communication +1

Volume 5
Issue 1 Machine Communication

Article 4

September 2016

The Messages of Mute Machines: Human-Machine Communication with Industrial Technologies

Andrea L. Guzman
Northern Illinois University, alguzman@niu.edu

Abstract

This essay argues for the designation of industrial and manufacturing machines as technologies of communication. Within communication scholarship, ICTs are synonymous with the word technology. Many of our theories regarding technology are based on human interaction with and through ICTs. However, ICTs are not the only technologies involved in communication. Drawing on scholarship from media studies, human-machine communication, and science and technology studies, I demonstrate how people's interactions with "mute" technologies constitute communication. Industrial processes could not occur without the exchange of information between human and machine, and these industrial "rituals" between human and machine produce a particular reality for the worker and the organization. I argue that to understand communication in a machine culture in which people are constantly interacting with a variety of technologies, communication scholars must begin to study the multiplicity of machines and devices that are part of our lives.

Keywords

Human-Machine Communication, Human-Computer Interaction, Media Studies, Manufacturing Machines, Industrial Robots, Automation, Cybernetics, Journalism

Information and communication technologies are integral to who we are and how we relate to others, and the importance of ICTs in our lives has made them the focus of extensive communication scholarship. Largely absent from our research regarding technology in communication, however, are other machines that also perform communicative functions. In this essay, I focus on one such group: manufacturing and industrial technologies. This technological class comprises machines and robots involved in the physical production of goods. Manufacturing and industrial technologies are neither designed for shuttling messages between humans nor for transmitting messages to humans in the same way as their ICT counterparts, but, as I argue, they are technologies of communication and our interactions with them warrant increased attention in communication research.

There are many technologies we have yet to engage fully with in communication, but I focus on manufacturing and industrial technologies for several reasons. These machines are a crucial aspect of production and the larger local and national economies built around manufacturing. Industrial machines, like most organizational technologies, also are an integral component of companies' social structures and culture.[1] During the mid-twentieth century, the manufacturing sector in the United States and other countries underwent an "automation revolution" that affected not only the work being done in factories but also the lives of individual workers and society at large.[2] Currently news organizations are grappling with the contemporary and future implications of automation enabled by artificial intelligence for the production and consumption of media.[3] The study of industrial technologies and automation in manufacturing can inform our understanding of contemporary issues of automation.

---

[1] David F. Noble, *Forces of Production: A Social History of Industrial Automation* (New Brunswick, N.J.: Transaction Publishers, 2011); Wanda J. Orlikowski, "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science* 3, no. 3 (1992): 398–427.

[2] Noble, *Forces of Production: A Social History of Industrial Automation*; John Diebold, "Goals to Match Our Means," in *The Social Impact of Cybernetics*, ed. Charles R. Dechert (New York, NY: Simon and Schuster, 1966), 1–10; Morris Philipson, ed., *Automation: Implications for the Future* (New York, NY: Vintage Books, 1962).

[3] Seth C. Lewis and Oscar Westlund, "Actors, Actants, Audiences, and Activities in Cross-Media News Work: A Matrix and a Research Agenda," *Digital Journalism* 3, no. 1 (2015): 19–37, doi:10.1080/21670811.2014.927986; Christopher W. Anderson, "Towards a Sociology of Computational and Algorithmic Journalism," *New Media & Society* 15, no. 7 (2013): 1005–21; Matt Carlson, "The Robotic Reporter: Automated Journalism and the Redefinition of Labor, Compositional Forms, and Journalistic Authority," *Digital Journalism* 3, no. 3 (2015): 416–31, doi:10.1080/21670811.2014.976412.

One of the difficult aspects of writing about technology in a discipline as large and diverse as communication[4] is that the theoretical underpinnings for how we study technology vary greatly as do the definitions of key terms, such as "media." For example, computer-mediated communication focuses on people's interactions with one another via digital media and the complexity of how technology shapes these interactions and affects their outcome as well as the people involved in them[5]. The predominant view of technology within CMC is that of a medium, or channel through which we communicate.[6] Other scholars focus on our direct interactions with media in Human-Machine Communication.[7] In *The Media Equation*, Reeves and Nass[8] explain how we invoke human social rules in our behavior toward computers. Similar to CMC, the media in this "equation" are technologies, but, unlike CMC, possess greater agency. Media studies, yet another area, focuses on the implications of the form and function of media for the creation and maintenance of culture;[9] however, the media of media studies are not restricted to technology. McLuhan defines media as "any extension of ourselves,"[10] and in *The Marvelous Clouds: Toward a Philosophy of Elemental Media,* Peters stretches the definition further: "Media, I will argue, are vessels and

[4] Peter Simonson et al., eds., *Handbook of Communication History* (New York, NY: Routledge, 2013).

[5] Joseph B. Walther, "Theories of Computer-Mediated Communication and Interpersonal Relations," in *The Sage Handbook of Interpersonal Communication*, ed. Mark L. Knapp and John A. Daly (Thousand Oaks, CA: Sage Publications, 2011), 443–79.

[6] David J. Gunkel, "Communication and Artificial Intelligence: Opportunities and Challenges for the 21st Century," *Communication+ 1* 1, no. 1 (2012): 1.

[7] Human-machine communication is a term that scholars across multiple fields such as Lucy A. Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions*, 2nd ed. (New York, NY: Cambridge University Press, 2009) have used to describe interactions between people and a variety of technologies. Some communication scholars use it as an umbrella term encompassing HCI, HRI, and HAI, and it can be a specific approach. See Andrea L. Guzman, "Making AI Safe for Humans: A Conversation with Siri," in *Socialbots and Their Friends: Digital Media and the Automation of Sociality*, ed. Robert William Gehl and Maria Bakardjieva (Routledge, In Press).

[8] Byron Reeves and Clifford Ivar Nass, *The Media Equation* (Standford, CA : CSLI Publications, 1998).

[9] J Meyrowitz, "Media and Behavior - a Missing Link.," in *McQuail's Reader in Mass Communication Theory*, ed. Denis McQuail (London, UK: Sage Publications, 2002), 99–108.

[10] Marshall McLuhan, *Understanding Media: The Extensions of Man* (Cambridge, Mass.: MIT Press, 1994), 7.

environments, containers of possibility that anchor our existence and make what we are doing possible."[11]

These differing conceptualizations of the role of technology and media in communication have implications for how we study technology as well as how we write about it and how different audiences interpret our scholarship. My argument draws from research from across communication and related fields, such as Science and Technology Studies, and is grounded in a theoretical approach most closely aligned with media studies and interpretivist approaches within HMC. However, I have written this essay for a broad audience of communication scholars because many areas of our discipline can contribute to and be informed by the study of manufacturing and industrial technologies. To this end, I make explicit the theoretical positions I employ that are axiomatic in some areas of communication research but not necessarily others and make clear my use of the term media and its cognates.

This article begins with an explanation of how ICTs became synonymous with technology in communication, while manufacturing and industrial machines were overlooked, before making the case for why industrial technologies, with limited verbal capability, are communicative: Workers interact with these machines within the context of human-machine systems where the biological and technological are dependent upon one another. These exchanges between human and machine have implications beyond the production of goods for the creation of the creation of culture and even the very nature of humans and machines. I propose a trajectory for the study of communication with industrial machines and conclude by discussing the challenge of recognizing and responding to future permutations of communication in conjunction with technological innovation.

Rethinking Technology in Communication Research

There is a dearth of research regarding manufacturing and industrial machines within communication,[12] and the research that does exist focuses on issues of organizational or interpersonal communication, such as worker interactions with each other [13] or reactions to automation.[14] Less attention is given to people's

[11] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, IL: University of Chicago Press, 2015), 2.

[12] I want to make clear that I am focused here solely on communication scholarship as printed within communication journals or in books by authors associated with the discipline. Industrial technologies have been studied in other fields, and some of this research informs arguments I make later in this essay.

[13] e.g. Yukako Sunaoshi, "Historical Context and Intercultural Communication: Interactions Between Japanese and American Factory Workers in the American South,"

direct interaction with these technologies, and even within this limited research, industrial machines are studied alongside ICTs and take a back seat to them. For example, Chesher[15] proposes a media studies approach to media technologies in mining operations and traces interactions among workers, ICTs, and mining equipment and other machines. However, Chesher's proposal focuses more on ICTs than industrial technologies. In *Understanding Media: The Extensions of Man*, McLuhan dedicates a chapter to the integral role automation and its technologies play in shaping culture but, overall, provides less space to discussing automation than he does to ICTs.[16]

In stark contrast to research regarding manufacturing and industrial technologies, scholarship regarding ICTs is voluminous. As its name suggests, the extensive body of Computer-Mediated Communication research has focused on computers as well as a host of digital devices that have emerged since the PC. Studies of Human-Machine Communication have centered around ICTs for more than two decades if Nass's Computers Are Social Actors paradigm[17] is used as a starting point. HMC scholarship has focused on people's direct interactions with a plethora of technologies including vocal interfaces,[18] social robots,[19] social media bots,[20] and automated new-writing programs.[21] Many of these newer technologies

---

Language in Society 34 (2005): 185–217; Kathleen J. Krone, Ling Chen, and Diane Kay Sloan, "Managerial Emotionality in Chinese Factories," *Management Communication Quarterly* 11 (1997): 6–50.

[14] e.g. Claude D. Beaver and Fred E. Jandt, "A Pilot Study on Alienation and Anxiety during a Rumored Plant Closing," *Journal of Applied Communications Research*, 1973, 105–17.

[15] C. Chesher, "Mining Robotics and Media Change," *M/C Journal* 16 (2013).

[16] McLuhan, *Understanding Media: The Extensions of Man*.

[17] Clifford Nass, Jonathan Steuer, and Ellen R. Tauber, "Computers Are Social Actors," *Conference Companion on Human Factors in Computing Systems*, CHI '94, 1994, 72–78, doi:10.1145/259963.260288.

[18] Guzman, "Making AI Safe for Humans: A Conversation with Siri"; Clifford Nass and Scott Brave, *Wired for Speech: How Voice Activates and Advances the Human-Computer Relationship* (Cambridge, Mass: MIT Press, 2005).

[19] Kwan Min Lee et al., "Can Robots Manifest Personality?: An Empirical Test of Personality Recognition, Social Responses, and Social Presence in Human?Robot Interaction," *Journal of Communication* 56, no. 4 (December 2006): 754–72, doi:10.1111/j.1460-2466.2006.00318.x; Eleanor Sandry, *Robots and Communication* (New York, NY: Palgrave Pivot, 2015).

[20] Robert William Gehl, *Reverse Engineering Social Media* (Philadelphia, PA: Temple University Press, 2014).

[21] e.g. Carlson, "The Robotic Reporter"; Hille Van der Kaa and Emiel Krahmer, "Journalist versus News Consumer: The Perceived Credibility of Machine Written

exchange verbal, and even, spoken messages with humans. There are exceptions to this trend including Sandry[22] who has recently urged communication scholars to expand the study of robots beyond devices designed to be social, but, overall, research regarding people's direct interactions with technology has been transfixed on ICTs.

The question that emerges from this review is "why does such a disparity exist?" Providing a comprehensive answer is beyond the scope of this essay, but I discuss several probable reasons as they relate to our assumptions about what defines a communication technology. The design and function of ICTs is a key factor, if not the main reason, why ICTs are studied prominently within communication research. As Information and Communication Technologies, these devices and programs are designed to be part of a communication process. That is there function. Mass communication research also emerged with and formed around the development and evolution of mass media industries,[23] and so these technological channels for disseminating content to audiences have been associated with communication from early on.

More recent innovations in ICTs also align with our definitions and perceptions of what it means to communicate. As Schramm stresses, a defining feature of human communication is the use of language: "As a matter of fact, the ability of man to create signs that will be portable throughout space and time is one of the characteristics that sets human communication apart from most animal communication."[24] Within the past thirty years, ICT designers have been able to overcome what Licklider once called "the language problem"[25] in human and computer interaction by giving digital devices the ability to send verbal and nonverbal messages recognizable to the average user. Advances in artificial intelligence and natural language programming have enabled companies to create

---

News," in *Research Paper Presented at the*, 2014, https://pure.uvt.nl/portal/files/4314960/cj2014_session4_paper2.pdf; Anderson, "Towards a Sociology of Computational and Algorithmic Journalism."

[22] Sandry, *Robots and Communication*.

[23] Wilbur Schramm, "Institutionalization of Advanced Communication Study in American Universities," in *The Beginnings of Communication Study in America: A Personal Memoir*, ed. Steven H. Chaffee and Everett M. Rogers (Thousand Oaks, CA: Sage Publications, 1997), 155–80.

[24] Wilbur Schramm, "Nature of Communication between Humans," in *The Process and Effects of Mass Communication*, Revised (Urbana, IL: University of Illinois Press, 1972), 25.

[25] J. C. R. Licklider, "Man-Computer Symbiosis," in *In Memoriam: J. C. R. Licklider 1915:1990*, ed. Robert W. Taylor (Palo Alto, CA: Systems Research Center, 1960).

ICTs that can better understand and respond to users in human-like ways. Some of these technologies even speak. Thus, our interactions with these devices and programs take on a familiar form that we recognize as communication.

In *The Marvelous Clouds*, Peters argues that "our very existence depends on a vast array of techniques for managing nature and culture, most of them ignored by recent communication theory due to their supposedly poor qualities of meaning making."[26] We have focused on the obvious media that fit into our existing conceptualizations of communication and have not fully appreciated how other media, broadly defined, also bring meaning to our lives. Peters's argument can be applied to industrial and manufacturing technologies that, at first glance, do not seem to fit well into what we know of communication technologies. In contrast to ICTs, manufacturing machines are designed with the primary function of physically creating goods. Their purpose is to build cars not to create social networks or interact with users. The verbal capacity of industrial machines also may greatly vary from ICTs; although, recent robotic additions to the factory floor are increasingly designed to be social,[27] a point I will return to. These technologies do not necessarily look or act like the ICTs we have come to associate with communication. Industrial technologies seem to stand mute, even if they are verbal, because on their face, they do not appear to "speak" in the same way as humans or ICTs or fit neatly into the communication process. They appear to have "poor qualities of meaning-making"[28] and have been treated as such within communication studies.

To understand mute machines as technologies of communication, we have to think beyond prevailing conceptualizations of technology rooted in ICTs. In the following pages, I demonstrate how humans and machines in industrial processes form communication systems in which both sides possess agency but are reliant upon one another to the extent that the whole process would break down if communication were to cease. These interactions between humans and industrial machines have meaning beyond the transmission of information that fuels factories: they are rituals, in Carey's sense of the term,[29] that contribute to an understanding of the self, other technologies, and, ultimately, culture.

---

[26] Peters, *The Marvelous Clouds: Toward a Philosphy of Elemental Media*, 3.

[27] e.g. "Adaptive Robotics Control Make Baxter & Sawyer Different," *Rethink Robotics*, 2016, http://www.rethinkrobotics.com/baxter/what-makes-our-robots-different/.

[28] Peters, *The Marvelous Clouds: Toward a Philosphy of Elemental Media*.

[29] James W. Carey, *Communication as Culture : Essays on Media and Society* (New York, NY: Routledge, 1989).

Human-Machine Relationships in Industrial Systems

The argument that industrial and manufacturing technologies are communicative is predicated on an understanding of communication as a process in which both humans and machines can take on the role of the communicator, sending and receiving messages. Both, then, have agency; although, as I will explain, this agency is not symmetrical.[30] The role of communicator is one that we readily associate with humans. Humans, after all, are alive and sentient. To explain how a machine, a nonhuman, gains agency and how both human and machine are involved in a communication process, I draw on cybernetic theory, Pickering's[31] concept of the "mangle," and points at which both intersect.[32]

Developed to create weapons and computer systems during World War II, cybernetics is a body of communication theory focused on control and information within a system.[33] Weiner introduced cybernetics as a "field of control and communication theory, whether in the machine or in the animal."[34] Cybernetics was radical as proposed in that it extended the ability to communicate beyond humans,[35] which historically had been and, arguably continue to be, the focus of communication studies research. Peters explains: "More important, this new view effaced the old barriers between human, machine, and animal. Anything that processed information was a candidate for 'communication.'"[36] As a result, cybernetics also is agnostic to the language, human, machine, or otherwise, being used to transmit a message and provide feedback.

Cybernetic theory has been influential in the design of manufacturing and industrial technologies and their automation. Dechert highlights the impact of cybernetics on automation: "In its strict applications, communications and control theory has become a major factor in contemporary technology and lies at the base

---

[30] Andrew Pickering, *The Mangle of Practice: Time, Agency, & Science* (Chicago, IL: University of Chicago Press, 1995).
[31] Ibid.
[32] Andrew Pickering, "Cybernetics and the Mangle: Ashby, Beer and Pask," *Social Studies of Science*, 2002, 413–37.
[33] Steve J. Heims, *John Von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death* (Cambridge, MA: MIT Press, 1980).
[34] Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (Boston, MA: Houghton Mifflin, 1950), 19.
[35] Robert T. Craig, "Communication Theory as a Field," *Communication Theory* 9, no. 2 (1999): 119–61; John Durham Peters, *Speaking into the Air: A History of the Idea of Communication* (Chicago, IL: University of Chicago Press, 2012).
[36] Peters, *Speaking into the Air*.

of the 'second industrial revolution."[37] One of cybernetics' contributions to technology and industry is its focus on the flow of information – communication – within and among systems.[38] Industrial operations are designed to comprise systems of humans and machines, even post automation.[39] Within these systems, the biological and the technological are dependent upon one another to the degree that they have been described in terms usually reserved for human-human relationships.[40] For example, Salvendy explains the roles for humans and robots in "Human Factors in Robotic Systems" published as a part of the *Handbook of Industrial Robotics*: "Humans can interact with robots in the following ways: as supervisors, as co-workers, and preparing and setting up as maintenance robots."[41] Both humans and machines are fit into production in specific roles that are necessary for the process to be successful.

The implication of this dependency is that both have a type of agency in cybernetic systems, according to Pickering.[42] For Pickering, our social practices from scientific research to industrial production are best understood as performative: they are emergent and continuously reworked in a "mangle," or sense-making process that involves both humans and material artifacts.[43] The agency of humans and non-humans within a particular practice is "temporal," according to Pickering.[44] It emerges at specific points within the practice as it unfolds. At some points, humans exert their agency, but at others, material objects

[37] Charles R. Dechert, "The Development of Cybernetics," in *The Social Impact of Cybernetics*, ed. Charles R. Dechert (New York, NY: Simon and Schuster, 1966), 17.
[38] Craig, "Communication Theory as a Field."
[39] Jila Kamali, Colin L. Moodie, and Gavriel Salvendy, "A Framework for Integrated Assembly Systems: Humans, Automation and Robots," *International Journal of Production Research* 20, no. 4 (1982): 431.
[40] e.g. Jon M. Shepard, *A Study of Office and Factory Workers* (Cambridge, MA: MIT Press, 1971); William A. Faunce, "Automation and the Division of Labor," *Social Problems* 13, no. 2 (1965): 149–60, doi:10.2307/798900.
[41] G. Salvendy, "Human Factors in Planning Robotic Systems," in *Handbook of Industrial Robotics*, ed. Shimon Y. Nof, First (New York, NY: John Wiley & Sons, 1985), 645.
[42] Pickering, *The Mangle of Practice: Time, Agency, & Science*; In "Cybernetics and the Mangle: Ashby, Beer and Pask" Pickering retroactively demonstrates theoretical overlap between the mangle and cybernetics.
[43] Pickering, *The Mangle of Practice: Time, Agency, & Science* Pickering builds upon Latour's work but also departs from it in important ways that are beyond our discussion.
[44] Ibid., 14.

come to the fore. Both people and material artifacts are inextricably involved in the practice that would cease without the other.

Neither Pickering's argument nor mine should be viewed as equating humans and machines, including on the issue of intentionality.[45] As Pickering explains, agency is commonly theorized as linked to intention. Humans, not machines, have the ability to form and act upon intentions. But as Pickering also points out, leaning heavily on Suchman's *Human-Machine Reconfigurations*,[46] our intentions and subsequent actions take into account the material objects within a particular setting.[47] Salvendy's chapter on the role of humans within robotic systems exemplifies the agency of machines within this paradigm. Salvendy's focus is not on robots within human systems: it is on how humans fit into robotic systems. The artificial precedes the biological. Humans also are theorized as serving as a medium, or channel, a role that usually is reserved for machines in some communication models.[48] Salvendy describes the "information-processing model of the human operator" as situating the person as "continuously presented with information to accomplish his or her work objectives. The operator is viewed as a channel through which information flows…"[49] At other times, machines take on the role of channel, and this "dance of agency," as Pickering[50] calls it, is ongoing between humans and things within a system.

This sense-making process between us and technology is described by Suchman as "human-machine communication."[51] This communication takes place at the human-machine interface in which we can send a message, or information within the cybernetic paradigm, to a manufacturing technology (or any technology for that matter). It can include pressing a button, typing a verbal command, speaking a vocal instruction, etc. Machines also send messages to humans even when language is not involved. For example, mechanical guides control a worker's movements with a manufacturing machine.[52] And as its name

---

[45] Pickering, *The Mangle of Practice: Time, Agency, & Science*.
[46] Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions*.
[47] Pickering, *The Mangle of Practice: Time, Agency, & Science*.
[48] c.f. Harold D. Lasswell, "The Structure and Function of Communication in Society," in *The Process and Effects of Mass Communication*, ed. Wilbur Schramm and Donald F. Roberts, Revised Edition (Urbana, IL: University of Illinois Press, 1972), 84–99.
[49] Salvendy, "Human Factors in Planning Robotic Systems," 649.
[50] Pickering, *The Mangle of Practice: Time, Agency, & Science*, 21.
[51] Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions*; Lucy A. Suchman, *Plans and Situated Actions: The Problem of Human-Machine Communication* (New York, NY: Cambridge University Press, 1987).
[52] Noble, *Forces of Production: A Social History of Industrial Automation*.

suggests, machine-paced production is used to set the speed at which humans and other machines work together to produce a product.[53] With guides and machine-paced production, the mute machine sends a message of how to work and how fast to work to humans, as well as to other machines. The message is not complex, but it conveys information to exert control, the cybernetic definition of communication.[54] What becomes clear in viewing manufacturing systems through a cybernetic framework is that humans and machines are enmeshed within a system of human-machine communication. Therefore, manufacturing systems are not just systems of production; they are systems of communication.

The argument that manufacturing machines are communicative and qualify for study within communication could end here. However, the cybernetic definition of communication, as well as cybernetics as a whole, has theoretical shortcomings.[55] One of the key problems with the conceptualization of communication in cybernetics is that it is functionalist[56] and offers a narrow understanding of communication as the sending and receiving of information, or what Carey calls the "transmission view" of communication.[57] Craig describes cybernetics as "epitomizing the transmission model."[58] What is missing is the meaning of this communication. In other words, what meaning is there to interactions between humans and manufacturing machines?

Creating Meaning Through Industrial Rituals

In a rejoinder to the discipline's research focus on the transmission view of communication, Carey puts forth a definition of "communication as culture" that focuses on the meaning produced in communication.[59] Carey argues in a "ritual view" of communication that through our daily interactions we create our reality: "Communication is at once a structure of human action – activity, process, practice – an ensemble of expressive forms, and a structured and structuring set of social relations."[60] Applying this framework to industrial technologies requires us to go beyond an examination of how messages are transferred from human to

[53] Ibid.; Salvendy, "Human Factors in Planning Robotic Systems."
[54] Charles R. Dechert, ed., *The Social Impact of Cybernetics* (New York, NY: Simon and Schuster, 1966); Craig, "Communication Theory as a Field."
[55] Craig, "Communication Theory as a Field."
[56] Ibid.
[57] Carey, *Communication as Culture*.
[58] Craig, "Communication Theory as a Field," 141.
[59] Carey, *Communication as Culture*.
[60] Ibid., 86.

machine to ascertain the particular social reality created in interactions between people and manufacturing machines. Communication messages contain two different levels of meaning: manifest and latent.[61] Manifest content is the surface-level meaning of the message. Cybernetics is concerned with the manifest content, or how the information being shared conveys a message for control of a process. Within the ritual view of communication, the latent, or deeper cultural meaning, of an interaction is paramount. Pickering, who is interested in the social and cultural implications of the "mangle," also diverges from cybernetics at this point, turning his analysis to the social aspects of how the practice of industry is created.[62] In this section, I focus on the latent messages between human and machine in manufacturing. To demonstrate how communication constitutes a social reality and is a factor in its renegotiation, I trace how the "human-machine relationship" evolves within manufacturing during the U.S.'s transition to industrial automation beginning in the early 1950s.[63]

The dominant Western cultural perspective of technology has long been that technology is a tool, a neutral entity waiting to be put to use by humans.[64] The nature of humans is that of tool bearers. As such, the power relationship between human and machines has skewed toward humans: people control machines. This cultural conception of technology has been incorporated into the design of machines and of manufacturing systems. Of mechanical and industrial devices prior to automation Diebold explains: "But no matter how small a portion of brute strength was involved in running a machine, a human worker was always needed to operate and control it. Production processes, therefore, were necessarily designed around the human worker as operator."[65] Devices and systems were communicatively designed for the operator to deliver a command to the machine.

As Noble explains in his Marxist critique of industrial automation, factories are sites of struggle for control between workers and owners.[66] Machines have played a central role in the political back-and-forth between management and employee over how work is performed, the pace of production, the quality of

---

[61] Schramm, "Nature of Communication between Humans."

[62] Pickering, *The Mangle of Practice: Time, Agency, & Science*.

[63] I focus on Noble's Marxist critique of machines within capitalist systems because it highlights how power is an integral part of the human-machine process. Pickering also uses Noble's discussion of automated machines to exemplify the mangle.

[64] Arnold Pacey, *The Culture of Technology*, First MIT Press (Cambridge, Mass.: MIT Press, 1983).

[65] John Diebold, "Congressional Testimony," in *Automation: Implications for the Future*, ed. Morris Philipson (New York, NY: Vintage Books, 1962), 25.

[66] Noble, *Forces of Production: A Social History of Industrial Automation*.

the product, etc. The aim of automation was and still is to maximize profit through achieving efficiencies in production via technology.[67] Efficiency is achieved through better technological control of the different components of the industrial process. Through increasingly autonomous machines, or machines that only needed to be connected to other machines, owners and engineers have sought to control the one variable they considered the most unpredictable and least efficient: the human worker.[68] According to Majchrzak and Davis, "a common fantasy among managers in the U.S. is the paperless, workerless factory that hums unstopped throughout the day and night, churning out products of high quality and low cost, without the problems resulting from the intrusion of people."[69] To reduce the uncertainty factor of humans, engineers designed industrial and manufacturing technologies that centered around the machine, instead of the human, and put the worker in service of the machine.[70] Noble explains the inversion of the relationship between humans and machines: "Where once the machinists controlled the actions of the machines…now the marchinery…was used to control the actions of the operators." [71]

This shift in control is communicated to workers through the human-machine configurations in factories and the direct interaction between worker and device. When machines set the pace or direct a task, they send a manifest message to the worker of how fast to work or how to work. The latent message, however, is one of control. By being paced or guided by machines workers are told that they are not in control. Shepard found a higher instance of alienation and sense of powerlessness among people working on automated assembly lines.[72] When faced with control by the machine, some workers would try to find ways to reassert power over the device and regain full control of themselves, including tampering with machines.[73] Workers reported to researchers in studies synthesized by

---

[67] Diebold, "Congressional Testimony"; Noble, *Forces of Production: A Social History of Industrial Automation*.

[68] Noble, *Forces of Production: A Social History of Industrial Automation*.

[69] Ann Majchrzak and Donald D. Davis, "The Human Side of Flexible Factory Automation: Research and Management Practice," in *People's Reactions to Technology*, ed. Shirlynn Spacapan and Stuart Oskamp (Newbury Park, CA: Sage Publications, 1990), 37–38.

[70] Noble, *Forces of Production: A Social History of Industrial Automation*; Diebold, "Congressional Testimony."

[71] Diebold, "Goals to Match Our Means."

[72] Shepard, *A Study of Office and Factory Workers*, 25.

[73] Noble, *Forces of Production: A Social History of Industrial Automation*; Robert Blauner, *Alienation and Freedom: The Factory Worker and His Industry* (Chicago, IL: The University of Chicago Press, 1964).

Shepard that a breakdown in the machine meant that "freedom and control are temporarily theirs."[74] And so, interaction between these workers and their machines became a struggle for control and the human-machine relationship that once was set and skewed toward the human was up for renegotiation.

Eventually this struggle tipped toward the machine in many industries as engineers were able to develop technologies that could control their own functions and interact with other machines to the degree that communication between human and machine became almost, if not completely, unnecessary. Of the evolution of communication between humans and machines during which control was renegotiated, Noble remarks: "Men behaving like machines paved the way for machines without men."[75] Through automation, engineers and business owners created a system of machines with humans that replaced a system of humans with machines. Technologies themselves are communicative in that their design embodies cultural values and social relationships.[76] Machines were no longer telling workers what to do; rather, automated technologies told humans what they were no longer needed to do.

Automation did not affect all workers equally because human-machine relationships are not uniform in industrial systems.[77] As Diebold explains, some people benefited: "The individual perceives automation as a job threat or, if he be a mathematician, engineer, or otherwise situated to benefit, he perceives it as a challenge and an opportunity."[78] These workers thrived because they were in control of machines. Despite automation's reputation for controlling humans, its ultimate goal was to increase human control of the industrial process[79] to the benefit of the company owners.[80] Texts explaining the advantages of automation compare the power dynamics of human and machine to those of master and servant. The first *Handbook of Industrial Robots* is dedicated to "all of us who believe in the wonders of human ingenuity and robot servitude for the betterment

[74] Shepard, *A Study of Office and Factory Workers*, 26.
[75] Noble, *Forces of Production: A Social History of Industrial Automation*, 36.
[76] Carey, *Communication as Culture*.
[77] Shepard, *A Study of Office and Factory Workers*; Blauner, *Alienation and Freedom: The Factory Worker and His Industry*; Faunce, "Automation and the Division of Labor."
[78] John Diebold, *Beyond Automation: Managerial Problems of an Exploding Technology* (New York, NY: McGraw-Hill, 1964), 7.
[79] Diebold, *Beyond Automation: Managerial Problems of an Exploding Technology*.
[80] Noble, *Forces of Production: A Social History of Industrial Automation*.

of our life."[81] Although industrial machines restrained or replaced lower-level workers, the operation of these machines and automated systems was placed under human control and the technologies and systems were imagined and built accordingly. In predicting the "factory of the future," Rosen proselytizes how a system could be designed that gives the human operator control while "using the robot system as a 'slave' to do the dangerous or less intellectually demanding parts of a task."[82] In this scenario, the robot carries out work once performed by a human but is itself at the service of a different human. In the human-machine relationship between operator and robot, the robot is designed to be controlled.

In this human-machine relationship, the manifest communication from human to machine is a message of what the machine should do. Manufacturing experts advocated machine and system design that made this sense of control explicit to the operator. Salvendy argues, "The human should feel in control of the plant and thus the computer software should be at his disposal."[83] In contrast to assembly line workers, operators in charge of automated systems reported a greater degree of control in their positions.[84] Blauner explains that, as a result, the operators in charge of automated systems also had a different relationship with the machine: "Completely the opposite of the assembly-line worker, he feels in control when production is going smoothly."[85] The latent message of human-machine communication between operator and automated systems is that the human is in control.

There is yet another dimension to communication in manufacturing. I have focused separately on the messages sent between machines and lower-level employees and between operators and machines to demonstrate distinct points at which communication takes place and how power and relationships are negotiated between human and machine. If we were to put these stand-alone scenarios into a simple communication model, the human and the machine would both occupy a position of communicator. However, as I have shown in my work on human-machine communication between people and vocal social agents, such as Siri, a technology concurrently functions as both a communicator and a medium, or a

---

[81] Shimon Y. Nof, ed., *Handbook of Industrial Robotics*, First (New York, NY: John Wiley & Sons, 1985), v.

[82] C.A. Rosen, "Robots and Machine Intelligence," in *Handbook of Industrial Robotics*, ed. Shimon Y. Nof, First (New York, NY: John Wiley & Sons, 1985), 25.

[83] Salvendy, "Human Factors in Planning Robotic Systems," 657.

[84] Blauner, *Alienation and Freedom: The Factory Worker and His Industry*; Shepard, *A Study of Office and Factory Workers*.

[85] Blauner, *Alienation and Freedom: The Factory Worker and His Industry*, 142.

type of channel.[86] In the case of industrial and manufacturing technologies, particularly from a Marxist perspective, messages are sent and power is exerted from one group of people over another through the machine.[87]

Pickering reframes Noble's account of the implementation of numerically controlled machine tools into workspaces and the subsequent power struggle between workers and management as "*the mangling of the social*."[88] The introduction of these machines was met with an initial response from workers, including attempts to subvert the machine, followed, in-turn, by a reaction from management, an adjustment of how workers interacted with the machine, and an ongoing back-and-forth among workers, employers, and the industrial technologies. Relationships between employer and employee, and levels of employees, are reworked in, with, and through the machine.[89]

The manifest and latent messages exchanged between human and machine in industrial systems have implications beyond the efficiency of a plant and its social structure. Diebold argues that regardless of where workers are positioned in relation to the machine "…automation is going to force the individual – and all of mankind – to reconsider his very conception of himself."[90] The implications are personal and cultural. As the design of some machines shifted from technologies controlled by humans to technologies controlling lower-level workers, the cultural relationship between human and machine inverted. Arbib documents that this change in how workers communicated with machines was accompanied by more than a loss of a job:

> …it also brought alienation because suddenly they were no longer possessed of the worth that all society recognized as a farmer or a craftsman, but they were on the labor market and they were worth what they could get in competition against the machine. Suddenly people could no longer count on that sense of meaning.[91]

These workers had internalized their communication with machines, which at one time signaled their control over the machine, to the extent that their relationship to the technology became part of their identity. The shift in human-machine

---

[86] Guzman, "Making AI Safe for Humans: A Conversation with Siri."
[87] Noble, *Forces of Production: A Social History of Industrial Automation*.
[88] Pickering, *The Mangle of Practice: Time, Agency, & Science*, 157.
[89] Ibid., 168.
[90] Diebold, *Beyond Automation: Managerial Problems of an Exploding Technology*, 7.
[91] Michael A. Arbib, "On Being Human in the Computer Age," in *Impacts of Artificial Ingelligence: Scientific, Technological, Military, Economic, Societal, Cultural, and Political*, ed. R. Trappl (New York, NY: Elsevier Science Publishers, 1985), 60.

communication and the resulting renegotiation of power skewed toward the machine, disrupted their sense Self. At the same time, for operators of automated systems, their relationship between human and machine was not upset, but reified.

The simultaneous renegotiation and reification of the relationship between human and machine has importance beyond the factory floor: it signals a reworking of the ontology of humans and machines. Suchman explains that "as our relations with machines elaborate and intensify, questions of the humanlike capacities of machines, and machinelike attributes of humans, arise again and again."[92] When machines are built to control people, the nature of the machine as that of a tool and the nature of humans as wielders of that tool begins to become less concrete. What once was in the purview of the human is now within the purview of the machine. However the ontological shift is not necessarily one way from the human category to that of the machine category. While machine attributes can rise to the level of human likeness, human attributes can also be reduced to that of the machine. Blauner argues:

> For when a worker is dominated and controlled by the machine system in the very process of his work, he, in effect, becomes reduced to a mechanical device. Reacting to the rhythms of technology rather than acting in some independent or autonomous manner, he approaches most completely the condition of *thingness*, the essence of alienation.[93]

However, humans have not given all control to machines. Operators of automated systems still remain in charge of their machines. The boundary between human and machine cannot be drawn solely on the premise of control because in some instances a human is controlled by machines and, in others, the human controls the machine. The line between human and machine, then, remains in negotiation.

Through communication, reality is "produced, maintained, repaired, and transformed," according to Carey.[94] This process unfolds in the exchange of messages and the daily rituals of interaction. Through industrial rituals, workers commune with machines and each other constructing a culture comprising both humans and machines. This social reality is not restricted to a particular organization; Instead communication between human and industrial machines contributes to and is influenced by individual conceptions of Self and cultural conceptions of what it means to be a machine and what it means to be a human.

---

[92] Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions*, 1.
[93] Blauner, *Alienation and Freedom: The Factory Worker and His Industry*, 20.
[94] Carey, *Communication as Culture*, 23.

Understanding Mute Machines

Industrial technologies are anything but silent, but communication studies has treated them as such. We have predominantly focused on ICTs and the social and cultural aspects of their development and use. In doing so, we have perpetuated an understanding of the machine in communication largely formed around a single technological class. While there is no doubt that ICTs are important within communication, they are not the only technologies that are part of our interactions with others and the world around us. Industrial machines also are technologies of communication. The production of manufactured goods is contingent on the relationship between human and machine and the exchange of information between them. These systems of production also are systems of communication from which both goods and meaning emerge.

The study of communication between humans and industrial technologies enables researchers to understand how people interact with and make sense of machines in manufacturing and how these interactions contribute to a particular reality for the workers and the organization. The interplay between people and material artifacts that Pickering[95] conceptualizes as "the mangle of practice" is what Orlikowski refers to as "constitutive entanglement" in organizational studies.[96] Within organizations, people's interactions with each other and objects, including technology, are "constitutive, shaping the contours and possibilities of everyday organizing."[97] Human interaction with industrial machines is part of a larger communication process in and through which the organization exists. We cannot understand the industrial workspace and how it is formed without studying the communication that unfolds among all of its elements, human and machine.

Of even greater consequence is how people's interactions with industrial technologies are informed by and feed back into society. Technology does not exist outside of society; as a human-made product that is developed, built, and used within certain social contexts, technology is cultural.[98] It also is in and of itself a form of communication.[99] Our interaction with any technology serves as the point at which we are introduced to and have to make sense of the values

---

[95] Pickering, *The Mangle of Practice: Time, Agency, & Science*.

[96] Wanda J. Orlikowski, "Sociomaterial Practices: Exploring Technology at Work," *Organization Studies* 28, no. 9 (2007): 1435, doi:10.1177/0170840607081138 Orlikowski specifically references Pickering's concept of the "mangle.".

[97] Ibid., 1444.

[98] Pacey, *The Culture of Technology*.

[99] Carey, *Communication as Culture*; James W. Carey, "Technology As a Totem for Culture: On Americans' Use of High Technology As a Model for Social Order," *American Journalism* 7, no. 4 (1990): 242–51.

embedded within it. That is why people's interactions with industrial machines are part of Orlikowski's "constitutive entanglement;" the machines themselves are built around and reflect organizational values and structures, such as who is in control. That is at the micro level. At the macro level, industrial technologies also embody larger societal values regarding industry, economic systems, labor, etc.[100] As I have discussed, our interactions with machines informs our sense of Self along with our conceptualization of the ontology of humans and machines. Our communication with industrial technologies is the nexus of human, machine, and cultural values at which our understanding of the world is negotiated.

The study of our interactions with industrial machines and the meaning derived through these encounters also advances communication studies. When we engage with any technology we are establishing what it means to communicate with it, including expectations of how we interact with the machine as well as the outcome of this interaction. For example, in my ongoing research regarding how we conceptualize of and interact with artificial intelligence programs, such as Siri, I have found that people's previous interactions with different types of technologies as well as humans are integral to how people perceive artificial agents and communicate with them accordingly.[101] Our communication with one technology informs and has implications for our interactions with other entities, both biological and technological. What we know and expect in communication with things and people, then, is inextricable from our previous encounters with humans and machines. As Jones argues, we are reaching a point where our communication with technology is outpacing our interactions with people, but we know very little about human-machine communication.[102] We cannot fully understand communication, period, without studying our interactions with devices that are part of our machine-saturated lives, including industrial technologies.

The entrance of industrial machines into the purview of communication opens up a new area of study within human-machine communication and communication overall. One of the challenges of integrating industrial technologies and automation into the study of communication is that we have largely ignored our interactions with manufacturing machines. Now we must retroactively make sense of these technologies and processes associated with them, such as automation, from a communication perspective. We also have to

---

[100] Noble, *Forces of Production: A Social History of Industrial Automation*; Lewis Mumford, *Technics and Civilization* (The University of Chicago Press, 2010).

[101] Andrea L. Guzman, "Imagining the Voice in the Machine: The Ontology of Digital Social Agents" (University of Illinois at Chicago, 2015).

[102] Steve Jones, "People, Things, Memory and Human-Machine Communication," *International Journal of Media & Cultural Politics* 10, no. 3 (2014): 245–58.

grapple with current human-machine configurations in industrial systems and try to keep pace with innovations and their implications for communication.

The areas of communication research that have focused on our direct interactions with technology, particularly media studies and HMC, can inform research regarding industrial machines moving forward. The breadth of work within HMC ranging from critical, cultural critiques[103] to empirical studies grounded in the social sciences[104] provides scholars from varying research traditions entry points into the study of communication with manufacturing technologies.[105] Because much of this literature is based on ICTs, scholars will have to make adaptations for industrial machines, but some approaches are readily applicable to these technologies. In *Robots and Communication,* Sandry puts forward a series of frameworks, rooted in the discipline's different theoretical traditions, for examining communication across ontological difference with "non-humanoid robots,"[106] a technological class that includes industrial robots. The concept of mediation that bridges theoretical divides between interpersonal and mediated communication and takes into account the technological and cultural aspects of communication[107] also could be useful in capturing the complex interactions within industrial systems. Borrowing from other fields that focus on industrial technologies or from related disciplines that can provide theoretical approaches to our interactions with material objects that are not available within communication scholarship also may be necessary.[108] Emerging research focused on our interactions with industrial technologies likely will have to take an

---

[103] e.g. ibid.; Gehl, *Reverse Engineering Social Media*; Robert William Gehl and Maria Bakardjieva, *Socialbots: Digital Media and the Automation of Sociality* (New York, NY: Routledge, 2017).

[104] e.g. Clifford Nass, Jonathan Steuer, and Ellen R. Tauber, "Computers Are Social Actors," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '94 (New York, NY, USA: ACM, 1994), 72–78, doi:10.1145/191666.191703; Byron Reeves and Clifford Ivar Nass, *The Media Equation* (CSLI Publications, 1996); Chad Edwards et al., "Initial Interaction Expectations with Robots: Testing the Human-To-Human Interaction Script," *Communication Studies* 67, no. 2 (2016): 227–38, doi:10.1080/10510974.2015.1121899.

[105] Although my research is grounded in an interpretivist epistemology, I find restricting calls for research to a singular approach to be unnecessary.

[106] Sandry, *Robots and Communication*.

[107] Leah A. Lievrouw, "New Media, Mediation, and Communication Study," *Information, Communication & Society* 12, no. 3 (April 2009): 303–25, doi:10.1080/13691180802660651.

[108] According to Lievrouw, early new media studies also drew from related fields.

approach similar to the one I followed here by combining research from communication (media, cybernetics, HMC) and related fields (STS, SSK, industrial robotics, organizational studies) until we have established a more complete body of work regarding industrial technologies within communication.

Communication scholars must be careful to avoid creating parallel research trajectories for ICTs, industrial technologies, and other types of technology that never intersect. The study of human-machine communication with industrial machines, with ICTs, and with other technologies must inform one another. Without putting these different areas of communication scholarship into dialogue, we cannot make sense of the larger phenomenon of human-machine communication. Furthermore, what once were distinct types of technologies, such as industrial machines and social robots, also are converging with one another.

ICTs, industrial machines, and manufacturing processes have been and continue to be integrated with one another, resulting in hybrid systems and technologies. I have presented manufacturing systems as consisting of industrial machines and humans to focus on the overlooked meaning making between people and manufacturing technologies. In actuality, systems of production may involve many different types of technologies including both industrial machines and ICTs. Automation in manufacturing consisted of replacing mechanical machines with autonomous technologies and integrating computers into production. As the former secretary of labor to President John F. Kennedy described, "the advent of the electronic brain controlling the mechanical muscle has made possible fully automatic factories and offices…"[109] In these systems of automation, messages flow and meaning is created among people, ICTs, and industrial machines. To study human-machine communication in industrial settings, scholars must take into account how we interact with ICTs and industrial technologies separately and concurrently, how interaction with one type of technology informs our interaction with the other, and, more importantly, the reality that is created for individual workers and the organization as a whole in our communication with and across multiple technologies.

Although I have discussed industrial machines as largely being mute, recent advances within robotics have produced manufacturing technologies that not only physically produce goods but also engage the humans they work with in the industrial human-machine relationship. For example, Rethink Robotics has created collaborative robots, named Baxter and Sawyer, that perform industrial

[109] Arthur J. Goldberg, "The Challenge of 'Industrial Revolution II,'" in *Automation: Implications for the Future*, ed. Morris Philipson (New York, NY: Vintage Books, 1962), 4.

tasks and have anthropomorphic features, such as expressive eyes, intended to make human interaction with them more intuitive.[110] These technologies, which are the product of convergence between systems that physically produce goods and robots designed to be social, bring a new life-like dimension to the worker-machine relationship in industrial systems.[111] Existing research in HCI and HMC focused on social ICTs has found that we treat media generally as social actors and respond in-kind to machines with human-like attributes.[112] Questions for communication scholars regarding social industrial robots include how and to what extent imbuing manufacturing machines with social features changes workers conceptualizations of industrial technologies and themselves in light of working alongside life-like machines; how workers communicate with these machines; and the nature of the human-machine relationship that result from our interaction with these machines.

Our interactions with industrial technologies and the implications of this communication are not limited to the factory. In particular, what we have learned from industrial automation, and its disruption of human-machine communication in manufacturing, can be applied to other contexts. Recent developments in AI and machine learning are expanding automation to processes people once thought beyond the grasp of the machine including communication industries.[113] News outlets are using "robot journalists,"[114] automated news-writing programs, to take raw data and churn out financial reports[115] and sports coverage.[116] The modern flows of journalism are increasingly constructed around automation.[117] Some of

---

[110] "Adaptive Robotics Control Make Baxter & Sawyer Different."

[111] Faunce, "Automation and the Division of Labor."

[112] Reeves and Nass, *The Media Equation*, 1996.

[113] Joshua Reeves, "Automatic for the People: The Automation of Communicative Labor," *Communication and Critical/Cultural Studies* 13, no. 2 (2016): 150–65, doi:10.1080/14791420.2015.1108450.

[114] Noam Lemelshtrich Latar, "The Robot Journalist in the Age of Social Physics: The End of Human Journalism?," in *The New World of Transitioned Media*, ed. Gali Einav (Cham: Springer International Publishing, 2015), 65–80, http://link.springer.com/10.1007/978-3-319-09009-2_6.

[115] Ross Miller, "AP's 'Robot Journalists' Are Writing Their Own Stories Now," *The Verge*, January 29, 2015, http://www.theverge.com/2015/1/29/7939067/ap-journalism-automation-robots-financial-reporting.

[116] Benjamin Mullin, "AP Will Use Software to Write NCAA Game Stories," *Poynter*, March 4, 2015, http://www.poynter.org/2015/ap-will-use-software-to-write-ncaa-game-stories/324601/.

[117] Seth C. Lewis and Rodrigo Zamith, "On the Worlds of Journalism," in *Remaking News*, ed. P. J. Boczkowski and C.W. Anderson (MIT Press, 2017).

the same concerns and questions of power and control that accompanied the shift in how factory workers interacted with manufacturing machines are surfacing again regarding the automation of communication.[118] Scholars interested in the automation of media industries and communication more generally may find our previous interactions with manufacturing technologies, how they were disrupted in automation, and the result for a worker's sense of self and understanding of the machine to be useful lenses to study this unfolding phenomenon. We also can shift our focus from automated communication technologies as ICTs to industrial technologies enmeshed in a manufacturing process. This theoretical shift would move research from a focus on the quality of the content produced by these programs[119] toward an understanding of how automated news-writing technologies fit into the production process, the points at which people communicate with these programs, and, as some scholars already have started to study, how journalists understand their place within the newsroom and journalism more broadly after the introduction of these automated technologies.[120]

Communication of the Future

As machines began to perform human-like tasks in the real world and as writers created sentient robots in the science fiction world, questions arose regarding the trajectory of automation and artificial intelligence.[121] These questions focused on how far technology would advance in its emulation of humans. People wondered if machines would one day be able to go beyond replacing physical labor to taking over higher-order thinking and creativity.

The first *Handbook of Industrial Robotics* published in 1985 was a 1,300-page tome of scientific papers and studies by leading roboticists, but, its foreword

[118] Carlson, "The Robotic Reporter"; Reeves, "Automatic for the People."

[119] e.g. Van der Kaa and Krahmer, "Journalist versus News Consumer"; Christer Clerwall, "Enter the Robot Journalist: Users' Perceptions of Automated Content," *Journalism Practice* 8, no. 5 (2014): 519–31, doi:10.1080/17512786.2014.883116.

[120] Arjen van Dalen, "The Algorithms behind the Headlines: How Machine-Written News Redefines the Core Skills of Human Journalists," *Journalism Practice* 6, no. 5–6 (2012): 648–58, doi:10.1080/17512786.2012.667268.

[121] e.g. Diebold, *Beyond Automation: Managerial Problems of an Exploding Technology*; Philipson, *Automation: Implications for the Future*; Dechert, *The Social Impact of Cybernetics*.

was written by science fiction author Isaac Asimov.[122] Asimov details his vision for robots, imagining a utopia:

> I see them [robots] taking over all work that is too simple, too repetitive, too stultifying for the human brain to be subjected to. I see robots leaving human beings free to develop creativity, and I see humanity astonished at finding that almost everyone *can* be creative in one way or another.[123]

The human-machine relationship of the future, according to Asimov, was to be one in which humans and machines complement one another. Robots perform menial tasks while humans pursue "higher matters." For Asimov, the question of creativity was not one of whether machines could be creative but rather of deciding to which entity – artificial or biological – creativity best belonged. In human-machine relationships, humans reach a higher potential.

Other theorists and scientists approached this question pragmatically. From this perspective, the future creative ability of the machine was not always clear or rosy. In 1960, Gabor, who would later win the Noble Prize, wrote the essay *Inventing the Future.* In it, Gabor surveys technical progress related to automation and intelligent machines and tackles the resulting cultural questions:

> Will the machine go a step further and cut out also the creative artist? Is all this talk about composing symphonies or writing sonnets just science fiction or is it a serious forecast of things to come? My answer is that I sincerely hope that machines *will* never replace the creative artist, but in good conscience I cannot say that they never *could*.[124]

Similar to Asimov, Gabor realizes that machines are powerful and indicates that creativity best belongs to the human. However, unlike Asimov, Gabor is not ready to preclude the quickly evolving machine, which is already doing the work of humans, from eclipsing humans in other areas.

We now have a clearer answer to Gabor's creativity question: It is "yes." And this development of the machine and of artificial intelligence is nowhere near stopping for industrial or creative applications. The implication for HMC research and communication is that our interactions and relationships with technology will

---

[122] Issac Asimov, "Foreword: Looking Ahead," in *Handbook of Industrial Robotics*, ed. Shimon Y. Nof, First (New York, NY: John Wiley & Sons, 1985), xi – xii.
[123] Ibid., xii.
[124] Dennis Gabor, "Inventing the Future," in *Automation: Implications for the Future*, ed. Morris Philipson (New York, NY: Vintage Books, 1962), 145.

continue to evolve. At this point, it is difficult to know just to what degree machines of all types will develop advanced communicative abilities and the types of relationships between humans and machines that will result. What is more certain is that without keeping pace with the evolution of machines and our interactions with them, communication itself stands still and is not fully equipped to handle the challenges of today or tomorrow. To understand the communication of the future in a culture in which humans and machines are intertwined, we need to make sure that we are listening to what is being said between humans and machines today, even when some machines do not appear to have anything to say.

Bibliography

"Adaptive Robotics Control Make Baxter & Sawyer Different." *Rethink Robotics*, 2016. http://www.rethinkrobotics.com/baxter/what-makes-our-robots-different/.

Anderson, Christopher W. "Towards a Sociology of Computational and Algorithmic Journalism." *New Media & Society* 15, no. 7 (2013): 1005–21.

Arbib, Michael A. "On Being Human in the Computer Age." In *Impacts of Artificial Ingelligence: Scientific, Technological, Military, Economic, Societal, Cultural, and Political*, edited by R. Trappl, 52–63. New York, NY: Elsevier Science Publishers, 1985.

Asimov, Issac. "Foreword: Looking Ahead." In *Handbook of Industrial Robotics*, edited by Shimon Y. Nof, First., xi – xii. New York, NY: John Wiley & Sons, 1985.

Beaver, Claude D., and Fred E. Jandt. "A Pilot Study on Alienation and Anxiety during a Rumored Plant Closing." *Journal of Applied Communications Research*, 1973, 105–17.

Blauner, Robert. *Alienation and Freedom: The Factory Worker and His Industry*. Chicago, IL: The University of Chicago Press, 1964.

Carey, James W. *Communication as Culture : Essays on Media and Society*. New York, NY: Routledge, 1989.

———. "Technology As a Totem for Culture: On Americans' Use of High Technology As a Model for Social Order." *American Journalism* 7, no. 4 (1990): 242–51.

Carlson, Matt. "The Robotic Reporter: Automated Journalism and the Redefinition of Labor, Compositional Forms, and Journalistic Authority." *Digital Journalism* 3, no. 3 (2015): 416–31. doi:10.1080/21670811.2014.976412.

Chesher, C. "Mining Robotics and Media Change." *M/C Journal* 16 (2013).

Clerwall, Christer. "Enter the Robot Journalist: Users' Perceptions of Automated Content." *Journalism Practice* 8, no. 5 (2014): 519–31. doi:10.1080/17512786.2014.883116.

Craig, Robert T. "Communication Theory as a Field." *Communication Theory* 9, no. 2 (1999): 119–61.

Dechert, Charles R. “The Development of Cybernetics.” In *The Social Impact of Cybernetics*, edited by Charles R. Dechert, 11–38. New York, NY: Simon and Schuster, 1966.

———. , ed. *The Social Impact of Cybernetics*. New York, NY: Simon and Schuster, 1966.

Diebold, John. *Beyond Automation: Managerial Problems of an Exploding Technology*. New York, NY: McGraw-Hill, 1964.

———. “Congressional Testimony.” In *Automation: Implications for the Future*, edited by Morris Philipson, 12–77. New York, NY: Vintage Books, 1962.

———. “Goals to Match Our Means.” In *The Social Impact of Cybernetics*, edited by Charles R. Dechert, 1–10. New York, NY: Simon and Schuster, 1966.

Edwards, Chad, Autumn Edwards, Patric R. Spence, and David Westerman. “Initial Interaction Expectations with Robots: Testing the Human-To-Human Interaction Script.” *Communication Studies* 67, no. 2 (2016): 227–38. doi:10.1080/10510974.2015.1121899.

Faunce, William A. “Automation and the Division of Labor.” *Social Problems* 13, no. 2 (1965): 149–60. doi:10.2307/798900.

Gabor, Dennis. “Inventing the Future.” In *Automation: Implications for the Future*, edited by Morris Philipson, 131–61. New York, NY: Vintage Books, 1962.

Gehl, Robert William. *Reverse Engineering Social Media*. Philadelphia, PA: Temple University Press, 2014.

Gehl, Robert William, and Maria Bakardjieva. *Socialbots: Digital Media and the Automation of Sociality*. New York, NY: Routledge, 2017.

Goldberg, Arthur J. “The Challenge of ‘Industrial Revolution II.’” In *Automation: Implications for the Future*, edited by Morris Philipson, 3–11. New York, NY: Vintage Books, 1962.

Gunkel, David J. “Communication and Artificial Intelligence: Opportunities and Challenges for the 21st Century.” *Communication+ 1* 1, no. 1 (2012): 1.

Guzman, Andrea L. “Imagining the Voice in the Machine: The Ontology of Digital Social Agents.” University of Illinois at Chicago, 2015.

———. “Making AI Safe for Humans: A Conversation with Siri.” In *Socialbots and Their Friends: Digital Media and the Automation of Sociality*, edited by Robert William Gehl and Maria Bakardjieva. Routledge, In Press.

Heims, Steve J. *John Von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death*. Cambridge, MA: MIT Press, 1980.

Jones, Steve. "People, Things, Memory and Human-Machine Communication." *International Journal of Media & Cultural Politics* 10, no. 3 (2014): 245–58.

Kamali, Jila, Colin L. Moodie, and Gavriel Salvendy. "A Framework for Integrated Assembly Systems: Humans, Automation and Robots." *International Journal of Production Research* 20, no. 4 (1982): 431–48.

Krone, Kathleen J., Ling Chen, and Diane Kay Sloan. "Managerial Emotionality in Chinese Factories." *Management Communication Quarterly* 11 (1997): 6–50.

Lasswell, Harold D. "The Structure and Function of Communication in Society." In *The Process and Effects of Mass Communication*, edited by Wilbur Schramm and Donald F. Roberts, Revised Edition., 84–99. Urbana, IL: University of Illinois Press, 1972.

Latar, Noam Lemelshtrich. "The Robot Journalist in the Age of Social Physics: The End of Human Journalism?" In *The New World of Transitioned Media*, edited by Gali Einav, 65–80. Cham: Springer International Publishing, 2015. http://link.springer.com/10.1007/978-3-319-09009-2_6.

Lee, Kwan Min, Wei Peng, Seung-A Jin, and Chang Yan. "Can Robots Manifest Personality?: An Empirical Test of Personality Recognition, Social Responses, and Social Presence in Human?Robot Interaction." *Journal of Communication* 56, no. 4 (December 2006): 754–72. doi:10.1111/j.1460-2466.2006.00318.x.

Lewis, Seth C., and Oscar Westlund. "Actors, Actants, Audiences, and Activities in Cross-Media News Work: A Matrix and a Research Agenda." *Digital Journalism* 3, no. 1 (2015): 19–37. doi:10.1080/21670811.2014.927986.

Lewis, Seth C., and Rodrigo Zamith. "On the Worlds of Journalism." In *Remaking News*, edited by P. J. Boczkowski and C.W. Anderson. MIT Press, 2017.

Licklider, J. C. R. "Man-Computer Symbiosis." In *In Memoriam: J. C. R. Licklider 1915:1990*, edited by Robert W. Taylor. Palo Alto, CA: Systems Research Center, 1960.

Lievrouw, Leah A. "New Media, Mediation, and Communication Study." *Information, Communication & Society* 12, no. 3 (April 2009): 303–25. doi:10.1080/13691180802660651.

Majchrzak, Ann, and Donald D. Davis. "The Human Side of Flexible Factory Automation: Research and Management Practice." In *People's Reactions to*

Technology, edited by Shirlynn Spacapan and Stuart Oskamp, 33–66. Newbury Park, CA: Sage Publications, 1990.

McLuhan, Marshall. *Understanding Media: The Extensions of Man*. Cambridge, Mass.: MIT Press, 1994.

Meyrowitz, J. "Media and Behavior - a Missing Link." In *McQuail's Reader in Mass Communication Theory*, edited by Denis McQuail, 99–108. London, UK: Sage Publications, 2002.

Miller, Ross. "AP's 'Robot Journalists' Are Writing Their Own Stories Now." *The Verge*, January 29, 2015. http://www.theverge.com/2015/1/29/7939067/ap-journalism-automation-robots-financial-reporting.

Mullin, Benjamin. "AP Will Use Software to Write NCAA Game Stories." *Poynter*, March 4, 2015. http://www.poynter.org/2015/ap-will-use-software-to-write-ncaa-game-stories/324601/.

Mumford, Lewis. *Technics and Civilization*. The University of Chicago Press, 2010.

Nass, Clifford, and Scott Brave. *Wired for Speech: How Voice Activates and Advances the Human-Computer Relationship*. Cambridge, Mass: MIT Press, 2005.

Nass, Clifford, Jonathan Steuer, and Ellen R. Tauber. "Computers Are Social Actors." *Conference Companion on Human Factors in Computing Systems*, CHI '94, 1994, 72–78. doi:10.1145/259963.260288.

———. "Computers Are Social Actors." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 72–78. CHI '94. New York, NY, USA: ACM, 1994. doi:10.1145/191666.191703.

Noble, David F. *Forces of Production: A Social History of Industrial Automation*. New Brunswick, N.J.: Transaction Publishers, 2011.

Nof, Shimon Y., ed. *Handbook of Industrial Robotics*. First. New York, NY: John Wiley & Sons, 1985.

Orlikowski, Wanda J. "Sociomaterial Practices: Exploring Technology at Work." *Organization Studies* 28, no. 9 (2007): 1435–48. doi:10.1177/0170840607081138.

———. "The Duality of Technology: Rethinking the Concept of Technology in Organizations." *Organization Science* 3, no. 3 (1992): 398–427.

Pacey, Arnold. *The Culture of Technology*. First MIT Press. Cambridge, Mass.: MIT Press, 1983.

Peters, John Durham. *Speaking into the Air: A History of the Idea of Communication*. Chicago, IL: University of Chicago Press, 2012.

———. *The Marvelous Clouds: Toward a Philosphy of Elemental Media*. Chicago, IL: University of Chicago Press, 2015.

Philipson, Morris, ed. *Automation: Implications for the Future*. New York, NY: Vintage Books, 1962.

Pickering, Andrew. "Cybernetics and the Mangle: Ashby, Beer and Pask." *Social Studies of Science*, 2002, 413–37.

———. *The Mangle of Practice: Time, Agency, & Science*. Chicago, IL: University of Chicago Press, 1995.

Reeves, Byron, and Clifford Ivar Nass. *The Media Equation*. CSLI Publications, 1996.

———. *The Media Equation*. Standford, CA : CSLI Publications, 1998.

Reeves, Joshua. "Automatic for the People: The Automation of Communicative Labor." *Communication and Critical/Cultural Studies* 13, no. 2 (2016): 150–65. doi:10.1080/14791420.2015.1108450.

Rosen, C.A. "Robots and Machine Intelligence." In *Handbook of Industrial Robotics*, edited by Shimon Y. Nof, First., 21–28. New York, NY: John Wiley & Sons, 1985.

Salvendy, G. "Human Factors in Planning Robotic Systems." In *Handbook of Industrial Robotics*, edited by Shimon Y. Nof, First., 639–64. New York, NY: John Wiley & Sons, 1985.

Sandry, Eleanor. *Robots and Communication*. New York, NY: Palgrave Pivot, 2015.

Schramm, Wilbur. "Institutionalization of Advanced Communication Study in American Universities." In *The Beginnings of Communication Study in America: A Personal Memoir*, edited by Steven H. Chaffee and Everett M. Rogers, 155–80. Thousand Oaks, CA: Sage Publications, 1997.

———. "Nature of Communication between Humans." In *The Process and Effects of Mass Communication*, Revised., 3–53. Urbana, IL: University of Illinois Press, 1972.

Shepard, Jon M. *A Study of Office and Factory Workers*. Cambridge, MA: MIT Press, 1971.

Simonson, Peter, Janice Peck, Robert T. Craig, and John P. Jackson, eds. *Handbook of Communication History*. New York, NY: Routledge, 2013.

Suchman, Lucy A. *Human-Machine Reconfigurations: Plans and Situated Actions*. 2nd ed. New York, NY: Cambridge University Press, 2009.

———. *Plans and Situated Actions: The Problem of Human-Machine Communication*. New York, NY: Cambridge University Press, 1987.

Sunaoshi, Yukako. "Historical Context and Intercultural Communication: Interactions Between Japanese and American Factory Workers in the American South." *Language in Society* 34 (2005): 185–217.

van Dalen, Arjen. "The Algorithms behind the Headlines: How Machine-Written News Redefines the Core Skills of Human Journalists." *Journalism Practice* 6, no. 5–6 (2012): 648–58. doi:10.1080/17512786.2012.667268.

Van der Kaa, Hille, and Emiel Krahmer. "Journalist versus News Consumer: The Perceived Credibility of Machine Written News." In *Research Paper Presented at the*, 2014. https://pure.uvt.nl/portal/files/4314960/cj2014_session4_paper2.pdf.

Walther, Joseph B. "Theories of Computer-Mediated Communication and Interpersonal Relations." In *The Sage Handbook of Interpersonal Communication*, edited by Mark L. Knapp and John A. Daly, 443–79. Thousand Oaks, CA: Sage Publications, 2011.

Wiener, Norbert. *The Human Use of Human Beings: Cybernetics and Society*. Boston, MA: Houghton Mifflin, 1950.