problem: the spectrum needed to deliver the HDTV service was nowhere to be found, thanks in large part to the continuing success of the then analog terrestrial broadcast standard-definition TV services.

The answer came in the form of digital video compression technology. It was a time of digital race, of digital innovation. Several competing groups with different formats and technologies were working feverishly around the globe. The adoption of the Advanced Television Systems Committee (ATSC) standard by the FCC in 1996 sealed the fate of a particular set of digital compression standard known as MPEG-2. The decision set in motion many subsequent products and services in not only terrestrial digital TV industry, but also digital satellite TV, and packaged media as well. It was as if the floodgate to all things digital had been open, and there was no going back.

III. THE ARRIVAL OF THE DIGITAL AGE

Consumers first embraced digital entertainment in the form of audio CDs in the 1980s, and later on in the form of DVDs in the early 1990s. During that same period of time, direct-to-home satellite TV services such as DirecTV, PrimeStar, and Dish Network had already begun providing digital TV services to consumers. The satellite boxes many consumers had in their homes were probably among the first digital video entertainment devices they had.

Meanwhile, the package media industry was going through a revival: Hollywood studios quickly switched from their home videocassettes business to digital disc media (DVDs first, followed by Blu-ray discs). Both films and TV shows increasingly counted home video business as an important revenue source. Above all, packaged media brings to consumers a control that they did not have with either theatrical or live broadcast TV experience. Packaged media gives consumers full control over the playback of a piece of content: pause, rewind, and fast forward.

As successful as TV is—from its early days, through the analog NTSC/PAL/SÉCAM systems, through its present day digital high-definition video and multi-channel digital audio—consumers remain captive to the broadcast stations' program schedules. Even though time-shift viewing was made possible by the development of the video cassette recorder (VCR), it was really the arrival of the digital video recorder (DVR), with its ease of use and flexibility to quickly move around the content, that gave consumers a new way of enjoying their favorite TV shows. The shift in consumers' viewing habits has had a profound impact on the TV industry. Even though the TV audience measurement industry has developed technology to include time-shift viewing, the underlying economic model does not yet fully support time-shift viewing. For instance, time-sensitive advertisement loses its value over time. Such a situation leads to stress on the TV ecosystem, and will undoubtedly create opportunities for new and innovative solutions.

IV. A PERFECT ENTERTAINMENT TECHNOLOGY STORM

Analog television broadcast in the United States ended on June 12, 2009. Terrestrial television broadcast in the United States, and most of Europe, has switched over to digital, and with it, high-definition video and digital sound. For many in the television industry, the switchover was as daunting a challenge as any they had faced in recent memory. But in terms of its impact on the modern economy and on the lives of everyday citizens, the analog-to-digital transition of television was dwarfed by something else: the Internet.

As the millennium drew to a close, portable mobile devices started to take hold with consumers. Apple's 2001 iPod, a simple, portable, digital music player, started a whole revolution of mobile devices that, in time, became one of the icons of the 21st century. That the device can stay with an individual throughout his/her day means that the device has to be personal. In time, the capabilities of such personal digital devices would evolve to usurp the functions of desktop personal computer (PC), TV, DVR, and yes, the old mobile phone as well. That an all-digital device can perform the functions of all these single-purpose devices is important. Consumers are teaching us that, in some cases, they are choosing to experience entertainment portably, even if on smaller screens.

By the start of the second decade in the 21st century, digital age is in full swing. While there is no threat that

consumers would be switching from watching video on their living room TV to a 4-in display on their mobile phones, it is clear that entertainment itself is undergoing a profound transformation. Nearly every electronic device, from home appliances and exercise machines to automobiles and airline seats, has built-in Internet access capability. Devices are said to be "smart," despite the often cumbersome sign-in process that consumers must go through. Still, slowly but surely, devices are getting smarter by the day.

A perfect brew of broadband penetration, rapidly falling computation and memory cost, and profusion of single-purpose software application ("apps") have brought us consumer devices that constantly watch and listen to the users, initially for user commands, but soon for context and more. Automatic content recognition (ACR) showcased prominently at the 2012 Consumer Electronics Show. Devices are poised to not only provide entertainment content to consumers, but also to provide real-time feedback to content sources about viewers' current preferences, and other contextual data. Audience measurement has arrived in the 21st century at last.

Digital age also made possible a new form of entertainment: electronic games. Arguably, video games can be said to be one of the earliest forms of digital entertainment. However, whereas motion pictures and television are mostly passive forms of entertainment, video games command a substantially deeper emotional engagement, as well as constant user interaction. Such fully interactive entertainments require more discussion than is possible in this paper. Suffice it to note here that from the first *Spacewar* computer game written by Steve Russell of the Massachusetts Institute of Technology (MIT), Cambridge, in 1961, followed by Atari's 1972 release of the game *Pong*, and a great many increasingly sophisticated video games, the video game industry grew from a niche market serving a relatively small group of gamers to the mass market success of game consoles such as Xbox, PlayStation, and Wii; the trajectory of the video game entertainment technology has finally converged with the motion pictures and television entertainment. Today, the same platform on which consumers play video games of all sorts also serves as a handy, if not familiar, portal to countless digital entertainment selections. The same digital connectivity that has brought success to such modern phenomena as *World of Warcraft*, a massively multiplayer online role-playing game (MMORPG), also presents online video services such as Netflix, Hulu, Amazon, and many more to home viewers.

In fact, these very same online video services have also found their way into virtually all consumer devices that have an Internet connectivity: portable media players, smartphones, tablets, laptops, PC, game consoles, DVD/Blu-ray players, set-top-boxes, etc.

Because one or more of these devices are always available to consumers, not only were consumers opting to watch their favorite shows at a time convenient to them, but also they are consuming the content anywhere they happen to be, and on any device they happen to use.

Even the very definition of entertainment content is undergoing revision.

V. LAZY SUNDAY GONE VIRAL

In 2005, a digital short called "Lazy Sunday" aired on NBC's Saturday Night Live. Shortly afterward, an unauthorized copy of the video became an instant Internet hit on YouTube, propelling YouTube as a go-to place for viral video. Today, many continue to enjoy homemade videos uploaded to user-generated content (UGC) sharing sites like YouTube, Vimeo, and many others. The phenomenon caught on, especially among the young and hipster crowds, the trendsetters of our time. As these are key demographics for the advertisement industry, viral marketing has become an important element of many modern ad campaigns.

Content, especially TV content, has long relied on advertisement as a revenue source. Different TV shows draw different audiences of different demographics. The advertisement industry, in turn, looks to television to deliver the needed audience for different ad campaigns. As new content platforms such as online video services and UGC sites emerge, the content industry has embraced and adapted to technologies that allow content to be distributed and brought to these new platforms. In 2007, responding to consumers' demand for professionally produced online video, two U.S. content providers, NBC Universal and Fox, launched the video site Hulu to much accolade. Today, consumers have numerous choices to access their favorite content online.

Another benefit of the Internet lies in its ability to connect people over distances, from a simple pairwise communication to social networks of friends. Out of this came a new form of content consumption: social viewing, or social TV. UGC may no longer be a home video of a cat on skateboard, but instead represent the conversations among social groups while watching content. Without the content, the conversations lack context. Indeed, to the viewing party, the UGC plus the content may represent their collective memory of the social event. This is the quintessential social media.

Meanwhile, the ferocious appetite for entertainment content, coupled with the power of digital and of connectivity, has unfortunately unleashed a dark side of the Internet: digital theft. Online piracy has grown from a casual file sharing to a multibillion dollar business, spanning the whole gamut of subscription business model, sell-through model, to streaming with advertisement model. Needless to say, the impact on legitimate new businesses is severe and will remain so until there are means to curtail these practices.

Although it remains to be seen what new business models would prove viable and sustainable in the coming

decades, one thing seems certain: all those who contribute to content value chain must be able to share in the profit generated thereof. That YouTube, whose initial rise has been attributed to an unauthorized copy of a copyrighted work, would subsequently enjoy a $1 billion valuation speaks to a troubling aspect of the digital business world today. Both Internet and media business models, business agreements, and underlying rights to use intellectual property will be motivated to find common ground as media become an increasing part of the digital economy. The sooner these common grounds are established, the sooner the digital economy will flourish upon such strengthened foundations.

VI. THE NEXT CHAPTER

In the final episode of *M*A*S*H*, which aired on the U.S. TV network CBS on September 17, 1972, 125 million viewers tuned in and watched. When the TV network ABC aired its final episode of *Lost* on May 23, 2010, 13.5 million viewers tuned in, and it was hailed as a great success for ABC. That the platforms from which consumers access their entertainment content have dramatically changed in these past decades cannot be any clearer. In fact, entertainment content remains in great demand across the globe. However, the technology that measures the success of content has lagged behind. In addition, the industries that rely on these analytics have much to overcome, as

successive platforms and technologies come about with seemingly lightning speed, fueled by consumers' appetite for convenient access to more content in more places and on more platforms. In February 2012, Super Bowl XLVI, one of the biggest sporting events in the United States, brought in more than 111 million viewers to the TV network NBC that aired it. On top of that, over 2 million online users watched it via live streaming—a first for Super Bowl. Consumers' appetite for entertainment content apparently still has room for more. Indeed, evidence suggests that consumers, rather than replacing older modalities of content consumption, are more likely to add to their selections of content consumption modalities.

It is almost certain that the coming decades will bear witness to major shifts and changes to every aspect of modern entertainment beyond anyone's imagination. Never before has our world seen a convergence of such a magnitude and broad reach in terms of technologies, businesses, and industries. The next chapter in this story will most certainly require collaboration among and across industries, for this digital perfect storm has only just begun. ∎
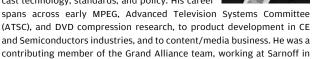
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Mr. Ng is an active member of several industry standards groups: DECE, CEA, DLNA, and W3C. He is a frequent speaker at industry forums on the subject of digital content in an IP-enabled world, focusing his attention on making digital entertainment a sustainable worldwide business reality.