Artificial Intelligence: Robots, Avatars, and the Demise of the Human Mediator

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As technology has advanced, you may have wondered whether (or simply when) artificial intelligence devices will replace the humans who perform complex, interactive, interpersonal tasks such as dispute resolution. Has science now progressed to the point that artificial intelligence devices can replace human mediators, arbitrators, dispute resolvers, and problem solvers? Can humanoid robots, attractive avatars, and other relational agents create the requisite level of trust and elicit the truthful, perhaps intimate or painful, disclosures often necessary to resolve a dispute or solve a problem? This article will explore these questions. Regardless of whether the reader is convinced that the demise of the human mediator or arbitrator is imminent, one cannot deny that artificial intelligence now has the capability to assume many of the responsibilities currently being performed by alternative dispute resolution (ADR) practitioners.

Artificial intelligence can be imbedded in a variety of physical forms. This article will focus primarily on robots designed to resemble humans and avatars. Robots can, of course, assume whatever form the designer desires, including human, animal, abstract, or strictly functional (as might be seen in an industrial enterprise). Artificial intelligence, however, does not need to be defined by a physical form. Much of what will be discussed in this article will be relevant to, and include, devices that do not have presence in the physical world.[1] Avatars, for example, initially were regarded as a "graphic

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representation of a real person in cyberspace."[2] Virtual worlds such as *Second Life*[3], *There*[4], and *Active Worlds*[5] are populated by millions of "residents," that being, individuals who direct their avatars in an essentially limitless number of interactions with other residents in a three-dimensional virtual world. The connection to an actual person once thought necessary is becoming less relevant, and the term "avatar" now includes non-player characters in three-dimensional online games and virtual online salespersons.[6]

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[1] Artificial intelligence useful for dispute resolution problem solving may exist only as software. Smartsettle, for instance, is an online negotiation system that uses optimization algorithms to produce results "beyond win-win." The *Smartsettle* website states:

> Smartsettle has a unique patent-pending multivariate blind bidding system that is superior to ordinary double blind bidding. While other blind bidding systems are restricted to single-issue cases between two parties, Smartsettle's method can be extended to any number of negotiators in conflict over decisions to be made on any number of variables.
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> . . . .
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> While some other blind bidding systems use a split-the-difference algorithm that tends to produce a chilling effect, Smartsettle's algorithms actually produce the opposite effect by rewarding negotiators for moving quickly to the Zone of Agreement, thus resulting in quicker settlements.

Smartsettle, Smartsettle's Visual Blind Bidding, http://www.smartsettle.com/resources/25-articles/31-smartsettles-unique-blind-bidding (last visited Oct. 20, 2009).

[2] Compu-Kiss Techionary, http://www.compukiss.com/techionary-glossary/a-4.html?page=1 (last visited Oct. 2, 2009). Webster's definition of an avatar includes "an electronic image that represents and is manipulated by a computer user (as in a computer game)." MERRIAM-WEBSTER DICTIONARY (2009), *available at* http://www.merriam-webster.com/dictionary/avatar; *see also* WAGNER JAMES AU, THE MAKING OF SECOND LIFE: NOTES FROM THE NEW WORLD 252 (2008) ("From the Sansrkit [sic] for 'godly incarnation,' [avatar is] a common virtual-world term for an onscreen alter ego or character controlled by the user. Avatar generally refers to the specific physical characteristics (gender, race, etc.) of a [virtual world] Resident. Many Residents have several avatars for different events, moods, social situations.").

[3] *See generally* Second Life, http://secondlife.com/ (last visited October 2, 2009).

[4] *See generally* There, http://www.there.com (last visited October 2, 2009).

[5] *See generally* Active Worlds, http://activeworlds.com/ (last visited October 2, 2009).

[6] Charles Rich & Candace L. Sidner, *Robots and Avatars as Hosts, Advisors, Companions, and Jesters*, AI MAGAZINE, Spring 2009, at 29, 30–31 (referring to Anna at http://www.ikea.com/us/en/ as an example of a "synthetic online salesperson").

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It is fascinating (and perhaps unsettling) to realize the complexity and seriousness of tasks currently delegated to avatars and robots. This article will review some of those delegations and suggest how the artificial intelligence developed to complete those assignments may be relevant to dispute resolution and problem solving. Relational agents, which can have a physical presence such as a robot, be embodied in an avatar, or have no detectable form whatsoever and exist only as software, are able to create long term socioeconomic relationships with users built on trust, rapport, and therapeutic goals.[7] Relational agents are interacting with humans in circumstances that have significant consequences in the physical world. These interactions provide insights as to how robots and avatars can participate productively in dispute resolution processes.

Artificial intelligence has two complementary components: the physical form of the device and the "intellectual" capacity of the software.[8] The difference between these two components is similar to "the difference

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[7] *See* Timothy Bickmore & Laura Pfeiffer, *Relational Agents for Antipsychotic Medication Adherence*, *in* CHI 2008 WORKSHOP ON TECHNOLOGY IN MENTAL HEALTH 1, 2 (2008), *available at* https://www.cs.tcd.ie/TIMH/01-Bickmore.pdf. *See generally* Daniel Schulman & Timothy Bickmore, *Persuading Users Through Counseling Dialogue with a Conversational Agent*, Notes before the 2009 Proceedings of Persuasive Technology 1–2, *available at* http://www.ccs.neu.edu/research/rag/publications/Persuasive09.pdf (explaining that "embodied conversational agents," which are computer-generated characters that appear and interact as human, can be particularly effective relational agents, but that relational agents, which are computer-generated artifacts designed to build and maintain long term social-emotional relationships with humans, need not be embodied social agents). *See also* Thomas Holz et al., *Where Robots and Virtual Agents Meet: A Survey of Social Interaction Research Across Milgram's Reality-Virtuality Continuum*, 1 INT'L J. OF SOC. ROBOTICS 83, 85 (2009), *available at* http://www.springerlink.com/content/c1235h2558367676/fulltext.pdf (observing that regarding the difference between robots and graphic representations such as avatars, one should not focus too closely on embodiment distinctions but should instead recognize that robots and other entities can serve identical purposes).

> [W]hile in the past software agents and robots have usually been seen as distinct artefacts of their respective domains, the modern conception is, in fact, to consider them as particular instances of the same notion of agent—an autonomous entity capable of reactive and pro-active behaviour [sic] in the environment it inhabits.

Id. Rich and Sidner do not use the phrase "embodied conversational agent," believing the term is confusing when robots are discussed because robots, not graphical agents, have real bodies. Rich & Sidner, *supra* note 6, at 30.

[8] *See Military Use of Robots Increases*, SCIENCE DAILY, Aug. 5, 2008, http://www.sciencedaily.com/releases/2008/08/080804190711.htm.

Electronic copy available at: http://ssrn.com/abstract=1461712

between [an] adverb and [a] noun."[9] In other words, a device can either *behave* intelligently as a result of automated or human-controlled directions, or a device literally can *be* intelligent in the sense that it requires no external influence to direct its actions.[10]

The more readily achievable goal is to create a device that behaves intelligently. Because we believe that humans are the most intelligent species, it should not be surprising that a significant amount of artificial intelligence research concerning this first goal involves devices that resemble humans—specifically, robots. Robotics scientists and specialists are creating physical representations of human beings that mimic our movements and even our appearances.[11] Robots are being developed that replicate human appearance and movement surprisingly accurately.

But simply creating a realistically behaving robot or avatar may not be sufficient. Will avatars and robots truly be able to engage humans? Or instead, will the prospect of interacting with lifeless entities feel so unnatural that artificial intelligence devices will not be able to encourage the conversations and disclosures necessary for successful dispute resolution and problem solving? Studies have concluded that persuasive dialogues with computer agents can change attitudes.[12] Results based on interactions in situations other than ADR suggest that avatars and robots acting as relational agents also are capable of behaviors that will facilitate dispute resolution and problem solving.

The more difficult, more exciting, and perhaps more troubling goal is the second one. Can we create devices that actually are intelligent and, if so, what role can those devices play in dispute resolution and problem solving processes? Can human mediators and arbitrators be replaced by robots and avatars that not only physically resemble humans, but also act, think, and reason like humans?[13] And to raise a particularly interesting question, can

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[9] *Id.*

[10] *Id.*

[11] *See, e.g.*, Claire Bates, *Mini-Me: The Robot that Looks and Sounds Just Like You*, THE DAILY MAIL (UK), Feb. 6, 2009, *available at* http://www.dailymail.co.uk/sciencetech/article-1137747/Mini-Me-The-robot-doll-looks-sounds-just-like-you.html; Michael Santo, *Empathetic Robotic Einstein Shows "Relativity" with Humans*, REAL TECH NEWS, Feb. 9, 2009, http://www.realtechnews.com/posts/6450; *Einstein Robot Smiles When You Do*, CHINA ECON. NET, Feb. 7, 2009, http://en.ce.cn/World/Americas/200902/07/t20090207_18140396.shtml.

[12] *See* Schulman & Bickmore, *supra* note 7, at 7.

[13] *See, e.g.*, Holz et al., *supra* note 7, at 83. Specifically, Holz states that:

robots, avatars, and other relational agents look, move, act, think, and reason even "better" than humans?

I. BUT WHAT DOES "BETTER" MEAN?

"Better" is a seductive term that demands an assessment and comparative ranking, yet has no apparent objective standards or moral component—"better" in what sense, according to whose judgment, and based on what values? When considering potential applications for artificial intelligence devices, one must keep in mind that devices can be created that could result in a loss of human control over both specific, discrete human interactions as well as computer-based programs that support a rapidly increasing share of society's workload.[14] Is this beginning to sound like the beginning of a bad science fiction novel? You wish.

> Trends such as inexpensive internet access and the diffusion of wireless computing devices have made ubiquitous or pervasive computing a practical reality that augments the normal physical environment and supports the delivery of services to human users anytime and anywhere. A lot of interfaces for these environments are built on the idea that a social interface, that is, an interface availing of human-like social cues and communication modalities, is the most natural and thus most effective way for humans to interact.

Id.; *see also* Hideki Kozima et al., *Keepon: A Playful Robot for Research, Therapy, and Entertainment*, 1 INT'L J. OF SOC. ROBOTICS 3 (2009), *available at* http://www.springerlink.com/content/v7hqn0q322679qn7/fulltext.pdf; James E. Young et al., *Toward Acceptable Domestic Robots: Applying Insights from Social Psychology*, 1 INT'L J. OF SOC. ROBOTICS 95 (2009), *available at* http://www.springerlink.com/content/p8452j71kt410472/fulltext.pdf. On the other hand, some scientists believe that a robot's artificial intelligence ultimately will be housed in a remote location:

> The ubiquity of cell networks and Wi-Fi networks can mean low-cost consumer robotic characters that can connect to a bank of servers on the other end of the wireless network—which can have on them artificial intelligence software. . . .
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> . . . If you have that processing power on this bank of servers, you can then have low-cost [robotic] hardware that is using supercomputers on the other end of the wireless networks to perform [its] mental calculations.

Daniel Terdiman, Head Over Heels for Tomorrow's Personal Robots, (Jan. 11, 2008), *available at* http://news.zdnet.com/2100-9595_22-183050.html (quoting David Hanson, founder of Hanson Robotics).

[14] *See* John Markoff, *Scientists Worry Machines May Outsmart Man*, N.Y. TIMES, Jul. 26, 2009, at A1, *available at* http://www.nytimes.com/2009/07/26/science/26robot.html.

In 2009, the Association for the Advancement of Artificial Intelligence met in Asilomar, California to debate whether artificial intelligence research should be limited. That location was chosen purposely to evoke the 1975 world-leading biologists' meeting held at that same location to discuss the newly discovered ability to reshape life by trading genetic material between organisms.[15] That meeting led to the discontinuation of certain experiments and new guidelines for recombinant DNA that allowed experimentation to continue.[16]

At the 2009 conference, scientists looked closely at artificial intelligence systems that communicate empathy to medical patients. This particular focus was part of their effort to determine possible dangerous consequences of artificial intelligence.[17] It is important to note that these are the same types of systems presented later in this article as prime examples of how far artificial intelligence devices have advanced and how valuable these devices will be for ADR.

One of the scientists' concerns intersects with an implicit theme in this article. Artificial intelligence devices are proliferating and, like it or not, increasingly will become a greater part of dispute resolution and problem solving processes.[18] In our everyday lives we will be forced to live with artificial intelligence devices that realistically mimic human behaviors.[19] These interactions will raise socioeconomic, legal, and ethical issues, and humans will have to think about the consequences of interacting, for instance, with a device that is as intelligent as, and perhaps even more empathetic than, our spouses.[20]

Will artificial intelligence devices become even more intelligent than human beings? Some scientists believe that this type of "intelligence explosion" will occur, and that smart machines in turn will develop even more smart machines until we reach the end of the human era.[21] A

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[15] *Id.* at A4.

[16] *Id.*

[17] *Id.* at A1.

[18] *See, e.g.*, *id.*; *infra* p. 40 and note 94. The author admittedly is someone who likes the idea but definitely shares concerns about possible loss of control and emphasizes that artificial intelligence users should not plan on simply flipping the "on" switch and walking away.

[19] Markoff, *supra* note 14, at A1.

[20] *See id.* at A4; *infra* p. 106 and notes 249–50.

[21] Markoff, *supra* note 14, at A4. Computer scientist Vernor Vinge predicted this end to the human era, which he named the "Singularity". An organization by that same name has begun offering classes to prepare for this predicted inevitability. *Id.*

reassuringly contradictory point of view, however, is that "[u]ntil someone finds a way for a computer to prevent anyone from pulling its power plug, . . . it will never be completely out of control."[22]

The predictions and suggestions in this article do not look quite so far ahead. This article discusses artificial intelligence devices that exist today, or at least will exist very soon, and suggests how these devices can be integrated into ADR processes. Some of the worrisome consequences of using artificial intelligence devices will be addressed, but extensive discussion about the potentially dangerous consequences of employing artificial devices that actually are intelligent goes beyond the scope of this article and must be reserved for another day.

But make no mistake. If one accepts the proposition that parties should have significant control regarding the nature of their ADR processes, then parties being encouraged (or forced) to live with artificial intelligence in their everyday lives will become more comfortable and familiar with these devices and eventually will expect and demand that these devices be included in dispute resolution and problem solving processes.

II. WHAT IS NECESSARY FOR ROBOTS AND AVATARS TO INTERACT EFFECTIVELY WITH HUMANS?

There are many ways to organize a discussion about the contributions that robots and avatars can make to dispute resolution and problem solving. This article divides that discussion into the two components described in the introductory section. It first addresses the question of how intelligently robots and avatars can behave today in light of scientific advances, and the article then asks whether, and to what degree, a robot or an avatar can be described as intelligent.

Although organizing the discussion in this manner certainly is helpful, more must be done at the outset. This article argues that robots and avatars can perform, at least for some purposes, as effectively as human mediators. To make that case it is necessary to identify the capabilities considered essential for effective human interaction and to then assess the degree to which robots and avatars possess those characteristics. This subsection summarizes a mainstream theory as to what capabilities are essential for

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[22] Janna Quitney Anderson & Lee Rainie, *The Future of the Internet II*, PEW INTERNET & AMERICAN LIFE PROJECT 21 (2006), *available at* http://www.pewinternet.org/~/media/Files/Reports/2006/PIP_Future_of_Internet_2006.pdf (quoting Internet Society board chairman Fred Baker).

human interaction. The article subsequently provides numerous examples of robots and avatars interacting with humans and fulfilling delegated duties. These examples from a variety of contexts demonstrate that contemporary robots and avatars are fully capable of effective human interaction.

When considering whether a robot or avatar can act as a surrogate for a human mediator, it is logical to assume that the robot or avatar must be able to replicate human physical and intellectual processes precisely. And if the goal is to provide a substitute for a human mediator that literally is as similar as possible—in effect a twin for that human—then this concern is well-founded.

But there is an important caveat. Artificial intelligence may not need to mimic human appearance, movement, and cognitive processes in order to achieve desired results. If the goal is not merely to duplicate the performance of a human mediator but instead to exceed, or even simply supplement, that performance, then it may prove counterproductive to design a robot or avatar that is a mirror image of a human. Artificial intelligence that is embodied in a physical form very different from a human, or that does not assume any form at all but instead exists merely in a "cloud," may be able to engage a human party who refuses to, or is unable to, engage with another human (at least at this particular point in time). Variables that include the personalities of the parties, the parties' present physical and emotional circumstances, the relationship among the parties, and the parties' comfort level with technology are among the factors that will determine whether it is most advisable to introduce artificial intelligence into a dispute resolution process in the form of a very realistic humanoid robot.

With that caveat in mind, there remains great value in exploring the question of whether a human mediator's place at the proverbial mediation table can be assumed by a humanoid robot. The most recent generation of robots and avatars has four critical human capabilities: "engagement, emotion, collaboration, and social relationship."[23] First, the article will discuss what is meant by these terms. Later subsections will provide examples of robots demonstrating these capabilities.

Engagement refers to the ability to initiate, maintain, and terminate a connection to another individual.[24] As suggested earlier, in order to engage, a device must behave intelligently. The direction of the eyes, the nod of the head, hand gestures, body position, the delay before response, the determination of when to interrupt—these cultural cues have been carefully

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[23] Rich & Sidner, *supra* note 6, at 30.

[24] *Id.*

studied and deconstructed, and, as a result, it increasingly is possible for robots and avatars to connect with humans by using these cues.[25]

Emotions play a major role in human behavior and are critical when it comes to initiating and sustaining relationships. Emotions can create obstacles to problem solving by diverting attention from substantive issues, damaging relationships, or providing opportunities for exploitation.[26] But emotions also can be a valuable asset, providing motivation, enhancing relationships, and making it easier to listen and learn.[27] Researchers are developing computational theories of emotion that allow robots and avatars to interact emotionally with humans, concluding that emotions are closely intertwined with cognitive processing "both as antecedents (emotions affect cognition) and consequences (cognition affects emotions)."[28] In order to interact with humans, a robot or avatar must recognize and understand cues such as facial expressions, gestures, and voice intonation and, in turn, convey information about its own emotional state by using appropriately responsive cues.[29]

Collaboration is, of course, a term that is near and dear to the hearts of dispute resolvers and problem solvers. Robots and avatars are being designed that can work together with humans (and possibly other robots and avatars) to achieve a shared goal.[30] Collaboration is a higher level process dependent on engagement, but the relationship is not strictly hierarchical.[31] The progress of the collaboration can affect how engagement behaviors are interpreted because, for example, failure to make eye contact when the collaborators both are focusing on a document will not indicate intent to disengage.[32]

Social relationships between humans and robots or avatars to date have been short-term with an immediate collaborative goal such as shopping or entertainment.[33] But that is changing. A social relationship is an extended

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[25] *Id.*

[26] ROGER FISHER & DANIEL SHAPIRO, BEYOND REASON: USING EMOTIONS AS YOU NEGOTIATE 5–6, 8 (2005).

[27] *Id.* at 7–10.

[28] Rich & Sidner, *supra* note 6, at 30 (citing J. Gratch et al., *Modeling the Cognitive Antecedents and Consequences of Emotion*, 10 J. COGNITIVE SYS. RES. 1, 1–5 (2008)).

[29] Rich & Sidner, *supra* note 6, at 30.

[30] *Id.* at 31.

[31] *Id.*

[32] *Id.*

[33] *Id.*

engagement that may be necessary, for instance, to address issues that require behavioral modification such as weight loss and substance abuse.[34] Domestic relationship and separation issues, for example, are often a subject of mediation and may require changes in behavior. A social relationship can improve collaboration and thus increase the chances of achieving a desired goal.[35]

This brief discussion of these capabilities will make it easier to appreciate and understand the sophistication of the artificial intelligence devices described below. And it certainly helps us understand what will be necessary for an artificial intelligence device to replace a human in a collaborative process. But again, please keep in mind that these characteristics will not be necessary in every circumstance and, in fact, are not present in all of the following examples. The fact that an artificial device does not have all the qualities necessary for an extended human interaction does not alter the fact that the device still may be able to accomplish a specific goal. And the fact that an artificial device does not replicate a human precisely may lead to more productive human interactions in certain situations.

III. THE ADVERB: ROBOTS BEHAVING INTELLIGENTLY

In order to determine how behavioral artificial intelligence devices can be integrated into dispute resolution and problem solving processes, it will be helpful to explore how those devices are being used in other contexts. Although some of the current applications are not immediately transferable to ADR, they do illustrate the state-of-the-art for artificial intelligence and may suggest potential applications. One application that certainly deserves close examination is robotic technology.

Robotic technology represents a type of artificial intelligence that has intrigued both scientists and the public at large for generations.[36] On the one hand, scientists are driven by intellectual curiosity and professional demands to discover new information and tools that explain and simplify our lives.[37]

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[34] Rich & Sidner, *supra* note 6, at 31.

[35] *Id*.

[36] *See, e.g.*, ISAAC ASIMOV, I, ROBOT (Bantam Spectra Books 2004) (1950); MARY WOLLSTONECRAFT SHELLEY, FRANKENSTEIN (Maurice Hindle ed., Penguin Classics 2003) (1818).

[37] There is, however, some debate about the relationship among supply, demand, and scientific innovation:

The public, on the other hand, often is inspired by popular culture that romanticizes the possibilities of the future.[38] Whatever the reason behind the fascination, however, one thing is apparent—robotic technology already is part of contemporary modern life and it quickly is becoming even more integral.[39]

Robots can present a variety of appearances that range from shockingly lifelike to futuristically hybrid human-mechanical. Carnegie Mellon University's Valerie and the Naval Research Laboratories' George, for example, present only a human face on top of a generic, metallic, cylindrical mobile base.[40] In contrast, Geminoid closely replicates human appearance and movements.[41] The European Union's JAST robot has a small cartoon-like head mounted on a torso with two highly dexterous humanlike arms (allowing for collaboration on assembly tasks) and the Massachusetts

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> The 'classical' Schumpeterian position is that demand plays little or no role at all; that innovation is directed entirely by entrepreneurs who force the development of new markets. To the contrary, however, there is at least some empirical evidence of supply-demand interaction in industrial markets, although the role of the consumer demand in innovation has remained much more obscure. *It is becoming accepted, however, that innovation in consumer environments is highly dependent upon factors of socialization that merge utility with symbolic and cultural factors*, and that this involves subtle transfers of knowledge from consumers to producers about emerging social trends and preferences.

Young et al., *supra* note 13, at 96 (emphasis added) (discussing the impetus behind technological developments such as the iRoomba domestic robot).

[38] *See id.* Even scientists themselves, such as Bill Smart of Washington University in St. Louis, are lured by the media portrayal of life in the twenty-first century: "When I envision the future of robots, I always think of the Jetsons." *Modern Use*, *supra* note 8.

[39] Young et al., *supra* note 13, at 95. The growing presence of robots in society prompted one scientist to remark that, "[s]imilar to how we encounter computing in our daily lives, people may soon have little choice in the matter of interacting with robots." *Id.* at 95; *see also Robotics Integrated with Human Body in Near Future? Technology Gulf Between "Have" and "Have Nots" Predicted by 2020*, SCIENCE DAILY, Dec. 8, 2008, http://www.sciencedaily.com/releases/2008/12/081205100137.htm (excerpting Antonio Lopez Pelaez & Dimitris Kyriakou, *Robots, Genes, and Bytes: Technology Development and Social Changes Towards the Year 2020*, 75 TECH. FORECASTING AND SOC. CHANGE 1176 (2008)); *Trust Me, I'm a Robot*, THE ECONOMIST, Jun. 8, 2006, at 18, *available at* http://www.economist.com/science/displayStory.cfm?Story_ID=7001829.

[40] See Rich & Sidner, *supra* note 6, at 31, for a photograph of George.

[41] *Id.* Geminoid is a very realistic humanoid robot modeled after Hiroshi Ishiguro, professor at Osaka University and researcher at ATR Intelligent Robotics and Communication Laboratories. Videos of Geminoid and a description of its development and design are available at http://www.pinktentacle.com/2006/07/geminoid-videos/.

Institute of Technology Media Lab's Leonardo closely resembles a small animal with significant expressive capability, particularly in its face.[42]

Mel is a penguin designed for "hosting."[43] Mel resembles a stuffed animal and has a moveable head, beak, and wings on top of a mobile base.[44] He can guide and inform humans about environments such as stores and museums, and supervise human actions with objects found in those environments.[45] Using algorithms for initiating, maintaining, and terminating conversations, Mel has demonstrated that he can follow a human's face and gaze, and also look and point at shared objects at appropriate times.[46] Mel can nod his own head, recognize human head nods, converse about himself, participate in collaborative demonstrations, locate a human in an office environment, engage the human in a conversation noting where that person is looking and the time that passed since the person last spoke, and respond to human cues signaling a desire to disengage.[47] Humans respond when Mel tracks their faces, returning Mel's gaze, and they nod more frequently at Mel when he recognizes their nods.[48]

Numerous examples from various disciplines and professions demonstrate how robots can be used. If the health sciences, for instance, find it productive to use robots when a patient's life, or at least his or her health and well-being, literally may be at risk, then certainly there is a role for robots in ADR.

Psychologists, for example, are using this form of artificial intelligence to achieve fairly sophisticated interactions with young patients suffering developmental disorders such as autism.[49] In this particular application,

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[42] *See* Rich & Sidner, *supra* note 6, at 32 (displaying photographs and descriptions of JAST and Leonardo).

[43] *Id.*

[44] *Id.*; *see also id.* at 34 (displaying a photograph of Mel).

[45] *See* Rich & Sidner, *supra* note 6, at 32. It is not unusual for robots to have a gender. Mel's creators identify to Mel as a male.

[46] *Id.*

[47] *Id.*

[48] *Id.* at 32–35.

[49] Kozima et al., *supra* note 13, at 3 (describing the success of Keepon, a therapeutic robot used with autistic children). Social robots also have been and continue to be developed for children who do not have developmental disorders: "This research trend is motivated not only by the potential pedagogical, therapeutic, and entertaining applications of interactive robots, but also by an assumption that the development and underlying mechanisms of children's embodied interaction form a fundamental substratum for human social interaction in general." *Id.* at 4. In other words, the way that

intelligent technology is embedded in a social robot, an electronic device with humanoid or other "creature-like" characteristics.[50] These robots are programmed to interact with children in a manner that replicates human interaction "by exchanging a variety of social cues, such as gaze direction, facial expression, and vocalization."[51] Notably, social robots have been able to elicit desirable behavior from autistic children that those children typically

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children interact with social robots will inform scientists of the appropriate characteristics to make social robots successful with adult interactions. *Id*; s*ee also* David Allen Larson, *Technology Mediated Dispute Resolution (TMDR): A New Paradigm for ADR*, 21 OHIO ST. J. ON DISP. RESOL. 629, 675–77 (2006) (discussing how children with autism can interact productively with avatars in a collaborative virtual environment).

[50] Kozima et al., *supra* note 13, at 4; Young et al., *supra* note 13, at 96–99. Social or "sociable" robots can be defined as:

> [T]hose which understand and communicate using human language to allow them to participate and be understood as social actors. Sociable robots could use human-like facial expressions that indicate their general state, or gestures such as shrugging, indicating that they do not understand a command. Or they could monitor facial expressions to determine if users are happy or distressed. This approach, in addition to the pure utility of communication, also considers user comfort, perception, naturalness and ease of communication.

Id. at 97–98. The problem that faces robot designers, however, is known as the "uncanny valley"—"the more human-like a robot is, the more believable and comfortable people find it. However, as likeness increases there is a breaking point beyond which familiarity drops and robots become eerie. . . . " *Id.* at 98; *see also* Holz et al., *supra* note 7, at 84–86; Masahiro Mori, *The Uncanny Valley*, 7 ENERGY 33, 33–35 (Karl F. MacDorman & Takashi Minato trans., 1970), *available at* http://www.androidscience.com/theuncannyvalley/proceedings2005/uncannyvalley.html; Chris Rollins, Realistic Robots Approach the Edge of the Uncanny Valley (Nov. 24, 2008), http://www.scientificblogging.com/welcome_my_moon_base/realistic_robots_approach_edge_uncanny_valley. The theory of the uncanny valley, hypothesized by Japanese scientist Masahiro Mori nearly forty years ago, assumes that "this eeriness will not be overcome until robots mimic human sociality so well that we do not cue in on the fact that we are interacting with a robot." Young et al., *supra* note 13, at 98. This may explain why one group of scientists developed their "Keepon" robot as a hybrid of minimalist design and essential humanoid features: "We believe that some basic traits common to people and animals (e.g. lateral symmetry and two eyes) are important cues to the potential for social agency. At the same time, keeping the appearance simple . . . is important for helping people understand and feel comfortable with the robot's behavior." Kozima et al., *supra* note 13, at 4.

[51] Kozima et al., *supra* note 13, at 4. Social robots in this setting are designed to provide "touch, eye contact, and joint attention" because they are "fundamental behaviors that maintain child-caregiver interactions and establish a basis for empathetic understanding of each other's mental states." *Id.* at 5.

do not demonstrate in their daily lives.[52] Not only have many of these children interacted directly with the robot to a greater degree than they have interacted with humans, they also have relied on the robot to facilitate interaction with third parties.[53] Thus, through the use of robotic technology, psychologists increasingly are able to achieve therapeutic results that otherwise would be difficult to obtain.[54]

If robots can elicit positive and desirable responses in this therapeutic context, then certainly one can imagine dispute resolution or problem solving circumstances where a social robot might encourage a productive response even though traditional attempts have failed.

Similarly, there is increasing interest in using social robots to fulfill the healthcare needs of an aging population.[55] The objective in this case is to create a robot that not only serves a utilitarian purpose, but also provides a "hedonic" experience.[56] The fact that robots can both provide this relatively high level of social experience, and also be perceived as something more than a piece of equipment, suggests that robots may be able to collect information from a party frankly too frustrated to communicate directly with other humans.

One team of roboticists is fine-tuning a robotic caretaker to work with the elderly in their homes, providing services and companionship that will enable aging people to retain greater independence for a longer period of

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[52] *Id.* at 12 (describing the success of Keepon, a therapeutic robot used with autistic children).

[53] *Id.* at 12–13.

[54] *Id.* at 13.

[55] *See generally* Marcel Heerink et al., *The Influence of Social Presence on Acceptance of a Companion Robot by Older People*, 2 J. OF PHYS. AGENTS 33, 33 (2008), *available at* http://www.jopha.net/index.php/jopha/article/view/28/21; Martha Pollack, *Intelligent Technology for an Aging Population: The Use of AI to Assist Elders with Cognitive Impairment*, AI MAGAZINE, Summer 2005, at 9, *available at* http://www.soe.ucsc.edu/classes/cmps080j/Spring08/AIMag26-02-article.pdf.; Kathleen Richardson, *My Friend the Robot*, TIMES HIGHER EDUCATION (UK), Feb. 16, 2007, *available at* http://www.timeshighereducation.co.uk/story.asp?storyCode=207843&sectioncode=26; Sherry Turkle, *Robot as Rorschach: New Complicities for Companionship*, Association of Advancement of Artificial Intelligence 2006 Workshops, *available at* www.aaai.org/Papers/Workshops/2006/WS-06-09/WS06-09-010.pdf.

[56] Heerink et al., *supra* note 55, at 33. The hedonic aspect is integral because "[e]lders do not always willingly accept new technologies. . . . [R]obots are not only perceived as assistive devices, they are also perceived as social entities. . . ." *Id.*; *see also* Kozima et al., *supra* note 13.

time than they otherwise might have.[57] This type of robot can be programmed to fit the specific needs of its owner, such as assisting a visually impaired owner with navigation around the house or reminding a cognitively impaired owner to take medication, while simultaneously providing basic social interaction.[58] As can be the case with other robotic technology applications, the advent of social robots to care for the elderly also eases the strain on a limited labor pool.[59]

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[57] Heerink et al., *supra* note 55, at 33–34 (explaining the benefits of using artificial intelligence for eldercare); Pollack, *supra* note 55, at 9 (discussing demographic shifts that make robotic and automated eldercare a necessity). One author notes:

> [A]ssistive technologies now being developed may enable older adults to "age in place," that is, remain living in their homes for longer periods of time. A large body of research has shown that older Americans prefer to maintain independent households as long as possible. Additionally, institutionalization [of the elderly] has an enormous financial cost, not only for elders and their caregivers, but also for governments. . . . Thus technology that can help seniors live at home longer provides a "win-win" effect, both improving quality of life and potentially saving enormous amounts of money.

Id.

[58] *See* Heerink et al., *supra* note 55, at 33; Pollack, *supra* note 55, at 12–14 (commenting on the types of assistive technology currently used in eldercare). In addition to social robots,

> an increasing number of [other eldercare] devices rely on AI and other advanced computer-based technologies. Examples include text-to-speech systems for people with low vision; a digital programmable hearing aid that incorporates a rule-based AI system to make real-time decisions among alternative signal-processing techniques based on current conditions; and a jewelry-like device that allows people with limited mobility to control household appliances using simple hand gestures. In addition, significant research has been done to design obstacle-avoiding wheelchairs.

Id. at 10–11.

[59] Pollack, *supra* note 55, at 10–11. The substitution of robotic workers for human ones is particularly important in the field of eldercare because:

> We are in the midst of a profound demographic shift, moving from a world in which the majority of the population is relatively young to one in which a significant proportion of people are over the age of 65. . . . While many older adults will remain healthy and productive, overall this segment of the population is subject to physical and cognitive impairment at higher rates than younger people. It is important to keep in mind that there is growth not just in absolute number of older adults, but also in the proportion of the population that is over the age of 65; there will thus be fewer young people to help older adults cope with the challenges of aging.

The percentage of older adults in the United States is rapidly increasing and will more than double between the years 2010 and 2030.[60] Although older adults may suffer cognitive impairments as they grow older, many retain the ability to engage in face-to-face conversations.[61] Because face-to-face conversation is multimodal (verbal, nonverbal, and paraverbal behavior), allows for repetition and clarification, and has mechanisms to help focus participants' attention, individuals with impairments still may be able to communicate face-to-face using methods that remain available.[62]

Believing it is necessary to establish social and emotional ties in order to motivate older adults over extended periods of time, researchers created an avatar relational agent to interact with older adults (aged 62 to 84) every day for two months in an effort to encourage those adults to exercise by walking.[63] Although the researchers would have liked to use unconstrained

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Id. at 9. As of the year 2000, the number of people over the age of sixty-five in the United States equaled approximately 12.3% of the population; this figure is expected to increase to 19.2% of the population by the year 2030. *Id.* at 10.

[60] Timothy Bickmore et al., *"It's Just Like You Talk to a Friend": Relational Agents for Older Adults*, 17 INTERACTING WITH COMPUTERS 711 (2005), *available at* http://www.ccs.neu.edu/research/rag/publications/05_IWC_BTCLCKHT.pdf.

[61] *Id.*

[62] *Id.*

[63] *Id* at 5. Using the term "embodied conversational agents" (ECA) to describe the relational agents it employs, the College of Computer and Information Science at Northeastern University is engaged in a variety of fascinating projects that use ECAs in the medical context in a manner that clearly is applicable to ADR processes. *See* Relational Agents Group of Northeastern University, http://www.ccs.neu.edu/research/rag/publications/index.html. For an example of an exchange between a relational agent and a user, see Figure 6, Partial Transcript of Sample Conversation Between Subject and Agent (A=Agent ; U=User):

1. A: Hello, Bertha. Great to see you.

2. U: Hi Laura.

3. A: How are you feeling today?

4. U: I'm not feeling so great.

5. A: I am sorry to hear that.

6. A: Tell me more about how you are feeling.

7. U: I'm tired.

8. A: How tired are you feeling?

9. U: I'm pretty beat.

10. A: Good grief, I hope you're not getting sick. Can you get some rest soon?
11. U: I think so.
12. A: That is great. I hope you come back feeling refreshed.
13. U: Me too!
14. A: So, are you from the East Coast originally?
15. U: No, I'm from another country.
16. A: Wow.
17. U: And you? Where are you from?
18. A: I was created right here in Boston.
19. U: Really?
20. A: How do you like living in Boston?
21. U: It's great.
22. A: Really?
23. U: Yeah.
24. A: So, is there anything I can do to help make this a more productive working relationship?
25. U: Nope, everything is OK.
26. A: That's wonderful.
27. U: Yeah.
28. A: So, let us talk about your pedometer readings.
29. A: Do you think you might do any more walking today?
30. U: No, I'm all done walking for today.
31. A: Do you have a good pedometer reading?
32. U: Yes, I have a good pedometer reading for today.
33. A: How many steps did you walk for today?
34. U: 10,525
35. A: Here is your progress chart. (progress chart is displayed)
36. A: So, let us talk about how you did since the last time we got together.
37. A: Your long term goal is to walk 10,000 steps a day.

speech input, concern about speech recognition software and natural language understanding led the researchers to offer on-screen multiple choice responses, dynamically updated throughout the conversation.[64] Users were given touch-screen monitors and results were compared with individuals given only pedometers and educational pamphlets.[65] The vast majority of respondents interacting with the relational agent looked forward to those interactions (75%), found the system easy to use, and perhaps most importantly, registered a statistically significant increase in recorded pedometer steps as compared to the control group.[66] Reporting they would like to continue interacting with Laura (the avatar),[67] users indicated that although the relationship initially was strange, by the end of the two month period they liked, trusted, and even cared for Laura.[68] Several users even reported that they felt that Laura also liked and cared about them.[69]

Note, however, that in a second study the researchers found that although the dialogues were written to provide significant variability in each day's interaction, most participants found the conversations repetitive at some point and consequently, many lost their motivation to follow the relational agent's advice.[70] One study participant remarked, for example, that "it would be great if Laura could just change her clothes sometime."[71] The researchers then designed a virtual laboratory to further explore long-term human-virtual agent relationships, and their first study evaluated how the perception of

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38. A: The last time we talked you said you would walk 10,000 steps.

39. A: According to your pedometer you walked 10,525 steps.

40. A: Looks like mission accomplished on the exercise.

41. A: We're doing some great work together.

Id. at 16.

[64] *Id.* at 6.

[65] Bickmore, et al., *supra* note 60, at 3.

[66] *Id.* at 20–23.

[67] *Id.* at 21 (using a rating system of 1 = "not at all" and 7 = "very much", users reported an average score of 6.4).

[68] *Id.* at 25.

[69] *Id.*

[70] Timothy Bickmore & Daniel Schulman, *A Virtual Laboratory for Studying Long-Term Relationships Between Humans and Virtual Agents*, 2009 PROC. OF 8TH INT'L. CONF. ON AUTONOMOUS AGENTS & MULTI-AGENT SYS. (2009) 1, 6, *available at* http://www.ccs.neu.edu/research/rag/publications/AAMAS09.pdf.

[71] *Id.*

agent repetition impacts adherence to a health behavior modification program.[72] This study, which involved only twenty-four participants and produced admittedly preliminary results, concluded that there is a negative effect as dialogue variability declines.[73] Participants' performance relative to their walking goals decreased significantly over time when perceptions of repetition increased.

These observations certainly are not surprising and serve as reminders that, as with human-to-human interactions, variability is a productive (and even essential) attribute for engagement. One cannot expect parties involved in a problem solving process to continue to be engaged with a relational agent that falls into a predictable, and eventually tiresome, pattern. Given current technology, even the most sophisticated relational agent will have a diminished capacity to provide conversational, emotional, tonal, facial, and physical responses as compared to a human. Consequently, it is particularly important to ensure that a relational agent does not fall into a discouragingly predictable pattern.

Avatars have been used successfully in other health care contexts. Two empathetic middle-aged avatar discharge nurses, one African-American and one Caucasian, were created to help hospital patients with low health literacy read and follow directions.[74] Understanding the value of multiple modalities for communicating health care information, the virtual nurses were given the ability to hold and point at an image of each patient's After Hospital Care Booklet (AHCP), providing verbal explanations while the patient followed along in a paper copy with explicit instructions as to when to turn the page.[75] The nurses spoke with the patients once a day every day, used a short "open book" quiz format to confirm patients' understanding, and alerted human nurses to intervene if a patient failed a quiz a second time, even after the virtual nurse guided the patient to where the correct answers could be found in the AHCP.[76] The system thus offered an intuitive conversational agent interface, redundant modalities for communicating medical information

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[72] *Id.*

[73] *Id.* at 7.

[74] *See* Timothy Bickmore et al., *Taking the Time to Care: Empowering Low Health Literacy Hospital Patients with Virtual Nurse Agents*, Notes before the Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems 1 (2009), *available at* http://www.ccs.neu.edu/research/rag/publications/CHI09.VirtualNurse.pdf.

[75] *Id.* at 4.

[76] *Id.*

(screen images, printed text, and synthetic speech), and comprehensive checks.[77]

Recognizing the importance of caring, empathy, and good "bedside manner," the nurses' informational dialogue was augmented with relational dialogue and relational behavior.[78] The nurses (who traveled around the hospital on a mobile kiosk), addressed patients by name, began every interaction with a social chat, used appropriate humor, offered feedback at every empathetic opportunity, and referred to information discussed in previous interactions in an attempt to foster continuity.[79] Forty-nine patients aged 20 to 75 found the system very easy to use after less than a minute of training, reported high satisfaction, expressed few reservations about receiving medical information from an avatar, and stated that they would follow the nurses' directions.[80]

In a second study, seventy-four percent of hospital patients stated that they actually would prefer to receive discharge directions from the virtual nurse rather than a doctor or a human nurse.[81] Patients reported that they did not receive enough time and attention from either the doctors or hospital nurses and very much appreciated that fact that the avatar nurses would spend whatever time was necessary to ensure that the patients understood the directions.[82] The hospital patients, who typically are entirely submissive and completely dependent on hospital staff, felt empowered and less helpless because they understood relevant medical information that allowed them to be more actively involved in their own health care.[83]

Empowered? Less helpless? More actively involved in the resolution of their problem? Mediators often work long and hard to assist parties to achieve these results. In fact, "[i]n a transformative approach, empowerment and recognition are the two most important effects that mediation can produce, and achieving them is its most important objective."[84] If avatars can help achieve results like this when a patient's life literally may be at risk,

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[77] *Id.* at 9.

[78] *Id.* at 4–5.

[79] *See* Bickmore et al., *supra* note 74, at 6.

[80] *Id.* at 9.

[81] *Id.*

[82] *Id.*

[83] *Id.*

[84] Robert Baruch Bush & Joseph Folger, THE PROMISE OF MEDIATION: RESPONDING TO CONFLICT THROUGH EMPOWERMENT AND RECOGNITION 84 (1994).

then it frankly is absurd to claim that avatars have no role to play in dispute resolution or problem solving.

A medical research team at Carnegie Mellon University has demonstrated that artificial, robotic intelligence can accomplish tasks previously considered impossible.[85] These scientists have developed a surgical robot that can perform minimally invasive surgical procedures without significant disruption of internal organs that a human surgeon simply cannot replicate.[86] Controlled with a joystick and designed with multiple joints that adjust automatically to maneuver through the intricate pathways of the human body, the robot mimics the natural movements and biological structure of a live being—in this case, a snake—to accomplish its goal while reducing the risks and complications associated with traditional surgery.[87]

Granted, although the application of snake-like mobility to a dispute resolution process may not be immediately apparent, this example illustrates that in certain situations robotic devices can accomplish what humans cannot. The fact, however, that this robot can be controlled so precisely confirms that the facial expressions and movements of a human-like robot also can be controlled to replicate those of a human to a very precise degree.

The United States Armed Forces are well aware of robots' potential applications. Robots can be dispatched, for example, into areas too dangerous for human personnel.[88] The same research team that created the surgical snake was enlisted to design and build a robot paramedic that can initiate diagnosis of a wounded soldier's condition before human paramedics are

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[85] Kristina Grifantini, *Snakelike Robots for Heart Surgery*, TECH. REV., Apr. 4, 2008, *available at* http://www.technologyreview.com/biomedicine/20516/; *see also* Cardiorobotics, Inc., http://cardiorobotics.com/about.htm (last visited Oct. 2, 2009); Howie Choset's Serpentine Robots, http://www.cs.cmu.edu/~biorobotics/serpentine/serpentine.html (last visited Oct. 20, 2009).

[86] Grifantini, *supra* note 85 (explaining how the robotic snake can perform minimally invasive surgical procedures).

[87] *Id.* As of April 2008, the scientists and their reptilian robot had operated successfully on "nine pigs and two human cadavers." *Id.* The team's company, Cardiorobotics, "expects to begin human clinical trials" for the apparatus sometime in 2009. *See* Cardiorobotics, Inc., *supra* note 85.

[88] Jennifer Chu, *A Robomedic for the Battlefield*, TECH. REV., Feb. 3, 2009, *available at* http://www.technologyreview.com/biomedicine/22045/. The need for prompt diagnosis is particularly important in the context of military action because 86% of fatalities on the battlefield occur within the first thirty minutes after a wound is inflicted. *Id.*

able to remove him safely from the battlefield.[89] The fact that the same research team that designed the snake was involved in this wartime application illustrates the flexibility and adaptability of robotic technology. The robot also can be used to "assess [a soldier's] injuries as he's being carried to a safe location," thereby enabling the paramedics to concentrate on transporting the patient while helping them avoid further casualties.[90] The ability to make a diagnostic assessment, obviously, is an invaluable example of artificial intelligence.

Perhaps not surprisingly, the military also has used robots to conduct operations and inflict injury on opposing forces.[91] One such robot is the unmanned ground vehicle (UGV), a device controlled remotely and—like the robomedic—used to perform duties that would be significantly more dangerous for a human soldier to fulfill.[92] In fact, American forces currently use an estimated six thousand UGVs in the Middle East and according to one report, "the military goal is to have approximately 30% of the Army comprised of robotic forces by approximately 2020."[93] To combat the ethical

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[89] *Id*. Like the surgical snake, the "robomedic" is controlled with a joystick from a remote location. *Id.*; *see also* Grifantini, *supra* note 85 (explaining how a robotic snake can perform minimally invasive surgical procedures).

[90] Chu, *supra* note 88. The United States Army already uses sophisticated technology to provide urgent care on the battlefield. *Id.* The Life Support for Trauma and Transport (LSTAT), for example, is a stretcher that is "essentially a portable intensive-care unit," equipped with tools such as a ventilator and a defibrillator. *Id.* Because the current LSTAT technology relies on human manipulation, the paramedics are susceptible to injury while they are working to save a patient. *Id.* Integrating these tools with the snake's robotic technology therefore would decrease the likelihood of additional battlefield injury. *Id.*

[91] *See, e.g.*, Pir Zubair Shah & Salman Masood, *U.S. Drone Strike Said to Kill Sixty in Pakistan*, N.Y. TIMES, Jun. 23, 2009, *available at* http://www.nytimes.com/2009/06/24/world/asia/24pstan.html?_r=1&ref=world; Erik Sofge, *America's Robot Army: Are Unmanned Fighters Ready for Combat?*, POPULAR MECHANICS, Mar. 2008, *available at* http://www.popularmechanics.com/technology/military_law/4252643.html; *Modern Use*, *supra* note 8; U. of Sheffield (UK) News Release, *Killer Military Robots Pose Latest Threat to Humanity*, Feb. 27, 2008, *available at* http://www.shef.ac.uk/mediacentre/2008/970.html.

[92] Sofge, *supra* note 91, at 1. While UGVs have yet to be armed with weaponry, "unmanned aerial vehicles have been loaded with missiles since 2001." *Id.* According to one source, the number of flight hours logged by unmanned aerial vehicles as of October 2006 was 400,000. U. of Sheffield, *supra* note 91. The UGVs currently are used "to peek around corners and investigate suspected bombs." Sofge, *supra* note 91.

[93] *Modern Use*, *supra* note 8. Lockheed Martin is one company developing these robot soldiers of the near future. Sofge, *supra* note 91. The company is in the preliminary

concerns prompted by such a vision, scientists developing the technology intend to maintain the "chain of command" between robots who gather information and humans who act upon it.[94]

The ethical concerns raised by artificial intelligence are complex and deserve their own dedicated discussion. Clearly, the ethical concerns will be dramatically increased when discussing artificial intelligence that is intelligent, the second form of artificial intelligence described in the introduction. But even when the discussion is limited to devices that only behave intelligently and must rely on external direction, one still must be vigilant and monitor the ways in which the device is being controlled.

The armed forces also have high hopes for the use of robotic insects to conduct reconnaissance and emergency rescue missions.[95] Unlike the robots described above, however, the robotic insects being developed actually are more appropriately understood as cyborgs—part animal, part machine.[96]

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stages of developing a UGV that can drive itself, rather than utilizing remote control technology. *Id.* As it stands right now, however, the company's MULE (Multi-function Utility/Logistics and Equipment) "is roughly the size of a Humvee . . . [and is] essentially one of the world's biggest radio-control cars." *Id.*

[94] *Modern Use*, *supra* note 8. Washington University professor Bill Smart comments that, "You don't want to give autonomy to a weapons delivery system. You want to have a human hit the button. You don't want the robot to make the wrong decision. You want to have a human to make all of the important decisions." *Id*. Unfortunately, maintaining a robot-human chain of command still can result in unintended results. For example, American military personnel remotely controlling an unmanned aerial vehicle have been accused of launching a missile that killed approximately sixty people attending a funeral in Pakistan. Shah & Masood, *supra* note 91.

[95] Emily Singer, *The Army's Remote-Controlled Beetle*, TECH. REV., Jan. 29, 2009, *available at* http://www.technologyreview.com/computing/22039/ [hereinafter Singer, *Remote-Controlled Beetle*]; *see also* Emily Singer, *TR10: Biological Machines*, TECH. REV., Mar/Apr. 2009, *available at* http://www.technologyreview.com/biomedicine/22111/ [hereinafter Singer, *Biological Machines*].

[96] Singer, *Remote-Controlled Beetle*, *supra* note 95. Building off the momentum of the cyborg beetle, the Pentagon now is attempting to create an early detection system for chemical warfare. David Hambling, *Cyborg Crickets Could Chirp at the Smell of Survivors*, NEW SCIENTIST, Jul. 11, 2009, *available at* http://www.newscientist.com/article/mg20327165.900-cyborg-crickets-could-chirp-at-the-smell-of-survivors.html. The idea has been described by one journalist as:

> [T]he equivalent of the "canary in a coal mine" . . . The latest plan is to create living communication networks by implanting a package of electronics in crickets, cicadas, or katydids—all of which communicate via wing-beats. The implants will cause the insects . . . to modulate their calls in the presence of certain chemicals.

Id.

Because "beetles and other flying insects are masters of flight control," research scientists have decided to integrate the innate biological abilities of these creatures with artificial intelligence that controls the direction and duration of the insect's path.[97] Needless to say, such technology would allow infiltration and observation of hostile territories with little risk of detection.[98] Furthermore, if a cyborg beetle were intercepted, the ramifications would be significantly less severe than if a human operative were captured.[99]

While military and medical applications might be an obvious step in the march of technology, one might be surprised to learn the speed at which robotic technology is being applied in the commercial sector.[100] Robotic farmhands, for instance, have been designed to combat "a lack of labour availability in a sector reliant on intense bursts of tough, seasonal work."[101] Farmers can produce crops more efficiently and economically because these devices eliminate human error and increase the rate at which difficult tasks can be accomplished.[102] Similarly, robots can be used in the construction

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[97] Singer, *Remote-Controlled Beetle*, *supra* note 95. Specifically,

> The beetle's payload consists of an off-the-shelf microprocessor, a radio receiver, and a battery attached to a custom-printed circuit board, along with six electrodes implanted into the animals' optic lobes and flight muscles. Flight commands are wirelessly sent to the beetle via a radio-frequency transmitter that's controlled by a nearby laptop. Oscillating electrical pulses delivered to the beetle's optic lobes trigger takeoff, while a single short pulse ceases flight. Signals sent to the left or right basilar flight muscles make the animal turn right or left, respectively.

Id.

[98] *Id.* This particular use of the cyborg beetle would require a "rig" that incorporated a small camera and, if used for rescue missions, a heat sensor. *Id.*

[99] *Id.*

[100] *See, e.g.*, Tom Simonite, *Robot Farmhands Prepare to Invade the Countryside*, NEW SCIENTIST, Jun. 1, 2009, *available at* http://www.newscientist.com/article/dn17224-robot-farmhands-prepare-to-invade-the-countryside.html; Steven Mackay, Virginia Tech News: Team Wins International Competition with Robots Designed to Save Lives of Construction Workers (Dec. 18, 2008), http://www.vtnews.vt.edu/story.php?relyear=2008&itemno=808.

[101] Simonite, *supra* note 100 (explaining the rationale behind application of robotic technology in the agriculture industry).

[102] *Id.* Although there is some concern that current robots cannot perform the same type of quality control that "a seasoned rustic" does when selecting produce from trees, scientists are conducting experiments on "autonomous mobile robots . . . [that] can capture detailed measures of every tree's foliage and even count the oranges they bear." *Id.* The same technology being developed to measure plants' physical characteristics also

industry to perform tasks that are extremely dangerous for human workers to perform, "such as inspecting high-rises or underwater bridge piers."[103] Because these robotic technology applications eliminate risks associated with manual labor, they likely will reduce costs for consumers when widely adopted.[104]

Perhaps even more interesting, however, is the growing number of robots within the home.[105] Machines such as the iRobot Roomba, "an autonomous and mobile vacuum cleaner robot that is affordable, has effective utility, and is a commercially successful product," are the tip of the iceberg for the typical household of the near future.[106] The value of domestic robots is being recognized at an exponential rate: a 2002 survey conducted by the United Nations determined that "the number of domestic and service robots more than tripled [over the previous year], nearly outstripping their industrial counterparts."[107]

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is being explored as a tool to minimize the amount of pesticides necessary to protect crops. *Id.*

[103] Mackay, *supra* note 100 (discussing the benefits to using robotic, rather than human, construction workers).

[104] *See* Simonite, *supra* note 100; Mackay, *supra* note 100. One industry expert states that, "Automation is becoming a necessity rather than an enhancement," for agriculture. Simonite, *supra* note 100. Similarly, the increasing number of construction site fatalities has driven the need for robotic "employees." Mackay, *supra* note 100.

[105] *See, e.g.*, Young et al., *supra* note 13 (reviewing two existing types of domestic robots and the need to refine the social interactive abilities of robots in general to promote greater acceptance in a domestic context); *Trust Me*, *supra* note 39 (discussing the rapid expansion of robotic technology in a domestic setting).

[106] Young et al., *supra* note 13, at 99. One group of scientists hypothesizes that "users will perceive domestic robots as a new kind of entity," rather than as "just another electronic appliance along with the microwave and home theater system." *Id.* This means that acceptance of social robots in the domestic setting will depend on "past experiences and external sources . . . Perhaps the strong role of media and exposure to science fiction has prepared people and has conditioned Pavlovian responses to domestic robots, such as fear of large robots or the attraction of cute, small robots." *Id.* at 101.

[107] *Trust Me*, *supra* note 39, at 18; *see also supra* note 105 and accompanying text. According to Dr. Henrik Christensen, a prominent roboticist with the Swedish Royal Institute of Technology, significant implications arise from the growing presence of robots in the home: "Security, safety and sex are the big concerns." *Id.* These concerns arise from the development of more sophisticated machine learning techniques. *Id.*; *see also* Anthes, *infra* note 173 and accompanying text (defining machine learning); Kane, *infra* note 142 (defining machine learning and explaining how its most recent application has enabled a robot to acquire new facial expressions).

Regardless of the preceding paragraphs, one still may not be able to imagine how robots can be integrated into dispute resolution and problem solving processes. Specifically, it may be difficult to believe that living, breathing human parties will be able interact with robots as comfortably and easily as they interact with other humans. But as humans become more accustomed to automated interactions within their homes, they also will become more comfortable interacting with robots outside of their homes in a variety of contexts. Furthermore, parties will come to expect the convenience and efficiency robots can provide.[108]

IV. APPEARANCES MATTER

In an effort to make interactions with robots and other forms of artificial intelligence feel more natural and comfortable, many scientists now are focusing on device design and mechanics.[109] These developers believe that the more realistic and lifelike a social robot appears and behaves, the more easily it will be able to establish "rapport" with human beings and the more likely it will be able to achieve the desired result.[110]

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[108] *See, e.g.*, Pollack, *supra* note 55 (discussing the benefits of artificial intelligence for the field of eldercare); Young et al., *supra* note 13; *Trust Me*, *supra* note 39 (describing the rapid expansion of robotic technology in the domestic environment). According to one source, for example, "South Korea has set a goal that 100% of its households should have domestic robots by 2020." *Id*.

[109] *See, e.g.*, Holz et al., *supra* note 7, at 84. One group of scientists notes: "[T]here is enough evidence to suggest that these robots need to exhibit a certain degree of social intelligence, for the way they manifest their awareness and react to the presence of humans, in order to be accepted as social peers, or simply tolerated within humanly populated environments." *Id.*

[110] *Id.* Specifically:

> Studies focusing on how the appearance of virtual characters can affect cooperation, change attitudes, and motivate users indicate that *humans treat them as social partners* and, in particular, that many of the rules that apply to human-human interaction carry over to human-agent interaction. . . .
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> . . . .
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> What distinguishes all the research in socially intelligent agents is the emphasis given to the role of the human as a social interaction partner of artificial agents and, subsequently, to the relevance attributed to aspects of human-style social intelligence in informing and shaping such interactions. *The consensus in social agent research is that effective human-agent interaction greatly leverages the instauration of a human-style social relationship between human and agent.*

The need to create robots that will be accepted raises unique challenges. Some scientists are focusing on the robots themselves—exploring ways to simulate human biological structures and physiological systems in an effort to create more physically intelligent robots.[111] Others are focusing on the humans—analyzing and applying social psychology theories to understand the ways in which humans learn, as well as the ways in which they adopt and interact with new technology. [112] Both lines of research require scientists to

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Id. (emphasis added); *see also* Toshiyuki Shiwa et al., *How Quickly Should a Communication Robot Respond? Delaying Strategies and Habituation Effects*, 2 INT'L J. OF SOC. ROBOTICS 141 (2009), *available at* http://www.springerlink.com/content/t575551x8151nw0p/fulltext.pdf. Essentially, "if a humanoid robot effectively uses its body's properties, people will communicate naturally with it." *Id.* at 141. On the other hand, some scientists are concentrating their research on how best to use robots with existing technology:

> [H]umanoid robots still have problems with their perception abilities. This remains one of the difficulties of using them in the real world. In the future, we expect that humanoid robots will be able to communicate with us as naturally as we do with one another. However, this is still too difficult due to various technical limitations, particularly their perception of human responses toward themselves. . . . Based on the above considerations, we propose the use of humanoid robots as a medium for broadcasting information in a public space.

Daisuke Sakamoto et al., *Humanoid Robots as a Broadcasting Communication Medium in Open Public Spaces*, 2 INT'L J. OF SOC. ROBOTICS 157–58 (2009), *available at* http://www.springerlink.com/content/64707h4g142q8482/fulltext.pdf.

[111] Holz et al., *supra* note 7; *see also supra* note 109 and accompanying text (describing technological advances in artificial intelligence); Shiwa et al., *supra* note 110 (noting the importance of robotic reaction time during communication to establish more realistic human to robot interactions).

[112] Young et al., *supra* note 13. The reason for this application of social science to computer science is appropriate because:

> Domestic robots are fundamentally unlike other common domestic applications of advanced technology such as the ubiquitous PC. Robots have an invasive physical presence and a unique interface paradigm: they actively and physically share spaces with people and display a level of autonomy and intelligence. Unlike the PC, which stays where it is placed and must be actively engaged and enabled, a robot will physically interact with and alter its surroundings and may not remain in a simply-defined allocated space. Furthermore, unlike physically-safe PC-based virtual environments, *interacting with a robot is more like interacting with a living entity*. The robot may move unexpectedly, users must follow its motion cues and physical state, and may not have direct access to orthodox interfaces such as a keyboard or display panel. Thus, users of robotic technology often have to learn new interaction styles. This difference means that *we cannot expect people to respond to robots in the same way that they do to other technologies*.

consider the context in which a given robot is to be used, the purpose for which the robot is intended, and the target user for which the robot was designed.[113] Anyone hoping to introduce robots and artificial intelligence into dispute resolution processes must become informed as to the results of this research.

Although there may be reluctance to rely on artificial intelligence for purposes more intimate in nature, one very personal area where physical artificial intelligence is being embraced concerns amputees and prosthetic technology.[114] Prostheses such as the iWalk PowerFoot One utilize artificial intelligence to determine and correct the position of artificial limbs—thereby enabling the devices to simulate more accurately the natural movement of the human body.[115] To complement the sophisticated functionality of these

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Id. at 97 (emphasis added) (endnote omitted); *see also* Heerink et al., *supra* note 55; *supra* notes 55–56 and accompanying text (noting that certain populations, such as the elderly, approach technology in a different manner than other demographic groups); William G. Kennedy et al., *"Like-Me" Simulation as an Effective and Cognitively Plausible Basis for Social Robotics*, 2 INT'L J. OF SOC. ROBOTICS 181 (2009), *available at* http://www.springerlink.com/content/3156571qg146p18u/fulltext.pdf. One team of scientists, for example, identified the way in which human infants acquire knowledge—that is, through simulation or imitation of another's behavior: "This simulation ability is the focus of [the research] and our premise is that humans base their models of others on themselves, their own capabilities and knowledge, and by using a cognitively plausible system to provide this capability, we can build cognitively plausible, social robots." *Id.* at 182.

[113] Young et al., *supra* note 13. In developing a robotic caretaker for senior citizens, for example, scientists must take into account the fact that "elders do not always willingly accept new technologies," while bearing in mind that the robot might be viewed as a social entity and not just a utilitarian one. Heerink et al., *supra* note 55, at 33; *see also* Sakamoto et al., *supra* note 110 (noting that current technological limitations, such as language recognition problems, make robotic technology particularly well-suited to the "passive social" application of a broadcast medium).

[114] Julian Smith, *We Have the Technology to Rebuild Ourselves*, NEW SCIENTIST (2009), *available at* http://www.newscientist.com/article/mg20126884.500-we-have-the-technology-to-rebuild-ourselves.html. Multiple factors have encouraged the funneling of resources to research bionic prosthetics, including the rising number of Americans suffering from diabetes, the ongoing injuries inflicted upon American military personnel in the Middle East, and the increasing ability to "pack more hardware into a limb than ever before" through smaller and more sophisticated components. *Id.*

[115] *Id.* The iWalk PowerFoot was designed by a team of MIT scientists, one of whom has both scientific and personal motivation for developing more lifelike artificial limbs: "Hugh Herr, director of the Biomechatronics Group at the Massachusetts Institute of Technology, [is] himself a double lower-limb amputee." *Id.* The "C-Leg" and the "Rheo Knee" are other types of prosthetic devices that rely on bionic technology. *Id.*

limbs, scientists are developing startlingly realistic coverings to create a more seamless appearance with the patient's body and maximize the patient's ability to control the limb.[116] In particular, researchers have created a type of artificial skin, also known as cosmesis, that utilizes artificial intelligence to sense and react to physical contact with the limb.[117] While this technology

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These prostheses rely upon "intelligent software that learns a user's gait and can adapt to changing terrain." *Id.* One patient who uses such a device, an Afghanistan War veteran injured by a landmine, now "can run well enough to coach his 11-year-old son's soccer team." *Id.*

[116] *Id.* One patient with a prosthetic hand commented on the number of people who have mistaken his artificial limb for the real thing, attributing this to the hand's silicon covering. *Id.* The device, marketed as the "i-Limb," is "a lightweight plastic hand in which each digit contains its own motor and can move independently in response to signals from two sensors attached to skin elsewhere on the user's body." *Id.* The hand also has intelligent software that enables it to recognize when it has "sufficient grip on an object" and prohibit further contraction of its "muscles." *Id.*; *see also* John-John Cabibihan et al., *Towards Humanlike Social Touch for Sociable Robotics and Prosthetics: Comparisons on the Compliance, Conformance, and Hsyteresis of Synthetic and Human Fingertip Skins*, 1 INT'L J. OF SOC. ROBOTICS 29 (2008), *available at* http://www.springerlink.com/content/55123g34g506xh0m/fulltext.pdf (exploring the types of synthetic skin currently available and evaluating the ability of each to simulate human movement and sensation).

[117] Smith, *supra* note 114. This specific cosmesis was created by a team of scientists hailing from such organizations as NASA and the National Institute of Aerospace. *Id.* A primary reason for developing more lifelike cosmeses is the centrality of touch to human socialization. Cabibihan et al., *supra* note 116, at 29. Scientists working to improve current technology in this field have noted that more realistic cosmeses would encourage greater acceptance of social robots on the one hand and alleviate the negative emotional effects experienced by amputees on the other:

> [O]ne should not easily assume that humans will be comfortable with the idea of shaking an artificial hand made from a stiff material . . . humanlike skin softness would be a reasonable requirement for the sociable robots envisioned to directly interact with humans in a social setting.
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> Similarly, humanlike appearance and softness characteristics are needed for prosthetic hands. The hand is the foremost representation of the self-image which each person projects and which is perceived by others. Any disfigurement of the hand . . . certainly affects the psychological well-being [and can result in] depression, feelings of hopelessness, low self-esteem, fatigue, anxiety, and sometimes suicidal ideation of the patient. . . . [C]oncealment of prosthesis usage is an effective coping strategy so that the prosthetic users can integrate socially and prevent stigmatization.

Id. at 29–30.

has been developed to treat human patients, it also has been used to build more realistic robots.[118]

If individuals can learn to rely on artificial intelligence in the form of prosthetic technology to perform functions that are extremely important, personal, and intimate, then there is no reason why we cannot learn to rely on artificial intelligence to perform functions that are communicative in nature.

The drive to develop more sophisticated prostheses is closely aligned to the desire to design social robots that can mimic the pace of human reaction and interaction.[119] Because social robots are designed to engage and communicate with humans, the assumption is that humans will approach robotic interactions much as they would other types of human interactions.[120] Consequently, users will expect social robots to have both nonverbal and verbal communication capabilities that replicate human behaviors.[121]

To simulate realistic nonverbal acts, roboticists are using the same type of technology that appears in prosthetic limbs to create robots that can interact physically with human beings in a more realistic manner.[122] For instance, roboticists have implanted pressure sensors in the cosmesis and fingertips of a social robot that can measure the force with which the robot's

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[118] *See, e.g.*, Bates, *supra* note 11 (reporting on a customized robotic doll designed to look like its owner); Rollins, *supra* note 50 (describing the increasingly lifelike appearance of robots); Santo, *supra* note 11 (discussing a lifelike Einstein robot that can smile and talk).

[119] *See, e.g.*, Shiwa et al., *supra* note 110, at 142–44 (describing the manner in which humans conduct themselves in social interactions and how to make robots simulate this behavior).

[120] Young et al., *supra* note 13, at 97–98.

[121] *Id.* While there seems to be agreement among roboticists and cognitive scientists that people are more amenable to life-like robots, it is unclear to what extent social robots need to replicate humanoid behaviors:

> [T]he "communication able" appearance of robot [sic] is not defined. In other words, the reason why a user regards a communication robot as "communication able" is ambiguous and it is unclear as to what ability of a communication robot is related to its "ability to act humanly" and its "ability to perform a task."

Hirotaka Osawa et al., *Using Attachable Humanoid Parts for Realizing Imaginary Intention and Body Image*, 1 INT'L J. OF SOC. ROBOTICS 109, 109 (2008), *available at* http://www.springerlink.com/content/eprvw77q622u7266/fulltext.pdf; *see also* Young et al., *supra* note 13, at 98 (discussing the perils of robots approaching the "uncanny valley" by simulating human expressions, movements, and appearances too closely).

[122] *See, e.g.*, Cabibihan et al., *supra* note 116; Osawa et al., *supra* note 121; Kristina Grifantini, *A Robot That Learns To Use Tools*, TECH. REV., Jul. 1, 2008, *available at* http://www.technologyreview.com/computing/21027/.

hand grips an object.[123] When the robot applies the maximum necessary pressure to retain the object, the hand ceases to contract further.[124] A domestic robot designed to perform housekeeping duties and programmed with this technology, for example, would be able to pick up a variety of household objects without breaking or destroying them.[125] Perhaps more importantly, this also means that a social robot designed to interact physically with humans would be able to shake a user's hand or lift a sickly patient without injuring him or her.[126]

This ability has obvious implications for dispute resolution and problem solving processes. By shaking hands, for example, a robot quickly would be able to introduce itself in a very familiar, even comforting, fashion. And speaking of comfort, conversational agents are being designed that can touch humans in an empathetic manner.[127] Empathy is a form of emotional support, and, as discussed earlier, emotions are an important element for establishing social relationships.[128] A physical touch acknowledges distress, for instance, and communicates understanding and caring.[129] Studies have revealed that when health care providers touch their patients, the hospital patients are more satisfied with their experiences; terminally ill older adults are comforted; cancer patients' pain and moods are improved; and pain, anxiety, depression and fatigue are reduced for a variety of conditions ranging from labor pains to serious burns.[130]

In a recent study, a "touchbot" agent—in this instance a mannequin—was developed that relied on a glove worn by the human user with an air bladder placed in the palm that can be inflated and deflated in synchronization with verbal statements.[131] A dialogue script that included a greeting, introduction, social chat, a discussion concerning the user's feelings

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[123] Cabibihan et al., *supra* note 116, at 30–31.

[124] *Id.*

[125] *Id.*

[126] *Id*; *see also* Heerink et al., *supra* note 55 (discussing the use of social robots to care for the elderly).

[127] *See* Timothy Bickmore & Rukmal Fernando, *Towards Empathetic Touch by Relational Agents*, Notes before the International Conference on Autonomous and Multi-Agent Systems (2009), *available at* http//::www.ccs.neu.edu/research/rag/publications/AAMAS09-empathy.pdf.

[128] *Id.* at 1; *see also supra* notes 16–19 and accompanying text.

[129] Bickmore & Fernando, *supra* note 127, at 1.

[130] *Id.* (citing numerous empirical studies).

[131] *Id.* at 2.

about cancer, and a closing was used, and empathetic feedback was supplied by inflating the glove.[132] Participants reported that the agent was communicating empathy, sympathy, or comfort, but still felt that the hand was not being controlled by the agent.[133] Although this attempt clearly did not resolve all the questions regarding the ability of an artificial intelligence device to communicate empathy by touch, it does suggest that a more realistic, sophisticated device may perform effectively.

A physical greeting is just one type of nonverbal cue. Researchers have compiled comprehensive lists of nonverbal cues and have described in great detail the nature of those cues.[134] Questions have been raised as to whether information technology will allow parties to communicate the signs of availability and affection necessary for affective relationships.[135] For those who believe that nonverbal cues are essential for establishing the trust and intimacy necessary for effective problem solving and dispute resolution (a viewpoint to which the author does not subscribe), a robot's ability to provide appropriate, realistic nonverbal cues will hold great value.

For centuries humans have gazed into each other's eyes, believing that the eyes were a gateway to the soul.[136] Accordingly, scientists are paying particular attention to robots' eyes. [137] As with the design of intelligent prosthetics, the design of robotic "vision" is modeled after human behavior and eye movement.[138] In one experiment, a robot was programmed with the

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[132] *Id.*

[133] *Id.* at 4. The results also indicated that three of nine participants found the touch "weird," and two of nine found it "awkward." *Id.*

[134] Larson, *supra* note 49, at 649–57 (summarizing studies that identify and measure as many as 125 verbal and nonverbal cues for affinity; questioning whether nonverbal cues are as important as many believe).

[135] *Id.*

[136] Recall former President George W. Bush's memorable declaration after he met Russian leader Vladimir Putin for the first time: "I looked the man in the eye. I found him to be very straightforward and trustworthy and we had a good dialogue . . . I was able to get a sense of his soul," Caroline Wyatt, *Bush and Putin: Best of Friends*, BBC NEWS, Jun. 16, 2001, http://news.bbc.co.uk/2/hi/europe/1392791.stm.

[137] *See, e.g.*, Osawa et al., *supra* note 121 (hypothesizing that robots with more realistic, humanoid eyes and eye movements will foster more effective human-to-robot interaction); Kristina Grifantini, *Making Robots Give the Right Glances*, TECH. REV., Mar. 11, 2009, *available at* http://www.technologyreview.com/computing/22271/.

[138] Grifantini, *supra* note 137. As one scientist noted: "The goal is [to] use human communication mechanisms in robots so that humans interpret [robot] behaviors correctly and respond to them in an appropriate way." *Id.* In addition to eyesight, other

ability to mimic the ways in which humans' eyes act and react when individuals are communicating with one another.[139] The robot then was directed to interact with pairs of human test participants, role-playing as a travel agent in three different "conversational scenarios."[140] By observing human eye movements and then programming a robot to replicate those movements, the scientists created a social robot that could use eye contact to "guide the flow of a conversation effectively . . . about 97 percent of the time."[141]

Feeling a bit uneasy? If so, then steady yourself. As we will see in the next section, the more one learns about the science the more exciting the potential becomes. But before we go any further, please keep in mind that artificial intelligence offers new options and avenues for communication among parties who may be unwilling or unable to proceed along traditional pathways. Knowing how difficult it can be to encourage and sustain a difficult conversation, dispute resolvers and problem solvers should be intrigued by these possibilities.

As expected, scientists are not peering closely only at the eyes. Again, in an effort to increase social acceptance, robots are being designed to smile, look surprised, and display a range of facial expressions.[142] This is accomplished by combining the same type of "muscle" technology used in prosthetic devices with a life-like cosmesis that is flexible and elastic.[143] The robot then is pre-programmed with several different expressions that mimic

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forms of nonverbal cues that robots may incorporate include touch, gestures, and posture. *Id.*

[139] *Id.*

[140] *Id.*

[141] *Id.* Specifically, "[t]hose at whom the robot gazed for longer took more turns speaking, those to whom [the robot] sent acknowledging glances spoke less, and those who were ignored completely spoke the least." *Id.*

[142] *See, e.g.*, Kristina Grifantini, *A Robot That's Learning to Smile*, TECH. REV., Jul. 10, 2009, *available at* http://www.technologyreview.com/blog/editors/23825/; Daniel Kane, *Robot Learns to Smile and Frown*, UNIV. OF CALIFORNIA AT SAN DIEGO, July 9, 2009, http://ucsdnews.ucsd.edu/newsrel/science/07-09Robot.asp; Rollins, *supra* note 50 (describing the technology used to create more lifelike robots, while cautioning that the more closely a robot emulates human characteristics, the closer it comes to the "uncanny valley" of creepiness).

[143] Rollins, *supra* note 50. In one such social robot, the face of the device "has about 30 facial muscles, each moved by a tiny servo motor connected to the muscle by a string." Kane, *supra* note 142 (explaining the mechanical technology used to build a robot that can replicate human facial expressions).

those used by humans to communicate specific emotions.[144] Similar to the way in which it might use eye-movement to interact, a social robot interprets "cues from the person speaking to it" to determine an appropriate expressive response.[145] This familiar, "natural" reaction helps to establish an empathic rapport that makes it easier for humans to interact with a robot.[146]

The ability to communicate nonverbal cues obviously is only part of the challenge of creating a socially acceptable robot. Leaving aside the substance of the conversation for a moment, the next question is whether a robot can replicate the manner and cadence of human conversation in addition to mimicking human physical movements.

When it comes to speech, a social robot does not need to provide a response as automatically or instantaneously as it does when nonverbal communication is involved.[147] Social robots do not need to respond as quickly as other forms of utilitarian technology, such as personal computers or digital music players, because humans will interact with realistic appearing social robots much as they would with other humans.[148] Because "humans [involved in a conversation] usually do not respond instantly," a human interacting verbally with a social robot will not expect the robot to respond immediately.[149] This characteristic of human communication helps roboticists because, much like a human, a robot requires time to process the

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[144] Kane, *supra* note 142 (describing how robots typically are designed to emulate human expressions).

[145] Rollins, *supra* note 50 (describing the technology used to create more lifelike robots while cautioning that the more closely a robot emulates human characteristics, the closer it comes to the "uncanny valley" of creepiness).

[146] *Id.*

[147] *See, e.g.*, Shiwa et al., *supra* note 110 (arguing that the more closely a robot emulates human behavior, including its communication response time, the more likely people are to engage successfully with it). One study found that users preferred robots "that start[ed] motion about 0.3 seconds and start[ed] utterance about 0.6 seconds after [a] user's action" to engage with the robot. *Id.* at 143.

[148] *Id.* This does not mean, however, that there is an indefinite amount of time for which a human will wait for a social robot to respond. *Id.* Rather, roboticists are attempting to determine the upper and lower thresholds of response time to balance the efficiency of the device on the one hand and the "humanity" of the device on the other. *Id.*

[149] *Id.* at 142 (explaining that there is a window of acceptable time in which a robot can respond, with physical response occurring prior to oral response).

information it has just received.[150] More importantly, a robot requires time to formulate a response.[151]

Dispute resolution process designers should think expansively and creatively about how robots can be used. Although the notion of interacting with an inanimate entity may seem initially unappealing, any reluctance may be surprisingly easy to overcome after encountering robots that accurately replicate human behavior in regard to their physical movements, facial expressions, and verbal patterns. Furthermore, the author has written extensively in the past concerning children and the ease with which they are integrating technologies into their lives at the most basic and essential levels.[152] The reader may not be able to imagine him or herself interacting with a robot in the same manner as he or she would with a human. But there is a generation of children quickly moving towards adulthood who spend significant amounts of time playing with avatars in virtual worlds such as *Second Life*[153] and the *World of Warcraft*.[154] These children often are more comfortable engaging in technology mediated communication than they are interacting face to face.[155] Not only will they be able to accept and interact

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[150] *Id.*

[151] *Id.*

> For example, with one of our robots, speech recognition takes calculation time that equals the duration of speech; if a user speaks for three seconds, the user needs to wait for three seconds after the speech, because there is no response from the robot until the speech recognition process is finished.

Id.

[152] *See* Larson, *supra* note 49; David Allen Larson, *Technology Mediated Dispute Resolution (TMDR): Opportunities and Dangers*, 38 U. TOL. L. REV. 213 (2006); David Allen Larson , *Online Dispute Resolution: Do You Know Where Your Children Are?*, 19 NEGOTIATION J. 199 (2003).

[153] *See* Second Life, Virtual Worlds, Avatars, Free 3D Chat, Online Meetings, http://secondlife.com/ (last visited Oct. 2, 2009). "Second Life is an online, 3D virtual world imagined and created by its Residents." *Id.*

[154] *See* World of Warcraft, http://www.worldofwarcraft.com/index.xml (last visited Oct. 2, 2009). World of Warcraft is a popular massively multiplayer online role-playing game (MMORPG), in which players control a character, or avatar, within a game world while exploring the landscape, fighting various monsters, completing quests, and interacting with other players or non-playing characters. The game claims to have more than 11.5 million fee paying players and it has been referred to as "World of Warcrack" because of its allegedly addictive nature.

[155] *See, e.g.*, Larson, *supra* note 49, at 644–45 (discussing how a group of Palestinian and Israeli children were able to discuss their religious and ethnic conflicts in an online forum and brainstorm workable solutions for the future).

with social robots, they will expect (and demand) that mediators, arbitrators, neutrals, and problem solvers do so also.

Recall Mel, the penguin robot described earlier. Mel has demonstrated that he can both engage and collaborate. His facial expressions can communicate emotion. Additionally, progress has been made regarding social interactions, for instance, in the health care engagements described above. Even though that work still is in its early stages, robots' and avatars' ability to behave intelligently and to engage and collaborate with humans raises interesting possibilities for dispute resolution. If the goal, however, is to create a robot or avatar that can be a surrogate for a human mediator, then that robot or avatar must actually be intelligent.[156]

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[156] This, of course, assumes that mediators are intelligent, an assumption that might be questioned after reviewing ethical complaints brought against mediators. *See* In re O.R., No. E034376, 2004 WL 585583, at *1 (Cal. Ct. App. Mar. 25, 2004) (affirming a visitation order based on the parties' mediated agreement despite the fact that the father called the mediator and had the agreement reached in mediation changed without the mother's knowledge or consent, determining that the mother's claims of extrinsic fraud and mistake lacked merit because she would have discovered the change if she had chosen to carefully review the agreement before it was signed and subsequently approved by the court); Lamberts v. Lillig, 670 N.W.2d 129 (Iowa 2003) (refusing to enforce alleged mediated settlement between father and maternal grandparents regarding visitation where there was no evidence father knowingly relinquished his constitutional parental caretaking interest when he entered into the agreement); In re Antosh, 169 P.3d 1091 (Kan. 2007) (publicly censuring attorney for improperly acting as "de facto" mediator in divorce case and accepting fees from both parties).

In *In re O.R.*, the father's counsel testified about what the mediator did: "The tentative agreement was reduced to writing, and [the father] had some concerns, so he called the mediator back and somehow she came up with this agreement based on those concerns. [And in a rather classic understatement, the counsel added] I'm not certain she went over that with the mother, apparently not." *In re O.R.*, 2004 WL 585583, at *2.

In *Lamberts*, the court stated,

> [The father] held a constitutional parental caretaking interest when he entered into the mediation with Arnie and Lucy. Yet, the document ultimately generated made no mention of this constitutional interest and provides no evidence of a thoughtful relinquishment of it. In fact, the document itself and the testimony at trial reveal that the parties' approach to the document was relatively informal, with little if any discussion of the legal ramifications—much less the more specific constitutional ramifications—of its signing. Indeed, it was generated in a mediation session that was not attended by counsel for either party. The mediator, when asked whether there was "any discussion about the facts that there may be underlying fundamental constitutional rights and issues" involved, explained,
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> > . . . You know what I think that—I don't remember if that was ever mentioned or not. It—I continue to try to stay away from any legal issues. I kept saying to both

V. THE NOUN: INTELLIGENCE

Just like robot designers who are studying humans in order to construct robots that physically act like humans, software developers are examining the human brain in an effort to develop more intelligent software applications.[157] European scientists recently created a computer chip that mirrors the structure of the human brain—enabling it "to mimic the brain's ability to learn more closely than any other machine."[158] The chip is composed of "200,000 neurons linked up by 50 million synaptic connections. . . . [T]he researchers recreate the neurons and synapses as circuits of transistors and capacitors, designed to produce the same sort of electrical activity as their biological counterparts."[159]

This innovation is particularly important because the more data an agent can learn and retain from prior experiences, the more effectively it will be able to simulate human intelligence.[160] Just as humans acquire much of their knowledge about the world around them from basic life experiences, an artificially intelligent device also must be able to recognize a particular experience, process the information from that experience, categorize and store the resulting data, and recall that data to make an informed decision the next time it is in a similar situation.[161]

One type of artificial intelligence that reproduces an important step in the human learning process is language recognition.[162] An intelligent device

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> parties, remember I'm not an attorney, that's not my expertise. My expertise is kids and that's what I would be arbitrating.
>
> Although it is unnecessary to define the precise threshold at which John would have become sufficiently informed to have validly waived his constitutional parental rights, it is clear the threshold was not reached in this case. The document signed at the mediation is unenforceable.

Lamberts, 670 N.W.2d at 134. In spite of the occasional egregious exception, the author asserts that we safely can assume that mediators are intelligent.

[157] Duncan Graham-Rowe, *Building a Brain on a Silicon Chip*, TECH. REV., Mar. 25, 2009, *available at* http://www.technologyreview.com/computing/22339/.

[158] *Id.*

[159] *Id.*

[160] *Id.*

[161] *Id.*; *see also* Erica Naone, *Software That Learns from Users*, TECH. REV., Nov. 30, 2007, *available at* http://www.technologyreview.com/computing/19782/.

[162] *See, e.g.*, David Talbot, *How IBM Plans to Win* Jeopardy!, TECH. REV., May 27, 2009, *available at* http://www.technologyreview.com/computing/22702/page1/; *see also* Brittany Sauser, *Man vs. Machine on* Jeopardy!, TECH. REV., Apr. 27, 2009, *available at*

obviously must be able to understand what the user is saying before the device can formulate an appropriate response.[163] Accordingly, many forms of interactive intelligent software include a language processing system, which operates in a manner similar to internet search engines.[164] One device, appropriately christened "Watson" by its creators, uses a language processing system that first divides a spoken sentence into its important elements.[165] The software then compares the elements to vast amounts of data stored within the software, cross-references the results for each component, infers the meaning of the statement through a process of elimination, and finally directs the device to offer an appropriate response.[166]

It may seem elementary,[167] but the value of any language recognition software would be greatly enhanced if the intelligent device could

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http://www.technologyreview.com/blog/editors/23451/; Brittany Sauser, *Is Language Innate or Learned?*, TECH. REV., Aug. 2, 2007, *available at* http://www.technologyreview.com/blog/editors/17672/.

[163] Shiwa et al., *supra* note 110 (arguing that the more closely a robot emulates human behavior, the more likely people are to engage successfully with it); Talbot, *supra* note 162 (describing IBM's Watson, a language recognition system).

[164] Talbot, *supra* note 162.

[165] *Id.* Watson is an IBM invention that the company hopes to use in a man-versus-machine round of the television quiz show *Jeopardy!*. *Id.* This is meant to promote the product for its eventual use: "IBM's end goal is a system that it can sell to its corporate customers who need to make large quantities of information more accessible." *Id.*

[166] *Id.* According to one computer scientist unaffiliated with the project, "[T]remendous progress has been made on this task in the last decade by researchers in natural-language processing . . . [P]itting IBM's Watson question-answering system against the top humans in a game of *Jeopardy!* is a fun way to publicize and showcase this progress." *Id.* Yet the same scientist also remarked that little scientific research has been published on this particular subject. *Id.*

[167] Recall the phrase "Elementary, my dear Watson," which often is attributed to Sir Arthur Conan Doyle's famous fictional detective Sherlock Holmes at those moments when Holmes was about to reveal one of his remarkably insightful conclusions to his trusted, and less talented, confidant Dr. John H. Watson. Holmes, however, did not ever utter this phrase, at least not in any of Arthur Conan Doyle's books. The closest he ever came was in the short story "The Crooked Man." Holmes noted that Dr. Watson must have had a busy day. Surprised, Watson asked how Holmes knew. Holmes responded, "'I have the advantage of knowing your habits, my dear Watson,' said he. 'When your round is a short one you walk, and when it is a long one you use a hansom. As I perceive that your boots, although used, are by no means dirty, I cannot doubt that you are at present busy enough to justify the hansom.' 'Excellent!' I cried. 'Elementary,' said he." The phrase does appear at the conclusion of a derivative work, the 1929 film *The Return of Sherlock Holmes* (Paramount Pictures 1929), although it may have originated in an 1899

"remember" its answer for use at a later date when asked the same or a similar question.[168] This ability to remember allows the intelligent device to provide responses based upon its cumulatively acquired knowledge, which certainly is more efficient than having to begin the process each time from the starting point.[169] Recognizing the importance of this capability, scientists again are turning to the structure and physiology of the human brain to create intelligent software that mimics our ability to learn—such as the aforementioned computer chip.[170] Building on this structural replication of the neural system, a group of University of Wisconsin scientists are studying the types of stimuli the human brain sends and receives to facilitate the learning process.[171] These researchers then will apply those stimuli to an artificial brain, thereby imbuing the intelligent device with the ability to learn.[172]

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stage production *Sherlock Holmes*. RALPH KEYES, THE QUOTE VERIFIER 54 (2006); *see also* Mordaunt Hall, *The Screen: Holmes and Moriarty*, N.Y. TIMES, Oct. 19, 1929, at 22.

[168] One researcher working on "the creation of a 'cognitive computer' [asserts that] the goal of building a computer as quick and flexible as a small mammalian brain is more daunting than it sounds." Susan Lampert Smith, *Cognitive Computing: Building a Machine That Can Learn from Experience*, Dec. 17, 2008, http://www.med.wisc.edu/news-events/news/cognitive-computing-building-a-machine-that-can-learn-from-experience/339.

[169] *Id.* (explaining the importance of machine learning); *see also* Gravitz, *infra* note 209 (discussing the "doctor kiosk," an ATM-like machine being launched for use in the medical sector); Talbot, *supra* note 162 (describing IBM's Watson, a language recognition system).

[170] Smith, *supra* note 168.

[171] *Id.*

> For example, neurons in the brain stem flood the brain with a neurotransmitter during times of sudden stress, signaling the "fight-or flight" response. "Every neuron in the brain knows that something has changed. . . . It tells the brain, 'I got burned, and if you [sic] want to change, this is the time to do it." Thus, a cat landing on a hot stovetop not only jumps off immediately, it learns not to do that again.

Id.

[172] *Id.*

> [Research psychiatrist Giulio] Tononi says the ideal artificial brain will need to be plastic, meaning it is capable of changing as it learns from experience. The design will likely convey information using electrical impulses modeled on the spiking neurons found in mammal brains. And advances in nanotechnology should allow a small artificial brain to contain as many artificial neurons as a small mammal brain.

Id.

Indeed, some success already has been achieved using this type of "machine learning" technology.[173] A team of scientists at the University of California at San Diego has created a social robot with humanoid features that can learn to create new facial expressions.[174] Whereas previous incarnations of social robots have been programmed to perform a finite number of facial expressions, this robot was programmed with software that can recognize different types of facial expressions.[175] The robot moves its head and facial "muscles," then looks in a mirror and runs recognition software to identify the expression it has made.[176] The robot next processes the information retrieved by the recognition software and runs an algorithm to determine the "muscles" used to create the expression.[177] Once the connection between the expression and the muscles has been established, the robot has "learned" a new way to manipulate its face and communicate a new emotion.[178]

Albert Einstein—or to describe it more accurately, the very realistic looking and expressive humanoid head of Albert Einstein—has attracted significant attention.[179] Constructed by Hanson Robotics, Einstein is covered in a material called "frubber" and has approximately thirty facial "muscles," each controlled by a tiny servo motor connected to the muscle by a string.[180]

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[173] *See, e.g.*, Kane, *supra* note 142; *see also* Grifantini, supra note 142; Gary Anthes, *Self-Taught: Software that Learns by Doing*, COMPUTERWORLD, Feb. 6, 2006, *available at* http://www.computerworld.com/s/article/108320/Self_Taught_Software_That_Learns_By_Doing?taxonomyId=018. Machine learning uses inductive algorithms to process data gathered by the device and draw inferences based on their results. *Id.*

[174] Kane, *supra* note 142 (describing how scientists have utilized advances in machine learning technology to create a robot that can learn to make new facial expressions).

[175] *Id.*; *see also supra* notes 142–44 and accompanying text (describing social robots that use pre-programmed facial expressions to communicate emotion).

[176] *Id.* The scientists termed this process of mobility "body babbling," a phrase reflecting the application of human developmental theories to robotics: "Developmental psychologists speculate that infants learn to control their bodies through systematic exploratory movements, including babbling to learn to speak. Initially, these movements appear to be executed in a random manner as infants learn to control their bodies and reach for objects." *Id.*

[177] *Id.*

[178] *Id.*

[179] *See* Leslie Katz, *Researchers Get Ready to Learn from Robo-Einstein*, July 16, 2009, http://news.zdnet.co.uk/emergingtech/0,1000000183,39684312,00.htm.

[180] *Id.*

Einstein is attracting attention not only because of his realistic facial expressions, but also because he does not require manual programming. He has been able to teach himself to smile, frown, and grimace as a result of research at the University of California at San Diego.[181] The researchers taught Einstein to form complex expressions by relying on developmental psychology and feedback from real-time facial expression recognition.[182] Believing that babies learn to control their bodies through systematic exploratory movements, including babbling to learn to speak, UCSD's Machine Perception Laboratory scientists employed the same theory to teach Einstein to form realistic facial expressions.[183]

The unpredictable nature of human conversation continues to pose significant challenges. Telephone airline reservations systems, for example, work only because conversations are tightly controlled using system initiatives and restricted vocabularies.[184] But research focused on machine learning and human brain replication makes one optimistic that unrestricted conversation will be possible.

Although this article has referred to robots and avatars as though they are interchangeable, their differences have significant implications. Graphical representations of actual persons can be created more easily than realistic robots that mimic human physical behaviors. Researchers using avatars thus can concentrate on improving sensing and thinking capabilities, such as emotion and social relationships, while relying on graphical animation and rendering technology for physical actions.[185] Sophisticated graphics and rendering technology are readily available as a result of advancements in the computer gaming and entertainment industries.[186] A Leonardo avatar has been developed to complement the Leonardo robot discussed earlier, for example, and a full body Greta avatar has been given expressive gestures and facial animation that permit researchers to study the role of emotions and communication style in conversation.[187] Avatars have helped people change their diet and exercise behavior while providing an opportunity to study interactive human social dialogue. If the goal is to introduce artificial intelligence devices that have the capacity for human interaction

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[181] *Id.*
[182] *Id.*
[183] *Id.*
[184] Rich & Sidner, *supra* note 6, at 37.
[185] *Id.* at 38.
[186] *Id.*
[187] *Id.*

(engagement, collaboration, emotion, and social relationship) into dispute resolution and problem solving processes, then avatars represent the more immediately available option.[188]

VI. ARTIFICIAL INTELLIGENCE APPLICATIONS

Not surprisingly, medical research scientists are putting artificial intelligence software to good use.[189] One team of British researchers, for example, has created a pair of robot scientists that can conduct genetic experiments.[190] Whereas previous laboratory robots only could perform simple experimental tasks, the robotic duo of Adam and Eve actually can formulate hypotheses, run experiments to test the accuracy of their hypotheses, and evaluate their results.[191] The utility of this robotic system is further enhanced by machine learning software that enables the pair to utilize their discoveries and alter their methodology accordingly.[192] This discovery

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[188] Although an avatar may be capable of human interaction, given current technology, the extent and subject matter of that interaction will be limited.

[189] Kristina Grifantini, *A Step Toward Robo-Science*, TECH. REV., Apr. 7, 2009, *available at* http://www.technologyreview.com/computing/22396/ [hereinafter Grifantini, *Robo-Science*]; *see also* Kristina Grifantini, Editors' Blog, *Robot Scientist Designs Its Own Experiments*, TECH. REV., Apr. 2, 2009, *available at* http://www.technologyreview.com/blog/editors/23288/.

[190] Grifantini, *Robo-Science*, *supra* note 189 (reporting on a scientific system designed to create and perform its own experiments).

> The [first] robotic system, dubbed Adam, hypothesizes about which genes in yeast code for the enzymes responsible for catalyzing certain biochemical reactions. . . .
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> . . . .
>
> Eve will eventually test drugs for treating malaria and schistosomiasis (an infection caused by several kinds of parasitic worm). Eve will do this by predicting how drug molecules should interact with laboratory samples. . . .
>
> . . . After Eve has discovered a few key compounds—ones that generate some desired activity or reactions in the laboratory—it will "make hypotheses about what could be important about the shape of the chemical that's causing the activity" [and] perform further experiments based on those assumptions. . . . Eventually, the two robots will work together: Adam will create yeast cultures that Eve will use in its experiments.

Grifantini, *Robo-Science*, *supra* note 189.

[191] *Id.*

[192] *Id.*

is particularly significant for healthcare because longer life expectancies have resulted in a disproportionately aging population.[193] As one geneticist remarked, "We can't take ten years to develop a drug anymore."[194]

The study of assistive technology in the field of eldercare also has helped increase the application and visibility of artificial intelligence dramatically.[195] Currently, two common types of intelligent software are used either separately or in conjunction with one another to assist individuals with cognitive or physical impairment: assurance systems and compensation systems.[196]

Assurance systems ensure the welfare of users by relying on networks of sensors to monitor daily activities and communicate with a designated contact person when a deviation occurs.[197] This type of system can range from the simple to the complex depending on the needs of the user.[198] If a cognitively impaired user is prone to wandering, for example, then sensors can be placed by each doorway.[199] If a user trips the sensor by exiting the premises, a message is transmitted immediately to notify the appropriate person.[200]

More complex systems also are available. An assurance system can monitor users who have a wide array of potential problems by placing sensors with different capabilities throughout a dwelling. [201]

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[193] *Id.*; *see also* Pollack, *supra* note 55; *supra* note 59 and accompanying text (describing demographic trends that predict nearly 20% of the United States' population will be aged 65 or older by the year 2030).

[194] Grifantini, *Robo-Science*, *supra* note 189.

[195] Pollack, *supra* note 55 and accompanying text (discussing how artificial intelligence is used to care for the elderly).

[196] *Id.* at 12–13. A third type of system, the assessment system, is still in its early experimental stage for use in eldercare. *Id.* at 20. The goal is to establish systems that can detect whether a user's cognitive abilities are within normal range for his age group and, eventually, to use "machine-learning methods to induce a person's normal level of functioning and to identify changes from that norm." *Id.* at 22.

[197] *Id.* at 13–14. Because these systems commonly are used in eldercare and other forms of healthcare for cognitively impaired patients, the contact person usually is a caregiver, such as a nurse or relative. *Id.*

[198] *Id.*

[199] *Id.*

[200] *Id.* This is of great importance in the realm of eldercare because "wandering is a significant problem for people with certain types of cognitive impairment." *Id.* at 13.

[201] Pollack, *supra* note 55.

Compensation systems work in concert with users to support and supplement their physical or cognitive abilities.[202] An example is El-E, a domestic robot that assists physically impaired users by locating and retrieving objects out of reach.[203] The robot's designers, recognizing the difficulty that robots can have with language recognition, built their device to respond to visual cues.[204] Using a combination of navigation intelligence and facial recognition software, the robot can retrieve items without the need for verbal directions. [205]

A wheelchair that responds to its user's neural transmissions is a second example of a compensation system.[206] The wheelchairs can be programmed

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> [T]he network may include a wide range of sensors, which are continually monitored both to recognize deviations from normal trends that may indicate problems (for example, failure to eat meals regularly, as determined by lack of motion in the kitchen) and to detect emergencies that require immediate attention (for example, falls, as indicated by cessation of motion above a certain height). The sophistication of the inference performed using the collected sensor data varies from system to system.

Id.

[202] *Id.* at 14–20.

[203] Scientific Blogging, *This Robot Can Bring You a Beer—Without Being Told*, Mar. 23, 2008, http://www.scientificblogging.com/news_releases/this_robot_can_bring_you_a_beer_without_being_told. The team has pursued its research for utilitarian, not just academic, purposes:

> To ensure that El-E will someday be ready to roll out of the lab and into the homes of patients who need assistance, the Georgia Tech and Emory research team includes Prof. Julie Jacko, an expert on human-computer interaction and assistive technologies, and Dr. Jonathan Glass, director of the Emory ALS Center at the Emory University School of Medicine. El-E's creators are gathering input from ALS (also known as Lou Gehrig's disease) patients and doctors to prepare El-E to assist patients with severe mobility challenges.

Id. The robot's name, El-E, is derived from "her ability to elevate her arm and . . . the arm's resemblance to an elephant trunk. . . . [She] can grasp and deliver several types of household items including towels, pill bottles, and telephones from floors or tables." *Id.*

[204] *Id.* In this case, the user identifies an object using a green laser pointer. *Id.* The robot is able to focus on the chosen object, navigate a path towards it, and retrieve the object for the user. *Id.*

[205] *Id.*

[206] Ariel Sena-Calvillo & Madeline Novey, *Brain-Controlled Robots Help People with Physical Disabilities*, ROCKY MTN. COLLEGIAN, Feb. 10, 2009, *available at* http://www.collegian.com/media/storage/paper864/news/2009/02/10/News/BrainControlled.Robots.Help.People.With.Physical.Disabilities-3621402.shtml.

with customized intelligent software that is able to distinguish among three different types of neural messages sent from the brain to a body part, with each message translating into a separate and distinct navigational command.[207] Again, recognizing the current difficulties associated with language recognition, scientists achieved their objective by utilizing non-verbal, physiological cues.[208]

One application of artificial intelligence in the medical sector, the "doctor kiosk," has similar great potential for widespread acceptance.[209] Akin to an automated teller machine used for personal banking, the doctor kiosk interacts with a patient to elicit the same information a doctor or nurse would at a regular check-up.[210] The impetus for developing such a device is

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> [The system works by] placing flat pads—known as nodes or non-invasive electroencephalograms—directly on the surface of the cerebral cortex, the part of the brain responsible for thought, memory, and perceptual awareness. The nodes are designed to interact and communicate with a person's brainwaves to an outside stimulus—in this case, to between seven and twelve nodes positioned on a cap worn by the user. The information received by the cap is then communicated to the machine's robot, which moves accordingly.

Id.

[207] *Id.* (discussing intelligent software that uses a patient's brainwaves to control and direct his or her wheelchair). The machine is tailored to each user's particular abilities:

> When designing each wheelchair, [Dr. Jose Del R.] Millán's team conducts a series of tests to analyze the individual's brainwaves and, based on the data, programs the robot to react to three physical movements: from a finger or hand twitch to a specific facial movement. . . .
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> . . . .
>
> "I work with a lot of people with a lot of different disabilities," [Millán] said of his interactions with [quadriplegics], people with Multiple Sclerosis and those who cannot speak in addition to their physical disabilities. He further explained that brain-controlled wheelchairs are an advantageous substitute for voice-controlled wheelchairs in this situation.

Id.

[208] *Id.*

[209] Lauren Gravitz, *The Doctor Kiosk*, TECH. REV., Feb. 25, 2009, *available at* http://www.technologyreview.com/biomedicine/22219/.

[210] *Id.* Specifically, the machine comes replete with:

> [A] tabletop computer and a number of peripherals—a blood-pressure cuff, a scale, a pulse oximeter to measure blood oxygen levels, and a peak-flow meter to determine whether someone's airways are constricted—as well as a blood-testing device commonly used in emergency rooms that can measure cholesterol and glucose

twofold: doctors want to diagnose potential or actual health problems at an earlier stage in their development, and medical administrators want to ease the strain on the healthcare system by streamlining the information-gathering process.[211] Through the use of intelligent software that sorts information, stores personalized data, and asks appropriate questions based on a patient's particular health history, the kiosk allows healthcare providers to maximize their resources by enabling doctors to focus on diagnostic tasks rather than administrative ones.[212]

Thus, we have an entity that can collect highly personal and intimate information, organize and store that material, and elicit additional information by asking questions based upon an individual's personal experiences and history. It is used to identify potential or actual problems at an early stage in order to prevent more serious problems from developing. In other words, we have a mediator.

Well, obviously, not quite yet. But there is no denying that information gathering is critical to any mediative or, in fact, any ADR process. While mediators and dispute resolvers do much more than collect information, the information gathering function may be one that can be performed by an artificial intelligence device. If the artificial intelligence ability of the medical kiosk described above is incorporated into a social robot that looks and behaves very much like a human, then the result may be an extremely effective and efficient information gathering tool.

An artificial information device used to collect, organize, and solicit additional information cannot replace a mediator or problem solver, but it

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> levels. ([Although] the current version requires a trained assistant to do the finger stick for blood collection . . . future versions will be automated).

Id.

[211] *Id.* The kiosk's creator, Ronald Dixon, is a physician at Massachusetts General Hospital in Boston, Massachusetts. *Id.* Dixon's vision for the use of such kiosks includes placement in shopping areas "to catch people who typically don't get screened, since a lot of the population doesn't go to the doctor unless they're sick." *Id.* Another benefit envisioned by healthcare professionals is placement of the kiosk within doctors' offices to increase efficiency and eliminate repetition of labor. *Id.* Furthermore, the kiosk has potential "to extend health-care access to the poorest nations." *Id.* One doctor on the project noted that, "there's a human-resource limitation overseas that's far larger than what we have in this country . . . [the kiosks] could provide common care to a huge percentage of people [and be] incredibly useful for routine follow-up for patients with issues such as tuberculosis or HIV." *Id.*

[212] Gravitz, *supra* note 209–11 and accompanying text (explaining how the doctor kiosk works to ease the strain on the medical labor pool).

may be able to make the entire dispute resolution process more efficient and cost-effective. Do not think of it as a replacement; think of it as selective subcontracting.

And, as discussed earlier, please keep in mind that significant work is being done regarding replicating the learning process of the human brain. As that research progresses, it will be possible to "subcontract" an increasing amount of a human mediator's, arbitrator's, or problem solver's responsibilities.

Similar to the work being done with medical information gathering kiosks, a team of German scientists has developed the Autonomous City Explorer (ACE) to engage with humans, elicit the information it needs to navigate its environment, and learn from its experience.[213] Unlike other navigational robots, ACE is not equipped with a global positioning system or a map database.[214] Instead, it relies on external data to plot its course and reach its destination.[215] ACE uses this information in conjunction with a program that allows it to perceive its immediate surroundings, determine a navigable path, and avoid obstacles—all while simultaneously following the directions provided by its user.[216] As with other machine learning devices, the technology used in ACE eliminates the need for extensive pre-

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[213] Andrea Bauer et al., *The Autonomous City Explorer: Towards Natural Human-Robot Interaction in Human Environments*, 1 INT'L J. OF SOC. ROBOTICS 127 (2009), *available at* http://www.springerlink.com/content/c04732439q011771/fulltext.pdf; *see also* Colin Barras, *Lost Robot Crosses City by Asking Directions*, NEW SCIENTIST, May 13, 2009, *available at* http://www.newscientist.com/article/dn17124-lost-robot-crosses-city-by-asking-directions.html.

[214] Bauer et. al., *supra* note 213, at 128. ACE was created this way because "systems which are to assist humans in a cognitive way will not always possess all the information required to fulfill their task. A central aspect of intelligent autonomous behavior is thus the ability to interact in order to retrieve information." *Id.*

[215] *Id.* Because ACE had to engage with humans to determine the appropriate route in his initial outing, "[t]he interaction had to be natural and intuitive for the humans, as they were picked randomly by the robot, had no prior contact with robotics technology, and were not instructed prior to the interaction." *Id.*

[216] *Id.* In their scholarly article describing their invention, the scientists noted that, "The chosen architecture enabled [ACE] to successfully travel a 1.5 km distance from the campus of [Munich Technical University] to *Marienplatz*, the central square of Munich. *ACE* completed this course autonomously within 5 hours, asking 38 passers-by for the way." *Id.* The results likely will be even more impressive when the ACE technology is used in social robots designed for domestic use, such as caretaking of the elderly, because they will not be distracted by "curious passers-by" as ACE was on his short trip across town. *Id.* at 137.

programming and enhances the utility of the device in real world situations where it encounters—quite literally—unknown territory.[217]

Artificial intelligence also is being put to good work in the commercial sector, largely due to technological advances sparked by national security concerns.[218] The intelligence being used in these situations actually is a variation of the assessment systems used for eldercare.[219] In highly-trafficked public areas, such as airports or national monuments, intelligent software works with surveillance cameras and imaging to determine when and if suspicious activity is occurring.[220] On a smaller scale, private commercial

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[217] *Id.* Importantly, "[t]he large number of people interacting [arose] from the fact that many of the interactions were started by curious passers-by." *Id*. This means that many people are quite amenable to engaging with a robot.

[218] James Vlahos, *Surveillance Society: New High-Tech Cameras are Watching You*, POPULAR MECHANICS, at 64, Jan. 2008, *available at* http://www.popularmechanics.com/technology/military_law/4236865.html. This phenomenon was described in rather chilling terms:

> An ABC News/*Washington Post* poll in July 2007 found that 71 percent of Americans favor increased video surveillance. What people may not realize, however, is that advanced monitoring systems such as the one at the Statue of Liberty are proliferating around the country. High-profile national security efforts make the news—wiretapping phone conversations, Internet monitoring—but state-of-the-art surveillance is increasingly being used in more everyday settings. By local police and businesses. In banks, schools, and stores. There are an estimated 30 million surveillance cameras now deployed in the United States shooting four billion hours of footage a week. Americans are being watched, all of us, almost everywhere.

Id. at 66; *see also* Simson Garfinkel & Beth Rosenberg, *Face Recognition: Clever or Just Plain Creepy?*, TECH. REV., Feb. 27, 2009, *available at* http://www.technologyreview.com/computing/22234/.

[219] Vlahos, *supra* note 218 (describing the extent to which surveillance devices and systems are being used in the commercial sector); *see also* Pollack, *supra* note 55; *supra* notes 195–201 and accompanying text (explaining how assessment systems work within the context of eldercare).

[220] Vlahos, *supra* note 218. At the Statue of Liberty, "a marquee terrorist target," the surveillance system

> can spot when somebody abandons a bag or backpack. It has the ability to discern between ferryboats, which are allowed to approach the island, and private vessels, which are not. And it can count bodies, detecting if somebody is trying to stay on the island after closing, or assessing when people are grouped too tightly together, which might indicate a fight or gang activity.

Id. at 66.

enterprises are using similar technology to prevent shoplifting.[221] These systems are programmed to recognize certain types of behavior or deviations from a pattern on a large scale and alert the appropriate party before a negative situation arises.[222]

As with domestic robots, artificial intelligence also has made an appearance on the home front.[223] Specifically, facial recognition software is being used to automatically "tag" and sort photos downloaded to personal computers from digital cameras.[224] The ability to organize and save

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[221] *Id.* In one grocery store chain, the company uses "StoreVision, a powerful video analytic and data-mining system." *Id.*

> There are as many as 120 cameras in some stores, and employees with high-level security clearances can log on via the Web and see what any one of them is recording in real time. An executive on vacation in Brussels could spy on the frozen-food aisle in Brooklyn.

Id. at 67.

[222] *Id.* The financial benefit of such surveillance systems in the commercial sector is quite apparent:

> In 2006 theft and fraud cost American stores $41.6 billion, an all-time high. Employee theft accounted for nearly half of the total (shoplifting was only a third), so much of the surveillance aims to catch in-house crooks. . . . The technologies employed by [the grocery store chain] don't stop crime but they make a dent; weekly losses are reduced by an average of 15%.

Id.

[223] Garfinkel & Rosenberg, *supra* note 218 (reviewing the latest face recognition software available for consumer use). Here, again, technological sophistication was prompted in large part by national security concerns:

> Face recognition was one of those brilliant but technically iffy and ethically tricky counterterrorism technologies deployed as a result of the September 11 attacks. The idea was to automatically screen out terrorists as they walked through security checkpoints—only it didn't work out that way: at a test in Tampa, for example, airport employees were correctly identified just 53 percent of the time. Civil-liberties groups also raised concerns about false positives—people being mistakenly identified as terrorists, and possibly arrested, just because of their looks. And so, without a demonstratable [sic] benefit, face recognition largely dropped off the public's radar.

Id.

[224] *Id.* Two products currently are available for consumer use: one manufactured by Apple for use with its iPhoto application and one manufactured by Google for use with its Picasa application. *Id.* The programs use machine learning tools (i.e. algorithms) that first identify objects in the photo that resemble facial features:

information obviously is valuable in many contexts. The acceptance of artificial intelligence devices is a matter of familiarity and trust. As individuals become increasingly comfortable relying upon artificial intelligence to provide support and assistance regarding their occupational, domestic, and medical concerns, they will become more comfortable relying on artificial intelligence to assist in resolving their disputes.

VII. AVATAR AND ROBOT MEDIATION

Mediation is a non-binding process through which parties resolve conflict with the help of a neutral third party, the mediator. Contrary to the adversarial approach of litigation, mediation emphasizes the importance of a "win-win" solution to the conflict with which both parties can feel satisfied. In essence, "mediation is facilitated negotiation."[225] Aside from that fact, however, definitions of mediation differ, and there are debates on a number of issues such as the extent to which a mediator should be evaluative, directive, or facilitative.[226] It is unlikely that a single definition can accurately describe a mediation process, and, in fact, a wide range of approaches may be used in any one case. Mediations may be facilitative or elicitive, evaluative or directive, transformative or problem solving, and court-annexed or private.[227] And these labels are not exclusive. Mediators' behavior can be understood as a continuum that can be both facilitative and evaluative "on the same issue, on different issues, simultaneously, or at

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> Next, one of three different technical approaches kicks in. Each of these approaches is, of course, covered by its own set of patents and bundled into various vendor offerings. One approach transforms the face into a mathematical template that can be stored and searched; a second uses the entire face as a template and performs image matching. And a third approach attempts to create a 3-D model based on the face, and then performs some kind of geometric matching. Based on [the authors'] experience with the software, [they] believe that Apple's system is using a landmarks approach, while the Google system is doing some kind of image matching.

Id.

[225] Leonard L. Riskin et al., DISPUTE RESOLUTION AND LAWYERS 13 (4th ed. 2009).

[226] Kimberlee K. Kovach, MEDIATION: PRINCIPLES AND PRACTICE 27–28 (3d ed. 2004) (listing eleven different basic definitions of mediation articulated by different practitioners and scholars).

[227] Frank E. A. Sander & Lukasz Rozdeiczer, *Selecting an Appropriate Dispute Resolution Procedure: Detailed Analysis and Simplified Solution*, *in* THE HANDBOOK OF DISPUTE RESOLUTION 386, 403 (Michael L. Moffitt & Robert C. Bordone eds., 2005).

different times."[228] A mediation can be facilitative on substance, directive on process, and can utilize caucuses.[229] The fact is that the adjectives used to describe a given mediation likely will change several, or even numerous, times during the session.

Choosing mediation is only the first step—different approaches may be selected depending upon factors such as the nature of the dispute, the relationship of the parties, the timing, and the type of third-party assistance required.[230] Keeping in mind the fluid nature of mediation, for organizational purposes it nonetheless makes sense to arrange the following discussion into familiar steps or stages and then suggest how artificial intelligence might be helpful at the different stages. As noted, these stages can arise and be pursued at different points in time during a mediation and will not develop according to a formal schedule. The following paragraphs will address circumstances that may arise at any time during a mediation session and suggest how artificial intelligence can make a productive contribution.

Relational agents can contribute to dispute resolution and problem-solving processes both by behaving intelligently and being intelligent. Their ability to connect with humans by engaging, expressing emotion, collaborating, and creating social relationships can be quite valuable to a dispute resolution or problem solving process. Before a mediation session begins, for instance, parties may be anxious and unsettled. The chance to interact with an empathetic, conversational relational agent, infinitely patient and willing to review and repeat without any loss of attentiveness, may prove especially helpful.

The author previously has written about how technology mediated dispute resolution[231] processes can be used to improve dispute resolution in the Deaf Community.[232] Many of those observations are relevant to this

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[228] *Id.* (citing Leonard L. Riskin, *Who Decides What? Rethinking the Grid of Mediator Orientations*, DISPUTE RESOLUTION MAGAZINE, Winter 2003, at 23).

[229] *Id.*

[230] *Id.*

[231] *See* Larson *supra* notes 49 and 152. Technology Mediated Dispute Resolution (TMDR) is a term that the author developed that includes and expands upon the more familiar term Online Dispute Resolution (ODR). TMDR includes the full range of technology assisted communication, including satellite and radio frequency communications, robots, web-based online communications, as well as more traditional devices such as telephones and fax machines.

[232] *See* David Allen Larson & Paula Gajewski Mickelson, *Technology Mediated Dispute Resolution and the Deaf Community*, 3 HEALTH L. & POL'Y 15 (2009), *available at* http://www.wcl.american.edu/org/hlp/09/09spring.pdf?rd=1 [hereinafter Larson &

article. For instance, if an artificial intelligence device does not have verbal abilities but can only communicate using text, then will that device still be able to communicate emotion? The Deaf Community's long time mastery of text based communication provides a clear answer to that question. Long before the non-Deaf population began sending e-mails and text messages, the Deaf Community was using the first generation of Teletypewriters, also known as Telecommunication Devices for the Deaf, to communicate information and emotion using terms such as ILY (I love you), CUL (see you later), and NP (no problem).[233]

American Sign Language (ASL) is not simply English on the hands. It is a visual-gestural language that has its own vocabulary and syntax.[234] Video Relay Service (VRS), a service that connects Deaf individuals to an interpreter who then dials a non-Deaf person and interprets the call, has been celebrated by the Deaf Community because it allows Deaf individuals to communicate in their natural language.[235] Video logs, or V-logs, are a form of web logs, commonly referred to as blogs.[236] Video logs are being used for both amusement and for serious discussions about Deaf Culture issues in ASL. Based in part on the Deaf Community's familiarity with video technology, my coauthor and I suggested in our earlier articles that it makes sense to introduce video technology into the Deaf Community's mediations.

The advantages of using an artificial intelligence device to welcome and introduce parties to a mediation that will be conducted by a human mediator are relevant both in the Deaf Community and the population at large. Attractive, very lifelike avatars and humanoid robots are capable of engaging the parties and presenting an introduction. An avatar's introduction can be made available on the Internet, sent to mobile devices, or e-mailed to the

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Mickelson, *Deaf Community*]; *See also* David Allen Larson & Paula Gajewski Mickelson, *Technology Mediated Dispute Resolution Can Improve the Registry of Interpreters for the Deaf Ethical Practices System: The Deaf Community Is Well Prepared and Can Lead By Example*, 10 CARDOZO J. CONFLICT RESOL. 131 (2008), *available at* http://cojcr.org/vol10no1/131-162.pdf.

[233] Larson & Mickelson, *Deaf Community*, *supra* note 232, at 19.

[234] *Id.* at 16 (citing CHARLOTTE BAKER-SHENK & DENNIS COKELY, AMERICAN SIGN LANGUAGE: A TEACHER'S RESOURCE TEXT ON GRAMMAR AND CULTURE 65 (Gallaudet Univ. Press 1991) (1980)).

[235] Larson & Mickelson, *Deaf Community*, *supra* note 232, at 19.

[236] Blogs are text-based websites that provide commentary on a wide variety of political to intensely personal issues typically arranged in reverse chronological order. The word blog is a portmanteau of "web log."

parties.[237] The introduction will be available on demand and can be reviewed repeatedly.[238] Although much of a mediator's introduction tends to be rather generic, an avatar's introduction easily can be edited to address any unique facts or concerns and can be saved for future mediations.

One problem with presenting a one-time, in person, face-to-face introduction when beginning a mediation is that mediators may forget what they have communicated "this time" and may omit important information.[239] Assuming its introduction has been saved in several readily accessible locations, an avatar never forgets.

Another problem is that both the mediator and the party may be eager to begin the "real" mediation and may be inclined to rush through the introduction. Important questions may not be addressed and that failure may complicate the process subsequently. If the parties are advised that first they will participate in a video (or humanoid robot) introduction for a certain amount of time that, in light of current technology, may have a fair degree of interactivity, one can be assured that at least the mediator will not rush the introduction.

If the introduction is provided to the parties before the participants meet in person, then the parties can review the introduction repeatedly. If the avatar has interactive capabilities, then parties who discover that they have new questions or concerns that they did not recognize during the first introduction may be able to have those concerns addressed by the avatar before the parties meet in person.

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[237] Larson & Mickelson, *Deaf Community*, *supra* note 232, at 23.

[238] *Id.*

[239] *Id.*; *see also* Eric Allen Engle, *An Introduction to Artificial Intelligence and Legal Reasoning: Using xTalk to Model the Alien Tort Claims Act and Torture Victim Protection Act*, 11 RICH. J.L. & TECH. 53, 56–57 (2004), *available at* http://law.richmond.edu/jolt/v11i1/article2.pdf.

> The computer is less likely than a human to overlook any of the Byzantine exceptions or exceptions to exceptions that may result in the application or non-application of a foreign or domestic procedural or substantive law. Computers are not more intelligent than humans. Humans are far more creative than the computer programs that they write. Computers, however, are more systematic and less prone to error in simple repetitive tasks than humans. This author is of the opinion that artificial intelligence can play a useful legal role as a diagnostic and a checklist. Artificial intelligence can act as backstop for human reasoning to prevent human error, such as oversight or omission of potential claims and defences, and guide potential lines of argument.

Id. at 4–5.

It is possible that after participating in the introductory session with an avatar several times, the parties will become increasingly comfortable interacting with an artificial intelligence device and may be amenable to additional technologies and applications. One should always keep in mind, nonetheless, that as enchanted as the mediation process designer may be with a newly discovered technology, the parties should have significant input regarding the nature of the process and should not be forced to accept particular technologies. Prohibiting coercion, however, does not bar gentle encouragement.

Additionally, one should not overlook the fact that an introduction by an avatar in no way precludes subsequent personal involvement by the mediator. An avatar's introduction may prove particularly efficient in that it may identify questions and misunderstandings that then can be specifically addressed by the mediator, who no longer is responsible for taking the time to articulate every step of the upcoming process. It will be important, however, for the mediator to be proactive and ensure that the introduction was understood.[240]

Once the parties are introduced to the relevant process and the other participants (including artificial intelligence devices), often a period of information gathering and issue identification occurs. In most situations, more information will help in reaching a solution. But as mediators know, information is not always disclosed based upon a schedule or a template. Critical information may be withheld until very late in a process. And unfortunately, sometimes essential information is never revealed, making resolution impossible.

Parties may find it easier to make certain types of disclosures to an artificial intelligence device. It may be less painful or frightening to disclose shameful or intimate information to a lifeless, nonjudgmental avatar or robot. When parties have reached an impasse, traditional options soon may be exhausted. On the one hand, an empathetic artificial intelligence device may be the appropriate option for eliciting information that has been unavailable thus far. On the other hand, it may be that an entirely dispassionate device is the appropriate conversational partner. Artificial intelligence offers a myriad of options and opportunities to move conversations forward when they appear to be hopelessly stalled. Even the simple fact that a party now is interacting with something else, apart from the suddenly stifling dynamic of the all-too-familiar other party and mediator, may be enough to encourage additional disclosures. A robot's or avatar's ability to engage and express

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[240] Larson & Mickelson, *Deaf Community*, *supra* note 232, at 23.

emotion obviously will be of great value when it comes to gathering information and identifying important issues.

The ability of an artificial intelligence device to elicit difficult disclosures should not overshadow the fact that an artificial device is well-equipped to collect and organize less emotional, but still essential, information. A patient, conversational relational agent can collect basic information, ask follow-up questions, and collect information that may prove voluminous. Without a relational agent, this information collection and organization process can take significant time and prevent the mediator from moving towards a more productive interaction. The mediators must, of course, still familiarize themselves with that information. But they now will have the luxury of having it organized and subsequently available on demand.

Recall the discussion about the doctor kiosk.[241] It was developed to facilitate earlier diagnoses of potential or actual health problems and to relieve pressure on the healthcare system by making the information-collecting process more efficient. Using artificially intelligent software, the doctor kiosk not only can collect, sort, and store information; it also can ask personalized questions based upon a patient's health history. It is difficult to believe that a "mediator kiosk" could not be similarly employed.

At some point, mediators and parties will brainstorm about possible solutions. Relational agents' ability to record and organize information offers obvious value and their interactive conversational capabilities allow them to be collaborative participants in conversations, encouraging parties to more clearly define their immediate suggestions while moving forward to build upon those ideas.

This is the point where an artificial intelligence device's ability to *be* intelligent can be particularly helpful. Smartsettle, a negotiation software program referred to at the very beginning of this article, does not present itself in the form of an avatar or a robot.[242] But it does maintain that it can improve parties' tentative or possible negotiated solutions by applying optimization algorithms.

There are many online dispute resolution providers that exist currently, but they primarily (and merely) provide digital parking places.[243] In other words, they provide public and private spaces on their website for saving and

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[241] *See supra* notes 209–12 and accompanying text.

[242] *See supra* note 1 and accompanying text.

[243] *See, e.g.*, The Mediation Room, http://themediationroom.com/ (last visited Oct. 2, 2009).

sharing information and engaging in text-based or perhaps verbal conversations. Some of them also make a limited form of artificial intelligence available in the form of blind-bidding. In blind-bidding systems, one party simultaneously submits several (typically three) increasingly more modest demands and the other party simultaneously submits (usually) the same number of gradually increasing offers. If either the first, second, or third pair of demands and offers falls within a pre-determined settlement range—for instance the demand and offer are within ten percent of each other—the case automatically and immediately settles.[244] Smartsettle attempts to do more. Their efforts to integrate optimization algorithms into a negotiation are a very real attempt to create a system that is intelligent.

Reference was made earlier to a pair of laboratory robots that not only can perform simple experiments, but also can formulate hypotheses, conduct experiments to test those hypotheses, and evaluate the results.[245] As this ability to act and think independently is further developed and refined, one can only imagine the collaborations that might be possible during an ADR brainstorming session.

Existing online dispute resolution providers frankly have not even begun to scratch the surface. The author does not believe that any existing online dispute resolution providers are using relational agents to facilitate their processes, although one might expect that they would be the first to do so. The author suspects, however, that the first dispute resolvers and problems solvers to use relational agents may not be the current online providers but rather entrepreneurial, face-to-face mediators who partner with a company, researcher, or an individual skilled in creating relational agents in other contexts.

Although mediations often take no longer than a day, they can last days, weeks, and even months. Research involving behavior modification in the medical context confirms that relational agents are capable of social interaction, in other words, extended engagements. This capability ensures that a relational agent's involvement need not be limited to a short-term or one-time interaction. Instead, engagements with relational agents can be maintained over substantial time periods and may, in fact, grow to be more comfortable and productive over time.

As intriguing as all of this may sound, one has to ask: is it realistic to suggest that practicing mediators can implement any of the preceding suggestions? What about access to the necessary technology? Although it

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[244] *Id.*; *see also* Cybersettle, http://www.cybersettle.com (last visited Oct. 2, 2009).

[245] *See supra* notes 190–94 and accompanying text.

will require a significant investment to create a humanoid robot, avatars can be created quickly and easily. And while the task of creating a conversational agent that can respond appropriately may seem daunting, tools for developing such agents are available. For instance, DTask and LiteBody are two open source, standards-based tools for developing embodied conversational agents and deploying them over the Web to standard Web browsers.[246] These tools are being used in two health education and behavior modification projects funded by the United States National Institutes of Health, and the developers are releasing the tools as open source to benefit the virtual human health and health research communities.[247]

Although there is evidence that relational agents can create therapeutic alliances with patients, questions may remain as to whether the positive interactions described in the preceding sections will be limited to medical treatment. Are robots and avatars capable of the behaviors necessary to engage productively when they interact outside of the health care environment? On the one hand, it can be argued that if humans respond to relational agents concerning issues that may have life-or-death implications, then humans certainly will be receptive to relational agents in other less desperate contexts where much less may be at stake. But on the other hand, one also can argue that when it comes to health issues, especially those with life-or-death implications, individuals will grasp at whatever lifeline is offered. The fact that the lifeline—in other words, the essential information and valued emotional support—is presented in the form of an avatar or robot makes no difference when it comes to serious health matters. Individuals will accept interactions with relational agents purely because, and only because, they are so desperate. This willingness to interact with relational agents will not carry over into other contexts.

Yet this willingness to be flexible in response to distress or pain may be the reason that there is a place for robots and avatars in dispute resolution and problem solving. Regardless of the fact that the pain may not be physical in nature, and in spite of the fact that the situation may not literally be life or death, people with seemingly intractable problems mired in contentious disputes feel emotional pain and will welcome help regardless of embodiment. Even if the reader still cannot imagine the type of artificial

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[246] *See* Timothy Bickmore et al., *DTask and LiteBody: Open Source, Standards-Based Tools for Building Web-Deployed Embodied Conversational Agents*, 2009 PROC. OF INTELLIGENT VIRTUAL AGENTS 1, *available at* http://www.ccs.neu.edu/research/rag/publications/IVA09.litebody.pdf.

[247] *Id.* at 7.

intelligence with which he or she can engage in a serious dialogue, then at least understand that our digitally native children will have no such reservations.[248]

As the reader proceeds through this article for the first time, the author is confident that possible artificial intelligence applications are becoming apparent. The observation was made earlier that existing online dispute resolvers are only scratching the surface when it comes to artificial intelligence devices. Similarly, the author must confess that the preceding paragraphs in this subsection only begin the discussion of how artificial intelligence devices can be integrated into dispute resolution processes. The author looks forward to continuing this discussion.

VIII. CONCLUSION

The author does not pretend to foresee all, or anywhere near all, of the possible applications of artificial intelligence in dispute resolution. Viable applications have been identified and discussed, but many issues still must be explored. Empathetic avatars that elicit and collect intimate and personal information, for instance, convert that information into a digital format. Confidentiality and security concerns will grow exponentially and protocols must be established regarding retention, transfer, and destruction of data. Research directed at mapping the brain and duplicating its processes in order to create robots, avatars, and other relational agents that actually are intelligent raises a host of exciting possibilities and concerns. The author hopes to further explore these concerns in future articles and encourages others to do so also. Furthermore, the author's greatest immediate hope is that the preceding material inspires dispute resolvers and problem solvers to think creatively about how artificial intelligence devices can be used effectively today.

One final thought: What about the title of this article? Obviously, the demise of the human mediator is not imminent. But artificial intelligence devices and programs are being integrated into our daily lives at an

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[248] Ninety-two percent of teen cell phone users, for instance, think gadgets make their lives easier and even the eighty-one percent who do not own cell phones agree. Amanda Lenhart et al., *Teens and Social Media*, 2007 PEW INTERNET & AM. LIFE PROJECT 30; *see also* John Giere, *Millenials: The Future is Now*, *in* ENRICHING COMMUNICATIONS, July 2008, *available at* http://www.alcatel-lucent.com/enrich/v2i12008/article_c1a4.html. ("This is a generation of natural-born technologists . . . specifically interested in . . . harness[ing] technology in a way that allows them to get their work completed quickly. . . . ").

increasing rate, often in ways that are not immediately apparent. It is unrealistic to believe that the ADR world somehow will avoid this evolution. There is a generation quickly moving to adulthood that spends significant time interacting with avatars in cyberspace. They rely on technology assisted communication for their most intimate conversations and look to the Internet to find answers to their most pressing questions. They will search for, and will not hesitate to use, artificial intelligence devices to assist them in dispute resolution and problem solving. They are able to interact with avatars, robots, and other forms of relational agents easily and will expect and demand dispute resolvers and problem solvers to be similarly prepared.

Do not underestimate humans' attraction to, dependence on, and affection for technology. In a survey by German broadband association Bitkom, approximately eighty-four percent of respondents aged 19–29 reported that they would rather do without their current partner or an automobile than forego their connection to the Web, and almost every single person (ninety-seven percent) declared that living without a mobile phone was unthinkable.[249] Whereas one can always find another person to love, life without the Web is unimaginable.[250]

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[249] *German Twenty-Somethings Prefer Internet to Partner*, REUTERS, Mar. 2, 2009, *available at* http://www.reuters.com/article/idUSTRE5213OS20090302.

[250] *Bad Week For: Flesh and Blood*, THE WEEK, Mar. 13, 2009, at 6.