communication +1

Volume 1 Futures of Communication Article 1

August 2012

Communication and Artificial Intelligence: Opportunities and Challenges for the 21st Century

David J. Gunkel
Northern Illinois University, dgunkel@niu.edu

Abstract

This essay advocates for a significant reorientation and reconceptualization of communication studies in order to accommodate the opportunities and challenges introduced by increasingly intelligent machines, autonomous decision making systems, and smart devices. Historically the discipline of communication has accommodated new technology by transforming these innovations into a medium of human interaction and message exchange. With the computer, this transaction is particularly evident with the development of computer-mediated communication (CMC) in the later half of the 20th century. In CMC, the computer is understood and investigated as a more-or-less neutral channel of message transfer and instrument of human interaction. This formalization, although not necessarily incorrect, neglects the fact that the computer, unlike previous technological advancements, also occupies the position of participant in communicative exchanges. Evidence of this is already available in the science of AI and has been explicitly described by some of the earliest writings on communication and the computer. The essay therefore 1) demonstrates that the CMC paradigm, although undeniably influential and successful, is insufficient and no longer tenable and 2) argues that communication studies needs to rework its basic framework in order to address and respond to the unique technological challenges and opportunities of the 21st century.

Keywords

Communication, Artificial Intelligence, Alan Turing, Media Studies, Computer Mediated Communication, Computers

Introduction

In a now well-known and often reproduced *New Yorker* cartoon by Peter Steiner, two dogs sit in front of an Internet-connected computer. The one operating the machine says to his companion, "On the Internet, nobody knows you're a dog."[1] The cartoon has often been cited to address issues of identity and anonymity in computer-mediated communication (CMC). According to this particular reading, what the cartoon portrays is that who or what one *is* in CMC is, as Sandy Stone, Sherry Turkle, and others have demonstrated, something that can be easily and endlessly reconfigured. This interpretation, although not necessarily incorrect, misses the more interesting and suggestive insight that is provided by the wired canines. What the cartoon illustrates is not only the anonymity and indeterminacy of others in CMC but also the unquestioned assumption that despite this anonymity, users assume that the other with whom they interact and communicate is another human being. The *other* who confronts us is always, it is assumed, another human person, like ourselves. These others may be "other" in a "celebrate diversity" sense of the word—another race, another gender, another ethnicity, another social class, etc. But they are never a dog. Consequently, what the cartoon illustrates, through a kind of clever inversion, is the standard operating presumption of mainstream communication theory and practice. Online identity is, in fact, reconfigurable. You can be a dog, or you can say you are. But everyone knows, or so it is assumed, that what is on the other end of the fiber-optic cable is another human user, someone who is, despite what are often interpreted as minor variations in physical appearance and background, essentially like we assume ourselves to be.

This essay investigates and seeks to intervene in this deep-seated and often unquestioned assumption, tracing the effect it has on our current understanding and the future direction of communication studies. In particular it explicitly recognizes and endeavors to deal with the fact that the majority of online communication is not human-to-human (H2H) exchanges but, as Norbert Wiener had already predicted in 1950, interactions between humans and machines and machines and machines.[2] Current statistics concerning web traffic already give machines a slight edge with 51% of all activity being otherwise than human.[3] And this figure is expected to increase at an accelerated rate. In a recent white paper, Cisco Systems predicts that machine-to-machine (M2M) data exchanges will

---

[1] Peter Steiner, "Dog Cartoon," *The New Yorker* (1993): 61.

[2] Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (Boston: Ad Capo Press, 1988), 16.

[3] Tom Foremski, "Report: 51% of Website Traffic is 'Non-human' and Mostly Malicious." *ZDNet*, 3 March 2012. http://www.zdnet.com/blog/foremski/report-51-of-web-site-traffic-is-non-human-and-mostly-malicious/2201

grow, on average, 86 percent a year, and will reach 507 petabytes a month by 2016.[4] Even if one doubts the possibility of ever achieving what has traditionally been called "strong AI," the fact is our world is already populated by semi-intelligent artifacts or smart devices that increasingly play the role not of communications medium but of information source or receiver. Communication studies, it will be argued, must come to terms with this development and reorient its theoretical framework so as to be able to accommodate and respond to situations where the *other* in communicative exchange is no longer exclusively human. This is, more than anything else, what will define the opportunities and challenges for communication research in the 21st century.

AI and Communication

Whether it is explicitly acknowledged or not, communication (and "communication" as the concept is understood and mobilized in the discipline of communication studies) is fundamental to both the theory and practice of artificial intelligence (AI). In particular, it is communication that provides the science with its definitive test case and experimental evidence. This is immediately evident in the agenda-setting paper that is credited with defining machine intelligence, Alan Turing's "Computing Machinery and Intelligence." Although the title "artificial intelligence" is a product of the Dartmouth Conference of 1956, it is Turing's 1950 paper and its "game of imitation," or what is now routinely called "the Turing Test," that defines and characterizes the discipline. Although Turing begins his essay by proposing to consider the question "Can machines think?" he immediately recognizes persistent and seemingly irresolvable terminological difficulties with the question itself. For this reason, he proposes to pursue an alternative line of inquiry, one that can, as he describes it, be "expressed in relatively unambiguous words." "The new form of the problem can be described in terms of a game which we call the 'imitation game.' It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman."[5] This determination is to be made on the basis of simple

[4] Cisco Systems, *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011–2016* (San Jose, CA: Cisco Systems, 2012). http://www.cisco.com/en/US/solutions/ collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf

[5] Alan Turing, "Computing Machinery and Intelligence," in *Computer Media and Communication: A Reader*, ed. Paul A. Meyer (Oxford: Oxford University Press, 1999), 37.

questions and answers. The interrogator asks A and B various questions, and based on their responses to these inquiries tries to discern whether the respondent is a man or a woman. "In order that tone of voice may not help the interrogator," Turing further stipulates, "the answers should be written, or better still, typewritten. The ideal arrangement is to have a teleprinter communicating between the two rooms."[6] (Figure 1). In this way, the initial arrangement of the "game of imitation" is, as Turing describes it, computer-mediated communication (CMC) *avant la lettre*. The interrogator interacts with two unknown participants via a form of synchronous computer-mediated interaction that we now routinely call "chat." Because the exchange takes place via text messages routed through the instrumentality of a machine, the interrogator cannot see or otherwise perceive the identity of the two interlocutors and must, therefore, ascertain gender based on responses that are supplied to questions like "Will X please tell me the length of his/her hair."[7] Like the wired canines with which we began, the identity of the interlocutors is something that is hidden from view and only able to be ascertained by way of the messages that come to be exchanged.

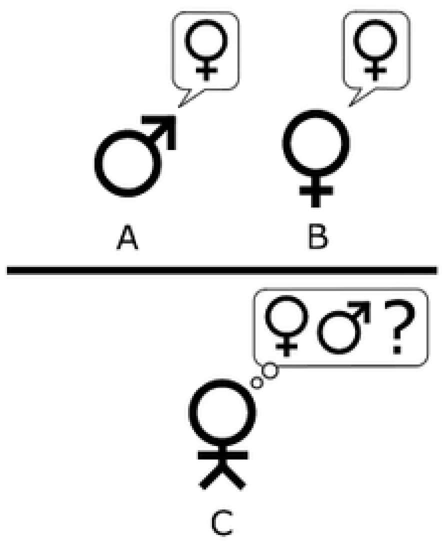

Figure 1: The Game of Imitation, Phase One
(Image provided by http://en.wikipedia.org/wiki/Turing_test)

Turing then takes his thought experiment one step further. "We can now ask the question, 'What will happen when a machine takes the part of A in this game?' Will the interrogator decide wrongly as often when the game is played like

[6] Turing, 37-38.
[7] Turing, 37.

this as he does when the game is played between a man and a woman? These questions replace our original, 'Can machines think?'"[8] In other words, if the man (A) in the game of imitation is replaced with a computing machine, would this device be able to respond to questions and "pass" as another person, effectively fooling the interrogator into thinking that it was just another human interlocutor? (Figure 2). It is this question, according to Turing, that *replaces* the initial and unfortunately ambiguous inquiry "Can machines think?" Consequently, if a computer does in fact becomes capable of successfully simulating a human being, of either gender, in communicative exchanges with a human interrogator to such an extent that the interrogator cannot tell whether he is interacting with a machine or another human being, then that machine would, Turing concludes, need to be considered "intelligent."

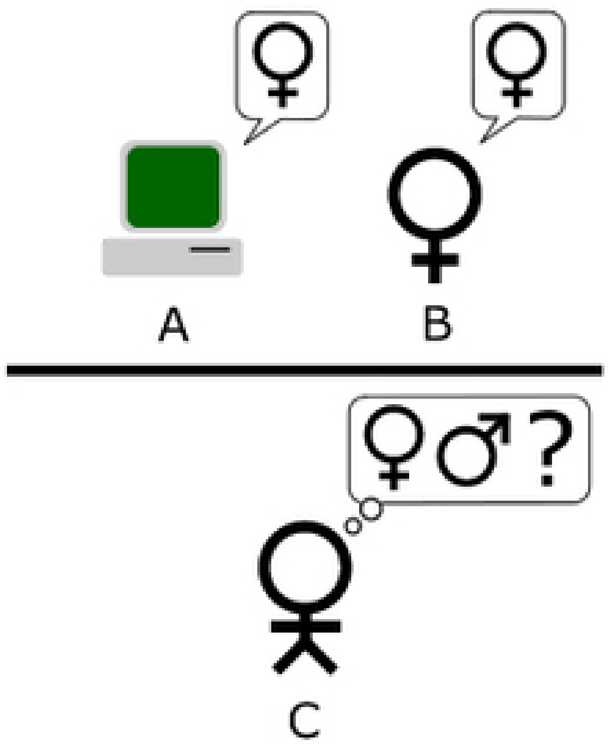

Figure 2: The Game of Imitation, Phase Two
(Image provided by http://en.wikipedia.org/wiki/Turing_test)

At the time that Turing published the paper, he estimated that the tipping point—the point at which a machine would be able to successfully play the game

[8] Turing, 38.

of imitation—was at least half-a-century in the future. "I believe that in about fifty year's time it will be possible to programme computers, with a storage capacity of about 10^9, to make them play the imitation game so well that an average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning."[9] It did not take that long. Already in 1966 Joseph Weizenbaum demonstrated a simple natural language processing application that was able to converse with human interrogators in such a way as to appear to be another intelligent agent. ELIZA, as the application was called, was a chatter-bot.[10] It was, technically speaking, a rather simple piece of programming, "consisting mainly of general methods for analyzing sentences and sentence fragments, locating so-called key words in texts, assembling sentence from fragments, and so on. It had, in other words, no built-in contextual framework of universe of discourse. This was supplied to it by a 'script.' In a sense ELIZA was an actress who commanded a set of techniques but who had nothing of her own to say." [11] Despite this, Weizenbaum's program demonstrated what Turing had initially predicted: "ELIZA created the most remarkable illusion of having understood in the minds of many people who conversed with it. People who know very well that they were conversing with a machine soon forgot that fact, just as theatergoers, in the grip of suspended disbelief, soon forget that the action they are witnessing is not 'real.' This illusion was especially strong and most tenaciously clung to among people who know little or nothing about computers. They would often demand to be permitted to converse with the system in private, and would, after conversing with it for a time, insist, in spite of my explanations, that the machine really understood them."[12]

Although there is a good deal that could be said in response to Turing's essay, the game of imitation, and empirical demonstrations like that provided by ELIZA, let me highlight two consequences that are especially important for communications research. First and foremost, Turing's essay situates *communication* as the deciding factor in AI. Because "the original question 'Can machines think?'" is considered by Turing to be "too meaningless," [13] he reformulates and refers the inquiry to a demonstration of communicative ability.

---

[9] Turing, 44.

[10] The generic term "chatter bot" was not utilized by Weizenbaum. It is first introduced in 1994 by Michael Maudlin, founder and chief scientist of Lycos, to identify another natural language processing application called Julia.

[11] Joseph Weizenbaum, *Computer Power and Human Reason: From Judgment to Calculation* (San Francisco, CA: W. H. Freeman, 1976), 188.

[12] Weizenbaum, 189.

[13] Turing, 37.

This is not a capricious decision, there is a good scientific reason for proceeding in this manner, and it has to do with what philosophers routinely call "the other minds problem." "How does one determine," as Paul Churchland characterizes it, "whether something other than oneself—an alien creature, a sophisticated robot, a socially active computer, or even another human—is really a thinking, feeling, conscious being; rather than, for example, an unconscious automaton whose behavior arises from something other than genuine mental states?"[14] And this difficulty, as Gordana Dodig-Crnkovic and Daniel Persson explain, is rooted in the undeniable fact that "we have no access to the inner workings of human minds—much less than we have access to the inner workings of a computing system."[15] In effect, we cannot, as Donna Haraway puts it, climb into the heads of others "to get the full story from the inside."[16] Consequently, attempts to resolve or at least respond to this problem inevitably involve some kind of behavioral demonstration or test, like Turing's game of imitation. "To put this another way," Roger Schank concludes, "we really cannot examine the insides of an intelligent entity in such a way as to establish what it actually knows. Our only choice is to ask and observe."[17] For Turing, as for many in the field of AI who follow his innovative approach, intelligence is something that is not directly observable. It is, therefore, evidenced and decided on the basis of behaviors that are considered to be a sign or symptom of intelligence—communication in general and human-level verbal conversation in particular. In other words, because intelligent thought is not directly observable, the best one can do is deal with something, like communicative interaction, that is routinely considered a product of intelligence and which can in fact be empirically observed, measured, and evaluated.

Second and directly following from this, Turing's proposal makes the assumption that communication is a product of intelligence. This means that anything—another human being, an animal, a machine, etc.—that is capable of performing communicative operations on par with what is typically expected of another human individual, irrespective of what actually goes on inside the head or

---

[14] Paul Churchland, *Matter and Consciousness* (Cambridge, MA: MIT Press, 1999), 67.

[15] Gordana Dodig-Crnkovic and Daniel Persson, "Towards Trustworthy Intelligent Robots - A Pragmatic Approach to Moral Responsibility." Paper presented to the North American Computing and Philosophy Conference, NA-CAP@IU 2008. Indiana University, Bloomington, July 10-12. http://www.mrtc.mdh.se/ ~gdc/ work/NACAP-Roboethics-Rev1.pdf

[16] Donna Haraway, *When Species Meet* (Minneapolis, MN: University of Minnesota Press, 2008), 226.

[17] Roger C. Schank, "What is AI Anyway?" in *The Foundations of Artificial Intelligence: A Sourcebook*, ed. Derek Partridge and Yorick Wilks (Cambridge: Cambridge University Press, 1990), 5.

information processor of the entity itself, would need to be considered intelligent. In philosophical terms, intelligence is considered to be a necessary and sufficient condition for communicative behavior. For this reason, Turing estimates that developments in machine communication will advance to such an degree that it will make sense to speak (and to speak intelligently) of machine intelligence by the end of the twentieth century. "I predict," Turing writes, "that by the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted."[18] Although this statement follows quite logically from Turing's argument, there has been and continues to be considerable resistance to it. For Turing, the critical challenge was already articulated by Lady Lovelace (aka Ada Augusta Byron, the daughter of the English poet Lord Byron), who not only wrote the software for Charles Babbage's Analytical Engine but is, for that reason, considered to be the first computer scientist. "Our most detailed information of Babbage's Analytical Engine," Turing explains, "comes from a memoir by *Lady Lovelace*. In it she states, 'The Analytical Engine has no pretensions to *originate* anything. It can only do *whatever we know how to order it to perform*.'"[19] According to Lovelace, a computer (and at the time she wrote this, "computer" referred not to an electronic device but a large mechanical information processor comprised of intricate gears and levers), no matter how sophisticated its programming, only does what we tell it to do. We can, in fact, write a software program, like ELIZA, that takes verbal input, extracts keywords, rearranges these words according to preprogrammed scripts, and spits out readable results. This does not, however, necessarily mean that such a machine is capable of original thought or of understanding what is stated in even a rudimentary way.

This position is taken up and further developed by John Searle in his famous "Chinese Room" example. This intriguing and influential thought experiment, introduced in 1980 with the essay "Minds, Brains, and Programs" and elaborated in subsequent publications, was offered as an argument against the claim of strong AI—that machines are able to achieve intelligent thought:

> Imagine a native English speaker who knows no Chinese locked in a room full of boxes of Chinese symbols (a data base) together with a book of instructions for manipulating the symbols (the program). Imagine that people outside the room send in other Chinese symbols which, unknown to the person in the room, are questions in Chinese (the input). And imagine that by following the instructions in the program the man in the room is able to pass

[18] Turing, 44.
[19] Turing, 50 (italics in the original).

> out Chinese symbols which are correct answers to the questions (the output). The program enables the person in the room to pass the Turing Test for understanding Chinese but he does not understand a word of Chinese.[20]

The point of Searle's imaginative albeit ethnocentric illustration is quite simple—simulation is not the real thing. Merely shifting verbal symbols around in a way that looks like linguistic understanding is not really an understanding of the language. A computer, as Terry Winograd explains, does not really understand the linguistic tokens it processes; it merely "manipulates symbols without respect to their interpretation."[21] Or, as Searle concludes, registering the effect of this insight on the standard test for artificial intelligence: "This shows that the Turing test fails to distinguish real mental capacities from simulations of those capacities. Simulation is not duplication."[22]

The difference between Turing's position and that of Lovelace, Searle, and Winograd depends on how one understands and operationalizes words like "intelligence," "thought," and "understanding." Initially these capabilities, what modern philosophers often situated under the general term "rationality," were what distinguished the human being from other things, most notably other living creatures, like animals, and artificially constructed mechanisms, like automatons or robots. For a modern thinker, like Rene Descartes, what distinguishes the human being from both the animal and machine is the fact that the former is capable of rational thought whereas animals and machines are mere mechanisms that operate without the faculty of reason. Conceptualized in this fashion, the animal and machine (or what Descartes identified with the hybrid term *bête-machine*) were effectively indistinguishable and ontologically the same. "If any such machine," Descartes wrote, "had the organs and outward shape of a monkey or of some other animal that lacks reason, we should have no means of knowing that they did not possess entirely the same nature as these animals."[23] What allows the human being to be differentiated from both the animal and a human-looking automaton is that human beings think and give evidence of this by way of expressing themselves in language. If one were, for example, confronted with a cleverly designed machine that looked and behaved like a human being, there

---

[20] John Searle, "The Chinese Room," in *The MIT Encyclopedia of the Cognitive Sciences*, ed. R. A. Wilson and F. Keil (Cambridge, MA: MIT Press, 1999), 115.
[21] Terry Winograd, "Thinking Machines: Can there be? Are we?" in *The Foundations of Artificial Intelligence: A Sourcebook.*, ed. Derek Partridge and Yorick Wilks (Cambridge: Cambridge University Press, 1990), 187.
[22] Searle, 115.
[23] Rene Descartes, *Selected Philosophical Writings*, trans. John Cottingham, Robert Stoothoff, and Dugald Murdoch (Cambridge: Cambridge University Press, 1988), 44.

would, Descartes argues, be a least one very certain means of recognizing that these artificial figures are in fact machines and not real men:

> They could never use words, or put together other signs, as we do in order to declare our thoughts to others. For we can certainly conceive of a machine so constructed that it utters words, and even utters words which correspond to bodily actions causing a change in its organs (e.g. if you touch it in one spot it asks what you want of it, if you touch it in another it cries out that you are hurting it, and so on). But it is not conceivable that such a machine should produce different arrangements of words so as to give an appropriately meaningful answer to whatever is said in its presence, as the dullest of men can do.[24]

Turing's game of imitation leverages this Cartesian tradition. If, in fact, a machine is able, as Descartes wrote, "to produce different arrangements of words so as to give an appropriately meaningful answer to whatever is said in its presence," then we would, Turing argues, have to conclude that it was just as much a thinking rational agent as another human being. But as soon as this capacity became experimentally possible with ELIZA and similar chatter bots, theorists like Searle add an additional qualifying criterion. Searle, therefore, recognizes that machines are able to manipulate linguistic tokens in order to compose sentences that make sense and are seemingly intelligible. But that is not, he maintains, what is involved with true intelligence. Something more is needed, namely that one "understand" the meaning of the words that are manipulated.[25] Although there is

---

[24] Descartes, 44-45.

[25] Although this appears to be a rather reasonable qualification, it falls victim to what Blay Whitby ("On Computable Morality: An Examination of Machines as Moral Advisors," in *Machine Ethics*, ed. Michael Anderson and Susan Leigh Anderson (Cambridge: Cambridge University Press, 2011), 144) identifies as a variant of the "no true Scotsman fallacy." The "No True Scotsman Fallacy," which was introduced by Antony Flew in his *Thinking About Thinking* (Fontana: London, 1975), is a way of re-interpreting evidence, in order to prevent the refutation of one's position. "Imagine," Flew writes, "Hamish McDonald, a Scotsman, sitting down with his *Glasgow Morning Herald* and seeing an article about how the "Brighton Sex Maniac Strikes Again." Hamish is shocked and declares that "No Scotsman would do such a thing." The next day he sits down to read his *Glasgow Morning Herald* again and this time finds an article about an Aberdeen man whose brutal actions make the Brighton sex maniac seem almost gentlemanly. This fact shows that Hamish was wrong in his opinion but is he going to admit this? Not likely. This time he says, 'No true Scotsman would do such a thing.'" In a similar way, Searle seeks to protect human exceptionalism from machinic incursion by redefining what is meant by the term "intelligence."

and remains considerable debate in the AI community whether the successful simulation of human-level communicative ability necessarily implies the presence of "intelligence" or not, what is not debated is that machines are in fact capable of communicating successfully with human users in a variety of contexts and in a way that is often indistinguishable from another person. And for research in communication studies—where communication and not intelligence is the focus—this is a real game changer.

The Machinery of Communication

In Turing's game of imitation, the computer occupied the position of both medium *through* which human interlocutors exchange messages and one of the participants *with* whom one engaged in these communicative exchanges.[26] Despite these two positions, communication studies has, with very few exceptions (which we will get to shortly), limited its approach and understanding to the former. That is, it has typically understood and examined the computer as a medium of human communicative interaction. This fundamental decision concerning the role and function of the computer has been supported and institutionalized by the relatively new sub-field of *computer-mediated communication* or CMC. This concept, although not necessarily situated under this exact terminology, was initially introduced and formalized in J.C.R. Licklider and Robert W. Taylor's 1968 essay "The Computer as Communications Device." In this important and influential essay, Licklider and Taylor argued for what was, at that time, an entirely different understanding of the computer. As the name indicates, the *computer* was initially designed to provide for rapid and automatic computation or "number crunching," and for this reason it was something limited

[26] It is unclear whether one ought to use the phrase "with which" or "with whom" in this particular context. Although this equivocation appears, to be a small grammatical issue, everything, it turns out, depends upon this decision. In making a choice between the one or the other, it is decided whether the machine is to be regarded as a thing, a mere object, or whether it is considered to be another subject. A similar concern has been identified and pursued, although from an altogether different angle, in Derrida's work on the gift, forgiveness, and hospitality. As Derrida explains in one of the texts collected in *Paper Machine* (Stanford, CA: Stanford University Press, 2005, p. 80): "I have already seemed to count on the distinction between *who* and *what*, to shake it up a bit, so let me be clear that in my present work, above all in my teaching, I try to reach a place *from* which this distinction between *who* and *what* comes to appear and become determined, in other words a place 'anterior' to this distinction, a place more 'old' or more 'young' than it, a place also that both enjoins determination but also enables the terribly reversible translation of *who* into *what.*"

to the fields of mathematics, electrical engineering, and computer science. For Licklider and Taylor, however, the computer was more than a mere calculator or numerical processor; it was a mechanism of human interaction that provided users with "a natural extension of face-to-face communication."[27] One year after the publication of "The Computer as Communications Device," ARPAnet, the precursor to the Internet, began operation. As if to fulfill Licklider and Taylor's thesis, the actual use of this network "did not support remote computing. The network evolved instead to become primarily a medium for interpersonal communication"[28]

Although Licklider and Taylor had called this new development "computer-aided communication," the term "computer-mediated communication" begins to gain acceptance in the decade that followed. In 1978, for instance, Starr Roxanne Hiltz and Murray Turoff employed the term in their extended examination of computerized conferencing, *The Networked Nation: Human Communication via Computer*. Although Hiltz and Turroff used the term "computer conferencing system" (CCS) to name "any system that uses the computer to mediate communication among human beings"[29], they had also employed "computer-mediated communication" as a generic designation for various forms of human communication via the computer, including "computerized conferencing, computer assisted instruction, and home terminals from which white collar work can be done."[30] The phrase "computer-mediated communication" was elevated to the status of a technical term in Hiltz's subsequent collaboration with Elaine Kerr, which was undertaken for the US government's National Science Foundation. This 1981 study was expanded and published in 1982 under the title *Computer-Mediated Communication Systems: Status and Evaluation*. In this report, computer-mediated communication was defined as "a new form of enhanced human communication."[31] "Essentially,

[27] J.C.R. Licklider and Robert W. Taylor, "The Computer as a Communication Device," *Science and Technology* (April 1968): 40. Also available at http://memex.org/licklider.html.

[28] William Dutton, "Driving into the Future of Communications? Check the Rear View Mirror," in *Information Superhighways: Multimedia Users and Futures*, ed, Stephen. J.Emmott (San Diego: Academic Press, 1995), 95

[29] Starr Roxanne Hiltz and Murray Turoff, *The Networked Nation: Human Communication via Computer* (Reading, MA: Addison-Wesley Publishing Company, 1978), xix.

[30] Hiltz and Turoff, 167.

[31] Starr Roxanne Hiltz and Elaine Kerr, *Computer-Mediated Communication Systems: Status and Evaluation* (New York: Academic Press, 1982), 3.

computer-mediated communication means that large numbers of people in business, government, education, or at home can use the computer to maintain continuous communication and information exchanges. More than a replacement for the telephone, mails, or face-to-face meetings, computer communication is a new medium for building and maintaining human relationships."[32] For Hiltz and Kerr then, "computer-mediated communication" designated human communication *through* the instrumentality of computers. Recent employments and characterizations of CMC have reiterated and solidified this characterization. For Susan Herring, editor of one of the first published collection of essays addressing the subject, "computer-mediated communication is communication that takes place between human beings via the instrumentality of computers."[33] And John December, editor of the now defunct *Computer-Mediated Communication Magazine*, answers the self-reflective question "What is CMC?" with a similar definition: "Computer-mediated communication is a process of human communication via computers."[34]

Defining the role and function of the computer in this manner is both intuitively attractive and conceptually sound. In fact, it possesses at least three advantages for scholars of communication. First, it situates the computer at an identifiable position within the process model of communication, which was initially formalized in Claude Shannon and Warren Weaver's *The Mathematical Theory of Communication*. According to Shannon and Weaver, communication is a dyadic process bounded, on the one side, by an information source or sender and, on the other side, by a receiver. These two participants are connected by a communication channel or medium through which messages selected by the sender are conveyed to the receiver[35] (Figure 3).

---

[32] Hiltz and Kerr, ix.

[33] Susan Herring, *Computer-Mediated Communication: Linguistic, Social and Cross-Cultural Perspectives* (Philadelphia: John Benjamins Publishing Company, 1996), 1.

[34] John December, "Notes on Defining of Computer-Mediated Communications," *Computer-Mediated Communication Magazine* (January 1997). http://www.december.com/cmc/mag/1997/jan/december.html.

[35] Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana, IL: University of Illinois Press, 1963), 7-8.

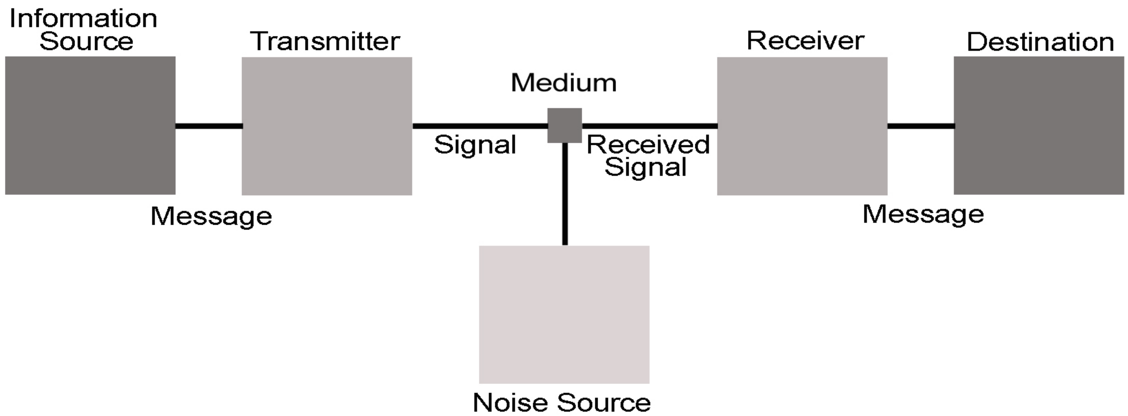

Figure 3 – The Shannon-Weaver Model of Communication (1949)

This rudimentary model not only is "accepted as one of the main seed out of which Communication Studies has grown"[36] but establishes the basic elements and parameters for future elaborations and developments. Although subsequent models, like those devised by George Gerbner, B. H. Wesley and M. S. MacLean, and Roman Jakobson, extend and complicate Shannon and Weaver's initial concept, they retain the basic elements of senders and receivers connected by a medium that facilitates the transmission of messages.[37] CMC locates the computer in the intermediate position of channel or medium. As such, it occupies the position granted to other forms of communication technology (e.g. print, telephone, radio, television, etc.) and is comprehended as something through which human messages pass. This understanding of the machine as medium has been taken up and further elaborated in the work of Marshall McLuhan, the media theorist whose influence extends beyond media studies and into the new field of CMC. For McLuhan, media—and the word "media" encompasses a wide range of different technological devices, applying not just to the mechanisms of communication, like newspapers and radio, but all kinds of tools and machines—are defined as "extensions of man." This is, of course, immediately evident in the

[36] John Fisk, *Introduction to Communication Studies* (New York: Routledge, 1994), 6.

[37] George Gerbner, "Toward a General Model of Communication," *Audio Visual Communication Review* IV.3 (1956): 171-199; Roman Jakobson, "Closing Statement: Linguistics and Poetics," in *Style and Language*, ed. Thomas A. Sebeok (Cambridge: MIT Press, 1960), 350-377; B. H. Wesley and M. S. MacLean, "A Conceptual Model for Communication Research," *Journalism Quarterly* 34 (1957): 31-38.

title of what is considered to be one of his most influential books, *Understanding Media: The Extensions of Man*. And the examples employed throughout this text are by now familiar: the wheel is an extension of the foot, the telephone is an extension of the ear, and the television is an extension of the eye.[38] Understood in this way, technical mechanisms have been defined as instruments or prostheses through which various human faculties come to be extended beyond their original capacity or ability.

Second, this intermediate position is also substantiated and justified by the traditional understanding of the proper role and function of the technological apparatus. According to Martin Heidegger's analysis in *The Question Concerning Technology*, the assumed understanding of any kind of technology, whether it be the product of handicraft or industrialized manufacture, is that it is a means employed by human users for particular ends.

> We ask the question concerning technology when we ask what it is. Everyone knows the two statements that answer our question. One says: Technology is a means to an end. The other says: Technology is a human activity. The two definitions of technology belong together. For to posit ends and procure and utilize the means to them is a human activity. The manufacture and utilization of equipment, tools, and machines, the manufactured and used things themselves, and the needs and ends that they serve, all belong to what technology is.[39]

Heidegger terms this particular conceptualization "the instrumental definition" and indicates that it forms what is considered to be the "correct" understanding of any kind of technological innovation.[40] As Andrew Feenberg summarizes it in the introduction to his *Critical Theory of Technology*, "the instrumentalist theory offers the most widely accepted view of technology. It is based on the common sense idea that technologies are 'tools' standing ready to serve the purposes of users."[41] And because a tool "is deemed 'neutral,' without valuative content of its own,"[42] a technological instrument is evaluated not in and for itself but on the

---

[38] Marshall McLuhan, *Understanding Media: The Extensions of Man* (Cambridge, MA: MIT Press, 1995).

[39] Martin Heidegger. "The Question Concerning Technology," in *The Question Concerning Technology and Other Essays*, trans. William Lovitt (New York: Harper & Row, 1977), 4-5.

[40] Heidegger, 4-5.

[41] Andrew Feenberg, *Critical Theory of Technology* (New York: Oxford University Press, 1991), 5.

[42] Feenberg, 5..

basis of the particular employments that have been decided by a human agent. This insight is succinctly described by Jean-François Lyotard in *The Postmodern Condition*: "Technical devices originated as prosthetic aids for the human organs or as physiological systems whose function it is to receive data or condition the context. They follow a principle, and it is the principle of optimal performance: maximizing output (the information or modification obtained) and minimizing input (the energy expended in the process). Technology is therefore a game pertaining not to the true, the just, or the beautiful, etc., but to efficiency: a technical 'move' is 'good' when it does better and/or expends less energy than another." [43] Lyotard's explanation begins by affirming the understanding of technology as an instrument, prosthesis, or extension of human faculties. Given this "fact," which is stated as if it were something that is beyond question, he proceeds to provide an explanation of the proper place of the machine in epistemology, ethics, and aesthetics. According to his analysis, a technological device, whether it be a cork screw, a clock, or a computer, does not in and of itself participate in the important questions of truth, justice, or beauty. Technology, on this account, is simply and indisputably about efficiency. A particular technological innovation is considered "good," if and only if it proves to be a more effective means to accomplishing a desired end.

Third, this instrumentalist understanding has been and remains largely unquestioned, because it constitutes what epistemologists routinely call "normal science." The term "normal science" was introduced by Thomas Kuhn in *The Structure of Scientific Revolutions* to describe those undertakings that are guided by an established and accepted *paradigm*. Paradigms, according to Kuhn, are "universally recognized scientific achievements that, for a time, provide model problems and solutions to a community of practitioners."[44] Normal sciences, as Kuhn demonstrates, have distinct theoretical and practical advantages. Operating within the framework of an established paradigm provides students, scholars and educators with a common foundation and accepted set of basic assumptions. This effectively puts an end to debates about fundamentals and allows researchers to concentrate their attention on problems defined by the discipline, instead of quibbling about competing methodological procedures or metaphysical substructures. For this reason, a paradigm provides coherent structure to a particular area of research. It defines what constitutes a problem for the area of

---

[43] Jean-François Lyotard, *The Postmodern Condition*: *A Report on Knowledge*, trans. Geoff Bennington and Brian Massumi (Minneapolis, MN: University of Minnesota Press, 1984), 44.

[44] Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1996), x.

study, delimits the kind of questions that are considered to be appropriate and significant, and describes what research procedures and resulting evidence will qualify as acceptable. When the computer is understood and examined as an instrument or medium facilitating human communication, research generally concentrates on either the quantity and quality of the messages that can be distributed by the system or the kinds of relationships established between the human senders and receivers through its particular form of mediation. Evidence of this can be found, as Kuhn argues, in the contents of standard textbooks, which "address themselves to an already articulated body of problems, data and theory, most often to the particular set of paradigms to which the scientific community is committed at the time they are written." [45] Without little or no exception, textbooks in the discipline of communication studies, whether introductory or advanced, address the computer as a *medium* of human communication and seek to investigate the effect this technology has on the quantity and quality of human interactions and relationships. For communication studies, then, CMC is normal science.

Back to the Future

Despite the remarkable success of CMC, this approach misses a crucial opportunity originally identified by Turing—the fact that a machine is not just be a means of human concourse but might also be a participant in communicative interactions. Although the field of communication studies appears to have marginalized or even ignored this aspect, the discipline actually began by trying to address and conceptualize the full range of opportunities. This effort was initially expressed in Robert Cathcart and Gary Gumpert's 1985 essay, "The Person-Computer Interaction." In this relatively early text ("early" in terms of the discipline's recognition and engagement with the computer), the authors draw a distinction between communicating *through* a computer from communicating *with* a computer. The former, it is argued, names all those "computer facilitated functions" where "the computer is interposed between sender and receiver." The latter designates "person-computer interpersonal functions" where "one party activates a computer which in turn responds appropriately in graphic, alphanumeric, or vocal modes establishing an ongoing sender/receiver relationship."[46] These two alternatives, which follow from but do not explicitly acknowledge Turing's game of imitation, were corroborated and further refined in

[45] Kuhn, 136.

[46] Robert Cathcart and Gary Gumpert, "The Person-Computer Interaction: A Unique Source," in *Information and Behavior*, vol. 1, ed. Brent D. Ruben (New Brunswick: NJ: Transaction Books, 1985), 114.

James Chesebro and Donald Bonsall's *Computer-Mediated Communication*, which was published in 1989. In this book-length analysis of the role and function of the computer, the authors detail a five-point scale that delimits the range of possibilities for "computer-human communication."[47] The scale extends from the computer utilized as a mere medium of message transmission between human interlocutors to the computer understood as an intelligent agent with whom human users interact. Although providing a more complex articulation of the intervening possibilities, Chesebro and Bonsall's formulation remains bounded by the two possibilities initially described by Cathcart and Gumpert.

Despite early identification of these two opportunities, communication studies has, for better or worse, restricted itself to addressing the computer as a medium of human interaction and, in the process, has effectively marginalized the other—situations where the computer can be considered an Other in communicative exchange. This is not an accident. As Cathcart and Gumpert insightfully point out, studies of communication have always and necessarily "minimized the role of media and channel in the communication process. The focus has been on the number of participants, source and receiver relationships, and forms and functions of messages. The media of communication have been accepted, more or less, as fixed or neutral channels for the transmission of messages among participants."[48] Over two decades of communications research has, in effect, proven this statement correct. In the field of communication studies in general and CMC in particular, the investigative focus has been on the number of participants, the quality and quantity of human relationships made possible by the technology, and the form and function of messages that are exchanged through its system. Although proceeding in this fashion seems both reasonable and normal (in the Kuhnian sense of the word), it is no longer, and perhaps never really was, tenable.

First, the assumption that the computer is exclusively a medium of human communication, however useful and expedient for structuring and supporting a particular research program, is necessarily interrupted and even resisted by the mechanisms and machinery of computing. Technically speaking, the computer, whether a timeshared mainframe, a networked PC, or any of the vast array of mobile and smart devices, has never been a fixed or neutral channel through which human interaction transpires. Frederick Williams pointed this out as early

[47] James W. Chesebro and Donald G. Bonsall, *Computer-Mediated Communication: Human Relationships in a Computerized World* (Tuscaloosa, AL: The University of Alabama Press, 1989).
[48] Robert Cathcart and Gary Gumpert, "Mediated Interpersonal Communication: Toward a New Topology" in *Inter/media: Interpersonal Communication in a Media World*, ed. Robert Cathcart and Gary Gumpert (New York: Oxford University Press, 1981), 27.

as 1982: "The computer is the first communications technology to interact intellectually with its users. Most technologies only transform light, sound, or data into electronic impulses for transmission, then reverse the process at the receiving end. Computers, by contrast, can accept or reject our messages, reduce or expand them, file them, index them, or answer back with their own messages."[49] A similar insight was provided by Ithiel de Sola Pool in the foreword to Wilson Dizard's *The Coming Information Age*: "Prior to the computer, every communication device took a message that had been composed by a human being and (with some occasional loss) delivered it unchanged to another human being. The computer for the first time provides a communication device by which a person may receive a message quite different from what any human sent."[50] And Cathcart and Gumpert draw a similar conclusion: "For the first time, a technology can not only speed and expand message exchange, but it can also respond with its own message to a human partner. The computer in this mode becomes a proxy for a sender-receiver in the communication dyad."[51]

For these early theorists, the computer was not able to be reduced to the customary instrument of communication. Although other technological innovations (e.g. printing, phonography, telegraphy, telephone, radio, film, television, etc.) may function appropriately as a kind of technical intermediary through which human beings exchange messages, the computer deviates from this expectation and interrupts its procedure. Instead of functioning as an immaterial and more-or-less transparent channel through which human agents exchange messages, the computer participates in and contaminates the process. It acts on the messages, significantly alters them, and delivers information that was not necessarily selected, composed, or even controlled by human participants. These various occurrences, furthermore, cannot be reduced to a form of unintentional noise introduced by the exigencies of the channel, which is precisely how the process models have dispensed with and accounted for this kind of machinic contribution. As Chesebro and Bonsall point out, "other communication technologies may affect the substantive meaning of a human message, but the alteration is typically an unintended by-product of the medium. The computer, on the other hand, is employed because it will reformat the ideas contained in a human message."[52] With the other media of communication, changes in the

[49] Frederick Williams, *The Communications Revolution* (Beverly Hills: Sage, 1982), 30.

[50] Ithiel de Sola Pool, forward to *The Coming Information Age: An Overview of Technology, Economics, and Politics*, 2nd edition, by Wilson P. Dizard (New York: Longman, 1985), xi-xii.

[51] Cathcart and Gumpert, "The Person-Computer Interaction," 116.

[52] Chesebro and Bonsall, 31.

human-generated message are explained as unintentional noise imparted by the instrument of transmission. With the computer, such alterations cannot be reduced to mere noise. They are necessary and integral elements of its function. The computer, therefore, substantively resists being exclusively defined as a medium and instrument through which human users exchange messages. Instead, it actively participates in communicative exchanges as a kind of additional agent and/or (inter)active co-conspirator.

Second, recognition that the computer can also be considered a participant in communicative exchange is not something that remains a mere theoretical possibility, it is already practically necessary. Consider, for instance, unwanted email or spam. Spam messages, which inform Internet users of everything from herbal supplements, which promise to enhance the size and operation of various parts of the body, to bogus stock and investment opportunities, are generated by and originate with a computer. As a result of the seemingly unrestrained proliferation of this kind of machinic generated messages, users and network administrators now employ spam filters, which effectively decide which messages to deliver to the human user and which ones to filter out. In the era of spam, therefore, email is no longer an exclusive instrument of human communication but shows signs of increasing involvement by machines in the communicative process. A less nefarious illustration is provide by the descendents of Weizenbaum's original chatter bot that now populate the virtual environments of games, provide online customer support, and interact with users in all kind of applications from e-commerce to web-based training. Like ELIZA, these advanced chatter bots are able to converse and interact with users in such a way that is often indistinguishable from another human being, leaving many users uncertain as to whether their online interlocutor was in fact another person or a machine. The most compelling and recent innovation in this area is probably Siri, which is a commercial application spun-off from DARPA's Cognitive Assistant that Learns and Organizes (CALO) program. Siri was initially developed and commercialized by SRI International and eventually sold to Apple in 2010. The software application was popularized via iPhone 4 and is currently an integral component of the company's iOS 6, an operating system for mobile devices, smart phones, and tablets. Siri has been described and marketed as "an intelligent personal assistant" and "knowledge navigator." It consists of a natural language user interface that can understand and process spoken commands and inquiries in a number of languages, a voice synthesis output device that supplies audible responses, and an impressive backend that is able to interact with and perform queries on both the local device and Internet-based data sources. Although Siri is by no means "intelligent" in the "strong AI" sense of the word, she (and the default vocal characteristics already gender the application female) is able to interact with human users as a smart and responsive interlocutor. In one of

Apple's clever television commercials from 2012, actor John Malkovich has a rather heady conversation with Siri, asking her for, among other things, advice about living the good life, where to find the best Italian cuisine, and a joke.

Conclusions – Paradigm Shift

So where does this leave us? Let me conclude with three statements that have, at this particular point in time, something of an apocalyptic tone. First, communication studies as we have known and practiced it is at an end. We need, however, to be cautious with how we understand and employ the word "end" in this particular context. In the field of communication studies, the operative paradigm—the framework that has defined what is considered normal science—situates technology as a tool or instrument of message exchange between human users. This particular understanding has been supported and codified by the dominant forms of communication theory, has guided and informed the accepted practices of communication research, and has been considered normal and virtually beyond question by a particular community of scholars. Because this conceptualization has been accepted as normative, the computer and other forms of information technology have been accommodated to fit the dominant paradigm. And the success of this effort is clearly evident within the last three decades of the twentieth century with the phenomenal growth of CMC as a recognized area of investigation and its institutionalization within professional organizations, university curricula, and standard textbooks and scholarly journals. At the same time, however, it is increasingly clear that the computer has not and does not behave according to this paradigmatic structure and effectively challenges long standing assumptions about the role and function of technology in communication. This challenge does not proceed from the successful achievement of "strong AI"; it is already deployed by and evident in seemingly "dumb" applications like email spam and chatter bots. The computer, therefore, constitutes what Kuhn would call an "anomaly."[53] It is something that does not quite fit within the dominant paradigm and, for that reason, calls into question basic assumptions and structures. For this reason, the computer is not necessarily a new technology to be accommodated to the theories and practices of communication studies as it is currently defined but introduces significant challenges to the standard operating procedures of communication research, initiating what Kuhn calls a "paradigm shift." What is at an "end," therefore, is not communication studies per se but the dominant paradigm that has, until now, structured and guided both the theories and practices of the discipline.

[53] Kuhn, 52.

Second, a new paradigm, especially during the time of its initial appearance and formulation, does not simply replace, reject, or invalidate the preceding one. For this reason, the previous *modus operandi*, although clearly in something of a state of crisis or at least bumping up against phenomena that it is longer able to contain, can still be useful, albeit in a highly restricted capacity and circumscribed situation. Within Newtonian physics, for example, what is true and what is false, is determined by the entities, rules, and conditions that come to be exhibited within the Newtonian system. As long as one operates within the framework or paradigm established by this system, it is possible to define what is and what is not valid for the Newtonian characterization of physical reality. All this changes, of course, when the normal functioning of Newtonian science is confronted with an alternative, like that formulated by Albert Einstein. Einstein's innovations, however, do not invalidate or foreclose Newtonian physics. They simply reinscribe Newton's laws within a different context that reveals other entities, rules, and conditions that could not be conceptualized as such within the horizon of Newtonian thought. In an analogous way, the change in paradigm that is currently being experienced in communication studies does not disprove or simply put an end to CMC research as such. Instead it redefines CMC as a highly specific and restricted case of what needs to be a much more comprehensive understanding of the role and function of computer technology within the field of communication.

Finally, although the computer effectively challenges the current paradigm, placing its normal functioning in something of a crisis, what comes next, what comprises the new paradigm, is only now beginning to make an appearance. And if the history of science is any indication, it may be quite some time before these innovations come to be formulated and codified into the next iteration of what will be considered "normal science." At this preliminary stage, however, we can begin to identify some aspects of what the next generation of communication studies might look like in the wake of this development. For now, the shape of the new paradigm is, for better or worse, influenced (or clouded) by the current situation, which provides the only conceptual apparatus and vocabulary we have at our disposal. We are, therefore, in the somewhat cumbersome situation of trying to articulate what will exceed the current paradigm by employing the words and concepts that it already defines and regulates. This will, of course, affect what can be said about the new challenges and opportunities, but we have no other way by which to proceed. From what we already know, it is clear that it is no longer accurate to define the computer exclusively as an instrument that is to be animated and used, more or less effectively, by a human being. The computer is beginning to be understood as an Other—another kind of communicative Other—who confronts human users, calls to them, and requires an appropriate response. This other aspect of the computer, as we have seen, was already predicted by Cathcart and Gumpert back in 1985. Communication studies, however, had (for reasons that are both understandable and justifiable) marginalized or ignored it, mainly because it did not fit the established paradigm. In reframing the computer according to the insights provided by this other and virtually forgotten alternative, all kinds of things change, not the least of which is our understanding of who, or what, qualifies as a legitimate subject of communication. For Norbert Wiener, the progenitor of the science of cybernetics, these developments fundamentally alter the social landscape: "It is the thesis of this book [*The Human Use of Human Beings*] that society can only be understood through a study of the messages and the communication facilities which belong to it; and that in the future development of these messages and communication facilities, messages between man and machines, between machines and man, and between machine and machine, are destined to play an ever-increasing part."[54] In the social relationships of the not-too-distant future (we need to recall that Wiener wrote this in 1950, the same year as Turing's influential paper), the computer will no longer comprise an instrument or medium through which human users communicate with each other. Instead it will occupy the position of another social actor with whom one communicates and interacts. In coming to occupy this other position, one inevitably runs up against and encounters fundamental questions of social responsibility and ethics—questions that not only could not be articulated within the context of the previous paradigm, but if they had been articulated, would have been, from that perspective, considered inappropriate and even nonsense. What, for example, is our responsibility in the face of this Other—an Other who is otherwise than another human entity? How do or should we respond to this other form of Otherness? How will or should this machinic Other respond to us?[55] Although these questions appear to open onto what many would consider to be the realm of science fiction, they are already part of our social reality. And it is time communication studies take seriously the impact and significance of this situation.

---

[54] Wiener, 16.

[55] For a detailed consideration of these questions, see David J. Gunkel, *The Machine Question: Critical Perspectives on AI, Robots, and Ethics* (Cambridge, MA: MIT Press, 2012).

Bibliography

Cathcart, Robert and Gary Gumpert. "Mediated Interpersonal Communication: Toward a New Topology." In *Intermedia: Interpersonal Communication in a Media World,* edited by Robert Cathcart and Gary Gumpert, 26-40. New York: Oxford University Press, 1981.

Cathcart, Robert and Gary Gumpert. "The Person-Computer Interaction: A Unique Source." In *Information and Behavior*, vol. 1, edited by Brent D. Ruben, 113-124. New Brunswick: NJ: Transaction Books, 1985.

Chesebro, James W. and Donald G. Bonsall. *Computer-Mediated Communication: Human Relationships in a Computerized World*. Tuscaloosa, AL: The University of Alabama Press, 1989.

Churchland, Paul. *Matter and Consciousness*. Cambridge, MA: MIT Press, 1999.

Cisco Systems. *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011–2016*. San Jose, CA: Cisco Systems, 2012. http://www.cisco.com/en/US/solutions/ collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf

December, John. "Notes on Defining of Computer-Mediated Communications." *Computer-Mediated Communication Magazine* (January 1997). http://www.december.com/ cmc/mag/1997/jan/december.html

Derrida, Jacques. *Paper Machine*. Translated by Rachel Bowlby. Stanford, CA: Stanford University Press, 2005.

Descartes, Rene. *Selected Philosophical Writings*, translated by John Cottingham, Robert Stoothoff, and Dugald Murdoch. Cambridge: Cambridge University Press, 1988.

Dodig-Crnkovic, Gordana and Daniel Persson. "Towards Trustworthy Intelligent Robots—A Pragmatic Approach to Moral Responsibility." North American Computing and Philosophy Conference, NA-CAP@IU 2008. Indiana University, Bloomington, July 10-12. http://www.mrtc.mdh.se/~gdc/ work/NACAP-Roboethics-Rev1.pdf

Dutton, William. "Driving into the Future of Communications? Check the Rear View Mirror." In *Information Superhighways: Multimedia Users and Futures*, edited by Stephen. J.Emmott, 79-102. San Diego: Academic Press, 1995.

Feenberg, Andrew. *Critical Theory of Technology*. New York: Oxford University Press, 1991.

Fisk, John. *Introduction to Communication Studies*. New York: Routledge, 1994.

Flew, Antony. *Thinking About Thinking*. Fontana: London, 1975.

Foremski, Tom. "Report: 51% of Website Traffic is 'Non-human' and Mostly Malicious." *ZDNet* (3 March 2012). http://www.zdnet.com/blog/foremski/report-51-of-web-site-traffic-is-non-human-and-mostly-malicious/2201

Gerbner, George. "Toward a General Model of Communication." *Audio Visual Communication Review* IV.3 (1956): 171-199.

Gunkel, David J. *The Machine Question: Critical Perspectives on AI, Robots, and Ethics* Cambridge, MA: MIT Press, 2012.

Haraway, Donna. *When Species Meet*. Minneapolis, MN: University of Minnesota Press, 2008.

Heidegger, Martin. "The Question Concerning Technology." In *The Question Concerning Technology and Other Essays*, translated by William Lovitt, 3–35. New York: Harper & Row, 1977.

Herring, Susan. *Computer-Mediated Communication: Linguistic, Social and Cross-Cultural Perspectives*. Philadelphia: John Benjamins Publishing Company, 1996.

Hiltz, Starr Roxanne and Murray Turoff. *The Networked Nation: Human Communication via Computer*. Reading, MA: Addison-Wesley Publishing Company, 1978.

Hiltz, Starr Roxanne and Elaine Kerr. *Computer-Mediated Communication Systems: Status and Evaluation*. New York: Academic Press, 1982.

Jakobson, Roman. "Closing Statement: Linguistics and Poetics." In *Style and Language*, edited by Thomas A. Sebeok, 350-377. Cambridge: MIT Press, 1960.

Kuhn, Thomas. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press, 1996.

Licklider, J.C.R. and Robert W. Taylor. "The Computer as a Communication Device." *Science and Technology* (April 1968): 40. http://memex.org/licklider.html.

Lyotard, Jean-François. *The Postmodern Condition*: *A Report on Knowledge*, translated by Geoff Bennington and Brian Massumi. Minneapolis, MN: University of Minnesota Press, 1984.

Pool, Ithiel de Sola. Forward to *The Coming Information Age: An Overview of Technology, Economics, and Politics*, 2nd edition, by Wilson P. Dizard. New York: Longman, 1985.

Schank, Roger C. "What is AI Anyway?" In *The Foundations of Artificial Intelligence: A Sourcebook*, edited by Derek Partridge and Yorick Wilks, 3-13. Cambridge: Cambridge University Press, 1990.

Searle, John. "The Chinese Room." In *The MIT Encyclopedia of the Cognitive Sciences*, edited by R. A. Wilson and F. Keil, 115-116. Cambridge, MA: MIT Press, 1999.

Shannon, Claude E. and Warren Weaver. *The Mathematical Theory of Communication*. Urbana, IL: University of Illinois Press, 1963.

Steiner, Peter. "Dog Cartoon." *The New Yorker* (1993): 61.

Turing, Alan. "Computing Machinery and Intelligence." In *Computer Media and Communication: A Reader*, edited by Paul A. Meyer, 37-58. Oxford: Oxford University Press, 1999.

Weizenbaum, Joseph. *Computer Power and Human Reason: From Judgment to Calculation*. San Francisco, CA: W. H. Freeman, 1976.

Wesley, B. H. and M. S. MacLean. "A Conceptual Model for Communication Research." *Journalism Quarterly* 34 (1957): 31-38.

Whitby, Blay. "On Computable Morality: An Examination of Machines as Moral Advisors." In *Machine Ethics*, edited by Michael Anderson and Susan Leigh Anderson, 138-150. Cambridge: Cambridge University Press, 2011.

Wiener, Norbert. *The Human Use of Human Beings: Cybernetics and Society*, Boston: Da Capo Press, 1988.

Williams, Frederick. *The Communications Revolution*. Beverly Hills: Sage, 1982.

Winograd, Terry. "Thinking Machines: Can there be? Are we?" In *The Foundations of Artificial Intelligence: A Sourcebook.*, edited by Derek Partridge and Yorick Wilks, 167–189. Cambridge: Cambridge University Press, 1990.