Shannon, Wiener, and the Alethic Value of Information

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ABSTRACT

This paper uses historical and deconstructive methods to examine contrasting visions of information's alethic value. It focusses specifically on the research and legacies of Claude Shannon and Norbert Wiener, two founding fathers of information science. Shannon's formulation of information as a statistical function of probability emphasizes a kind of pragmatism: information that can be broken into bits and transmitted through a system possesses alethic value. Wiener's research and career set a contrasting example to that of Shannon in relation to a construction of truth. The alethic value of information in the Wienerian tradition is derived not only from its pragmatic transference within a system, but also from the way in which it interacts with other systems through feedback loops. The dichotomy set by Shannon and Wiener implicates broader questions surrounding conceptualizations of truth in LIS research today.

ALISE RESEARCH TAXONOMY TOPICS

Information ethics; Information use; Political economy of the information society

AUTHOR KEYWORDS

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INTRODUCTION

In the 21st century, there exists a certain cultural fascination with the scientific research of the 1940s. The atrocities of WWII provided the groundwork for a small number of labs in which scientists, much like soldiers, fought evil, battling in secrecy to advance technology around communication and weaponry before the Nazis were able to do the same. Flush with military funding and inspired by the moral charge to end the war, advancements were made seemingly overnight by the brightest minds around the world. Then, as the fog of WWII settled and the chill of the Cold War set in, these scientists were left to grapple with the practical and ethical ramifications of their work. Such background is fodder for excellent stories. In this paper, I specifically tell the stories of two of these individuals with competing visions for information research: Claude Shannon and Norbert Wiener. Their research and legacies highlight a difference in how the alethic value of information is assessed in LIS research and education.

Shannon never wrote a treatise on truth, but his research nonetheless implicates a specific understanding of truth in relation to information. His initial formulation of information as a statistical function of probability emphasizes a kind of pragmatism: information that can be accurately formulized into bits and transmitted through a system possesses alethic value. Wiener was a contemporary of Shannon, working with him before and following WWII on questions of information and communication. Wiener's research and career, however, set a contrasting example to that of Shannon in relation to a construction of truth. The alethic value of information in the Wienerian tradition is derived not only from its pragmatic transference within a system, but also from the way in which it interacts with other systems through feedback loops. The contrasting visions of Shannon and Wiener implicate broader questions surrounding conceptualizations of truth.

METHODS

This paper employs methods that are historical, allegorical, and deconstructive. They are historical insofar as I draw from foundational information science texts from the 1940s and 50s. I probe questions of alethic value from the individuals credited with inventing information theory, and such historicity allows me to accurately convey conceptualizations of truth in LIS. At the same time, my methods are, in part, allegorical. I choose two individuals from a number of theorists working in this domain during and following WWII, simplifying scholarly discourse in order to magnify competing visions of truth and information. In the following section, I craft two founding father figures, anachronistically compelling them to speak to a technological world they would not recognize on ethical issues they never faced. Finally, this paper is deconstructive. In establishing a dichotomy between Shannon and Wiener, I demonstrate how the Shannonian tradition of pragmatic truth value is traditionally favored in our field. I then reverse this dichotomy, arguing for greater Wienarian influence in LIS research and education.

SHANNON AND WIENER

Claude E. Shannon

To understand how Claude Shannon crafted truth in relation to information, it is important to unpack his perception of information and information theory. To do so, I turn to his career during and following WWII.

Shannon worked with and studied under Norbert Wiener as a master's student at MIT in the 1930s (Bynum, 2010). In 1940, Shannon completed his master's thesis, "A symbolic analysis of relay and switching circuits," in which he "used Boolean algebra to establish the first

theoretical underpinnings of digital circuits […. As] a consequence, it has frequently been described as the most influential master's thesis ever written" (Atmar, 2001, p. 208). Following his master's degree, Shannon was hired by Bell Laboratories where he stayed during and immediately following WWII working on new methods of enciphering and communicating information to aid the US war effort. In 1948, he published his seminal paper, "A Mathematical Theory of Communication," which was subsequently published as a book coauthored by Warren Weaver. In this book, Shannon and Weaver (1964) largely ignored semantic aspects of information, clarifying that "information must not be confused with meaning" (p. 8). Instead, they focused on the technical aspects of information communication, mathematizing how information may be broken down, transmitted through a system, and then reassembled at the other end with accuracy even in the presence of noise. Shannon (1948) defines information as the mathematical opposite of entropy; whereas entropy is a measure of the disorganization of matter and energy, information is a measure of the organization of matter and energy (p. 393). Shannon's formulation of information transformed it into a technical, measurable concept holding enormous practical significance. His theories published in 1948 remain "at work in the smartphones, fitness trackers, and countless other devices we use today. So it is that Shannon has typically received credit for jump-starting the computer revolution" (Hill, 2019, p. xvi). Shannon's contributions are ingenious, abstract, and practical, cementing his reputation in information science.

Today, the significance of Shannon's research on information is obvious. However, the way his mathematization of information implicates its alethic value is more obfuscated. To understand the relationship between information and truth in the Shannonian tradition, one must return to the way in which Shannon divorces information from meaning; "Even in Shannon's day, malcontents grumbled that divorcing information from context and thus from meaning had made the theory so narrowly formalized that it was not useful as a general theory of communication" (Hayles, 1999, p. 8). Information theorists of the mid-twentieth century saw the potential of Shannon's theory in transforming not only technology, but the way we view the world. However, Shannon (1956) admonished against drawing broader conclusions from information research. In a four-paragraph article titled, "The Bandwagon," Shannon (1956) affirmed his view that "information theory is, essentially, a branch of mathematics, a strictly deductive system" (p. 3). To study information meant to submit to "the slow and tedious process of hypothesis and experimental verification" (Shannon, 1956, p. 3). The truth of information theory is neither derived from meaning nor exposition; rather, it is derived from mathematical formulation and systems-oriented experimentation. In other words, if information operates successfully within a closed system, it contains minimal alethic value regardless of meaning. This Shannonian formulation of information provided the groundwork for ensuing decades of exciting systems-oriented information science research. It also impacted even more humanistic tendrils of information theory. For example, philosopher of information Luciano Floridi (2011) takes an arguably Shannonian approach to truth and information, arguing that all information is truthful insofar as it is composed of data corresponding accurately to a referent at a specific level of abstraction (p. 183).

Shannon's focus on systems-oriented research dominated his later research. Throughout the latter half of the 20th century, he focused on inventions that interested him like chess-playing machines and automated mice (Horgan, 2016). However, I suggest that his attention to how information operates within systems ultimately blinded him to the impact of those systems. In a 1992 interview with John Horgan republished in 2016, Shannon was asked about the eccentric

nature of his later inventions: "'I've always pursued my interests without much regard for final value or value to the world,' he said cheerfully. 'I've spent lots of time on totally useless things'" (para. 7).

Norbert Wiener

During WWII, Wiener, like Shannon, contributed to the US war efforts. Unlike Shannon, Wiener remained at MIT where he led research in digitized information communication, radar, and the creation of a new automated antiaircraft weapon (Bynum, 2008). After the war, Wiener's research earned him a reputation as an expert in the burgeoning field of information science. Wiener (2019) agreed with Shannon that information was a mathematized property of organization distinct from matter and energy. Unlike Shannon, he argued that this definition of information had implications beyond the computing systems for which it proved immediately beneficial. Wiener instead "set out to explain how information is the lingua franca of both animal and machine" (Hill, 2019, p. xv), naming this new area of research cybernetics; "cybernetics signaled that three powerful actors—information, control, and communication—were now operating jointly to bring about an unprecedented synthesis of the organic and the mechanical" (Hayles, 1999, p. 8). His seminal book, *Cybernetics or Control and Communication in the Animal and the Machine*, was first published in 1948, the same year as Shannon's (1948) "The Mathematical Theory of Communication." This book demonstrated the depth and breadth of Wiener's expertise. In it, the mathematics behind information and entropy are explained. However, Wiener also engaged in topics as diverse as neurophysiology, enlightenment-era philosophy, sociology, evolutionary biology, game theory, psychology, economics, and anthropology, arguing "the most fruitful areas for the growth of the sciences were those which had been neglected as a no-man's land between the various established fields" (Wiener, 1948, p. 4). In fact, "It's likely that the breadth of Wiener's erudition and ambition contributed to his eclipse by Shannon" (Hill, 2019, p. xv). There is less room for practical instantiation of these elements of Wiener's work.

In addition to his commitment to exploring "the boundary regions of science," Wiener's (2019) reputation also declined due to his outspoken criticism against the way research was exploited by government and military powers following WWII (p. 5; pp. 41-42). Wiener publicly took principled stands "against the use of science—his science—to develop new ways to wage war, exploit labor, and destroy the environment. […] Putting his money, and his career, where his mouth was, Wiener refused to take on research funded by the military, which effectively excluded him from much of the cutting-edge work in computers at a crucial moment in their history" (Hill, 2019, p. xvi). As early as his 1948 monograph on cybernetics, Wiener (2019) urged researchers "to confine our personal efforts to those fields, such as physiology and psychology, most remote from war and exploitation" (p. 42). Wiener continued research, publication, and advocacy until his death in 1964, but his reputation was never able to recover from the hit it took due, in part, to the unpopularity of his pacifist stances at the time.

Wiener's writing on cybernetics coupled with his principled example of information research points to an understanding of alethic value that encompasses but extends beyond Shannon's. Like Shannon, Wiener was deeply engaged in how information could be fragmented into bits and communicated through systems. Unlike Shannon, he recognized that systems were never closed but always breaking open into feedback loops with other systems. For example, in his 1950 monograph, *The Human Use of Human Beings*, Wiener (1950) writes about how technology crafted in controlled laboratory environments will inevitably escape these confines,

interacting with humans, society, governmental powers, and the environment. This has short-term consequences, immediately impacting things like labor, war, and the consolidation of power (Wiener, 1950). It also harbors long-term consequences; the technological change of the previous four hundred years "is partly the result of […] an increased mastery over nature which, on a limited planet like the earth, may prove in the long run to be an increased slavery to nature" (Wiener, 1950, p. 46). The alethic value of information, therefore, is not simply tied to its functioning within a system. It is connected to how information breaks free from closed systems to impact other systems through feedback.

To understand what this means, it is important to return to information as a principle of organization contrasting entropy, a principle of disorganization. Both Shannon and Wiener agree that true information, minimally, is that which can operate within a closed system without increasing entropy within that system. Wiener adds that true information, when it escapes a closed technological system, should also not increase entropy in other, broader systems. Wiener thus breaks information theory from the strictly deductive Shannonian view and adds an ethical dimension into information research.

CONCLUSION: INFORMATION TRADITIONS TODAY

I use Shannon and Wiener in this paper to draw forward a dichotomy still rife within information science. On the one hand, there exists the Shannonian emphasis on research that is focused more granularly on modelling information in closed environments. Truth, in this tradition, is deductive and axiomatic, and information gains alethic value if created models are applicable and functionable in specific spaces. On the other hand, there exist Wienerian threads of research in which liminal spaces between LIS and other disciplines are explored and feedback is prioritized. Truth in this tradition is complicated beyond deductive methods, and alethic value is gained in recognizing how information ruptures closed models, structures, and systems. In information science, the Shannonian half of this research dichotomy has traditionally been favored. It is easier to acquire funding for research with immediate technological impact, and it is easier to define a fledgling discipline by building a cohesive research corpus rather than continuously dipping into the "no-man's land between the various established fields" (Wiener, 1948, p. 4). Therefore, Shannon is usually hailed as the father of the information revolution in the United States "while Wiener's legacy remained relatively obscure" (Hill, 2019, p. xvi).

There are many signs, however, that Wiener's research and legacy are currently resurging in popularity; "in the burgeoning age of artificial intelligence, the line between human and machine is becoming increasingly blurred. Cybernetics was far ahead of its time in anticipating how fruitful those parallels could be" (Hill, 2019, p. xvi). Wiener's 1948 monograph reads with such relevance that its second edition was republished in 2019 by The MIT Press. In it, Wiener (2019) builds ethical scaffolding around information theory, hoping that such scaffolding would serve to buffer inventions he knew "belong[ed] to the age" but which he simultaneously recognized as contributing "to the concentration of power […] in the hands of the most unscrupulous" (p. 42). His warnings and fears, which many scoffed at as dire at the time of initial publication, no longer seem like far-fetched doomsday predictions. Moving forward, I suggest that LIS leans on Wiener's example of alethic value, evaluating information not simply on its functioning within closed models but also in how it escapes the confines of such systems, impacting the rest of the informational world.

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