The Story of Wearable Technology: A Framing Analysis

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ABSTRACT

The global wearable technology market is forecasted for strong growth over the next five years with revenue expected to reach $14 billion in 2016 and grow to $34.2 billion by 2020 (CCS Insight, 2016). The wearable industry has undergone a long metamorphosis and growth and is presently becoming more mainstream with the popularization of fitness trackers and smartwatches. Because media portrayals influence public perception of topics covered by the media, exploring media portrayals of wearables is an important component part of understanding trends in growth and popularity of wearables. No other study has analyzed how the media has talked about wearable technology. This study examines newspaper coverage of wearable technology from 1988-2016 using the news framing perspective.

A systematic content analysis was conducted on 182 articles from the *Wall Street Journal*, *The New York Times*, *USA Today*, *New York Daily News*, *New York Post* and *The Washington Post* analyzing issue frames, interview sources, episodic vs thematic frames, and type of wearable. This study found that among the four issue frames (progress, regulation, conflict, and generic risk) progress was the dominant frame. Episodic news frames emphasizing individual or specific examples were heavily relied on over thematic frames. The frequency of mentioning sources was not related to episodic/thematic coverage except for "professor" as an interview source. This study also found a significant relationship between interview source and year for "no source." The results of this research provides useful insight into how wearable technology has been framed over the past 28 years by the news media which is helpful for companies creating and marketing these technologies, journalists writing about this type of technology, and scholars interested in understanding how the media talks about a new technology while it is in the process of diffusion.

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CHAPTER 1. INTRODUCTION

According to a heuristic proposed by Saffo (1992), it takes about thirty years for a new idea to fully seep into our culture. Since it is the users that make collective sense of innovations, widespread acceptance of a new technology requires a co-evolution of technology and culture. Technology acceptance requires a dialogue between inventors and users, and about a decade for innovation to really begin. Saffo (1992) claims that there is more to this thirty-year rule than the mere fact of slow change; three distinct periods can be found. During the first decade, excitement builds, puzzlement ensues, and there is not a lot of penetration. During the second decade: lots of flux, but penetration of the product into society starts. If the technology reaches the third decade it is considered standard with widespread usage (Saffo, 1992). When inventions such as the telegraph, radio, telephone, television, films, aviation and personal computers are examined closely the same thirty-plus year pattern is detected (Winston, 1998; Saffo, 1992).

Similar to other technologies, wearable computing has undergone a long metamorphosis and growth. This is in part because wearable devices can perform many of the same computing tasks as mobile phones and laptop computers, co-evolving with these devices, but in some cases can outperform these hand-held devices due to sensory and scanning features (Tehrani & Michael, 2014). The terms “wearable technology,” “wearable devices,” and “wearables” all refer to electronic technologies or computers that are incorporated into items of clothing or blended into accessories or jewelry which are worn on the user’s body (Tehrani & Michael, 2014). Displays have become smaller and more powerful, sensors have become cheaper, wireless connectivity has boomed, and miniaturization has allowed advances in wearable devices (Chan, Esteve, Fourniols, Escriba, & Campo, 2012).

According to the International Data Corporation (IDC) Worldwide Quarterly Device Tracker, the worldwide wearable market is expected to grow 44.4% from the 80 million units expected to ship in 2015, to reach 111.1 million units shipped in 2016 (IDC, 2015). CCS Insight's (2016) global wearables forecast indicates strong growth over the next five years, with revenue expected to reach $14 billion in 2016, and $34.2 billion by 2020. Wrist-worn devices, such as fitness, activity, and sports trackers as well as smartwatches, are still considered to be the trailblazers in the wearables market. Fitness, activity, and sports trackers are expected to account for almost half of all shipments in the next 12 months, at more than 60 million units, where smartwatch sales are expected to exceed 30 million units (CCS Insight, 2016). The worldwide wearable device market will continue to grow as second and third generation iterations reach the market and build upon the hardware and software of their predecessors (IDC, 2015). China has emerged as a powerhouse for wearables with the Chinese company Xioami dominating the market with its Mi Band (CCS Insight, 2016). The fitness band market in China is projected to be twice the size of the US market and 2.5 times that of Western Europe by 2018 (CCS Insight, 2016).

Augmented reality (AR) and virtual reality (VR) have gained momentum with shipments forecasted to grow 15 times to 96 million units by 2020, at a value of $14.5 billion (CCS Insight, 2016). Low-cost VR headset designs based on Google Cardboard saw sales of almost 5 million in 2015 due to the success of smartphone-based VR. Samsung's Gear VR headset as well as the arrival of dedicated VR headsets from HTC, Oculus VR, and Sony are expected to reach record sales of nearly $1 billion by the end of 2016 (CCS Insight, 2016). User-generated 360-degree pictures and videos are expected to be an important source of viewing material for VR headsets, which should trigger greater interest in 360-degree wearable cameras. Because of this, sales of

250,000 units are expected in 2016 and rise to 3.3 million by 2020 (CCS Insight, 2016). This will account for 13 percent of the entire wearable camera market of 25 million units (CCS Insight, 2016).

CCS Insight (2016) estimates that just over 9 million Apple Watches were sold in 2015, which gives the company a 41 percent share of the 22 million smartwatches sold that year. However, Apple's sales fell well below CCS Insight's initial expectation of 20 million watch sales in 2015. Ben Wood, CCS Insight's Chief of Research argues for a link between consumer awareness of wearables and Apple, stating: "As we predicted consumer awareness of wearables in key markets like China, the US and UK has gone sky-high in 2015. We believe this can be attributed to what we are calling 'the Apple Watch effect' as well as growing success of brands such as Fitbit in the US and Xiaomi in China" (para. 5). In terms of software, IDC (2015) claims, "watchOS has become the measuring stick against which other smartwatches and platforms are compared" (Top Five Smartwatch Platform Highlights section, para. 1). IDC (2015) notes that there is still much room for improvement and additional features, but that Apple has the momentum to stay ahead of the rest of the market.

Google's Android Wear vendor list includes technology companies ASUS, Huawei, LG, Motorola, and Sony as well as traditional watch makers Fossil and Tag Heuer. With so many options users have an option of style and price, but that is the only thing that differentiates the products since the experience using Android Wear is largely the same from one device to the next (IDC, 2015). In addition to Apple and Google, Samsung has its own smartwatch operating system named Tizen. Because Tizen is compatible with most flagship Android smartphones, and has an application selection rivaling that of Android Wear, Samsung poses a threat to Google's market share (IDC, 2015). The smartwatch pioneer, Pebble, will cede market share to both

AndroidWear and watchOS, but is not expected to disappear altogether because it is one of the most easy to use and affordable smartwatches on the market (IDC, 2015).

The information provided by the mass media helps inform beliefs about new technology and news frames become the lens through which the innovation is evaluated (Vishwanath, 2009). Vishwanath (2009) examined the framing of new communication technology and its relationship to consumer adoption. Vishwanath (2009) found that “ease of use” and “performance” issues received the most attention from consumers. Weaver, Lively, and Bimber’s (2009) study on nanotechnology found that issue frames of science and technology in top 10 U.S. newspapers emphasized “progress,” “regulation,” “conflict,” and “generic risk,” and actors and responsibilities were deemphasized. Kang, Lee, & De La Cerda’s (2015) study on how the smartphone is framed in TV news found that “ease of use,” “performance,” and “Apple” issues were emphasized. News sources of professors, the government, and industry analysts were frequently used and TV news framed episodic aspects more than thematic ones (Kang et al, 2009).

Ted Nelson coined the term “HyperText” in the 1960’s and once remarked that it took it twenty years to become an overnight success, since the technology did not come into fruition until the mid-1980’s (Saffo, 1992). However, the idea of hypertext can be attributed to Vannevar Bush’s (1945) fictional Memex that could theoretically index, search and link content (Bush, 1945). This study aims to tell the story of how wearable technologies evolved and are talked about in the media through a news framing analysis looking at issue frames and episodic vs thematic frames as well as understanding who is relied on to speak about the technology. Because of the expected growth and widespread acceptance of wearable devices in the next five years, this study helps understand how wearables have been framed by the news to consumers

over the past three decades. A content analysis of 182 newspaper articles from the top six highest circulating United States daily newspapers was conducted to analyze issue frames, source frames, episodic-thematic frames, and type of wearable device.

CHAPTER 2. LITERATURE REVIEW

Wearable Computing

Barfield & Caudell (2001) define "wearable computer" as a "fully functional, self-powered, self-contained computer that allow the user to access information anywhere and at any time" (p. 471). This definition assumes that wearables are networked, which some are, however others store data to be transferred to other devices later (Skiba, 2014). In addition to being a self-contained computer, wearable technology can describe "many different forms of body mounted technology, including smart clothing, and functional clothing" (Dunne, 2004, p. 5). Wearables can gather data from either the wearer's body or from the environment, provide information, or do both (Educause, 2013). The connected age means being connected to three things: resources, people, devices and perhaps oneself (Skiba, 2014). According to Melanson and Gorman (2012), "wearable computing promises to extend that always-on connection even further and, potentially, change the nature of what it means to be 'connected.'" (para. 4). Wearables are considered the next step in the evolution of ubiquitous computing, a term coined by Weiser (1993) that describes how technology retreats into the background and becomes part of the fabric of our lives (Skiba, 2014).

Wearable technology is unique and is frequently more sophisticated than mobile phones and laptops because of sensory and scanning features such as biofeedback and tracking of physiological function (Tehrani & Michael, 2014). Wearable devices can include watches, glasses, contact lenses, e-textiles, smart fabrics, headbands, beanies and caps, rings, bracelets, and even hearing aid-like devices designed to look like earrings (Tehrani & Michael, 2014). While most wearables can be taken on and off with ease, there are some that are more invasive forms such as implanted devices like micro-chips or smart tattoos (Tehrani & Michael, 2014).

The purpose of wearable technology, whether worn on the body or incorporated within, is to provide constant, convenient, seamless, portable and mostly hands-free access to paired electronics and computers (Tehrani & Michael, 2014). Even though there are many different kinds of wearable devices, all are unobtrusive (i.e. small, lightweight, without wires, body-wearable including in clothing), support a primary task (i.e. do not disturb and are useful all the time), and are context-aware (i.e. casual use, "smart") (Kenn, n.d.). According to Mann (n.d.) wearable computing is the study or practice of inventing, designing, building, or using miniature body-borne computational and sensory devices that are worn under, over, in, or are themselves clothing.

Pederson (2005) identifies four unique ways interactivity benefits wearable users. First, wearables promote social interaction and should provide a seamless ability to interact with other people at all times. Second, wearables facilitate interaction with environments and can even allow the user to tag the space for when the next user comes along. Third, wearables offer unique ways to interact with the software (machines). Finally, wearables promote unknown interactivity. According to Racoma (2015) wearable devices have an array of functional purposes. They can assist individuals that are visually impaired and/or hard-of-hearing with interacting with their environment. They can access and share information quickly and wirelessly as well as making computations and prepare electronic documents on the go. Wearables can be used for multimedia entertainment purposes as well as interacting and controlling other connected devices. They can capture and share text, audio, and visual data, which can aid learning and instruction as well as schedule and remind about events. In terms of personal health wearables can provide an array of functionality including, but not limited to counting steps, heart rate monitoring, tracking workout progress, and calories burned (Racoma, 2015).

Brief History of Wearable Innovations

Accepting the definition that wearable technology is many different forms of body mounted/worn technology, and that the main idea behind wearable computing is the augmentation of human capabilities by wearing devices, the first wearable technologies worth noting are the eyeglasses invented in 1286 and the pocket watch invented in 1762, augmenting the human capability to see and track time (Desjardins, 2015; Medici, 2015). While eyeglasses may not be considered technology in the contemporary sense of the word they serve an important function for wearables, specifically in regards to augmented and virtual reality. The Nuremberg Egg was the first portable mechanical timekeeping device, produced in Nuremberg, Germany, in the mid-late 16th century, considered to be a wearable. The Nuremberg Egg was a spring-driven clock that was made to be worn around the neck. These wearable timekeeping devices were a novelty and their accuracy was limited since they only had a single hand showing hours (Dohrn-van Rossum & Dunlap, 1996; Fanthrope L. & Fanthorpe, P., 2007). Pocket watches revolutionized maritime navigation as well as made it possible to create railway timetables and established the virtue of punctuality in everyday life (Rhodes, n.d.). In addition, pocket watches took away power from official entities such as city magistrates, churches and landowners and turned time keeping into a commodity that is evident by its significance as a status symbol, first among the wealthy and then of middle-class men (Rhodes, n.d.). In 17th century China the first "smart ring" was developed during the Qing Dynasty era (1644-1911). The ring featured a 1.2 cm long, 0.7 cm wide abacus that sat on one finger. The abacus had seven rods, with seven beads on each rod and due to its size, the beads could only be moved with small tools such as pins (Rhodes, n.d.; Mann, n.d.; Desjardins, 2015).

The first device that is considered a wearable computer was invented by Edward Thorp and Claude Shannon in 1961, designed to specifically give the wearer an upper hand at roulette. This device was an analog computer the size of a cigarette-pack with four push buttons and built into a shoe (Rhodes, n.d.). It was controlled by a toe tap, to indicate the speed of the roulette wheel, and the computer would send musical tones via radio to the wearer's hearing aid indicating where a bet should be placed (Melanson, 2013; Rhodes, n.d.; Knoblauch, 2014). All in all the device gave the wearer a 44% edge in roulette (Melanson, 2013).

The 1960's also paved the way for virtual reality with the "Sensorama Simulator" and "Sword of Damocles" (Rhodes, n.d.). The "Sensoroma Simulator" was patented in 1962 by cinematographer Morton Helig which played a 3D film along with stereo sound, aromas, and wind in order to create an immersive sensory environment (Rhodes, n.d.). This idea of layering sensory stimuli was the first experience of its kind and paved the way towards virtual reality as we know it today (Rhodes, n.d.). The "Sword of Damocles" was invented by Ivan Sutherland in 1966, and was a large head mounted machine that is considered to be the first VR and AR head mounted display system (Rhodes, n.d.). In 1967, Hubert Upton invented an analogue wearable computer with an eyeglass-mounted display to aid lip reading (Rhodes, n.d.).

The 1970s brought wearable devices to more of the mainstream market with both the HP and Pulsar calculator watches in 1975 and the Sony Walkman in 1979. The Sony Walkman not only made portable music possible, but also fashionable and cool (Du Gay, Hall, Janes, Mackay, & Negus, 1997). In 1977, C.C. Collins developed a wearable camera-to-tactile vest for the blind that used a head-mounted camera to convert images into a square tactile grid on a vest (Rhodes, n.d.). The 1970's also brought more wearable computers used to predict roulette wheels, including Alan Lewis' digital camera-case computer similar to that of Thorp and Shannon's as well as Eudaemonic Enterprises digital wearable shoe computer (Rhodes, n.d.). The 1980s brought the Seiko UC 2000 Wrist PC, marketed as a portable PC, which allowed users to tell time add up, and input up to 2kb of data via a keyboard strapped to the arm. In 1984, the Nelsonic Space Attack Watch made gaming portable with the two front-facing buttons allowing wearers to play a basic *Space Invaders* style arcade game (Melanson, 2013). In 1989, the Private Eye head-mounted display was invented which scanned a vertical array of LED's across the visual field using a vibrating mirror. Even though the monochrome screen was only 1.25 inches on the diagonal, images appear to be a 15-inch display at 18-inch distance (Rhodes, n.d.).

Steve Mann is considered by some as the "father of wearable computing" as well as the "world's first cyborg" since he is a pioneer in the area (Mann, n.d.). In 1981, Mann wired a 6502 computer (as used in the Apple-II) to a steel-frame backpack that controlled flash-bulbs, cameras, and other photographic systems that was powered by lead-acid batteries (Mann, n.d.). Doug Platt's "hip-PC" system debuted at "The Lap and Palmtop Expo" in 1991, and was a shoebox-sized computer based on the Ampro "Little Board" XT model. The screen was a Reflection Technology Private Eye display, the keyboard an Agenda palmtop used as a chording keyboard attached to a belt (Rhodes, n.d.). In 1993, Thad Starner started constantly wearing his computer that was based on Platt's design (Rhodes, n.d.). Platt and Starner custom made the system with parts from a kit made by Park Enterprises, a Private Eye display, and the Twiddler chording keyboard made by Handkey (Starner, 1999). This design, many iterations later, became the MIT "Tin Lizzy" wearable computer design (Rhodes, n.d). In 1994, Mann developed the "Wearable Wireless Webcam" that transmitted images point-to-point from a head-mounted analog camera to a base station, via amateur TV frequencies, that processed the images and displayed on a webpage in near real-time (Rhodes, n.d.). Later, the system was used to transmit processed video and was used in augmented reality experiments with Starner (Rhodes, n.d.). In 1993, Starner wrote the first version of the Remembrance Agent augmented memory software which was an automated associative memory that would recommend relevant files from a database, using whatever notes that were currently being written on a wearable computer (Rhodes, n.d.).

Also in the 1990's, the idea of ubiquitous computing was proposed by Mark Weiser, which consisted of a world in which most everyday objects would have computational devices embedded in them (Weiser, 1991). Another notable invention was the active badge system which provides a way of locating individuals within a building by determining their location based off their badge. The device transmits a unique infra-red signal every 10 seconds which provides the location of the wearer (Rhodes, n.d.). In 1993, BBN completed its Pathfinder system which included a wearable computer, global positioning system (GPS), and radiation detection system (Rhodes, n.d.). In 1994, Mik Lamming and Mike Flynn developed the "Forget-Me-Not," a wearable device that was a continuous personal recording system that would record interactions with people and devices and store this information in a database for later query. The device interacted with wireless transmitters in rooms and with equipment in the area to remember who was there, who was being talked to on the telephone, and what objects were in the room (Rhodes, n.d.).

In 1993, The Knowledge-based Augmented Reality for Maintenance Assistance (KARMA) developed by Steve Feiner, Blair MacIntyre, and Dorée Seligmann at Columbia University used a Private Eye display over one eye, giving an overlay effect when the real world was viewed with both eyes. The whole system ran through a desktop computer and relied on sensors attached to objects in the physical world to determine their locations (Feiner, MacIntyre,

& Seligmann, n.d.). Edgar Matias and Mike Rucci of the University of Toronto developed a "wrist computer" that was strapped to the user's forearms and could be used by bringing the wrists together and typing (Rhodes, n.d.). Finally, in 1997 a fashion show was put on with the collaboration of Creapôle Ecole de Création (Paris) and Alex Pentland (M.I.T., Boston), with the goal of envisioning the impending marriage of fashion and wearable computers. The Smart Clothes Fashion Show was held in Paris (Rhodes, n.d.).

The 21st century has brought further innovation. Bluetooth technology was introduced in the early 2000's which allowed users to talk hands-free. In addition, what is possibly the first collaboration between a company specializing in digital technology and a clothing company occurred in 2000 with the introduction of Nike+. Nike and Apple collaborated to make a fitness tracking kit via a shoe embedded tracker, runners could view time, distance, pace, and calories during a workout on an iPod Nano screen (Medici, 2015). Fitness trackers command the largest market of the wearable industry today (CCS Insight, 2016). Fitbit is one of the pioneering companies into this market with the release of the Fitbit Classic in 2008. The Google Glass Explorer program was launched in 2012, and is essentially a smartphone with a head-mounted glasses display (Medici, 2015). While Google shut down the Explorer program on January 15, 2015, to send the product back to the lab, the program put smart glasses and wearable technology on the cultural radar (Bilton, 2015). The first solar powered jacket was released in late 2014 by Tommy Hilfiger, which allows users to charge their phones on the go. Since 2014 there have been numerous smartwatch and fitness, health, and sport trackers. Notably, in 2015 the Apple Watch was released. Fashion has started to play an integral role in the release of new wearables. One example is Ringly, a ring that pairs with the user's smartphone and provides notifications through vibrations and light displays (Medici, 2015). Projecting into 2016 and beyond, more virtual reality headsets are expected to appear joining those such as Oculus Rift, Sony PlayStation VR, Microsoft HoloLens, Samsung Gear VR, HTC Vive, and Google Cardboard.

Framing

In a study of smartwatches, Kim and Shin (2015) found that wearable devices are seen as more than just utilitarian tools, but personalized, trendy items that reflect identities, emotions, and aesthetic values of the wearer. Attitudes toward new and novel technology can appear severe at first, but continued exposure to the technology can result in a higher overall acceptance over time (Profita, Gilliand, Zeagler, Starner, Budd, & Do, 2013). An example of this can be seen with the Bluetooth headset. At first appearance the device made it seem like users were talking to themselves, which is undesirable since it is socially unacceptable. However, since they have become adopted and accepted within society they no longer hold that same stigma (Profita et al., 2013). Changing beliefs is often seen as key to the successful diffusion of an innovation (Vishwanath, 2009). The information provided by the mass media helps inform these beliefs and frames become the lens through which the innovation is evaluated (Vishwanath, 2009).

Selection of reality and salience of communication are both involved in framing, so that a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation is promoted (Entman, 1993). Typically, frames define problems, diagnose causes, and suggest remedies. Frames define problems by determining what a causal agent is doing with what costs and benefits. This is usually measured in terms of cultural values. Frames diagnose causes by identifying the forces creating problems. Frames can also suggest remedies by offering and justifying treatments for problems and predicting likely effects (Entman, 1993).

Frames highlight some bits of information about an item that is the subject of communication thus elevating them in salience. Salience means making a certain piece of information more meaningful, noticeable, and memorable to audiences. For Entman (1993) schemata and closely related concepts such as categories, scripts, or stereotypes connote mentally stored clusters of ideas that guide individuals' processing of information. Basically, frames select and call attention to certain details while simultaneously directing attention away from other aspects. Entman (1993) highlighted the functionality of frames in the news: namely, "to select some aspects of a perceived reality and make them more salient in a communication text, in such a way to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (p. 52). This definition can be seen as a bit all-encompassing by critics such as Scheufle & Iyengar (2012).

According to Scheufele & Iyengar (2012), "framing effects refer to behavioral or attitudinal outcomes that are not due to differences in what is being communicated, but rather to variations in how a given piece of information is being presented (or framed) in public discourse" (p. 1). The roots of framing research can be traced to sociology (Gamson & Modigliani, 1987, 1989; Goffman, 1974), psychology (Kahneman, 2003; Kahneman & Tversky, 1979) and linguistics (Lakoff & Johnson, 1981).

Framing research can be traced back to the work of psychologists Amos Tversky and Daniel Kahneman (1979). They used the term "framing" to describe the subtle differences in the definition of choice alternatives. In their experiments Tversky and Kahneman (1979) presented participants choices that were identical in their expected value, but differed in the terms used to describe their choice options (i.e. a fixed probability of "winning" or "losing" some amount of money). What they demonstrated was that human choice was contingent on the description of choice problems, and that, "perception was reference dependent" (Kahneman, 2003, p. 703.) For example, when presented with outcomes in terms of potential gains, people showed risk aversion and chose the more certain payoff. However, when the same outcome was presented in a way that suggested potential losses instead of gains, people become risk-seekers, preferring the outcome with the less certain payoff (Kahneman, 2003). Therefore, the way information is interpreted differs depending on how that information is contextualized or framed.

Another example, is the "broken-B" stimulus used by psychologists Jerome Bruner and Leigh Minturn in the 1950's. This stimulus was an image of a character with a slightly detached upright line that could either be interpreted as the number 13 or the letter B. Participants in one condition were shown the stimulus after being shown a sequence of letters and in the other condition a sequence of numbers. Clear differences were found in how the groups interpreted the symbol (Bruner & Leigh, 1955). This tradition of framing research can be labeled "equivalence framing" because it is based off the assumption that the information being presented is informationally equivalent across different frames (Scheufele & Iyengar, 2012). A second assumption from this tradition is that participants interpret the stimulus in the context in which it is framed (in a particular experimental condition) and have no reason to assume that it could be seen differently (if framed in an alternative way) (Scheufele & Iyengar, 2012).

Framing research can also be traced to research rooted in social movements and general sociology literature (Gamson, 1992; Gamson & Modigliani, 1987, 1989). This research addresses the concern about the lack of ecological validity of single-equivalence frame studies and approach framing as a macro-level or meso-level, rather than an individual-level phenomenon (Scheufele & Iyengar, 2012). Because of this, this research approach offers fairly broad and all-encompassing definitions of framing. For example, Gamson (1992) conceptualizes framing as the relationship between ideas and symbols used in public discourse, and the meaning that people construct around political issues. Gamson and Modigliani (1987) define frames as "a central organizing idea or story line that provides meaning to an unfolding strip of events...The frame suggests what the controversy is about, the essence of the issue" (p. 143). Scheufele & Iyengar (2012) call this tradition "emphasis" framing, "since the observed effects represent differences in opinion that cannot be attributed exclusively to differences in presentation" (p. 7). Scheufele & Iyengar (2012) assert that because of this way of thinking frames have morphed into messages that makes the broader framing concept redundant as a theory of media effects.

However, equivalence framing has expanded to include more content elements and therefore merits a discussion about the difference between salience-based effects--such as priming and agenda setting-- and applicability effects, such as framing, which assumes messages resonate due to underlying cognitive schema (Scheufele & Iyengar, 2012). Agenda setting refers to the transfer of salience of issues from mass media to audiences. McCombs & Shaw (1972) looked at audience members' judgments about the perceived importance of issues by operationalizing issue salience in news outlets. Later studies swapped perceptions of importance with terms such as salience, awareness, attention, or concern (Edelstein, 1993).

Another salient-based effect is priming, which in many ways can be seen as the logical extension of the agenda setting process. This is another concept with roots that can be traced back to psychology. According to psychologists Collins and Loftus (1975), "when a concept is primed, activation tags are spread by tracing an expanding set of links in the network" (p. 409). Applying this concept to the media, if an issue is made more salient it is most likely used as one of "the standards by which governments, policies and candidates for public office are judged" (Iyengar & Kinder, 1987, p. 63).

Because both priming and agenda setting are salience-based effects, they are often grouped together with framing. However, despite being grouped together they each have clearly distinguishable theoretical premises (Scheufele & Iyengar, 2012). Regardless of their theoretical differences, some scholars argue that they should all be grouped together to form a singular conceptual framework. McCombs (1992) argued in favor of this line of thought stating that framing is an agenda setting effect, “both the selection of topics for the news agenda and the selection of frames for stories about those topics are powerful agenda-setting roles” (p. 9). According to Scheufele & Iyengar (2012) these efforts to conceptualize framing, agenda setting, and priming under a single model were motivated by Entman’s (1993) definition of framing (provided at the beginning of this section), since this definition explicitly refers to news selection and salience as the theoretical underpinnings of framing. Entman & Scheufele (2012) go on to say that Entman’s work had a powerful effect on framing research. It set the stage for numerous studies, but that his all-encompassing definition also helped set the stage for conceptual vagueness.

Agenda setting and priming create accessibility-based effects (Iyengar, 1990). Meaning that when a news source highlights certain issues, certain nodes in the brain are triggered, which spreads cognitive activation to related concepts. As a result, these more salient issues are triggered in the brain, and received from memory more easily, which can influence things such as choosing a political candidate (Scheufele & Iyengar, 2012). While framing is considered an applicability effect (Price & Tewksbury, 1997) which can be traced to attribution theory (Heider, 1978). Attribution research dealt with human tendencies to make sense of seemingly unrelated information by detecting patterns that matched with pre-existing schemas. Depending how applicable frames are to particular cognitive schemas the effects of the frame will be strengthened or weakened. This line of thought is in line with Bruner and Minturn’s (1955) broken B experiment (Scheufele & Iyengar, 2012). It is important to note that schemas are culturally shared. Cross-cultural comparisons may not produce as strong applicability effects since the schema will not be understood in the same context.

Framing and Technology. Given the importance of media portrayals to public perceptions of topics covered by media, trends in the growth and popularity of wearables over time may be tied at least in part to their portrayal by the media. Studies have looked at technology frames in the media such as Weaver et al.'s (2009) analysis of news media frames about nanotechnology and Kang et al.'s (2015) study of the smartphone news frames. News framing can be viewed as the process of "symbolic packaging" by various actors in diverse institutional settings (Kang et al, 2015). Multiple factors including values, trust, and frames of argument help consumers develop attitudes and take actions toward technology (Druckman & Bolsen, 2011).

When writing a story journalists not only choose a frame based off an issue (e.g. progress, regulation, conflict, or generic risk), but also if they want to present the information more as a portrait (episodic frame) or a landscape (thematic frame). Episodic news frames involve a case or event in which an individual is the focus of the story (Iyengar, 1990). Thematic news frames emphasizes an issue at the social level including background information in a social/political context (Iyengar, 1990). In episodic frames emphasis is placed on how individual behaviors or personal stories are affected by a problem. Whereas with thematic frames social responsibility is placed on those that have power to control the problem like corporations or government entities (Kang et al, 2015). Weaver's (2009) study of nanotechnology found that early news coverage about the technology deemphasized social responsibility even though the societal outcomes of the technology played an important role at the social level. The way that the news covers wearable technology episodically or thematically can have an influence over corporate image, consumer opinion, and consumer action. In addition, it is possible to presume that news framing is associated with either personal or social aspects about wearables which can influence consumer evaluation and adoption.

The technology acceptance and adoption perspective (Davis, 1989; Venkatesh & Davis, 2000) can add another lens relating to news framing. The technology acceptance model (TAM) posits that a user forms two beliefs when considering use of a new technology: perceived usefulness and perceived ease of use (Christenson, 2013). Perceived usefulness is considered a powerful indicator of intention to adopt. TAM 2 (Venkatesh & Davis, 2000) extended antecedents of perceived usefulness, systems characteristics, and contextual measures. TAM 2 included social influence (e.g. subjective norms, voluntariness, image, etc,) and cognitive process (e.g. job relevance, output quality) (Christenson, 2013). Venkatesh and Bala (2008) further specified antecedents to perceived usefulness by including research on framing in decision making as antecedents of perceived ease of use as well as a social context. Easy functionality, enhancement on task performance by using the technology, and experts' recommendation can be a catalyst of acceptance of technology (Kang et al, 2015). Consumers use their information experience to make judgments about wearable technology adoption. In regards to the smartphone, emphasizing task effectiveness, easiness, benefits, and interviews can facilitate the process of technology acceptance (Vishwanath, 2009). Since wearable technology, particularly smartwatches, can be viewed as part of the same technology cluster as smartphones, these frames may also facilitate the process of smartwatch acceptance.

Furthermore, the news media also cover the issue of "progress" of technology in order to keep the audience informed (Maeseele, 2010). Einsiedel (1992) found that in regards to "progress," research findings about technologies were frequent issues covered in the news media.

In Canada, Einsiedel (1992) found that government “policy” about technologies, environment, energy, and communications were found to be important issues worthy of news coverage. In Weaver et al.’s (2009) study on nanotechnology news in the top ten U.S. newspapers issues frames of “progress,” “regulation,” “conflict,” and “generic risk” were emphasized. In Vishwanath’s (2009) study examining the relationship between news framing and consumer technology adoption found that “ease of use” and “performance” issues received large attention by consumers. The role of “celebrity” in promoting nanotechnologies benefits was found in a study done on British newspapers (Anderson, Allan, Peterson, & Wilkinson, 2005).

Another important aspect to consider when looking at technology frames is who is speaking about the technology. Corporate actors and the government play a key role in dissemination of technologies. According to Maeseele (2011) corporations and the government's economic and cultural resources put both in such a position that other social members can use them as a news source. Other sources the news media often rely on are “entrepreneurs,” “technology experts,” “scientists,” “researchers,” “public interest groups,” and “the developers of products” (Pense & Cutcliffe, 2007). If a technology is involved with a legal dispute, “lawyers” and “law professors” are frequent news sources (Kang et al., 2009). In comparison, the voice of “citizens” or “consumers” about technology is relatively sparse in news sources (Einsiedel, 1992). According to Cho (2006,) this one-sided coverage can distort reality and make news stories a tool for one-sided information flow, which in turn can alter consumer’s fair judgment.

Message content plays a role when considering adopting a new innovation. In today’s media landscape consumers receive information about an innovation from a multitude of formal and informal sources including the mass media, manufacturer websites, user blogs, feedback forums (e.g. Amazon) and technology portals (e.g. CNet, and Mashable) (Vishwanath, 2009).

The information learned from these sources helps create initial impressions, but also construct meaning, which can endure and affect future interactions with the technology (Vishwanath, 2009). Vishwanath, (2009) recognized the important role of message content on belief formation and extended the notion of frames to the study of diffusion of innovations. Vishwanath (2009) found that small, subtle changes in the content of messages and their direction have a strong and significant effect on technology adoption. Frames increase the salience of certain beliefs which then in-turn become the consumer's expectations from technology and influence the decision to adopt it (Vishwanath, 2009). Based on the aforementioned literature, and emulating to some extent the questions of Kang, Lee, and Cerda (2015), the following research questions are proposed:

RQ1: What issues about wearables are covered in newspaper stories over time?

RQ2: What interview sources have covered wearables in newspapers over time?

RQ3: How prevalent is episodic and thematic coverage of issues about wearables in newspaper stories?

RQ4: Does prevalence of interview sources in newspaper stories about wearables vary when coverage is episodic or thematic?

RQ5: What types of wearables (i.e. head-mounted displays, smartwatches, activity trackers, other) are covered the most frequently?

CHAPTER 3. METHODOLOGY

A thematic content analysis of 182 newspaper articles was conducted to examine the prevalence of issue frames, interview sources, episodic vs thematic frames, and type of wearable.

Sample

The news outlets sampled were chosen using *The Alliance for Audited Media's* 2013 top five daily newspapers by circulation. *The Alliance for Audited Media* is a non-profit founded in 1914 and comprised of America's leading advertisers, advertising agencies, advertising technology providers, and content providers with the goal of providing independently verified media and information critical to evaluating media (AAM, 2016). The information provided by *The Alliance for Audited Media* is used by reputable sources such as *The Newspaper Association of America.* Due to restricted access to *The Los Angeles Times* archives, because no database allowed access to full text articles older than 2016, the newspaper was dropped from the sample. The final sample consisted of six newspapers: *The Wall Street Journal, The New York Times, USA Today, New York Daily News, New York Post* and *The Washington Post.* The sixth paper, *The Washington Post,* was included due to the small sample sizes of the *New York Daily* and *New York Post.* Full text newspaper stories were collected using LexisNexis for all newspapers except for *The Wall Street Journal*, which was collected using ABI/INFORM Global a ProQuest database.

An iterative process was used to identify a set of search terms that would accurately capture the language used to define wearables and thus generate as many relevant articles as could be feasible. In order to examine the terms used to describe wearables across time, three pilot searches were conducted using "Steve Mann," "Google Glass," and "Apple Watch." These three searches were used in order to identify what words were used to describe three prominent points in the history of wearables across a range of contexts and time periods, including a well-known early wearable technology pioneer and two prominent products worn in different ways. Five randomly selected articles using each of the three pilot study terms were examined for what terms were used to describe wearables in the various stories. A review of these 15 articles confirmed the appropriateness of the search terms “wearable device” or “wearable computing” or wearable computer” that were used for the final sample.

The date range 1986-2016 was selected in order to capture as many articles as possible over the past three decades. The number of articles generated by newspaper was as follows: *The Wall Street Journal*, 400 articles, *The New York Times,* 387 articles, *USA Today*, 187 articles, *New York Daily News,* 39 articles, *New York Post,* 66 articles, and *The Washington Post,* 272 articles. A challenge for researchers is to decide how to identify and acquire the appropriate text for quantitative content analysis. Some scholars use the constructed week sampling method to control for cyclical biases while creating maximum sampling efficiencies (Luke, Caburnay & Cohen, 2011). Riffe, Aust & Lacy (1993) argued that a constructed week methodology is more efficient than pure random or consecutive day sampling. However, what is not certain is how many constructed weeks are the most efficient. Since this study does not get at overall prevalence, in order to generate a more manageable subsample for extensive coding, this study choose to use a systematic random sample using a skip interval to select one-seventh of the initial list of articles for a final sample of 194 articles that spanned from 1988-2016. The breakdown of articles by newspaper is as follows: *Wall Street Journal,* 57 articles, *The New York Times,* 56 articles, *USA Today,* 27 articles, *New York Daily News,* 6 articles, *New York Post,* 9 articles, and *The Washington Post,* 39 articles. The final sample after coding consisted of 182 articles: 12 articles were dropped since they did not mention any type of specific wearable technology.

Coded Variables

A news story was the unit of analysis with the variables including: issue frames, interview sources, episodic vs. thematic frames, and type of wearable technology. Each article was coded for the presence or absence of each variable. Issue frames and episodic vs thematic frames were mutually exclusive. An individual interview source was coded as one source, but multiple sources of the same category were coded. The categories were not mutually exclusive in order to get a broader picture of who was relied on to speak about the technology. Type of wearable technology were not mutually exclusive, but each category was only counted once.

Issue frames. Weaver, Lively, and Bimber (2009) identified four issue frames for science and technology that generally cut across the news frame categories used by other researchers. These four frames were: progress, regulation, conflict, and generic risk. The progress frame "emphasizes the benefits to society that flow from a natural process of discovery and application and minimizes issues of responsibility, choice, priorities, and regulation" (Weaver et al, 2009, p. 147). Regulation, captures stories that emphasize the market-consumer-regulation triad. For Weaver et al (2009) it captured stories that use nanotechnology in production processes, consumers who may be harmed by the actions of these corporations, or government agencies with responsibility for acting to protect the public. The third frame, the conflict frame, differs in emphasis from a regulation frame by drawing attention to disputes among specific societal interests or actors. The conflict frame focuses on the conflict itself and competing claims or interests. The fourth and final issue frame identified by Weaver et al (2009) is the generic risk frame. This frame takes a wait-and-see approach about the good and bad aspects of new technologies and avoids attributing responsibility. Each article was coded as having a dominant issue frame of either progress, regulation, conflict, or generic risk with each category treated as mutually exclusive.

Interview Sources. Interview sources were coded, using categories from Kang, Lee, and Cerda's (2015) smartphone study. Interview sources were coded as one source if the same interview sources appears more than once in a story. Interview source categories are as follows: a) professors (e.g. law, marketing, mobile technology); b) lawyer (e.g. patent lawyer); c) company spokesperson (e.g. Samsung or Apple); d) consumer (e.g. users); e) analysts (e.g. experts, market analysts); f) government (e.g. FCC); g) other (e.g. juries); and h) no source (story without an interview source). If the same interview source appeared more than once in an article it was coded only once, but multiple sources of the same category were counted. Interview sources were not mutually exclusive in order to get a more inclusive picture on who journalists rely on for stories about wearable technology over time.

Episodic and thematic frames. News stories primarily emphasizing individual responsibility and personal stories or depict concrete events that illustrate issues were coded as having an episodic aspect (Iyengar, 1991). Stories that focused on social responsibility or government aspects in addition to presenting collective or general evidence and placing issues in a general context were coded as having a thematic aspect (Iyengar, 1991).

Coding and Reliability

This study's author and an additional independent coder, a communication graduate student, coded the articles. The author coded the entire sample between April 16 and April 26, 2016, and a second coder used the same codebook to code a randomly selected sample of 27.5 percent (50 news articles) of the articles used in the original sample. Each post was coded for the aforementioned issue frames, interview sources, episodic vs. thematic frames, and wearable category. A copy of the complete codebook used for this study can be found in the Appendix. In cases where some coded categories have very low prevalence scholars have noted that measures of intercoder reliability that attempt to account for likelihood of chance agreement can be overly strict (see Artstein & Poescio, 2008; Di Eugenio & Glass, 2004). Therefore, given the low category prevalence for some variable categories in this study, the more lenient Holsti's (1969) coefficient measure was used to assess reliability. Average agreement was 94.8% across variables, with individual reliability scores ranging from 76% to 100%.

CHAPTER 4: RESULTS

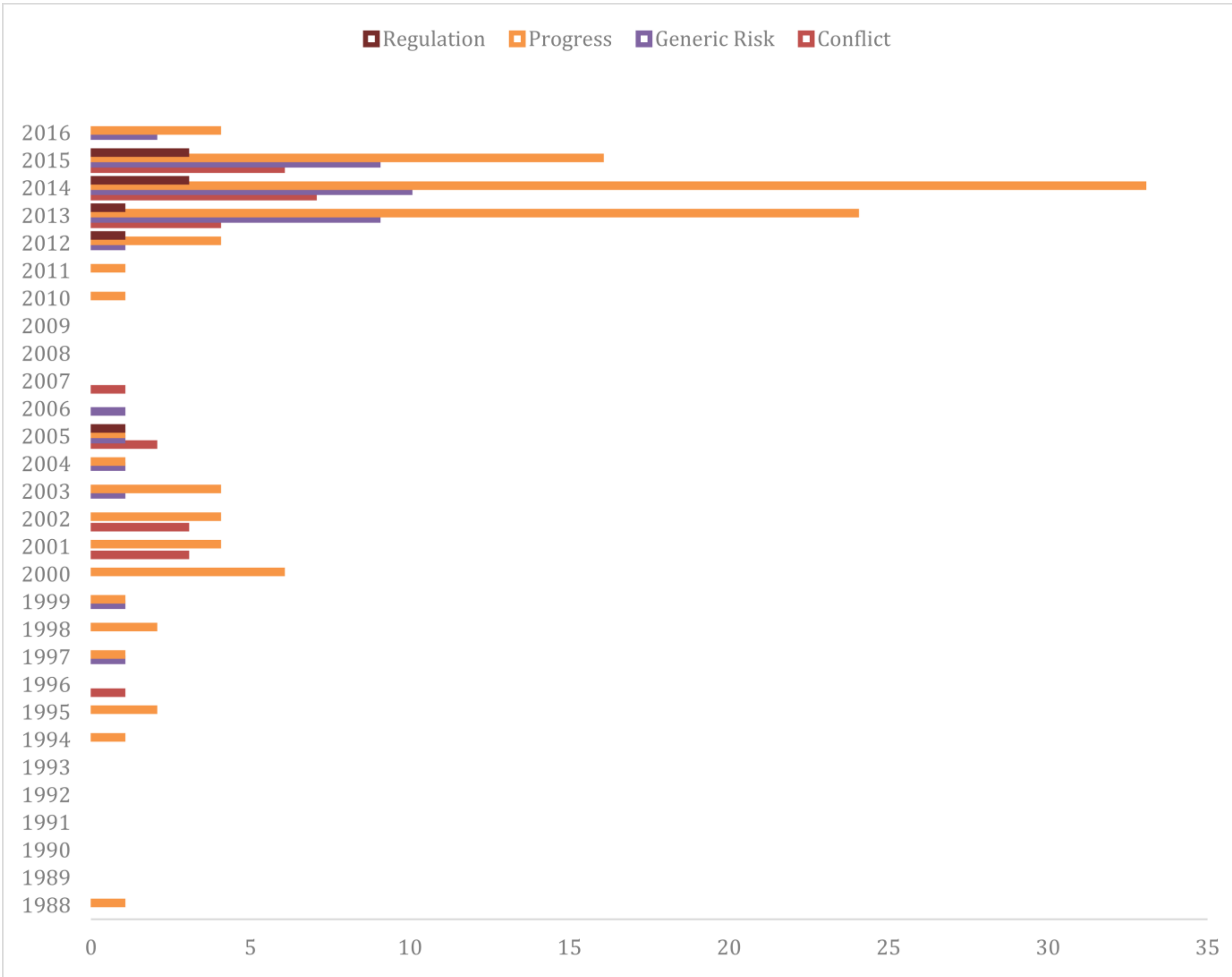
Issue Frames

RQ1 asked which issue frames were the most prevalent (Table 1) over time (Figure 1). The "progress" issue frame was the most prevalent frame used in news stories, appearing in 60.4% (n = 110, 95% C.I. = .532-.673) of the articles. The "generic risk" and "conflict" frames followed, appearing in 21% (n = 38, 95% C.I. = .156-.274) and 13.7% (n = 25, 95% C.I. = .095-.195) of the news stories respectively. The least utilized news frame was the "regulation" frame, appearing in 4.95% (n = 9, 95% C.I. = .026-.091) of news stories. Logistic regression analysis of issue frames by years found that year of publication was not a significant predictor of issue frame prevelance.$\chi^2(3, N = 182) = 3.77, p = .29$.

Table 1. Prevalence of issue frames.

Issue Frame	*n*	%	95% C.I.
Progress	110	60.4%	53.2%-67.3%
Generic Risk	38	20.9%	15.6%-27.4%
Conflict	25	13.7%	9.5%-19.5%
Regulation	9	5.0%	2.6%-9.1%

Figure 1. Issue frame by year



Interview Sources

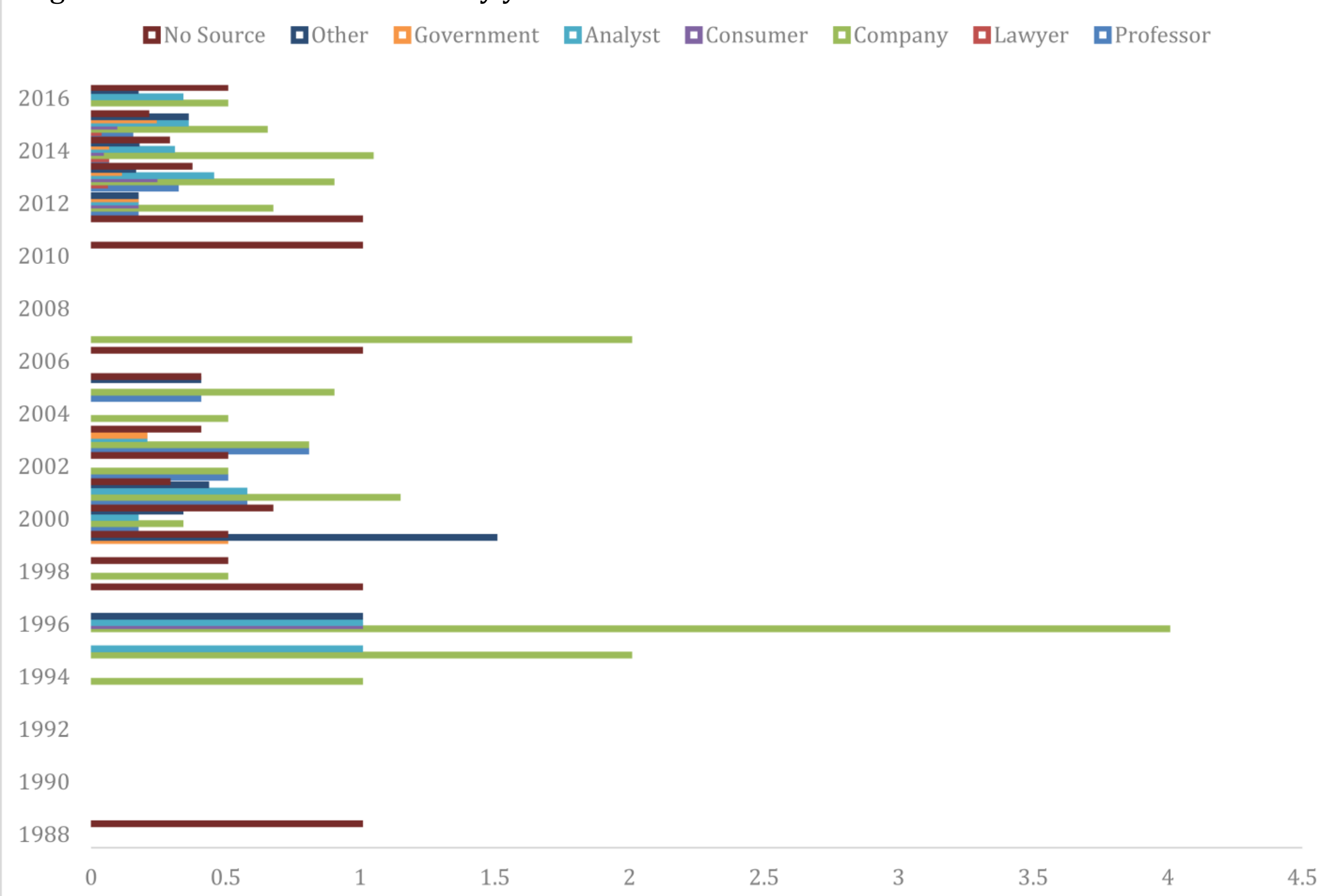
RQ2 asked which interview sources were used to cover wearable technology in news stories (Table 2) over time (Figure 2). "Professor" as an interview source was mentioned a mean of 0.187 times (SD = 0.534) per story. "Lawyer" as an interview source was mentioned a mean of 0.033 times (SD = 0.208) per story. "Company spokesperson" as an interview source was mentioned a mean of 0.824 times (SD = 1.138) per story. "Consumer" interview source was mentioned a mean of 0.088 times (SD = 0.539) per story. "Analyst" as an interview source was mentioned a mean of 0.313 times (SD = 0.670) per story. "Government" as an interview source was mentioned a mean of 0.099 times (SD = 0.422) per story. "Other" as an interview source was mentioned a mean of 0.220 times (SD = 0.582) per story. "No source" as an interview source appeared in 33% (n = 60, 95% C.I. = .266-.401) of the articles.

Correlation between year of publication and number of times a "professor" was cited was non-significant, $r(182) = -.092$, $p = 0.22$. Correlation between year of publication and number of times a "lawyer" was cited was non-significant, $r(182) = .081$, $p = 0.28$. Correlation between year of publication and number of times a "company spokesperson" was cited was non-significant, $r(182) = .024$, $p = 0.75$. Correlation between year of publication and number of times a "consumer" was cited was non-significant, $r(182) = .043$, $p = 0.563$. Correlation between year of publication and number of times an "analyst" was cited was non-significant, $r(182) = .063$, $p = 0.40$. Correlation between year of publication and number of times a "government" official was cited was non-significant, $r(182) = .074$, $p = 0.32$. Correlation between year of publication and number of times "other" interview source was cited was non-significant, $r(182) = -.023$, $p = 0.76$. Using the dichotomous variable of source or no source as a dummy coded outcome variable the correlation between year of publication and number of times "no source" was cited was significant, $r(182) = -.148$, $p = 0.047$.

Table 2. Interview source per story

Interview Source	**M**	**SD**
Professor	0.187	0.534
Lawyer	0.033	0.208
Company Spokesperson	0.824	1.138
Consumer	0.0879	0.539
Analyst	0.313	0.670
Government	0.099	0.422
Other	0.220	0.582
No Source	0.330	0.471

Figure 2. Interview source mean by year



Episodic vs. Thematic Frames

Issue frame. The episodic frame was the dominant frame used in news stories, appearing in 94% of the articles (n = 171, 95% C.I. = .895-.966). Thematic frames were used in news stories, appearing in 6% of the articles (n = 11, 95% C.I. = .034-.105). A chi square test found the relationship between issue frame and episodic/thematic was significant χ^2 (3, N = 182) = 9.14, p = .028. RQ3 asked which issues were covered episodically vs thematically (Figure 3). The "progress" issue frame was predominately episodic, appearing in 97.3% of the articles (n = 107). The "generic risk" and "conflict" frames followed, appearing in 92.1% (n = 35) and 92% (n = 23) of the articles respectively. The episodic frame for "regulation" appeared in 66.7% of the articles (n = 6).

Interview source. RQ4 asked about the relationship between interview source and episodic/thematic frames. The dichotomous episodic or thematic variable was a dummy coded variable. The correlation between the number of times a "professor" as an interview source was cited for episodic/thematic frames was significant, $r(182) = -.171$, $p = .021$, with professors more likely to be mentioned for thematic than episodic stories. The correlation between the number of times a "lawyer" as an interview source was cited for episodic/thematic frames was non-significant, $r(182) = -.071$, $p = .341$. The correlation between the number of times a "company spokesperson" as an interview source was cited for episodic/thematic frames was non-significant, $r(182) = .022$, $p = .772$. The correlation between the number of times a "consumer" as an interview source was cited for episodic/thematic frames was non-significant, $r(182) = .041$, $p = .578$. The correlation between the number of times an "analyst" as an interview source was cited for episodic/thematic frames was non-significant, $r(182) = .015$, $p = .837$. The correlation between the number of times "government" as an interview source was cited for episodic/thematic frames was non-significant, $r(182) = -.05$, $p = .5028$. The correlation between the number of times "other" as an interview source was cited for episodic/thematic frames was non-significant, $r(182) = -.071$, $p = .341$. The correlation between the number of times "no source" as an interview source was cited for episodic/thematic frames was non-significant, $r(182) = -.018$, $p = .806$.

Type of wearable device. RQ5 asked which type of wearable technology was talked about the most in news stories (Figure 4). Head-mounted displays were the most frequent type of wearable device, found in 39.6% articles, ($n = 72$, 95% C.I. = .327-.468), followed by other, found in 39% articles ($n = 71$, 95% C.I. = .322-.463). Smartwatches were found in 26.4% articles ($n=48$, 95% C.I. = .205-.332). Fitness bands were mentioned the least, found in 7.14% of the articles ($n = 13$, 95% C.I. = .0422-.118).

Figure 3. Issue frame by episodic/thematic

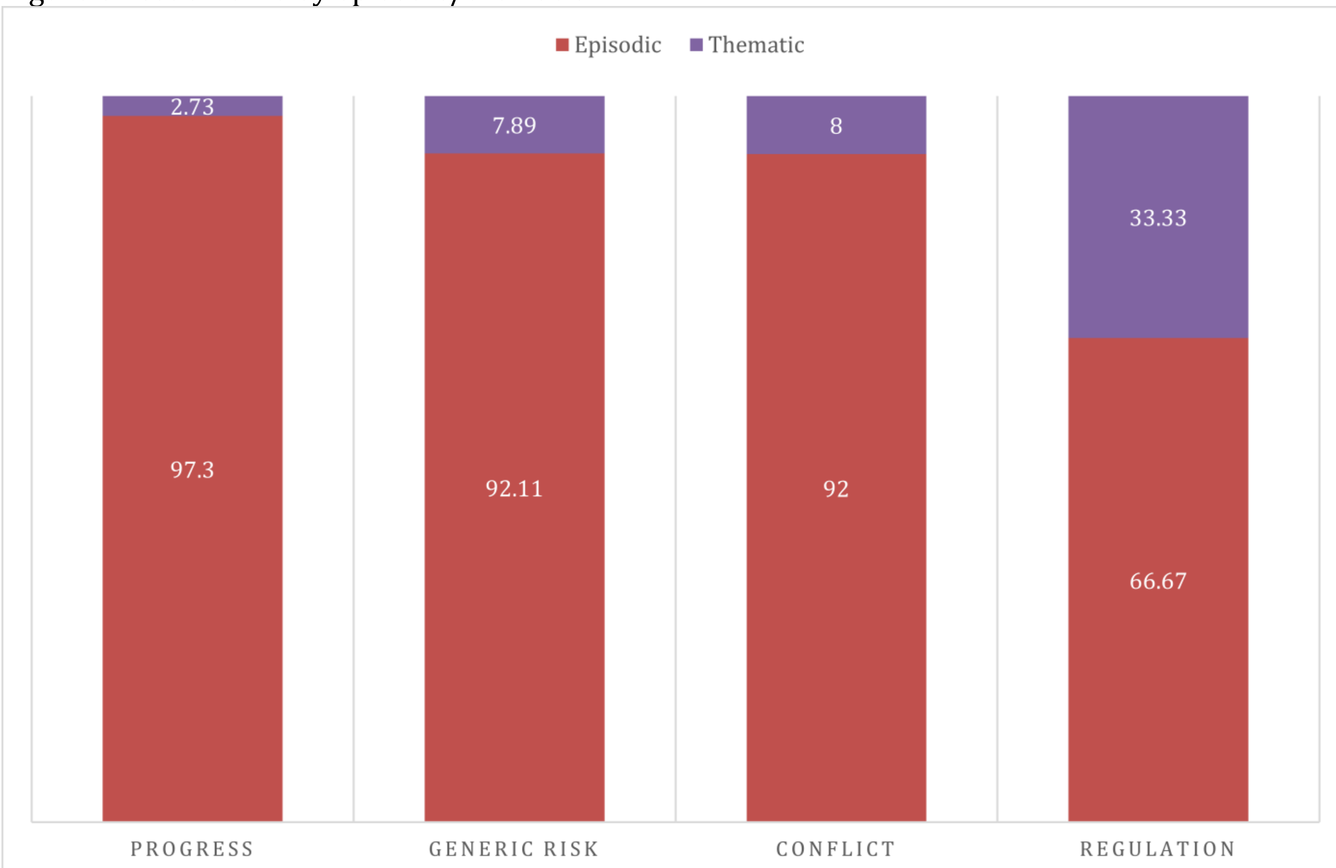
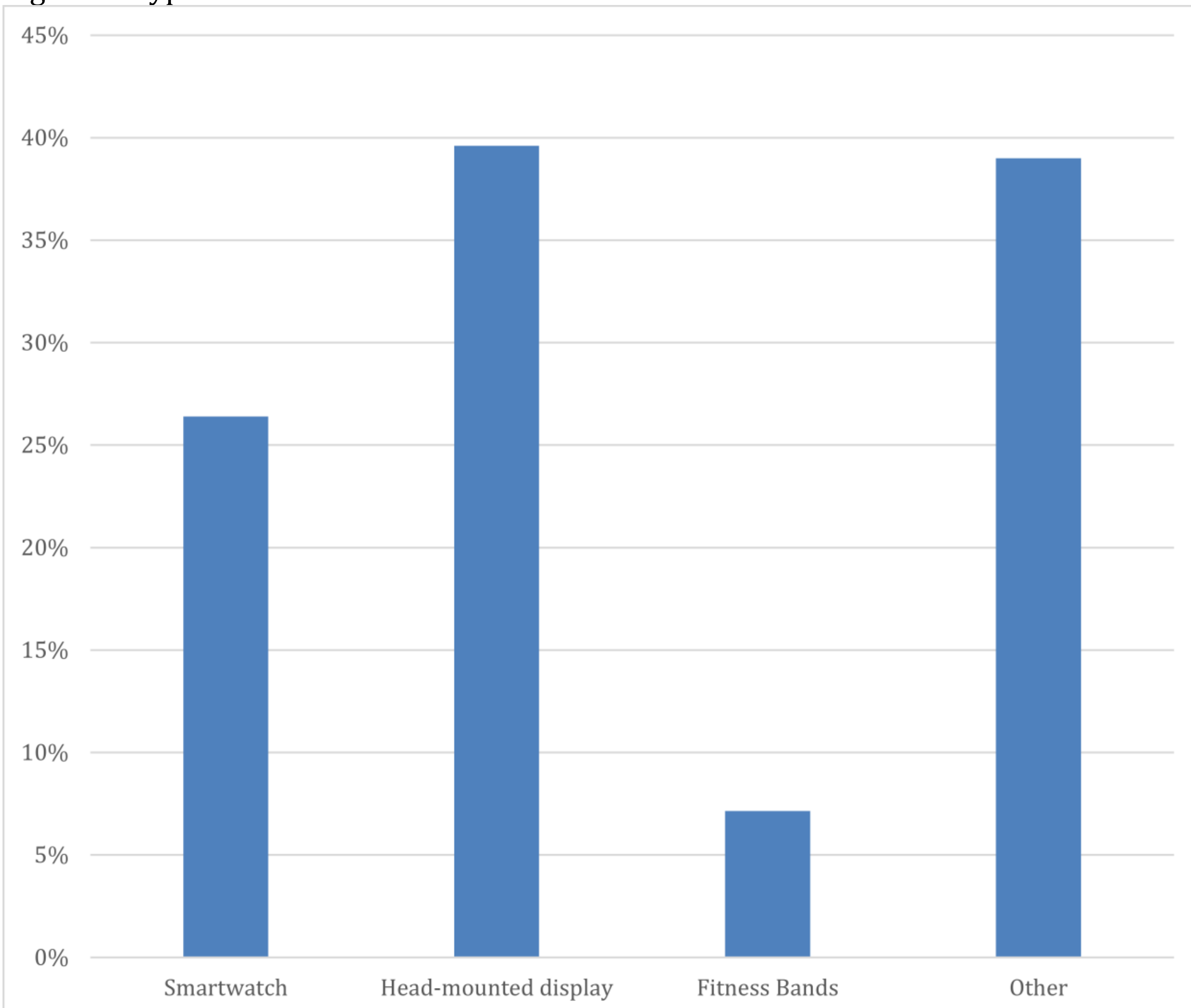


Figure 4. Type of wearable device



CHAPTER 5. DISCUSSION AND CONCLUSION

Summary of Findings

Previous studies have examined framing of new technology (e.g. nanotechnology, smartphones), but none have looked at how wearable technology are framed by newspapers. Therefore, the present research attempted to expand on technology framing to that of wearable technology. This study provides evidence that wearable technology is predominately framed through a “progress” lens and that the majority of news stories are episodic in nature.

RQ1 asked what frames were used overall and how often. The progress frame was used the most often followed by generic risk and conflict. Regulation was used the least. The progress frame captured stories that emphasized beneficial aspects of new technology and deemphasized issues of conflict, risk, or regulation. The progress frame predominantly emphasized the features and uses of the wearable technology. This was evident in numerous articles devoted to product reviews. Weaver et al (2009) identify the progress frame as the norm in much popular reporting on science and technology. While Weaver et al (2009) were focused on nanotechnology this study offers evidence that the “progress” frame is also dominant in news articles on wearable technology. Because wearable technology has not yet reached wide-spread adoption throughout society, no big risk events or privacy concerns have reached the public arena, and societal conflict about wearable technology overall is very low, the progress lens become the default frame used by journalists. Google Glass raised some privacy concerns with the products ability to record what the wearer was seeing without the consent of others, but since the product never reached beyond the explorer phase to mainstream consumption these concerns have subsided.

Because of the reliance of progress-framed stories consequently readers might imply that technology developments “just happen” and are not primed to think about responsibility

(Weaver, 2009). Another explanation could be that when new technologies start to emerge such as wearables, journalists have a hard time wrapping their head around it so default to progress themed stories. Once the technology has matured and become more familiar, journalists may become more critical of the technology and focus on other aspects besides the perceived benefit from its invention. Because wearable technology encompasses a broad range of products under its definition that have the ability to perform a wide array of functions, it may be that patterns such as Saffo's (1992) thirty-year rule apply better to more static technology than media-oriented technology. Journalist's reliance on the progress frame is not surprising because it provides an interesting story while keeping the audience informed by explaining and highlighting features and uses of the new technology (Maeseele, 2010; Einsiedel, 1992).

Findings for RQ2 were all non-significant between interview source and year, except for "no source." A possible explanation for this could be that as wearables become more talked about by the news media, the need for using a source declines since the technology is becoming more familiar. This is interesting, because it has been noted that sources have enormous power to shape news stories (Cho, 2007) and that media frames emerge as journalists emphasize certain sources (Entman, 1993). Another explanation, is that typically product reviews rely on first person narration and do not rely on sources. In addition, stories that were about wearable technology companies stocks did not rely on sources.

RQ3 asked if episodic or thematic frames would be more prevalent. This study found that the majority of news stories were episodic. These stories emphasized individual stories, specific evidence, and aspects. However, when using the "regulation" frame episodic stories were used slightly less. A possible explanation for a decrease in episodic framing for a thematic lens could be because the stories are talking about more societal issues that require collective evidence.

Weaver et al.'s (2009) study on nanotechnology found that when broken down by time-period the progress frame dominated early coverage (late 1990's to early 2000's), but by the mid-2000's saw a rise in stories framed around regulation. Weaver et al (2009) viewed this as a positive reflection on journalism that allowed context for the public to form their own judgements and values involved in science and technology. Iyengar (1991) has noted that people are less inclined to think in terms of responsibility and accountability when people view developments around them in an event-centric way rather than in a thematic context. While this study did not find a correlation between time and the regulation frame, it is interesting that when the regulation frame is employed less stories are framed episodically than found for the other three frames. Regulation is a frame typically employed after some type of event or issue raises concern and comes towards the tail end of adoption. Even though there was not a correlation between regulation and year, figure 1 shows that the regulation frame starting to be used more as time goes on. This could be an indication that as wearables continue to be talked about and accepted, less background information will need to be provided and more emphasis can be placed on societal issues regarding the technology, which would also employ a thematic frame.

RQ4 asked if the prevalence of interview sources was related to episodic vs. thematic frames. This study found that the frequency of mentioning sources was not related to episodic and thematic coverage, except for when professors were used an interview source. When a professor was used as an interview source the story used a thematic frame. A possible explanation for this is since thematic frames present more general/collective evidence professors are relied on as a reputable source to support broader claims about societal issues. RQ5 was more exploratory in asking what kinds of wearables were covered the most frequently. This study found that head-mounted devices were the most commonly talked about. A possible explanation for this finding is due to the novelty and hype surrounding Google Glass in 2013 which skewed the coverage of wearable devices. Another explanation could be *The Washington's Post* high frequency coverage of Xybernaut, a company located in Fairfax County, Virginia that makes wearable computers that include a heads up display.

Implications

The results of this research provides useful insight into how wearable technology has been framed over the past 28 years by the news media which is helpful for companies creating and marketing these technologies, journalists writing about this type of technology, and scholars interested in understanding how the media talks about a new technology while it is in the process of diffusion.

Theoretically, this paper extends Weaver et al.'s (2009) nanotechnology news issue frames to a new technology. This study found that the progress frame is relied on as the default form of storytelling when it comes to wearable technology. Even though the first wearable computer was invented in the 1960's, and the technology has seen a long metamorphosis and growth, it has still not reached widespread diffusion and acceptance throughout society. Therefore, similar to previous research (Maeseele, 2010), this study found that the news media cover the issue of "progress" of technology in order to keep the audience informed of new product developments.

This was the first study done analyzing how newspapers frame wearable technology. This study borrowed issue frames from another type of technology which may not have captured the nuances to this specific technology. Future research could use a constant comparative model to infer frames specific to wearable technology.

This study also has practical implications. Because the progress and episodic frames were dominant and company spokespeople were often relied on as interview sources, they may hinder consumers from weighing all the information and making an unbiased decision. Druckman & Bolsen (2011) found that the best way to facilitate reasonable opinion formation is to provide multiple frames as a means of alternative ways of thinking about new technologies in order to allow individuals to weigh these frames against one another. With progress-framed news stories technological advancements seem inevitable and does not create space for dialogue about risks or privacy concerns that come with a new technology, especially wearables that can track bodily functions.

Limitations

While this study had some interesting findings, there are still certain limitations to consider. This study was a drawn from a relatively narrow sample. If a broader sample was used the study might have found different results. In addition, this study only looked at American newspapers that are archived on *Lexis Nexis* and *ABI/Inform* databases. Some scholars claim that search engines, such as Google, are superior to traditional information databases, like *Lexis Nexis*, in tapping the fell depth of public discourse on issues (Weaver et al, 2009). Cacciatore (2012) found that online media paint a broader picture of emerging technologies by incorporating more thematic content related to applications, policy, and social implications. Future research should explore comparing traditional print sources to online content. Because China's market share for wearable technology is expected to be twice as large as the United States a similar study done on Chinese newspapers is an area for future research to explore. However, how applicable a frame is to an individual's cognitive schema impacts the strength of the frame and because cognitive schema are culturally shared cross-cultural comparisons may not produce as strong applicability effects because the schema will not be understood in the same context.

In addition, this study only coded certain frames and the issues were mutually exclusive. If codes were not mutually exclusive, perhaps another pattern would have emerged. This study also choose key word search terms based off a pilot study, but overall prevalence was not captured due to the limiting scope of key words.

Intercoder reliability was another limitation of this study. The reliability for some variables were not particularly strong by strict standards associated with measures that take into account likelihood of chance agreement, because these measures are somewhat unforgiving for variables where prevalence of one or more categories is proportionally low. Holsti's (1969) agreement coefficient was used instead. The "progress" frame's agreement rate was on the lower side of agreement at 78% and should be interpreted with caution. Frames were chosen to represent how the wearable mention was specifically framed within the article and could have led to interpretation issues of the whole article. For example, one coder may interpret the frame as "conflict" if another company was mentioned, but there was no other issue besides competition leading the other to code it "progress." More explicit coding examples and definitions may be necessary to apply the issue frames to wearable technology. This may be a limitation of the issue frames used in this study. Because these frames were transposed from nanotechnology to wearable technology they may not capture the nuances specific to this technology.

Conclusion

This study attempted to contribute to framing literature by analyzing how newspapers frame wearable technology. Similar to previous research on technology frames (Weaver et al,

2009) the “progress” frame is utilized as the default frame for story-telling. In addition, episodic frames were used more than thematic frames which highlight specific examples and individual stories. While this study was exploratory in nature, its findings may pave the way for other framing studies on wearable technology in other contexts such as blogs or online articles.

CHAPTER 6. REFERENCES

AAM. (2016). *About AAM.* Retrieved from http://auditedmedia.com/about/

Anderson A., Allan, S., Petersen, A., & Wilkinson, C. (2005). The framing of nanotechnologies in the British newspaper press. *Science Communication*, *27,* 200-220. doi:10.1177/1075547005281472

Artstein, R., & Poesio, M. (2008). Inter-coder agreement for computational linguistics. Computational Linguistics, 34(4), 555-596. doi:10.1162/coli.07-034-R2

Barfield, W., & Caudell, T. (2001). *Fundamentals of wearable computers and augmented reality*. Mahwah, NJ: Lawrence Erlbaum Associates.

Bilton, N. (2015, Feb. 4). Why Google Glass broke. *The New York Times.* Retrieved from http://www.nytimes.com/2015/02/05/style/why-google-glass-broke.html?_r=0

Bruner, J. S., & Minturn, L. (1955). Perceptual identification and perceptual organization. *Journal of General Psychology, 53*, 21-28.

CCS Insight. (2016). *Wearables Market to Be Worth $25 Billion by 2019*. Retrieved from http://www.ccsinsight.com/press/company-news/2332-wearables-market-to-be-worth-25-billion-by-2019-reveals-ccs-insight

Chan, M., Esteve, D., Fourniols, J., Escriba, C., & Campo, E. (2012). Smart wearable systems: Current status and future challenges. *Artificial Intelligence in Medicine, 56*, 137-156. doi:10.1016/j.artmed.2012.09.003

Cho, S. (2007). TV news coverage of plastic surgery, 1972-2004. *Journalism and Mass Communication Quarterly, 84,* 75-89. doi:10.1177/107769900708400106

Chong, D., & Druckman, J. N. (2007). A theory of framing and opinion formation in competitive elite environments. *Journal of Communication, 57*, 99-118.

Christensen, E. (2013). Technology acceptance model. *Encyclopedia of Management Theory,* 829-831.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82,* 407-428.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*, 319-340.

Di Eugenio, B., & Glass, M. (2004). Squibs and discussions - the kappa statistic: A second look. *Computational Linguistics*, 30, 95-101.

De' Medici, L. (2015, November 3). The history of wearable technology – Past, present and future. Retrieved from https://wtvox.com/featured-news/history-of-wearable-technology-2/

Desjardins, J. (2015, May 20). Infographic: The History of Wearable Technology. Retrieved from http://www.visualcapitalist.com/the-history-of-wearable-technology/

Dohrn-van Rossum, G. (1996). *History of the hour: Clocks and modern temporal orders*. Chicago: University of Chicago Press.

Druckman, J. N., & Bolsen, T. (2011). Framing, motivated reasoning, and opinions about emergent technologies. *Journal of Communication, 61*, 659-688. doi:10.1111/j.1460-2466.2011.01562.x

Du Gay, P. (1997). *Doing cultural studies: The story of the Sony Walkman*. Thousand Oaks [Calif.]; London: Sage, in association with The Open University.

Dunne, L. E. (2004). *The design of wearable technology: addressing the human-device interface through functional apparel design.* Retrieved from http://ecommons.cornell.edu/bitstream/1813/150/2/Lucy%20E%20Dunne-

Edelstein, A. S. (1993). Thinking about the criterion variable in agenda-setting research. *Journal of Communication*, *43*, 85-99.

Einsiedel, E. F. (1992). Framing science and technology in the Canadian press. *Public Understanding of Science, 1*, 89-101. doi:10.1088/0963-6625/1/1/011

Entman, R. (1993). Framing - toward clarification of a fractured paradigm. *Journal of Communication*, *43*, 51-58. doi:10.1111/j.1460-2466.1993.tb01304.x

Fanthorpe, L., & Fanthorpe, P. (2007). *Mysteries and Secrets of Time* (Vol. 11). Dundurn.

Feiner, S., MacIntyre, B., & Seligmann, D. (n.d.). KARMA Knowledge-based augmented reality for maintenance assistance. Retrieved from http://monet.cs.columbia.edu/projects/karma/karma.html

Gamson, W. A. (1992). *Talking politics*. New York: Cambridge University Press.

Gamson, W. A., & Modigliani, A. (1989). Media discourse and public opinion on nuclear power: A constructionist approach. *American Journal of Sociology, 95*, 1-37. doi:10.1086/229213

Gamson, W. A., & Modigliani, A. (1987). The changing culture of affirmative action. In *Research in political sociology*, edited by R. G. Braungart and M. M. Braungart. Greenwich, CT: JAI Press.

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. New York, NY: Harper & Row.

Heider, F. (1958). *The psychology of interpersonal relations*. New York: Wiley.

Holsti, O. (1969). Content analysis for the social sciences and humanities. Don Mills, ON: Addison-Wesley.

International Data Corporation. (2015). *IDC Forecasts Worldwide Shipments of Wearables to Surpass 200 Million in 2019, Driven by Strong Smartwatch Growth.* Retrieved from https://www.idc.com/getdoc.jsp?containerId=prUS40846515

Iyengar (1991). *Is anyone responsible? How television frames political issues*. Chicago, IL: University of Chicago Press.

Iyengar, S. (1990). The accessibility bias in politics: Television news and public opinion. *International Journal of Public Opinion Research, 2,* 1-15.

Iyengar, S., and D. R. Kinder. (1987). *News that matters: Television and American opinion*. Chicago, IL: University of Chicago Press.

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist*, *58*(9), 697-720. doi:10.1037/0003-066X.58.9.697

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, *47*(2), 263–291. http://doi.org/10.2307/1914185

Kang, S., Lee, K. M., & De La Cerda, Y. (2015). U.S. television news about the smartphone: A framing analysis of issues, sources, and aspects. *Online Journal of Communication and Media Technologies, 5*, 174-196.

Kenn, H. (n.d.). *Wearable Computing* [PDF document]. Retrieved from https://www.cubeos.org/lectures/W/all_slides.pdf

Kim, K. J., & Shin, D. (2015). An acceptance model for smart watches: Implications for the adoption of future wearable technology. *Internet Research*, *25*, 527-541. doi:10.1108/IntR-05-2014-0126

Knoblauch, M. (2014, May 13). *The History of Wearable Tech, From the Casino to the Consumer.* Retrieved from http://mashable.com/2014/05/13/wearable-technology-history/#KFNZ5WNECZqa

Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: University of Chicago Press.

Luke, D. A., Caburnay, C. A., & Cohen, E. L. (2011). How much is enough? New recommendations for using constructed week sampling in newspaper content analysis of health stories. *Communication Methods and Measures*, 5, 76-91. doi:10.1080/19312458.2010.547823

Maeseele, P. (2010). On neo-luddites led by ayatollahs: The frame matrix of the GM food debate in northern Belgium. *Environmental Communication: A Journal of Nature and Culture, 4*, 277-300. doi:10.1080/17524032.2010.499211

Maeseele, P. (2011). On news media and democratic debate: Framing agricultural biotechnology in northern Belgium. *International Communication Gazette, 73*, 83-105. doi:10.1177/1748048510386743Masters%20Thesis.pdf

Mann, S. (n.d.). Wearable computing. In *The Encyclopedia of Human-Computer Interaction, 2nd Ed.* (chapter 23). Retrieved from https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/wearable-computing

Matias, E., MacKenzie, I. S., & Buxton, W. (1996). A wearable computer for use in microgravity space and other non-desktop environments. *Companion of the CHI '96 Conference on Human Factors in Computing Systems* (pp. 69-70). New York: ACM.

McCombs, M. E. 1992. Explorers and Surveyors: Expanding strategies for agenda-setting research. *Journalism Quarterly, 69,* 813-824.

McCombs, M. E., & Shaw, D. L. (1972). The Agenda-Setting Function of Mass Media. *The Public Opinion Quarterly*, *36*, 176–187.

Melanson, D. (2013, September 18). Gaming the system: Edward Thorpe and the wearable computer that beat Vegas. Retrieved from http://www.engadget.com/2013/09/18/edward-thorp-father-of-wearable-computing/

Melanson, D. & Gorman, M. (2012, December). Our Augmented Selves: The Promise of Wearable Computing, *DISTRO*, 53-66.

Pedersen, I. (2005). A semiotics of human actions for wearable augmented reality interfaces. *Semiotica,* 183-200. doi:10.1515/semi.2005.2005.155.1part4.183

Pedersen, I. (2014). Are wearables really ready to wear? [viewpoint]. *IEEE Technology and Society Magazine*, *33,* 16-18. doi:10.1109/MTS.2014.2319911

Pense, C. M., & Cutcliffe, S. H. (2007). Risky talk: Framing the analysis of the social implications of nanotechnology. *Bulletin of Science, Technology & Society, 27,* 349-366. doi:10.1177/0270467607306592

Price, V., and D. Tewksbury. (1997). *News values and public opinion: A theoretical account of media priming and framing.* In Progress in communication sciences: Advances in persuasion (Vol. 13), edited by G. A. Barett and F. J. Boster. Greenwich, CT: Ablex. Retrieved from https://archive.org/details/Engadget_DISTRO_Magazine_Issue_70

Profita, H., Clawson, J., Gilliland, S., Zeagler, C., Starner, T., Budd, J., & Do, E. Y. (2013). Don't mind me touching my wrist: A case study of interacting with on-body technology in public, 89-96. doi:10.1145/2493988.2494331

Racoma, J. A. (2013, July 02*). Wearable tech: A brief history and a look into the future*. Retrieved from http://www.androidauthority.com/wearable-computing-history-238324/

Riffe, D., Aust, C. F., & Lacy, S. R. (1993). The effectiveness of random, consecutive day and constructed week sampling in newspaper content analysis. *Journalism Quarterly*, 70, 133-139.

Rhodes, B. (n.d.). A brief history of wearable computing. Retrieved from https://www.media.mit.edu/wearables/lizzy/timeline.html#1994b

Saffo, P. (1992). Paul Saffo and the 30 year rule. *Design World*, *24*, 16-23.

Scheufele, D. A. & Iyengar, S. (2012). The state of framing research: a call for new directions In K. Kenski & K. H. Jamieson (Eds.), *The Oxford Handbook of Political Communication Theories.* New York: Oxford University Press.

Skiba, D. J. (2014). The connected age and wearable technology. *Nursing Education Perspectives*, *35*, 346.

Smith, M. R., & Marx, L. (1994). *Does technology drive history?: The dilemma of technological determinism*. Cambridge, Mass: MIT Press.

Starner T. (1999). *Wearable computing and contextual awareness* (Doctoral dissertation). Retrieved from https://www.researchgate.net/profile/Thad_Starner/publication/2646023_Wearable_Computing_and_Contextual_Awareness/links/55ada21708aed614b097bb27.pdf

Tehrani, K. & Michael, A. (2014). Wearable Technology and Wearable Devices: Everything You Need to Know. *Wearable Devices Magazine*, Retrieved from WearableDevices.com

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*, 186-204. doi:10.1287/mnsc.46.2.186.11926

Vishwanath, A. (2009). From belief-importance to intention: The impact of framing on technology adoption. *Communication Monographs, 76*, 177-206. doi:10.1080/03637750902828438

Weaver, D., Lively, E., & Bimber, B. (2009). Searching for a frame news media tell the story of technological progress, risk, and regulation. *Science Communication, 31*, 139-166. doi:10.1177/1075547009340345

Weiser, M. (1991). The computer for the 21st century. *Scientific American*, 265, 94-104. doi:10.1038/scientificamerican0991-94

Weiser, M. (1993). Ubiquitous computing. *Computer, 26*, 71-72.

Winston, B. (1998). *Media technology and society: A history: From the telegraph to the internet*. New York; London; Routledge. doi:10.4324/9780203024379

APPENDIX: CODEBOOK

Weaver, Lively, and Bimber (2009) Four Issue Frames for Science and Technology

Process Category	**Description/Definition**	**Include If…**	**Do NOT include if…**
Progress	Emphasizes benefits to society that flow from a natural process of discovery and application and minimizes issues of responsibility, choice, priorities, and regulation	Story is explicitly about technological progress and advances (e.g. advances in software, miniaturization of hardware, etc.)	Story emphasizes issues of responsibility, choice, priorities, and regulation
Regulation	Captures stories that emphasize the market-consumer-regulation triad	Story is explicitly about regulation of technology that deals with the market-consumer-regulation triad and emphasizes the government as an actor and its responsibility for protecting the public at large from harm	Story is about the conflict and not the process of regulation
Conflict	Focuses on the conflict itself and competing claims or interests	Story explicitly focuses on the conflict itself and disputes among specific societal interests or actors	Story references the government's role resolving the conflict
Generic Risk	Wait-and-see approach about the good and bad aspects of new technologies and avoids attributing responsibility	Story identifies potential risky outcomes of innovation	Story attributes responsibility, mention of natural technological progress from discoveries that will improve society, discusses regulatory consideration, or any mention of conflict or disagreement

Kang, Lee, and Cerda's (2015) Interview Source Categories

Process Category	**Description/Definition**
Professor	e.g. Law, marketing, mobile technology, computer science, etc.
Lawyer	e.g. Patent lawyer
Company spokesperson	e.g. Samsung or Apple
Consumer	e.g. Users
Analysts	e.g. experts, market analysis, industry analysts
Government	e.g. FCC, politicians
Other	e.g. Juries
No source	Article without an interview source

Iyengar's (1991) Episodic vs. Thematic frames

Process Category	**Description/Definition**
Episodic	Emphasizes individual responsibility and personal stories. Depicts concrete events that illustrate issues.
Thematic	Social responsibility or government aspects. Presents collective or general evidence. Places issues and events in some general context.