What is Human-Machine Communication, Anyway?

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Citation: Guzman, A.L. (2018). What is human-machine communication, anyway? In A.L. Guzman (Ed.)., *Human-machine communication: Rethinking communication, technology, and ourselves* (pp. 1 – 28). New York, NY: Peter Lang.

Keywords: Human-Machine Communication (HMC), Communication Theory, Cybernetics, Human-Computer Interaction (HCI), Human-Robot Interaction (HRI), Human-Agent Interaction (HAI), Social Robot, Conversational Agent, Algorithm

Version: Author draft.

Information: This is the Introduction to *Human-Machine Communication: Rethinking Communication, Technology, and Ourselves*; Andrea L. Guzman, PhD, Editor; Digital Formations Series; Steve Jones, Series Editor; Peter Lang Publishing. Will be published in late 2018.

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Abstract

This edited volume introduces readers to the growing area of Human-Machine Communication (HMC) research within the communication discipline. As defined within this chapter, HMC is the creation of meaning between humans and machines, with technology theorized as a communicator, a subject with which people communicate, instead of a channel through which humans interact with one another. HMC research focuses on the process of communication between human and machine and the implications of encounters between people and technology for individuals, society, and humanity. HMC envelopes communication research within Human-Computer Interaction (HCI), Human-Robot Interaction (HRI), and Human-Agent Interaction (HAI) while at the same time is inclusive of philosophical, critical/cultural, and related approaches regarding the integration of social technologies into everyday spaces. This introduction outlines the fundamental aspects of HMC by answering key questions regarding HMC's historical and theoretical origins, the rationale for its establishment, and the nature of its research. This chapter highlights how deeply entrenched communication research has been within an anthropomorphic paradigm and how much work is yet to be done toward understanding what it means for people to communicate with robots, artificial intelligence (AI), conversational agents, algorithms, and other emerging technologies.

What is human-machine communication, anyway?

The question that serves as this chapter's title is the guiding theme for this edited volume. It is one that I and other human-machine communication scholars have been asked numerous times as we have attempted to formalize this area of study and its central concept. Most people grasp that, as its name implies, human-machine communication, or HMC, has something to do with people's interactions with technology. In actuality, human-machine communication is both a concept and an area of research within communication. It is the *creation of meaning among humans and machines* and the study of this meaning-making and related aspects. But in a discipline where communication has long been conceptualized as a human process through machines, exactly what human-machine communication is, where it fits into the study of communication, and what it can potentially bring to communication are not readily clear. HMC as an area of study within communication also is still taking shape. Its primary catalyst has been scholars from throughout the discipline coming together to discuss their research, to address shared questions, and to help build a scholarly community. Because HMC is taking shape from the ground-up, questions related to the nature of HMC are just as critical for existing HMC scholars as they are for scholars and students new to this area.

This chapter begins to provide some of these answers. I say, begin, because this book is only one step, but an important one, toward codifying this area of study. The conceptualization of HMC presented is not mine alone. To address questions regarding the nature of HMC, I have studied more than seven decades of research regarding the idea of communication between people and technology both inside and outside the discipline. I have listened to how other HMC scholars conceptualize what it is that they do and paid careful attention to the ways in which this volume's authors explained their contributions. In staking out what HMC is within the coming

pages, I provide a glimpse into what has influenced the shape of HMC so that other scholars can build upon these ideas. Toward this end, I begin by orienting the reader to HMC in relation to communication generally. Next, I discuss the origins of HMC outside the discipline and within it, before explaining why HMC as a new area of study is needed. Finally, I more thoroughly explain and define HMC while introducing this volume's chapters that exemplify HMC research.

Questions of Communication

For many people, communication is understood as a process taking place between themselves and someone else. To communicate means posting to social media followers, texting a loved one, talking with a friend, giving a presentation to colleagues, or reading the latest news written by a journalist. Communication also is, and has been, defined as a human-only process by those who study it. As the study of communication was coalescing in the mid-twentieth century, influential scholars purposefully drew its boundaries around human interaction (e.g., Schramm, 1973). In textbooks, communication is presented within a primarily, if not exclusively, human context, with models, theories, and examples focused on people's interactions. A visual of the transactional model of communication depicting messages flowing between two human-like figures greets visitors to the "What is Communication?" section of the National Communication Association's website.[1] Representations of mass communication historically have replaced the face-to-face image of interpersonal contexts with a depiction of a single source – a media organization composed of people – transmitting information to a *human* audience. In this default conceptualization of communication, technology is the medium or channel. It is the mobile phone people use to text that loved one or a specific app that delivers the day's news.

Questioning the Role of Technology

As I explain in further detail later, many emerging technologies no longer readily fit into this role of medium only. They are designed to function as things with which people interact. The mobile phone is not only a means for contacting friends but also a talkative assistant that helps people carry out tasks. That news app doesn't deliver just any story; it "learns" people's preferences, providing individualized content. Some of the news stories coming through that app now are being created by computer programs instead of reporters. And the robots people once encountered only in science fiction are moving into their homes.

It is these exchanges between people and technology that are examples of human-machine communication and are the focus of this area of research. *In human-machine communication, technology is conceptualized as more than a channel or medium: it enters into the role of a communicator*. In contrast to models of human communication, HMC models have messages flowing between and among humans and machines. The "image" of communication shifts from humans facing each other to a human facing a machine. Described this way, HMC seems relatively straightforward, the swapping of a machine for a human within an interaction. Indeed, substituting a technology for a person in experiments that test a communication or social theory has been one of the important ways scholars have studied people's interactions with computers (e.g., Reeves & Nass, 1998).

Questioning Meaning-Making ~~Through~~ *With* Technology

However, communication is conceptualized as more than the study of roles in a process and the transmission of information (Carey, 1989). Central to the development of communication theory

is a focus on the meaning of messages and their effects (Rogers, 1997) and, as Schramm (1973) explains, how this meaning enters into people's relationships with one another:

> When we study communication, therefore, we study people – relating to each other and to their groups, organizations, and societies, influencing each other, being influenced, informing and being informed, reaching and being taught, entertaining and being entertained. To understand human communication, we must understand how people relate to one another. (pp. 3-4)

Communication also is the means through which people learn about their world (Blumer, 1969), form an understanding of Self and Other (Mead, 1967) and contribute to the shape of society (Cooley, 1897/2004). Communication research, then, is about who we are, who we are to one another, and the very reality that we are creating (Carey, 1989).

From this perspective, the view of human-machine communication switches from that of a process between a person and technology to the *creation of meaning between human and machine.* The questions surrounding HMC now seem much more complex. And, they are. How do messages from robots affect us? What sorts of relationships emerge when a technology becomes a communicator? How do people understand themselves as the result of their interactions with a virtual agent? What type of society is being constructed through people's ongoing communication with both humans and machines? What is communication now that it extends to our interactions with machines? These are some of the many complex questions that human-machine communication scholars seek to answer.

How Have We Theorized Communicating with Machines?

The study of people's interactions with technology has an extensive history, and the current direction of HMC and its conceptualization have been influenced by research inside communication and scholarship outside of it. This section briefly reviews those influences by focusing on key points of theoretical intersection and divergence.[2] Overall, engineers and computer scientists have used the idea of communication to help guide technology design and development of technological interfaces with a goal of facilitating use. Meanwhile, the study of a specific medium or research regarding people's direct interactions with media have had a place within the study of communication, but this research has received considerably less attention because it was outside communication's prevailing anthropocentric paradigm.

Engineering, Computers, & Communication

While many communication scholars are cognizant of the theoretical intersections between communication and fields within the social sciences and the humanities, they may be less aware of the importance of the idea and theories of communication to researchers within engineering and technology. That the discipline's foundational model (Shannon & Weaver, 1949) had its roots in engineering is an often overlooked connection between communication and technological fields, a point I will return to later. Since the mid-twentieth century, engineers, computer scientists and other researchers have approached people's use of computers and other technologies within the context of communication. This research has spanned numerous fields and disciplines including engineering, computer science, artificial intelligence (AI), ergonomics, and information science and helped to spur the development of interdisciplinary fields such as computer-supported cooperative work (CSCW) and Human-Computer Interaction (HCI). The

term "human-machine communication" has its origins in this scholarship[3] and has only recently been increasingly used by communication scholars.

The Role of Communication in Designing Technology. The framing of people's interactions with technology as a type of communication has guided research and development for a wide range of technologies, including underwater devices (Sheridan & Verplank, 1978), planes (Sarter & Woods, 1995), spaceships (National Aeronautics and Space Administration, 1976), artificial intelligence programs (Weizenbaum, 1966), and computers generally (Licklider, 1960). Within these contexts communication carries a denotation similar to or drawn from cybernetics: it is the transfer of information for the purposes of control (Wiener, 1948). At the same time, communication with and among machines has never been far from a human context in that engineers have used human communication as a guide for designing the points of contact between people and technology, machine interfaces.

Most contemporary technology users take for granted the relative ease with which they control their devices but getting data into early computers and the results out of them was anything but simple or efficient. These hurdles of input and output were framed as problems of communication (e.g. Licklider & Clark, 1962). What Licklider (1960) called "the language problem," the difference between machine and human languages, was viewed as a barrier to use and adoption. The ontological difference between people, biological beings, and computers, programmed things, also was a formidable communication problem, as NASA states:

> Even when people do not speak the same language, they can communicate with one another to some degree (using gestures, facial expressions, etc.) because they

> share common biological structure and needs, common patterns of thought and behavior, and large overlapping stores of knowledge about the world. Machines and humans do not share these things, and most of the burden of communication falls on the human. (1976, p. 3.4)

As computers became smaller and began moving into everyday spaces, the general difficulty people experienced with adapting to computers continued to be viewed as a communication issue. In their essay regarding computer use as a form of communication, Oberquelle, Kupka, and Maass (1983) argue: "The problems of today's computer use mainly result from *difficulties in the communication between human and the machine*" (p. 309, emphasis authors).

The solutions devised also were based in communication. The exchange of information was approached as a dialogue (e.g., Meadow, 1970) with human conversation as the prototype. For example, Hayes and Reddy (1979) argue: "We believe that graceful interaction in these and the many other contingencies that can arise in human conversation is essential if interfaces are ever to appear co-operative and helpful…" (p. 231). Developers also took the relational dynamics of human communication into account, deciding that in interactions, the human, as "master," would command the machine, as "servant" (e.g., Flanagan, 1976; Mooers, 1959). The development of language-based interfaces furthered this focus on the use of technology as a communicative process with technology (Suchman, 1990). Some researchers pushed back against using human communication as a prototype, countering that reproducing human interaction within a human-machine context was neither always possible nor desirable (e.g., Nickerson, 1976), but, overall, human communication has served as an influential model for technology design.

Although scholarship across engineering, computer science, and related fields frames technology problems as a lack of or breakdown in communication and turns to human communication for answers, the concept of communication itself and communication theory often are not the focus of this research. What communication is and does is axiomatic, and what communication is all about within these contexts is using technology. The aim of improving people's communication with machines – from the perspective of engineers and computer scientists – is facilitating and promoting technology use.

In an edited volume regarding "man-machine communication," Meadow (1970) defines the book's key concept as a "two-way conversation that is goal-oriented – aimed toward the accomplishment of a specific objective – and in which both parties contribute a necessary function" (p. 4). That objective, as becomes clear in the remainder of the book, is helping people accomplish tasks. NASA's (1976) definition of "human-machine communication" also is focused on the point of contact between people and technology: "the characteristics of the interface through which a human user instructs or programs a machine, interacts with it during execution, and accepts information from it" (p. 3-79). This general view of the purpose of people's interactions with machines also is integral in Human-Computer Interaction research.[4] One of HCI's objectives has been and continues to be the development of the human-computer interface, the point of information exchange between human and computer and the processes surrounding it (Baecker, Grudin, Buxton, & Greenberg, 1995). Jacob (2003) explains regarding HCI: "We can view the fundamental task of human-computer interaction as moving information between the brain of the user and the computer. Progress in this area attempts to increase the useful bandwidth across that interface by seeking faster, more natural, and more convenient communication means" (p. 145).

Theorizing Communication in Technology Use. From the standpoint of communication theory, this research regarding people's interactions with machines precedes from what Carey (1989) called a transmission view of communication. Communication is about the exchange of information toward some desired effect. The machine is theorized as having a degree of agency in that it performs a distinct role during an interaction (Fischer, 1990; Meadow, 1970) and draws from its own resources in processing and responding to messages (Riley, 1989). But, its ontology is very much tied to its status as a technology and the predominant cultural conceptualization of technology as tools.[5] Human-machine communication within this context is a process of interacting with technology, a tool, as to leverage it for some purpose.

What has been largely absent from this body of work in relation to communication theory is the social aspect of communication, including how technologies figure into people's social worlds and the implications for society (Zhao, 2006). The subjectivity of the technology is limited: its place within a user's social world is extremely restricted, if acknowledged at all. Outside its use, the technology has no bearing on how people understand their world and themselves. Communication with technology is an "isolated" process without implications beyond what transpires within the interaction.

There are notable exceptions such as Suchman's (1987) foundational work in human-machine communication that approaches people's interactions with technology as "situated actions," collaboratively unfolding between human and machine: "Communication in this sense is not a symbolic process that happens to go on in real-world settings, but a real-world activity in which we make use of language to delineate the collective relevance of our shared environment" (p. 180). Suchman (2009) also draws on scholarship from feminist theory and Science and

Technology Studies (STS) to interrogate the social and cultural dimensions of human-machine communication.[6] More recently HCI scholars also have taken up critical and cultural questions; although, reconciling critical and cultural work with the practical aims of HCI research to inform design and facilitate use has proved challenging (Rogers, 2012).

Overall, communication has played an integral role in the development of technology and its use. The technologies that are now inspiring communication scholars to pay attention to human-machine communication are the result of decades of research guided by the idea of communication outside the discipline. Researchers in HCI have made important strides in the transmission of information from human to machine and facilitating technology use. However, with a focus on communication within this context, other aspects of communication with technology have received less attention, including social aspects and cultural implications.

Medium as Message and Messenger

While scholars outside the discipline initially propelled human-machine communication research, communication scholars have not been entirely out of the picture. Communication scholars have directly contributed to HCI and related areas within the past few decades. There also are some theoretical traditions within the discipline that have focused their research directly on the medium and have potential for furthering the study of people's interactions with machines and addressing existing theoretical oversights.

Communication Engineering vs Human Communication. Some of the fields whose literature was assimilated by communication scholars were the same fields focused on technology research and development, including cybernetics and information theory (Craig, 1999; Rogers, 1997).

Cybernetics defined communication as a process of information transfer among people, animals, and machines (Wiener, 1948): Who or what were involved in the interaction were not the defining element of communication in cybernetics – the process was.[7] Similarly Shannon and Weaver's (1949) theory, considered to be communication's foundational model, evolved from a theoretical context similar to cybernetics.[8] As originally explicated by Shannon (1948), the model included sending messages between people and machines. And so, some of the literature that would inform communication's early theories conceptualized communication as a process between humans as well as humans and machines.

Scholars who were helping to shape communication, however, decided that the discipline would focus on human interaction.[9] Existing theories were retrofitted to a human-only context, including Shannon and Weaver's (1949) model (Rogers, 1997). As an engineer, Shannon originally wrote *The Mathematical Theory of Communication* (Shannon, 1948) as a theory of communication engineering. Shannon's focus was maximizing the transmission of signals from one point (a human or machine) to another point (a human or machine). As Rogers (1997) explains, Shannon's original model had nothing to do with meaning-making. Shannon's theory often is attributed to both Shannon and Weaver because it was later republished in a book, of the same name, with an introduction by Weaver. According to Rogers (1997), this introduction (Weaver, 1949) adds to and adapts Shannon's theory from an engineering to social science context, recasting it as a means to study the effects of messages. The specific elements of the model that within engineering could be occupied by a human or a machine came to be associated with humans-only (Rogers, 1997). The distinct roles for humans and machines became codified and were reinforced in subsequent models (e.g., Barnlund, 1970; Lasswell, 1972): humans are

communicators (senders and receivers) and technology is the medium, or channel, through which people exchange messages. This has been the dominant paradigm for communication research.

HCI in Communication. The question then is: How did communication scholars come to study interactions with machines? Part of the answer is in the evolution of technology toward the end of the twentieth century. According to Rogers (1986), communication scholars began to focus their research on communication technologies themselves, rather than the media content carried by these technologies, as cable and satellite television and personal computers moved into everyday spaces. What set these technologies apart from their predecessors was their interactivity: people could send messages to one another through these devices and, crucial to our discussion here, also interact more directly with the technology itself (Rogers, 1986).

In the computer-mediated communication (CMC) research that followed, scholars still privileged human communication; however, some communication scholars acknowledged that the internet also enabled "human-to-machine" and "machine-to-machine communication" (Jones, 2004), and early within the study of CMC, several researchers began asking questions about people's direct interactions with technology. Scholars focused on how people interacted with specific programs to access information stored within them, such as electronic card catalog systems (e.g., Borgman, 1983; Paisley, 1983; Rice & Borgman, 1983). Communication researchers also theorized some aspects of CMC as including people's interactions both through and with technology. Rafaeli (1988) conceptualized interactivity as a process between people carried out through technology as well as between people and technology. Similarly, presence and social presence were defined as phenomena that occurred while people were interacting with

one another or with technology (e.g., Biocca, Harms, & Burgoon, 2003; Lombard & Ditton, 1997).

Research by Nass and colleagues delved even further into people's communicative behavior toward technology. Whereas communication scholars removed technology from the position of source or receiver in adapting Shannon's model, scholars conducting experiments within this line of research put media back into these roles (see Reeves & Nass, 1998, pp. 13–15). What they found is that people act toward media as if the media are distinct social actors, drawing on the social norms of communication with humans (Reeves & Nass, 1998). The Computers Are Social Actors, or CASA, paradigm (Nass, Steuer, & Tauber, 1994) has provided the foundation for subsequent research into the varied aspects of people's interactions with computers. Today, this work regarding computers and related technology is classified within the communication discipline as HCI research.[10] Often this scholarship has been influenced by HCI research outside the discipline (e.g., Rafaeli, 1988; Rice & Borgman, 1983) as well as contributed to it (e.g., Nass et al., 1994). HCI within communication has predominantly adopted a social scientific approach in studying people's behavior toward technology.[11]

Medium Theory, Cultural Studies & Beyond. Communication research within HCI is currently the area of study within the discipline most closely focused on people's direct interactions with machines. However, other areas of the discipline have made important contributions to understanding technology in communication. These areas, such as medium theory and cultural studies, have eschewed the predominant paradigm within communication because they developed out of different schools of thought; although, the degree to which scholarship within these areas is immediately applicable to the study of human-machine communication varies. Still

they have the potential to offer HMC scholars ways of asking and answering new questions and addressing questions not addressed by HCI or research outside the discipline.

The area of media studies known as "medium theory" (Meyrowitz, 2002) formed around scholarly inquiry into the nature of technology and its resulting impact on society. Its work often is summarized by the well-known argument of one of its primary theorists, Marshall McLuhan: "the medium is the message" (1994, p. 7). Medium theorists focus on the implications of the form and function of media, including its underlying technology, (e.g., Innis, 2007; McLuhan, 1994; Mumford, 2010) with particular interest in the social shifts resulting from the introduction of a new medium (Meyrowitz, 2002). In contrast with media effects and HCI, medium theory is more closely aligned with the humanities and includes normative assessments of a medium. Regarding HMC, medium theory originated in media that facilitated human communication, such as electronic media linking people in a "global village" (McLuhan, 1994). While medium theory views a medium as more than neutral channel, a medium still in many ways is exactly what its name suggests. However, as Meyrowitz (2002) explains, medium theory is not so much a particular theory as it is "a *perspective* for studying the effects of media on behavior" (p. 106). It is this "perspective" that can be and has been adapted for the study of media that function as communicators (e.g., Gehl & Bakardjieva, 2017).

Communication scholars studying technology also have worked within or been influenced by cultural studies, critical studies, race studies, feminist studies, the philosophy of technology, and STS.[12] For example, there has been a push among media, communication, and STS scholars for more interdisciplinary dialogue and research focused on the material aspects of ICTs (Gillespie, Boczkowski, & Foot, 2014). These areas of scholarship originated outside of communication and extend beyond its borders, each having distinct aims and approaches to

research. All, however, provide ways of studying various aspects of the intersections among technology, communication, self, and society. For example, from a cultural studies perspective, Carey (1990) argues that "technology is thoroughly cultural from the outset" (p. 245). As such, it "is a symbol *of* (it represents how the world works) and a symbol *for* (it coerces the world into working in terms of the representation)" (Carey, 1990, p. 245, emphasis author's). Unlike the "dominant paradigm" of media research focused on measuring the effects of manifest media content (Gitlin, 2002) or HCI research centered on facilitating people's interactions with technology, cultural studies interrogates the implications of the latent messages of media. Although these messages often are those sent from person-to-person, Carey's (1990) statement demonstrates that cultural studies also can focus on the ways culture is embodied within technology and enacted within its use.

What is shared among these various approaches is a rejection of technology's neutrality and a focus on the power dynamics embodied within and enacted through machines with varying implications: People's assimilation of technology into the self renders them 'borg (Haraway, 2000); algorithms are not only the means for using a search engine but also the vehicles of encoding and reinforcing racial bias (Noble, 2018); robots are becoming just as much a part of the domestic sphere as the industrial sphere, as is the power struggle regarding them (Fortunati, 2017); and, as Verbeek argues, "In fulfilling their functions, artifacts do more than function – they shape a relation between human beings and their world" (2005, p. 208).

Why Human-Machine Communication, *Now*?

Given that communication has been key to developing and studying technology across multiple disciplines, there is a question of why another area of study focused on people's interactions with machines is needed. Those advocating for a new area have offered several reasons, such as the shifting nature of technology and the inadequacy of communication theory to account for these changes (e.g., Gunkel, 2012; Jones, 2014). Yet, collaboratively addressing these issues has been difficult given the structure of the discipline. These combined factors – the technological, the theoretical, and the institutional – have spurred HMC's development.

The Technological

The interactivity of new media was the impetus for communication scholars to begin focusing more directly on technology (Rogers, 1986), and it is the evolution of technology that is, yet again, motivating scholars to ask new questions regarding machines in communication (e.g., Gunkel, 2012; Jones, 2014; McDowell & Gunkel, 2016). These changes include advances in text and voice-based modes of interaction; natural language processing that allows people to interact with technology as they would another human; and the integration of verbal and non-verbal social cues. The result is technologies that are inching closer to the goal of "natural" (human-like) communication as envisioned by Licklider (1960). These technologies enable a qualitatively different type of interactivity than their predecessors. To use the machine is to communicate *with* it, and the "it" is more than a tool to use. Devices and applications have varying degrees of agency programmed into their design and emerging in their use (Neff & Nagy, 2016). True, all machines can be theorized as possessing a degree of agency (Latour, 2007; Pickering, 1995), but emerging technologies are designed around this agency and emphasize it, so that some present themselves as distinct entities (Siri, Jibo, etc.) in

communication. In addition, communication with these technologies often is personalized. These technologies do not just talk, they talk *with us*. They know *our* name, can distinguish *our* voice, and learn *our* preferences. They enter into *our* social world as active participants through their design and use (Zhao, 2006). The machine has become a communicative subject, and it is this subjectivity,[13] rather than interactivity, that marks this technological transition, prompting scholars to ask what subjectivity means for individuals, society, and the study of communication.

The Theoretical

This fundamental shift in the subjectivity of technology cannot be adequately addressed in existing models of communication because the discipline's dominant paradigm was formed around older media designed to facilitate people's interactions with one another and had as its focus how humans have acted toward, interacted with, and were affected by one another. For this reason, communication scholars have simultaneously called for consideration of how people interact with machines (e.g., Nass & Steuer, 1993) as well as a reconsideration of the conceptualization of communication (e.g., Gunkel, 2012). There are extensive bodies of work outside the discipline that have drawn upon the idea of communication to guide technology design and to inform research, and this research should be consulted by communication scholars. However, as explained, this scholarship proceeds from a narrow view of communication, most often overlooking larger cultural factors and implications. This research also is not solely focused on communication. The field of HCI, for example, also focuses on questions of engineering, computer science, and cognitive processing (ACM, 1992). Communication is about relationships, and it is the relational aspects of people's interactions with one another that has been central to communication research (Schramm, 1972, 1973). Beyond addressing theoretical

gaps in research outside the discipline, communication is uniquely positioned to provide an understanding of the relational aspects of people's interactions with machines that function as subjects designed to form relationships with people. The caveat, of course, is that communication scholars must adapt scholarship based on human relationships to human-machine contexts while building upon emerging threads of research regarding people's communication with technology.

The Institutional

Trying to form a clear picture of people's interactions with machines from existing and emerging research has been hampered by institutional factors endemic to the discipline. Since its formalization, the study of communication has been fractured (Berger, 1991) and amorphous (Comstock, 1983). The discipline is divided along multiple lines: type of communication; research origins (Craig, 1999); philosophical and theoretical differences (Anderson & Baym, 2004). New divides also are forming. For example, communication scholars are now active in Human-Robot Interaction that is its own field different from HCI inside and outside communication.[14] The study of people's interactions with machines has also been fractured. For example, at the discipline's core conferences, the impact of AI in journalism, people's conceptualizations of AI, people's behavior toward AI, and media representations of AI are likely to be presented in different divisions. Many communication scholars studying people's interactions with technology also take their research outside the discipline. Part of the rationale for doing so is that their work is interdisciplinary; however, at the same time, the discipline's anthropomorphic paradigm can make it difficult for these scholars to make inroads within communication conferences and journals. Overall, the scholarly spaces within communication in which scholars can present and publish their research regarding human communication with

machines and engage in discourse with one another are limited. So too is the visibility of this scholarship. Furthermore, as I have explained, no one theoretical or methodological approach to the study of people's interactions with technology can provide a complete understanding of what is taking place and its implications. To address larger overarching questions regarding human-machine communication, scholars representing these different areas need to be in dialogue with one another. For these reasons, an institutional space is needed to engage in this discourse.

What, *then*, is human-machine communication?

Formalizing the study of human and machines in communication has been a process shaped by conversations among scholars, observations of technological trends, consultation with scholarship inside and outside the discipline, and reflection on the state of communication research. We[15] have been motivated by the realization that communication is, once again, at a critical moment. The promise of human-like communication that has guided the design of technology for so long is paying off. Communication scholars now have the opportunity to bring their expertise to the study of humans and machines and provide meaningful insight into this intertwined shift in communication and technology. There is not a division within the discipline untouched by the increasing communicative nature of machines because almost every facet of people's lives is affected by social technologies, directly or indirectly.

Tackling the theoretical questions raised by the shift in technology required first addressing the institutional hurdle of creating a space for the requisite dialog: That scholarly space is the area of communication we now call Human-Machine Communication. Our goal has been to facilitate connections across the many divides separating HMC scholars, from specific technologies studied to philosophical and methodological approaches to research. In fostering

this inclusivity, we are not trying to efface differences in this research; instead, we are trying to productively leverage them. HMC events have encouraged participation from across the discipline so that we can learn from one another, identify shared aspects of research, understand differences, and address issues spanning all of HMC, such as raising the salience of our research within the discipline.

HMC – An Area of Study Explained

Crucial to having scholars engage with this space was to select a name representative of its research. Several areas of study focused on people's interactions with technology exist, such as HCI, but an alternative name is used for several reasons. While communication scholars working within these interdisciplinary areas study questions of communication, the larger fields themselves encompass other types of research. These fields also often have a conceptualization of communication that is narrower than that of the discipline; a specific theoretical and methodological orientation; and a focus on a specific class of technologies, such as robots. Adopting the same name as an existing field would tie this new area of study to unrelated research, reinforce existing research agendas without addressing their oversights, and potentially alienate scholars focused on different technologies. Human-Machine Communication as an area of study is not a competitor to HCI, HRI, or HAI within communication or related research; it subsumes them. HMC can be thought of as an umbrella encompassing the many approaches to people's communication with various technologies.

Some people have remarked that "machine" and "human-machine" are antiquated: machine does not have the same modern connotation as technology. It conjures images of industrial technologies. However, from my perspective, that is the benefit of using machine

instead of technology, not a detriment. As I have argued (Guzman, 2016), communication scholars have historically focused on the study of ICTs while overlooking manufacturing technologies: But manufacturing technologies also are communicative, not to mention they too are now being designed to be increasingly social with some of the same anthropomorphic features as robots for the home (see "Adaptive Robotics", 2016). The term machine reminds scholars that whatever technology is part of the interaction they are studying, that device and people's communication with it is but one part of a much bigger phenomenon. Furthermore, that phenomenon is not just a product of the present. At a cultural level, modern technology use and the ways that people think about technology is also influenced by the past, including the hulking, gritty machines of the industrial revolution and the sleeker, blinking machines of the automation revolution (Guzman, 2016). Human-machine not only stands for the parties involved in the communication (human and machine) but also the ontological relationship between humans and machines and the cultural dimensions that have so often been overlooked.

The last element of HMC is arguably its most important: communication. The use of communication instead of related synonyms, such as interaction, serves as a disciplinary marker. It says this research isn't just about communication: it *is* communication research. This is where communication as a discipline stakes its claim.[16] At the same time, this also is where HMC scholars are carving out their space within the discipline. A common experience among HMC scholars is one of being told that their work does not belong in the discipline or that people's interactions with technology do not qualify as communication (or both). Using the term communication within the context of humans and machines is – intentionally – a direct challenge to the anthropomorphic conceptualization of communication within the discipline.

HMC – A Concept Defined

While this explanation provides a general sense of what HMC scholars do, the focus of this research is not entirely clear. What is the "human-machine communication" that HMC scholars are studying? Answering this question is somewhat difficult given that HMC as an area of research is broad in terms of the types of technologies studied and the perspectives from which this research takes place. HMC's aim to be inclusive sets it apart in that by bringing together different ways of thinking about people's communication with technology it serves as a bridge among the discipline's many divisions. At the same time, it is a hurdle because the philosophy underlying any research influences what is studied and how. This problem is similar to and, in fact, originates in the existing lack of a singular definition of communication within the discipline (e.g., Dance, 1970, 1984). Still, there are common elements to the conceptualization of communication, and, similarly, there are core aspects of human-machine communication.

What sets HMC apart from human-human communication is the nature and role of technology. Within HMC, the machine is a distinct subject with which people interact. Interactions between human and machine have been viewed as analogous to interpersonal communication (e.g., Nass & Steuer, 1993), occurring in and among a group of people. A person may make a request of a robot that then replies, or a group of friends may huddle around a voice-based agent asking it off-the-wall questions and listening to its joking answers. Communication between human and machine also may be asynchronous and follow a model closer to that of mass communication. For example, automated news-writing programs turn raw data into news stories for consumers.[17] Regardless of whether the exchange is similar to that of an interpersonal or mass communication context,[18] the machine occupies the role of communicator and is approached as such within HMC research.

In communication's prevailing paradigm, the roles of people and things are assigned based on the nature of each, and these roles are absolute. The reconfiguration of the role of machines within HMC, in contrast, is based on technology's design and function in relation to the person interacting with it, be it directly or indirectly. For this reason, the role of technology may neither be solely that of a communicator nor entirely that of a medium; rather, it may be that of a communicator and a medium. For example, Apple's Siri is designed to function primarily as a communicator in a dyadic exchange with people; however, Siri also functions as a medium that people use to control a phone and retrieve messages as well as a "messenger" relaying people's requests, often unbeknownst to them, back to Apple (Guzman, 2017). Other technologies with which people directly communicate, such as social robots, also mediate people's interactions and social relationships with one another (Höflich, 2013). Human-machine communication as a process is an exchange of messages between people and technology, but in the course of the interaction and as a result of it, both the machine and human[19] may also take on other roles.[20]

Beyond who and what are involved in which roles in an interaction is the question of the nature of communication itself within HMC. What exactly is transpiring between a human and a machine? The answer to this question can be found by revisiting the discipline's history as its boundaries were forming. Scholars adapted and expanded Shannon's (1948) theory as a way of explaining and accounting for the meaning people derive in their interactions with one another. Humans became senders and receivers and machines were shut out of these roles because communication scholars were interested in more than the transmission of signals or relay of information; they were after meaning. Communication was to be about, as Schramm is quoted above stating, "how people relate to one another" – how they create meaning. As Carey (1989) later stressed, communication is more than the exchange of a wave and message of "hello"

between neighbors or the content of a news story; these acts – regardless of whether they are verbal or nonverbal, co-present or mediated, fleeting or sustained—are the rituals through which and to which meaning is imparted.

Communication is about the meaning people derive in and through their interactions with other people and, now, in and through their interactions with machines. The definition of "communication" within human-machine communication and human-human communication is the same – as it should be if they are to occupy the same discipline. At its core communication is the creation of meaning. Human communication, the default, is the creation of meaning among humans. *Human-machine communication is the creation of meaning among humans and machines.* It is a process in which both human and machine are involved and without one or the other communication would cease (Guzman, 2016). Stating that the definition of communication within human communication and HMC are the same is not an attempt to diminish ontological differences between humans and machines. Nor is it to say that the ways people interact with others and the meaning derived is the same as people's interactions with machines. An important aspect of HMC includes charting similarities and differences between these two types of communication. That human communication is now a *type of communication* is key. HMC "frees" the machine from its relegation to the role of medium, and, as a result, communication itself is loosed from a definition based on the ontology of participants. Communication is no longer synonymous with human communication. Instead, human communication becomes a type of communication along with HMC.

HMC – The Questions Driving Research

As an area of communication research, Human-Machine Communication *comprises the study of the creation of meaning among people and machines, and aspects thereof, and is inclusive of the different philosophical, theoretical, and methodological approaches within the discipline.* The question that follows is, "What does HMC research look like?" Because HMC by its very definition is broad and encompasses scholarly work within the social sciences and humanities, there is no singular way of conducting HMC research. With that said, all HMC research shares a focus on the machine as communicator and aspects of meaning-making between humans and machines with the goal of informing our understanding of communication. General research questions spanning HMC focus on understanding the machine as communicator; the machine's entry into our daily communication; the ways in which we communicate with machines; the relationships we form with machines as a result of our communication with them; the implications of communication with machines for self and society; and the resulting changes to communication theory and research now that machines function as communicators. There also are larger cultural questions regarding why we want to build communicative technologies in the first place and whether and why people want to engage or shun them. The chapters in this volume offer a glimpse of these and other questions asked by HMC scholars and the different approaches taken to answering them.

In *Chapter One*, Autumn Edwards explores fundamental questions regarding how people conceptualize robots as communicators: Her study focuses on people's perceptions of the nature of robots in relation to humans and animals. In particular, Edwards asks how people determine the sameness and difference among humans, machines, and animals, and how various factors related to these ontological associations enter into people's communicative behavior with robots. In *Chapter Two,* Eleanor Sandry also addresses questions related to the nature of humans and

machines but does so by critiquing the long-standing goal of making machines more human-like to promote interaction. In this theoretical essay, Sandry draws on various aspects of communication theory to argue that the difference between humans and machines can be constructed through communication in such a way that it is not a hurdle to overcome but, rather, a potential facilitator of the human-machine relationship.

For HMC scholars, the study of a machine as a communicator goes beyond asking "what is this I am communicating with?" to inquiring "what is this in relation to me?" In *Chapter Three*, Leslie Fritz traces how the human-robot relationship forms even before a robot physically enters people's lives. Fritz's rhetorical analysis of the crowdfunding websites for the social robots Jibo and Buddy demonstrates how the social identity of robots is constructed through their marketing, design, and consumers' interpretations of these materials. Robots historically have been designed to step into existing human roles, raising the question of how people perceive interactions with robots taking the place of a human. That is the key question driving a study of robots in educational contexts by Chad Edwards, Brett Stoll, Autumn Edwards, Patric Spence, and Andrew Gambino. In *Chapter Four*, Edwards et al. detail how students' public speaking anxiety increases when told they would be evaluated by a robot instead of a human and what this reaction says about people's expectations of interactions with robots within specific contexts.

The study of the exchange of messages between human and machine and the resulting effects has received the most scholarly attention, and several chapters focus on providing overviews of this research. In *Chapter Five,* Matthew Lombard takes stock of the progression of one of the first and most important areas of theory to focus on people's interactions through and with technology: presence. Within the context of HMC, presence is the experience of nonmediation when communicating with a technology. In detailing the development of presence

research, Lombard highlights future questions and applications, and the importance of understanding presence as it relates to emerging technologies. In *Chapter Six*, S. Austin Lee and Yuhua (Jake) Liang[21] review their research regarding persuasion in HMC with a focus on persuasive messages conveyed by social robots. Many of the same techniques of persuasion that are effective in human communication also are effective in human-machine communication; although, there are still many messaging strategies that have yet to be tested within HMC as well as newly emerging contexts for these interactions. HMC research also includes the study of general issues surrounding technology, asking what about these issues are the same or different within the context of machine as communicator. In *Chapter Seven*, Christoph Lutz and Aurelia Tamò consider privacy issues related to communication with healthcare robots. Drawing on Actor Network Theory and applying it to an HMC context, Lutz and Tamò trace the various facets of robot-patient interactions, raising questions regarding patient privacy that arise at each juncture.

This volume primarily focuses on HMC within the context of people's interactions with social robots; however, HMC research involves a variety of technologies. In *Chapter Eight*, Terje Colbjørnsen uses qualitative analysis to study people's conceptualizations of selection algorithms (Spotify, Netflix). How do people conceptualize an unseen thing as a communicator when they cannot even exchange verbal messages with it? What aspects of people's interactions with algorithms inform their understanding of them? These are some the questions addressed in Colbjønsen's analysis of indirect and asynchronous communication with algorithms.

As discussed in *Chapter Three,* people learn about technologies via messages about them. But people's conceptualizations of robots and AI extend well beyond marketing materials. They have a "cultural presence" (Sconce, 2000) established through decades of media portrayal. HMC

research also includes the study of this cultural presence,[22] its construction, and its role in people's conceptualizations of technology. In *Chapter Nine*, Patric R. Spence, David Westerman, and Xialing Lin examine how news reports about robots in the workplace enter into people's opinions of those robots within the United States. Through their study, Spence et al. explain not only people's feelings about robots and how they are shaped but also people's perceptions of what it would be like to communicate with robots. In *Chapter Ten*, Sakari Taipale and Leopoldina Fortunati dissect multiple aspects of people's opinions of robots recorded through a multi-country survey in the European Union. European residents overwhelmingly fear job displacement from robots, but, as Taipale and Fortunati also explain, several other factors may mitigate this fear, paving the way for robots to become the next "new media."

The final chapters address the larger implications of human-machine communication for the nature of communication and our own humanity. Ethics in communication has been formed around the assumption that humans alone are communicators. But, as David Gunkel argues in *Chapter Eleven*, the entry of machines into the communicator role upsets this assumption and, thus, the ethics built upon it. In this philosophical essay, Gunkel explores the concept of responsibility in communication now that human authors are being replaced by artificial writers. In *Chapter Twelve*, Charles Ess takes on questions surrounding what some people consider to be the most taboo form of human-machine communication—sex. In this philosophical essay on ethics, Ess provides an overview of the development of the study of ethics in relation to HMC before offering a new way of thinking through the polarized debate regarding sexbots. What Ess makes clear is that communication with sexbots, and any other machine, is an exercise in our humanity. Both chapters underscore that when communicating with an artificial Other, we not

only have to make sense of what it is but who we are and want to be in world of social machines. Communication, even with machines, shapes the Self.

The Most Important Question

To return to the original question, human-machine communication is both old, as conceptualized outside the discipline, and new, as it is taking shape within communication. It is more than the transmission of information between people and technology, HMC is about meaning-making. As an area of study within communication, HMC also is about carving out intellectual space within an already crowded discipline, challenging the very identity of the discipline. This book provides a glimpse into human-machine communication and its research, but HMC is so much more than what is in these pages. These chapters represent a view of HMC as it is emerging, just after social agents and algorithms were becoming the norms in people's lives and just before social robots, such as Jibo, became available to the public. As this book is going to press, technologies designed as communicators have only increased and become more widely available. Everything from refrigerators to cars to watches now exchange messages directly with people. What is needed now is for more communication scholars to take up the study of HMC bringing with them new insights and questions. The most important question at this point, then, is not "what is HMC?" but, rather, "what will human-machine communication become?"

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Notes

[1] See https://www.natcom.org/about-nca/what-communication.

[2] This section is a general overview. More research is needed to completely trace the many ways scholars have approached people's direct interactions with machines, particularly regarding HCI.

[3] Multiple terms have been used to refer to interactions between people and technology: man-machine interaction, man-machine communication, man-machine conversation, human-computer communication, human-machine interaction, and human-computer interaction (which is the most commonly used term). Any reference to "man-machine" interaction is for historical purposes. It is no longer appropriate to use "man-machine" because it excludes other genders.

[4] HCI grew out of research in multiple fields and is interdisciplinary, see Pew (2003) and Grudin (2017) regarding its history and Rogers (2012) regarding its theoretical evolution.

[5] Regarding this conceptualization of technology see Pacey (1983) and Verbeek (2005).

[6] This critical/cultural view appears in new chapters in a subsequent edition.

[7] For more on cybernetics's contribution to communication see Rogers's (1997) profile of Wiener and Wiener's (1948) own work. Ironically, it is cybernetics's agnosticism toward the nature of communicators that Craig (1999) attributes to its limited influence: "Cybernetics, then, is also interesting and sometimes implausible from a commonsense view because it points out surprising analogies between living and nonliving systems, challenges commonplace beliefs about the significance of consciousness and emotion, and questions our usual distinctions between mind and matter, form and content, the real and the artificial" (p. 141).

[8] Shannon, Weaver, and Wiener all influenced one another's thinking, as they acknowledge in introduction and footnotes in their works. All three are associated with cybernetics (Heims, 1991) and occupied the same scholarly circles as key technologists, such as Vannevar Bush and John von Neumann, and social theorists, such as Kurt Lewin and Margaret Mead (see Wiener's

introduction in *Cybernetics*). Shannon also was influential in artificial intelligence (McCarthy, Minsky, Rochester, & Shannon, 1955) and Weaver (1965) in machine translation.

[9] People's communication with machines and animals is often given a nod in early research that sets out a human-human research agenda (see Schramm, 1972, and the beginning of Weaver, 1949).

[10] There is a difference between HCI, the field, and the study of HCI within communication. Communication scholarship provides a particular means of theorizing the interaction between human and computer and of studying people's behavior with technology. But communication is only one of many disciplines contributing to HCI (Grudin, 2017; Lazar, Feng, & Hochheiser, 2010) with the study of HCI extending well beyond questions of communication.

[11] Reeves and Nass (1998) extoll social-scientific research within their work.

[12] The purpose of including so many areas of study within the same paragraph is to alert the reader to the many directions for studying people's interactions with machines; It is not intended to diminish them. I urge scholars in these areas, who are more qualified than me, to take up the challenge of explaining how their research can further HMC or even challenge it.

[13] For more on the idea of subjectivity, see also Jones (2014). My discussions with David Gunkel also helped to crystalize this idea.

[14] See for example, the special issue of *Intervalla*, Social Robots and Emotion: Transcending the Boundary Between Humans and ICTs (Sugiyama & Vincent, 2013).

[15] The "we" refers to the individuals involved in initial efforts to establish HMC (see the Preface).

[16] There is the question of how human-machine communication can serve as a disciplinary marker when it first was used outside the discipline, and this is a valid point. However, the term human-machine communication largely has fallen out of use in the fields in which it originated.

[17] Marconi, Siegman, and Machine Journalist (2017) provide an overview of automated journalism.

[18] Although these two "sides" carry a great deal of disciplinary baggage (Reardon & Rogers, 1988), interpersonal and mass communication are used here because they are easily recognizable frame of reference for communication scholars. How the configurations of HMC compare and contrast to those of human interaction is yet to be studied. However, given the multiple roles a single technology performs in interacting with humans, it would not be surprising if HMC further complicates our understanding of interpersonal and mass communication.

[19] A person, after all, can be a medium.

[20] That technology can perform different roles in communication complicates research regarding it. In my work, I have attempted to reconcile both roles by focusing on a technology's primary role, that of a communicator, and addressing other roles, that of a medium, within the context of the first (see Guzman, 2016, 2017).

[21] Lee and Liang co-authored this chapter; however, Liang passed away before its publication.

[22] The study of cultural portrayals of technology brings still more bodies of work to bear on HMC research, including the study of specific media – literature, film, and television – and specific genres within media, including science fiction and news.