Human-Machine Communication

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12/7/2010

INF 382C - Fall 2010

The ability of humanity to communicate complex thoughts and ideas with one another through the use of the language, writing and gestures constitutes one of the species' most unique traits, and arguably represents part of what makes humanity human. Throughout much of human history, human made objects lacked the capacity to emulate human communication and until the advent of machines with the ability to make simple computations, humans remained humans while machines remained tools. Once human created machines began making simple computations which appeared decisive and human-like, humanity seemingly endowed these inanimate machines with special powers akin to human communication. Despite the novelty of these new machines and their computational abilities, the machines do not communicate as humans do and therefore, numerous problems arise when humans attempt to communicate with the machines.

Anthropologist Lucy Suchman discusses the many difficulties in human-machine communication in her 2007 work, *Human-Machine Reconfigurations*. Suchman begins with a discussion on the differences between the plans and situated actions of human actors and relates the difference to the problems of human-machine communication. The dominant discourse in rationalist Western thought revolves around the idea of each individual human as a logically inclined entity, removed from social context, capable of planning a course of action and executing that plan. And this interpretation of the human being as a rational Cartesian individual planning and executing actions has been deified by Western scientific and academic discourse for at least the last several centuries. Suchman eloquently explains that the Western rationalist model of human existence contains an inherent flaw in that humans possess not only the capability to act, but often do act within situated contexts. Suchman utilizes a comparison between a European and a Micronesian mariner to illustrate this point. The stereotypical "rational" European mariner forms a plan to navigate from point A to point B over the open ocean and sticks to that plan regardless of the context of sea conditions, weather or other unforeseen situations. The Micronesian mariner by contrast, utilizes a set of maritime practices and natural contextual information to get from point A to point B without a prior formulated plan, which allows the Micronesian to act within any given situation nature might present. These contrasting modes of existence between the European and the Micronesian mariners indicate vastly different worldviews and denote comprehensive differences in the ways in which the contrasting cultures might build and utilize tools and machines.

Computational machines engineered in the Western tradition make excellent yes/no decisions, using if/then/else statements to infer what course of action the machine should take next. Western computational designers based modern computational machines entirely around digital binary systems. Accordingly, the machines represent information as merely a 1 or a 0 with no shades of grey in between. The engineering arrangement of yes/no, if/then, 1/0 inherently implies that a computational machine based on this arrangement will also require a plan — will we turn right here?: if yes then 1, else if no then 0 — and the computational machine reacts appropriately to such a command, just as a steering wheel would on a car. Suchman notes that the power in this binary relationship derives from the "fundamental interrelatedness" that positions the binaries "as separate categories to be obscured" (2007, p. 275). Accordingly, the interrelatedness of the binary system bases itself on opposing separateness rather than on networked connectedness. This oppositional binary relationship pervades many aspects of Western society — male/female, good/evil, day/night. Thus the engineering of Western computational machines arises not of necessity — the engineering of the machines might have evolved differently given alternate resources, ideas and historical circumstances — but as a reflection of Western cultural norms and values.

Given the binary nature of the Western computational machine's engineering, these machines have great difficulty in understanding any grey areas between black and white, including the grey area of human intent. Suchman explains that machines have "severe constraints on their access to the evidential resources on which human communication of intent routinely relies" (2007, p. 167). To alleviate the severe constraints machines have in identifying human intent, computational machine designers attempt to circumvent any misunderstandings by designing anticipatory mechanisms based on previous user actions. When the user's intent does not match the machine's anticipation of the user's action, likely based on a misunderstanding of the users intent in the previous action, problems arise and compound exponentially upon one another. "Because of the constraints on the machines access to the situation of the user's inquiry, breaches in understanding, that for face-to-face interaction would be trivial in terms of detection and repair, become 'fatal' for human-machine communication" (Suchman, 2007, p. 168). Thus human-machine communication breaks down because human communication relies on the intent behind the action and the meanings behind the words, neither of which machines engineered in the Western tradition can comprehend the nuances of given their binary nature.

Suchman identifies areas in which computational machines can better reflect human nature and existence. She mentions a number of art installations that utilize the same machines that fail to understand human intent to explore human nature and communicate that exploration of humanity to the viewers of the installation. One such installation involves a three dimensional projection of an infant interacting with the visitor who acts as the infant's caregiver. Suchman states in her analysis of the art piece that the installation's "elements create an interactive space characterized by a mix of predictability and contingency...that affords the installation its affective kinship to the 'real world' encounter that it simulates" (2007, p. 280). As this installation combines machines and humans in a non-oppositional conjoined space, the binary nature of computational machines becomes muted and human and machine interact in a symbiotic networked space. Suchman discusses several other similar art installations utilizing computational machines interacting with humans in a "cyborg"-like manner that she believes better reflect human communication. While such installations may hold promise in more robust human-machine communication, Suchman fails to mention any examples of machines that reflect better strategies in engaging humans in the for-profit capitalist context on which Western civilization rests.

The economics of design remains the primary factor inhibiting the advent of a machine that more accurately reflects Suchman's ideals, and the economics of design therefore adversely affects human-machine communication. Henry Petroski refers to a discussion on design between a psychologist, an architect and an engineer. While the architect and the psychologist expounded on the aesthetics of design, the engineer declared that "the design process is characterized mostly by tensions between competing objectives that are resolved by compromises, usually driven by the realities of manufacturing cost and sales price" (2003, p. 4). Given infinite resources, the design of computational machines could be entirely re-invented and made into anything conforming to physical laws and human imagination - perhaps including non-binary machines that might better grasp human intent. However, the feasibility of a project to re-invent Western computational machines rests entirely on the constraints of economics - manufacturing costs and sales price. Thus even if Suchman's ideal machine could be manufactured with infinite resources, the sales price of such a machine would be too excessive for all but the most affluent.

Further, the capitalist economic marketplace values the utility and function of the machine, as noted by the engineer in Petrowski's piece stating " the primary purpose of most things is to perform a function" (2003, p. 4). The art installations Suchman describes that better reflect human-machine communication have little utilitarian value in the capitalist marketplace. Rather the installations allow for the reflection upon what it means to exist as a human in a human manufactured virtual construction. Yet reflection holds little if any economic value, and in fact reflection in this instance creates a negative economic impact in that the installation prevents economic productivity on the part of both human and machine. Both the human visitor and the machine incorporated into the art installation would be better utilized by capitalists to generate a profit in the marketplace through the manufacture of some good or service in exchange for a nominal salary to the human. Thus, as the art installations Suchman describes as better examples of human-machine communication contain a negative economic benefit, the instances of human-machine communicative design as art installations will be relegated to elite circles of the bourgeoisie who possess the resources necessary for the conspicuous consumption of economically non-productive human and machine resources.

Considering Suchman's unrealistic expectations for the implementation of effective designs for human-machine communication, addressing the difficulties in human machine communication must employ a more utilitarian strategy. Donald Norman states that "for effective interaction with machines, the machines must be predictable and understandable. People must be able to understand their state, their actions, and what is about to happen." (2007, p. 153). Norman notes that non-digital machines often provide visual and auditory clues as to their state — such as the whistling of a tea kettle. Norman continues to explain that computational machines based on binary engineering often fail to provide these same clues as to the machine's state and therefore a user has no feedback from the computational machine as to whether the machine functions correctly or not. Norman describes a case in which an IBM programmer did not implement adequate feedback in a computational program to explain to the presenter why the program failed to work correctly, causing considerable embarrassment to the presenter when the presentation failed in front of his colleagues. Engineers eventually traced the source of the problem to a network security protocol, and Norman suggested that if adequate feedback had been provided, the engineers would have known the source of the problem much sooner. Although Norman might be correct in his assessment that adequate feedback would have helped in diagnosing the problem, generating that feedback would have been extremely difficult to program. Error checking in software design remains by far one of the most difficult tasks for any programmer in that code behaves differently on different platforms and in different environments, just as most machine behavior varies in different weather conditions. Providing feedback to users on every platform and in every environment becomes next to impossible in that each local system can be set up in any number of infinite ways and the programmer cannot possibly anticipate every scenario in which the code will run. In Norman's particular case, network security could be configured in an infinite variety of ways and the programmer could not account for all of them, nor would the program necessarily have access to the information from the network that the network blocked the program's access to the internet. Nevertheless, the code the IBM presenter planned to run before an audience certainly should have been tested in the presentation's local environment before the actual presentation to thwart the embarrassment caused by the program's failure in front of an audience.

Norman provides a list of design rules to assist with human-machine communication. In addition to his prescription for the predictability of machines and a way for humans to understand the machine's state through feedback mechanisms, Norman suggests providing "continual awareness, without annoyance" (152). Microsoft proved the difficulty in implementing such a prescription upon release of its Windows Vista operating system. The OS provided constant feedback of the systems functionings according to Norman's prescription, yet this constant feedback drove users insane causing them to disable these feedback messages entirely. Computational machines perform so many operations every second, that constant feedback would grind their usefulness to a halt while annoying and ultimately enraging the users of the machines. Thus Norman's prescription of feedback from the machine as it performs operations does not in practice seem particularly useful to users, designers, marketers or manufacturers of computational machines.

As neither Suchman's fanciful, nor Norman's practical solutions to the problems of human-machine communication appear particularly useful to users or designers, both designers and users must learn to better understand one another, and moreover, understand the computational machines that they must both design and use to function in modern society. Gary Marchionini notes that " Humans will live and work in a hybrid physical and digital world" (173). The blending of the physical and virtual digital world represents a watershed moment in human history. Never before have humans created so many mechanical artifacts, nor created so much information or a whole society reliant upon those artifacts. This hybrid physical-virtual world creates reconfigurations of the ways in which humans and machines interact with one another. Marchionini states that "people are changing what they do with information—they no longer only consume it (read/view/listen/ ponder) but they annotate, link, and extend it as they consume—i.e., they interact with it " (173). Thus, the users of computational machines gradually become more savvy about how those machines work and the users' understanding of these computational machines arises from necessity as these machines have emerged as a prerequisite for existence in the modern world. The use of computational machines has been forced upon individual humans in that individuals require the machines to communicate with friends, family and co-workers, as well as function in society with tasks such as banking, travel and even to find a form of wage labor or apply for government assistance. This reconfiguration of social structures around a hybrid physical-virtual world also creates new issues for those users who fail to understand both the machines that they must use, as well as for the users who neglect or ignore the social ramifications of their use of these machines.

Numerous inherent consequences result from the reconfigurations of society around the human-machine hybrid. Suchman summarizes literary theorist Alexandra Chasin's assessment of human-machine social configurations stating:

> Chasin points to the correlation, within the United States at least, between a dwindling middle class and increasingly polarized working and affluent population, and the increase in both the number of household appliances and domestic workers..."in this climate, electronics stabilize the idea that a service class of being(s) is proper and even necessary; here, electronics participate in, and thereby reinforce, the unequal social and psychological dynamics upon which the myth of a constantly expanding middle class depends" (2007, p. 220).

Chasin recognizes the consequences to both society and individual humans in this new hybrid physical-virtual reality. Machines have become servants to both the affluent and the dwindling middle class in US society, and in their mechanical servitude, the machines reinforce the social inequalities inherent in US market capitalism, rendering human servants as acceptable as mechanical servants. And yet machine servitude merely masks a growing chasm between the upper and lower classes in US society, as the dwindling middle class struggles to keep pace with their forced addiction to mechanical servants to the detriment of both the lower class and the middle class itself. Suchman continues with Chasin's assessment stating "the smart machine's presentation of itself as the always obliging, labor-saving device erases any evidence of the labor involved in its production and operation, 'from bank personnel to software programmers to the third-world workers who so often make the chips'" (221). The outsourcing of human servants by machine servants in fields as diverse as banking and tourism will likely continue unabated as mechanized servants become more powerful and more productive than before, as well as more affordable than the humans they replace, and the adverse consequences arising from this outsourcing will have profound effects on many humans in a variety of service industries. Although Suchman notes that others have suggested that "the effectiveness of any labor saving device both presupposes and generates new forms of human labor" (2007, p. 221), US based multinational corporations routinely utilize and exploit these new forms of human labor in places where labor is much cheaper than the US, as Chasin suggested in her comment on the "third-world workers" who often make the chips that run the computational machines. Software programming has also increasingly moved from the US to parts of the world with drastically cheaper labor costs, a necessity within capitalism to increase profits and continue economic growth.

Although some of humanity may long for a return to pre-capitalist egalitarian hunter-gatherer societies, or even a return to pre-computational machine capitalist societies, such societies will not arise without a catastrophic failure of humanity's now fully mechanized civilization — a collapse of the power grid, a scarcity of energy resources to feed that power grid, or a mass human boycott of all machines by consumers and the proletariat. With such events unlikely in the near future, users must learn to understand binary engineered machines, just as much as designers need to conform to the needs of the majority of users. Should users fail to do this, they will be left on the impoverished side of the digital divide, condemned to a life as machine-like servants, serving the capitalist masters of the machines. Given the current discourse trumpeting the benefits of the capitalist mode of production in Western societies, and the United States in particular, individuals on the impoverished side of the digital divide will hold the same serf-like social status that the machines have...and often even less. As Chasin noted, machines present themselves as obliging and thus unlikely to question the motives of their capitalist masters, as a human servant might. Although certainly a sad state of affairs for advocates of humanism, the tenets of US capitalism insist that each human individual or machine produce a commodity or perform a service which has a marketable value for the lowest cost possible.

As machines become ever cheaper thanks to the exploitation of third-world human labor, they will inevitably replace their human counterparts in US service industries.

Devout computational system designers and their marketing cohorts have dominated the human cultural discourse, convincing a majority of humans that the computational machines possess human-like communicative power, and this discourse has led to a serious misunderstanding of what an inanimate object can be endowed by its creator to do. The human inclination to communicate with machines appearing to possess human characteristics as though the machines possessed human communicative abilities seems rational, but for millions of years the majority of human beings rarely expected their stone, iron, bronze, paper or steel tools to communicate with them. Archaeologists who find stone tools millions of years old must recreate and test the stone tools they recreate to discover the wear patterns on them to better understand how the tools might have been used. The archaeologists have no expectation that the tools will talk to them or understand their intent, nor likely did the hominid millions of years ago. Users cannot expect computational machines with them in a human-like fashion any more than a sword or book can. Users of computational machines must therefore develop a more mature attitude toward their tools and gain a better mastery of them. The mastery of use of any tool necessitates inquiry and practice on the part of the user and a user cannot expect that a computational machine will communicate with him or her any more than a stone could communicate to a user how to build a fire. Although the use of computational machines has been forced upon individual humans in that individuals require them to communicate and function in society, each human must understand that to adapt to this new society, they must better understand the machines on which the society is predicated. The humans who do not do this will be condemned to a life of poverty and enslavement not to the machines that run the social structures, but rather to those powerful humans who control the manufacture and access to those machines. Although it is certainly true that even those who understand the machines will also be enslaved by their corporate masters, they will have power over the design and manufacture of those machines...and perhaps one day, the humans who understand the machines will tire of the social inequities inherent in the free market and use the machines to reconfigure the society again in a more equitable and socially just manner.

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