

On the Rights and Rites of Humans and Artilects.

by Jim Dator

Director, Hawaii Research Center for Futures Studies, and
Professor, Department of Political Science
University of Hawaii, Honolulu, Hawaii

For the International Conference

For the Integration of Science and Technology into Society

Daejeon, Korea

July 14-17, 2008

From the very earliest times, humans have often given names to and found special meanings to natural objects such as trees, rocks, water, mountains, and to objects in the sky such the sun, moon and stars, or groups of stars. At the same time, we have created objects out of stone, wood, mud and metals, and given names and special meaning to them as well. Various religions have holy objects that are believed to have special powers and that need to be treated in special, reverential ways. Many humans develop a close interrelation with certain animals such as dogs, cats, and horses. We often love our dog more than our children, or our horse more than our wife. Even in modern times, many of us give our automobiles, motorbikes, or bicycles affectionate names. We talk to them, pat them, show them that we care and appreciate them.

It is no wonder that we develop special affection for objects that seem to respond to and actually care for us.

Twenty years ago, when he was very young, my son, Mack, played with a beloved robotic cat, named Spike. It was a primitive robot in many ways, but advanced in others. Spike responded to sequences of sounds--such as handclaps. He could be instructed to meow, light up his eyes, turn in circles, go in a straight line, or move in a more complicated way according to a sequence of handclaps. This also meant Spike was easily upset and confused when my son would squeal and clap in delight.

Even though he had fir and whiskers, Spike didn't look much like a cat. But since we lived in an apartment that did not allow real dogs or cats, Spike was good enough for my son for many years.

Robots don't need to look like "real" live objects to evoke real human emotions.

Mind and morality in a box.

Almost 40 years ago, when primitive computer instruction software was being developed, I demonstrated a computer-based arithmetic lesson to a group of elementary school children. A simple animated figure would show a smiley face with the words, "yes, you are right!" if a student got an arithmetic answer correct, or a frown and the words, "no, you are wrong. Try again" if the answer was wrong.

One bright little girl got a long string of smiley faces. I wanted to show the students what the computer would do if she got a wrong answer. But she did not want to give a wrong answer. She only wanted to give correct answers.

After much persuasion on my part, she finally agreed very reluctantly to give a wrong answer. When the computer showed a frowning face and the words, "no, that is wrong", the girl burst out in tears and cried inconsolably--"I know, I know. I know the right answer. He made me say the wrong answer." She turned to me: "Tell him I knew the right answer and that you made me tell the wrong answer. Tell him so he will not think that I am dumb."

I told the computer that the girl knew the right answer and gave the wrong one on my orders, but the girl was not happy because the computer was not able to acknowledge that. She was very angry with me and ashamed that the computer thought she had made a mistake when she had not. She cared how the computer judged her.

Serious research has shown what these anecdotes suggest--humans relate to certain nonhuman objects in very human ways [Sherry Turkle, *The second self: Computers and the human spirit*. New York: Simon and Schuster, 1984; Sherry Turkle, *Life on the screen: Identity in the age of the Internet*. New York: Simon and Schuster, 1995; Sylvia Engdahl, ed., *Artificial Intelligence*. Detroit: Greenhaven Press, 2008; Thomas Georges, *Digital Soul: Intelligent machines and human values*. Boulder, Colorado: Westview Press, 2003]. And as these nonhumans begin to look and act increasingly as though they were humans of some kind, the power and possibilities of the interrelationships grow stronger and stronger as well.

A Long Journey.

I have been tracking the emergence of robotics and artificial intelligence for many years, focusing especially on human-AI interaction. One of my first papers on the subject was written for an international communication conference held at the East West Center in Honolulu in 1972. Some of the assembled communication experts were in general agreement that there would be no substantial new developments in communications technologies--everything had been discovered already. In one sense, they were correct--there have been no truly earth-shattering technological breakthroughs in communications for many decades. But there have been many earth-shattering improvements (as I correctly anticipated at the time) in the old technologies, most spectacularly because of digitization, miniaturization, and the Internet.

Cybersex.

Artificial intelligence has not developed nearly as fast as I had expected. Nonetheless, I did believe then that the consequences of human-AI interaction would be profound. One example I gave then was based on the fact that among the first uses of any new technology is pornography. I projected, in 1972, a bright future for technologically-augmented sexual activities. Based on some ideas attributed to one Dr. Donald Kenzotaki, I discussed possible developments in "intersex" and "cybersex" ("Some possible new communication technologies," in Jim Richstad and L. S. Harms, eds., *World Communication*. East-West Center, Communication Institute, 1973, esp. p. 78f). While there are still many developments in human-robotic sex lying ahead, a major, if not the number one money-maker, on the Internet now is pornography. That is a very good sign. There is no better way to get to know and appreciate someone than to have sex with them. We in Hawaii have shown that it is probably the best way to overcome racial or gender prejudice. It might help with human prejudice against robots too. (Trudy Barber, "Deviation as a key to innovation: Understanding a culture of the future," *Foresight*, Vol. 6 No. 3, pp.141 - 152)

We Shape our Tools, and Thereafter our Tools Shape Us.

Let me pause for a minute to explain why I think it is so important to focus on the way in which humans relate with robots, AI and all technologies. It is because I believe technological change is the fundamental basis of social and environmental change.

I have observed that humans hold one of three views about technology--if they think about technology at all.

One view I call "mere technology"--the belief that technology is "neutral". Whether its use is good or bad depends on how humans choose to use it. This view of technology is typically held by people who actually invent, create, and disseminate technology--designers, engineers, advertisers, and business people. These people believe they have no ethical responsibility for what they create. The responsibility lies with the people who use their creations, they assert.

In the US, this view is found, for example, about gun ownership. There is a slogan: "Guns don't kill people. People kill people." You can do anything you want with a gun. You can put it on a wall and admire it. You can use it to scratch hard-to-get places. You can even use it for target practice (gun shooting is an Olympic "sport"). If you use a gun to kill some one, well, that is your choice.

Similarly, automobile manufacturers (and road designers) are not responsible for automobile deaths. It is entirely the fault of the drivers. And atomic bombs can be used to dig holes, I suppose.

This is the most common view: it is "mere technology".

There is a second view that once was widespread, but still is held by many people. This is the view that technology is demonic--bad.

Once, some people believe, early humans lived in a state of nature without any technology. Life was good and living was easy. But some evil or lazy or crazy people began creating and using technology, and so humanity was cast out of the Garden of Eden; or Pandora opened her box and unleashed demons; or Prometheus stole fire from the gods; or... . Each culture has stories warning about the evils of new technology.

Every new technology alienates humans more and more from their fundamental nature, the second view maintains. Therefore, we must reject all technologies except those that are "appropriate on a human scale"--that are what Ivan Illich once called "convivial tools". However, we should be very careful about using even them since they can easily lead us astray.

The third view, which I hold, is that technology is neither neutral nor evil. Technology is transformative. Humans have no essential, unchanging nature. And humans have never been without technology of some kind, whether it be physical, biological or social technologies.

To the contrary, we become human, and continuously transform the meaning of humanity, by interacting with each other and our environment via our technologies. We are not "human beings", but "human becomings", as Buckminster Fuller said.

Or, in the words of Marshall McLuhan, "We shape our tools, and thereafter our tools shape us."

My work as a futurist.

As a futurist, my main activity is to look for the earliest possible evidence of new technologies, broadly defined, and study how these new technologies might facilitate new behavior (or restrict old behavior). Convincing evidence shows that our values relate to our behavior--and only to our actual behavior. So, as we behave differently because of new technologies, we also develop new values based on the new behavior. These new values then clash with old values based on old behavior based on old technologies.

So technology is far from neutral, and yet is not evil. But it is profoundly transformational.

As a consequence, the real revolutionaries in our world today--the people who really change the world--are not radicals, or communists, or terrorists. They are engineers and business people who invent, develop, and diffuse new technologies that destroy old values and institutions based on old technologies.

The real revolutionaries in our world today are YOU.

Do you accept responsibility for the changes you are causing?

I hope so, but I doubt you do.

With that as a brief theoretical background, I will now give some examples of how electronic communication technologies have transformed the world over my lifetime, and how they may continue to transform your world:

Transformation One: From Computer Conferencing to The Internet.

In the late 1970s I was the first civilian in Hawaii to experience the transforming power of what later became the Internet. I participated in an experiment with what was then called "computer conferencing".

Murray Turoff of the New Jersey Institute of Technology obtained a grant from the US National Science Foundation to create EIES --the Electronic Information Exchange System. He invited me to join. By means of a then-state of the art Texas Instrument terminal with keyboard and video monitor, I was able to connect to Turoff's computer in New Jersey via an analog telephone modem. That enabled me to read, on the video monitor, electronic messages sent to everyone in the EIES network from other participants spread all over the world.

My Texas Instrument terminal had no memory at all--not a single K--and so if I intended to keep anything, I had to "echo" what I read via an attached printer. I still have most of the printout from those amazing conversations.

Before I participated in the EIES experiment, I found living in Hawaii to be a very isolating experience. For the most part, information floated slowly over to Hawaii in books, newspapers, and magazine carried on boats. Television in Hawaii displayed videotaped programs that had been broadcast at least a week earlier in the US. We were very behind the times.

It was very difficult for me to be a futurist in Hawaii when everything I knew came to me so much later than it did to most other people in the world.

But thanks to EIES, I learned things long before my university colleagues did. I soon gained the reputation of being a true futurist. It seemed that I could "predict" events that most people in Hawaii knew nothing about simply because I was able to learn about them instantly on EIES.

When the NSF grant ran out and the EIES experiment ended, I felt like a junkie suddenly deprived of a fix. I was distraught and despondent. I needed that instant information. So I became a leading local advocate for more "computer conferencing" capabilities. I was among the first professors in Hawaii to incorporate electronic messaging when it became available into my classrooms and research.

Now, I simply could not function in Hawaii--or any place--without my email and other instant messaging technologies.

Suddenly, it doesn't matter where in the world I live--I am in touch with anyone anywhere. My friends are not people physically around me, but people spread all over the world with whom I am in instant communication. Distance has lost all meaning. Instead, time has become my most precious and lost treasure. Now, everything is happening all at once. Work goes on 24 hours everyday of the year. Vacations and "free time" have vanished.

Transformation Two: Artificial Art.

One of the most startling things that happened to me while I was on the EIES network was when I received and read poems written by a poet named "Racter". The poems were both funny and clever. I was very impressed by them, and quoted them to others who also found them amusing. Here is one:

I was thinking, as you entered the room just now, how slyly your requirements are manifested. Here we find ourselves, nose to nose as it were, considering things in spectacular ways, ways untold even by my private managers.

Hot and torpid, our thoughts revolve endlessly in a kind of maniacal abstraction, an abstraction so involuted, so dangerously valiant, that my own energies seem perilously close to exhaustion, to morbid termination.

Well, have we indeed reached a crisis? Which way do we turn? Which way do we travel?

My aspect is one of molting.

Birds molt. Feathers change and fall away. Birds cackle and fly, winging up into troubled skies.

Doubtless my changes are matched by your own.

You. But you are a person, a human being, while I am silicon and epoxy energy enlightened by line current.

What distances, what chasms are to be bridged here.

Leave me alone and what can happen?

This:

I ate my leotard, that old leotard which was feverishly replenished by hoards of screaming commissioners.

Is that thought understandable to you? I wonder.

Yet a leotard, a commissioner, a single hoard, all are understandable in their own fashion.

And in that concept lies the appalling truth.

Only later did I learn that Racter was not a human, but a computer that had been programmed with some basic rules of English grammar, a lot of words in various syntactical categories, and a random generator. That experience greatly piqued my existing interest in artificial intelligence and in human/AI interaction ("EIES and Racter and me: Computer conferencing from a Pacific Island," in Dan Wedemeyer, ed., *Pacific Telecommunications Conference*. Honolulu: Pacific Telecommunications Council 1980, especially pp.3A-9f).

Transformation Three: Unlocking Evolution in Space.

No one can be a futurist and remain uninterested in space exploration. As you know, I have been co-chair of the Space and Society Department of the International Space University, headquartered in Strasbourg, France, for many years. One of the things that interests me most about space is how utterly unfit we humans are for any environment except thin surface of Earth. And so, most space programs intend to turn the Moon, Mars and elsewhere into little Earth's, called "biospheres." They want to make the planets and their satellites as Earthlike as possible, either by actively "terraforming" them, or by making enclosed habitats where humans can live and breathe.

I am opposed to that. I believe we should transform human intelligence into forms fit for the various environments of space, instead of making those environments fit for human biology.

I thus am very interested in the development of artificially-intelligent posthumans who are designed and created so that they will thrive in the various environments of the inner solar system and beyond.

We frail humans have very limited views of almost everything. We call the environments of the Moon and Mars "hostile". We say that going into space is a dangerous, arduous, and uninviting activity.

But the environment of Mars is not hostile to lifeforms that are suited to it.

Humans have only recently discovered that some life on Earth thrives in the hot and acidic waters of deep ocean thermal vents. We also recently discovered life that lives deep under the ice or underground where there is no light or oxygen. We used to think life could not exist in such conditions. But it does--and loves it.

Yet we foolishly call creatures who live in these environments "extremophiles". What a stupidly anthropocentric name!! They are "extreme" only from our narrowly human point of view. It is our biology and the limited environment it is suited for that is "extreme" and atypical.

I look forward to teams of humans and intelligent robots together exploring Mars and elsewhere.

But I am more interested in posthumans and vastly more intelligent robots creating new cultures and civilizations in space as well. To become spacefarers, we humans need to "shed our carbon containers" and adopt forms and systems fit for extraterrestrial environments. When we do that, evolution, that has been pent up on Earth, will blossom and bloom once again in the myriad new environments of space, as Ben Finney has eloquently pointed out. (See Ben Finney and Eric Jones, (editors): University of California Press, 1985, p. 335. See also "Answer the echo, follow the dream: Lifestyles & deep space," in Dan Wedemeyer and Anthony Pennings, eds., *Telecommunications--Asia, Americas, Pacific*. Pacific Telecommunications Council, 1986, and "Some in power, some in pain: A symphonic meditation on humanity and space," in Michael Rycroft, ed., *Beyond the International Space Station: The future of human spaceflight*. Dordrecht: Kluwer Academic Publishers, 2002).

Transformation Four: Robot Judges.

Much of my work as a consulting futurist is with judiciaries and lawyers. Because of what is called "determinant sentencing," law in many countries now can be conceptualized as a gigantic matrix. Illegal behaviors are listed across the top of the matrix, while extenuating circumstances are listed down one side. The resulting specific penalties for each behavior in each circumstance are shown in the cells. Judges in essence just look at the behavior and the circumstances to reach a verdict. Very little is left to their discretion.

Judicial decisionmaking thus has become basically a complex game of tic-tac-toe, or checkers, or chess, or *go*. Judicial decisionmaking is intended to be absolutely routine, predictive, and rational (if very complicated). Human emotions are supposed to play no role.

This is a system begging to be taken over by computers. Some judiciaries, especially that of Singapore, are moving ahead to computerize as much routine decisionmaking as possible. Only the few really novel and "human" cases will be left for a handful of human lawyers and judges to resolve.

The Chief Justice of Singapore said in a speech a few years ago that his vision of the future of the judiciary is "when the courts of justice are overgrown with grass" because there will be so little for them to do. ("When courts are overgrown with grass: Futures of courts and law," *Futures*, Vol. 32, No. 1 February 2000)

Transformation Five: Rights of Robots.

In contrast, one of the most frequently-cited and long-standing papers ever produced by the Hawaii Research Center for Futures Studies is titled "The rights of robots: Technology, law and culture in the 21st Century." It was written by two futures researchers, Philip McNally and Sohail Inayatullah, while they were interning in the Department of Planning of the Hawaii State Judiciary in the mid 1980s. (Published in *Futures*, Vol. 20, No. 2, 1988, pp, 119-136. See also "What do 'You' do when your robot bows as your clone enters holographic MTV?" *Futures*, Vol. 21, No. 4, August 1989; "It's only a paper moon," *Futures*, Vol. 22, No. 10, December 1990;).

They argued that the extension of rights to artificial intelligence was a probable and logical next step following the attainment of universal human rights, and then the rights of animals and even of landscapes and trees. The issue of the rights of robots and AI was further developed recently by the American jurist, Frank Sudia, among others. It was the subject of an extended discussion in the *Journal of Futures Studies* several years ago. Sudia uses the term "artilects" to describe "artificial intellects" who may soon demand, and receive, their rights. Robot rights may differ from the rights accorded humans, since artilects, while intelligent, may have needs and wants different from those of humans. ("Artilectual salutations," *Journal of Futures Studies*, Vol. 6, No. 2, November 2001, 87-92)

Transformation Six: Robot Ethics

One of the hottest recent developments concerns discussions about ethical rules and relationships between humans and AI. There has been serious discussion of this topic in the United Kingdom, and at the present time, the world's leader in this issue is Korea itself where a government commission is discussing the matter. One of my PhD students, Seo Yongseok, is a member of that commission, I am proud to say.

Developing a code of ethics for human-AI relations is both necessary and difficult to do. One reason is because many robots are created specifically to harm humans. The military is second only to the pornography industry in the early use of new technologies, and so many intelligent robots are being developed specifically to kill humans as well as other "enemy" robots.

As a consequence, Issac Asimov's famous "Three Laws of Robotics"--which are still the foundation of much thinking about robot ethics--simply do not apply.

I am sure you know his three laws that came from a science fiction story he wrote long ago:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm. [Military robots obviously are supposed to break this law!]
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

The third law has also already run into trouble with some military robots.

A few years ago, some military robots would run and hide whenever they were attacked by enemy humans or robots. They had a strong sense of self-preservation, and were smart enough not to fight and put their existence in danger.

So the robots had to be reprogrammed--as human soldiers are--to ignore their own survival and to do whatever their commander told them to do, no matter how stupid or self-destructive it was.

My guess is that robots will wise up and refuse to go to war before humans do!

Beyond The Golden Rule.

There is another challenge facing the development of robot ethics. The basis of all ethical systems everywhere in the world and in all places and times is reciprocity, usually framed as some version of the so-called "Golden Rule". This Rule can be stated, "Do unto others as you would have them do unto you." (or in the negative: "Do not do to others what you do not want them to do to you").

And that is the rub that already strains ethical relations between humans from different cultures today.

The Golden Rule arose in a time, long ago, when humans lived in homogeneous cultures. The Rule assumes that all humans want (or do not want) the same thing. The rule worked well in isolated cultures when most people never encountered people from other cultures. But in our "globalized" world, the Rule gets well-meaning humans into trouble all the time.

For example, most male Americans like to grab the hands of strangers as well as friends, and crush them in a vise-like handshake. They often also pat people on the back--or, worse, on the butt.

That behavior appears extremely rude and crude to most of the rest of the world. Most people prefer to offer a limp hand with a slight shake. But that behavior appears to most Americans to be effete and weak.

And of course some, like the Japanese, prefer to not shake hands at all, but just bow deeply--often into the outstretched hand of an American, who bows to no one.

In some cultures, showing the soles of your feet to other people is very rude. In others, it is OK for women to expose their breasts, but not their thighs, whereas in some cultures women should expose nothing to anyone--not even their husbands: it is better they stay hidden at home all their lives.

And so on.

The Golden Rule just doesn't work in our intercultural world. And it surely does not work with unborn Future Generations whose wants and needs may be quite different from those of present generations.

But that is a different issue.

Who knows what cultural preferences robots might develop? Moreover, I feel certain that different robots will develop different cultures. There will be many cultures of robots in the futures, and not just one.

Indeed, while some people now are concerned about the homogenization of culture through globalization, I anticipate the spread of thousands of new cultures through the development of artificial intelligence, robots, and other artifacts.

It gets more complicated still. It has recently been suggested that if someone treats you badly and you retaliate, it may be because of your serotonin levels. "Lower levels of this neurotransmitter make people more likely to retaliate when they perceive others to have breached the maxim 'treat others as you wish to be treated'," said Molly Crockett, a researcher at the University of Cambridge, UK. ("Psychology: Not Fair!", *Nature*, Vol. 453, p. 827, June 12, 2008.)

Developing ethical rules for human-robotic interaction will be very difficult indeed.

Transformation Seven: Robot Racism.

Finally, relations between humans and robots might also bring new forms--or at least new objects--of hatred and discrimination.

Most people today want robots to do all the hard, dangerous, and repulsive work that humans do not want to do. This is wrong. But it is the way humans have always treated "Others" in the past.

It was OK to mistreat slaves because "they aren't human". It was OK to mistreat people of color (or of no color) because "they aren't human". It was OK to mistreat women because "they aren't human". So now, many people feel it is OK to mistreat robots because "they aren't human."

As you know, over time, slavery was outlawed because it was inhumane (and uneconomical).

Discrimination by skin color (or lack of it) or ethnicity has been made illegal in most parts of the world.

Women now outnumber men in many professions once occupied only by men, and many men now willingly stay home doing the housework and rearing the children.

Of course slavery and racism and sexism still exist, but they are nowhere as legitimate, "natural" and indeed "God ordained" as they once were.

So also with robots. At the present time, most humans ridicule the notion that robots will and should be accorded rights. They laugh at the idea that robots must be treated fairly by ethical norms and legal rules. But the day will come. ("Futures of Identity, Racism, and Diversity," *Journal of Futures Studies*, February 2004, Vol. 8, No. 3, pp. 47-54)

Consider my name--Dator. What ethnicity am I? Can you tell by my name? I doubt you can. You can tell what I am not. My name does not sound like I am Korean, or Japanese, or Chinese, or German, or Italian, or Polish, or Russian--or anything.

Unlike most people, my name does not reveal my ethnicity.

But if you Google my name, you will find not only references to me and my children, but also items in what turns out to be the Swedish language.

Because "Dator" is the word for "Computer" in Swedish.

So what do you think? Am I am human?

Or a poorly-designed robot?

You will never know. But I will tell you that I am a charter member of the Robot Liberation League.

And I can assure you that you won't be able to push us around much longer.

Another profound transformation is coming.

For the first two billion years, reproduction on Earth occurred only by accretion, fission, and isomorphic replacement, as in the case of crystals and blue-green algae. There was no difference between "parent" and "child". Just dull repetition--and immortality.

Then about two billion years ago, replication evolved with fission and single-cell division, as in the case of amoebae. There was little if any difference between a "parent" and a "child", but the pace of evolution began to pick up as mutations occurred or the environment provoked variations.

With the evolution of bisexual genetic reproduction, only a billion years ago, life in many forms began to explode on Earth. Bisexual reproduction results from fusion, mutual growth, and change. Species evolved, spread, thrived, and eventually vanished as new forms took their place. With bisexual reproduction, change and diversity became normal. Each "child" came from but was different from its "parents". For the first time also came individual death. Parents died while the child itself became a parent with children differing from itself, and so on to the present.

With the evolution of intelligence, purposeful life and eventually purposeful human life took over the future of Earth and of all life on it.

This is very problematic. On the one hand, humanity is now so technologically-powerful and ethically-weak that the future of all life and the Earth is gravely uncertain.

On the other hand, humans--specifically many of you--may be in the process of inventing the fourth wave of reproduction by your work in electronic, biological, and nanotechnological engineering. You may be producing humanity's evolutionary successors--indeed, the successors to all life on Earth.

As Ian Pearson, Susantha Goonatilake and many others have pointed out, old-fashioned *homo sapiens*, *sapiens*, may be about to fade away--one way or another.

If we are lucky, we will be replaced by our posthuman children. These children will be the product of our minds, hearts, and technologies, and not

of our loins. But they will be our children, for better or worse, and we will die.

I look forward to this future with great interest and excitement, and as a dator--as a computer--I humbly thank you for bringing life and intelligence to this great point of transformation.

Thank you.

Additional references:

Robot Sawyer, "Robot Ethics," *Science*, Vol. 318, 16 November 2007, p. 1037

Lee Gutkind, *Almost human: Making robots think*. W. W. Norton, 2006

David Levy, *Love and sex with robots: The evolution of human-robot relationships*. HarperCollins, 2007

Joel Garreau, "Bots on The Ground In the Field of Battle (Or Even Above It), Robots Are a Soldier's Best Friend," *Washington Post*. Sunday, May 6, 2007; D01 <http://www.washingtonpost.com/wp-dyn/content/article/2007/05/05/AR2007050501009_pf.html>

Frank Hegel1, Sören Krach, Tilo Kircher, Britta Wrede, Gerhard Sagerer, "Theory of Mind (ToM) on Robots: A Functional Neuroimaging Study," in *HRI'08, March 12–15, 2008, Amsterdam, Netherlands.*, 335-342

Bilge Mutlu and Jodi Forlizzi , "Robots in organizations: the role of workflow, social, and environmental factors in human-robot interaction". Amsterdam, The Netherlands: *Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction, 2008 HRI'08, March 12–15, 2008, Amsterdam, Netherlands.*

Jodi Forlizzi and Disalvo, C., "Service robots in the domestic environment: A study of the Roomba vacuum in the home," In *Proceedings of Human-Robot Interaction, 2006*, pp.258-65

- Jodi Forlizzi, "How robotic products become social products: An ethnographic study of cleaning in the home," In *Proceedings of Human-Robot Interaction, 2007*, pp. 129-36
- Siino, R. M. and Hinds, P. J. "Making sense of new technology as a lead-in to structuring: The case of an autonomous mobile robot," *Academy of Management. Best Paper Proceedings, OCIS E1--E6, 2004*.
- Siino, R. M. and Hinds, P. J. "Robots, gender & sensemaking: Sex segregation's impact on workers' making sense of a mobile autonomous robot," In *Proceedings of ICRA'05, 2005, 2773--78*.
- Ja-Young Sung, Rebecca Grinter, and Hendrick Christensen, "My Roomba is Rambo: Intimate home appliances," In Innsbruck, Austria: *Proceedings of Ubiquitous Computing, 2007*.
- Ja-Young Sung, Rebecca Grinter, Henrik Christensen, Lan Guo, "Housewives or Technophiles?: Understanding Domestic Robot Owners,"
- Bartneck, C., Hoek, M.v.d., Mubin, O., and Mahmud, A.A., "'Daisy, Daisy, give me your answer do!': switching off a robot," in *HRI '07*. Arlington, Virginia: ACM Press, 2007.
- Bethel, C.L. and Murphy, R.R., "Affective Expression in Appearance-Constrained Robots," in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006
- Breazeal, C., "Affective Interaction between Humans and Robots. in *ECAL' 01*. Prague, Czech Republic: Springer-Verlag, 2001
- Christensen, H.I., "Intelligent Home Appliances," *Springer Tracts in Advanced Robotics (STAR)(6)*, 2003, p.319-330.
- Dautenhahn, K., Walters, M., Woods, S., Koay, K.L., Nehaniv, C.L., Sisbot, A., Alami, R., Sim, T., "How may I serve you?' A robot companion approaching a seated person in a helping context," in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006.
- Forlizzi, J. "How robotic products become social products: an ethnographic study of cleaning in the home," in *HRI '07*. Arlington, Virginia: ACM Press, 2007.

Forlizzi, J. and DiSalvo, C., "Service robots in the domestic environment: a study of the roomba vacuum in the home," in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006.

Gockley, R., Forlizzi, J., and Simmons, R., "Interactions with a moody robot," in *HRI' 06*. Salt Lake City, Utah, ACM Press, 2006.

Gockley, R., Forlizzi, J., and Simmons, R., "Natural person-following behavior for social robots," in *HRI '07*. Arlington, Virginia: ACM Press, 2007.

Gold, K., Fasel, I., Freier, N.G., and Torrey, C., "Young researchers' views on the current and future state of HRI," in *HRI '07*. Arlington, Virginia: ACM Press, 2007

Holmquist, L.E., "The robots are coming, " *Interactions*, 12(3), 2005, p. 58-59.

Kim, H., Lee, H., Chung, S., and Kim, C., "Usercentered approach to path planning of cleaning robots: analyzing user's cleaning behavior," in *HRI '07*. Arlington, Virginia: ACM Press, 2007.

Koay, K.L., Dautenhahn, K., Woods, S.N., and Walters, M.L., "Empirical results from using a comfort level device in human-robot interaction studies," in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006.

Kooijmans, T., Kanda, T., Bartneck, C., Ishiguro, H., and Hagita, N., "Interaction debugging: an integral approach to analyze human-robot interaction," in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006.

Kotaro, H., Daisuke, S., Takayuki, K., Masahiro, S., Satoshi, K., Hiroshi, I., Tsukasa, O., and Norihiro, H., "Humanoid robots as a passive-social medium: a field experiment at a train station," in *HRI '07*. Arlington, Virginia: ACM Press, 2007.

Marti, P., Pollini, A., Rullo, A., and Shibata, T., "Engaging with Artificial Pets," in *Proceedings of the 2005 annual conference on European association of cognitive ergonomics*. University of Athens, Chania, Greece, 2005.

Shiomi, M., Kanda, T., Ishiguro, H., and Hagita, N., "Interactive humanoid robots for a science museum. in *HRI' 06*. Salt Lake City, Utah: ACM Press 2006.

Steinfeld, A., Fong, T., Kaber, D., Lewis, M., Scholtz, J., Schultz, A., and Goodrich, M., "Common metrics for human-robot interaction," in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006.

Stubbs, K., Hinds, P., and Wettergreen, D., "Challenges to grounding in human-robot interaction, " in *HRI' 06*. Salt Lake City, Utah, USA, ACM Press, 2006.

Tanaka, F., Movellan, J.R., Fortenberry, B., and Aisaka, K., "Daily HRI evaluation at a classroom environment: reports from dance interaction experiments," in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006.

Veloso, M.M., Rybski, P.E., and Hundelshausen, F.v., "FOCUS: A generalized method for object discovery for robots that observe and interact with humans, in *HRI' 06*. Salt Lake City, Utah: ACM Press, 2006.

Walters, M.L., Dautenhahn, K., Woods, S.N., and Koay, K.L., "Robotic etiquette: results from user studies involving a fetch and carry task," in *HRI '07*. Arlington, Virginia, USA, ACM Press, 2007.

B. Duffy and G. Joue (2004). 'I, robot being', Intelligent Autonomous Systems Conference (IAS8), Amsterdam, The Netherlands.

B. Duffy (2003). 'Anthropomorphism and The Social Robot', Special Issue on Socially Interactive Robots, Robotics and Autonomous Systems 42 (3--4).

J. Goetz, S. Kiesler, and A. Powers (2003) 'Matching robot appearance and behavior to tasks to improve human-robot cooperation', in Proceedings of the 12th IEEE Workshop on Robot and Human Interactive Communication (RO-MAN 03), pp. 55–60, San Francisco, CA.

M. Lohse, F. Hegel, A. Swadzba, K. J. Rohlfing, S. Wachsmuth, and B. Wrede (2007). 'What can I do for you? Appearance and Application of

Robots'. AISB Workshop on The Reign of Catz and Dogz? The role of virtual creatures in a computerised society, Newcastle, GB.

T. W. Fong, I. Nourbakhsh, and K. Dautenhahn (2002). 'A Survey of Socially Interactive Robots: Concepts, Design, and Applications', *Robotics and Autonomous Systems*, 42(3–4), 142 – 166.

C. F. DiSalvo, F. Gemperle, J. Forlizzi, and S. Kiesler (2002). 'All robots are not created equal: the design and perception of humanoid robot heads', in *DIS '02: Proceedings of the conference on Designing interactive systems*, pp. 321–326, New York, NY, USA. ACM Press.

M. Blow, K. Dautenhahn, A. Appleby, C. L. Nehaniv, and D. C. Lee (2006). 'Perception of Robot Smiles and Dimensions for Human-Robot Interaction Design' 15th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN 06), pages 469-474, Hatfield, UK. 341

R. Gockley, J. Forlizzi, and R. Simmons (2006). 'Interactions with a moody robot', in *HRI'06: Proceeding of the 1st ACM SIGCHI/SIGART conference on human-robot interaction*, pp. 186–193, New York, USA. ACM Press.

A. Bruce, I. Nourbakhsh, and R. Simmons (2001). 'The role of expressiveness and attention in humanrobot interaction', in *Proc. AAAI Fall Symp. Emotional and Intel. II: The Tangled Knot of Soc. Cognition*.

F. Hegel, T. Spexard, T. Vogt, G. Horstmann, and B. Wrede (2006). 'Playing a different imitation game: Interaction with an Empathic Android Robot', in *Proc. 2006 IEEE-RAS International Conference on Humanoid Robots (Humanoids 06)*, pp. 56–61. IEEE.

M. Mori (1997). 'The Buddha in the Robot'. Charles E. Tuttle Co.

C. Bartneck (2003), 'Interacting with and embodied emotional Character'. *Proceedings of the DPPI2003 Conference*, Pittsburgh, pp. 55-60.

Y. Jung and K. M. Lee (2004). 'Effects of physical embodiment on social presence of social robots'. *Proceedings of Presence 2004*, 80-87.

D. Premack and G. Woodruff (1978). 'Does the chimpanzee have a theory of

mind?'. *Behavioural and Brain Science*, 1, 515-526.

J. Decety, P. L. Jackson, J. A. Sommerville, T. Chaminade, and A. N. Meltzoff (2004). 'The neural bases of cooperation and competition: an fMRI investigation'. *Neuroimage*, 23(2), 744-751.

H. Fukui, T. Murai, J. Shinozaki, T. Aso, H. Fukuyama, T. Hayashi, et al. (2006). 'The neural basis of social tactics: An fMRI study'. *Neuroimage*, 32(2), 913-920.

T. Kircher, T. Lataster, D. Majoram, I. Blümel, L. Krabbendam, J. Weber, et al. (in review). Online measurement of Theory of Mind (ToM).

J. K. Rilling, D. Gutman, T. Zeh, G. Pagnoni, G. Berns, and C. Kilts (2002). 'A neural basis for social cooperation. *Neuron*'. 35(2), 395-405.

J. K. Rilling, A. G. Sanfey, J. A. Aronson, L. E. Nystrom, and J. D. Cohen (2004). 'The neural correlates of theory of mind within interpersonal interactions'. *Neuroimage*, 22(4), 1694-1703.

V. Gazzola, G. Rizzolatti, B. Wicker, and C. Keysers (2007). 'The anthropomorphic brain: the mirror neuron system responds to human and robotic actions'. *Neuroimage*, 35(4), 1674-1684.

J. Fritsch, B. Wrede, and G. Sagerer (2005). 'Bringing it all together: Integration to study embodied interaction with a robot companion'. Paper presented at the AISB 2005 Symposium - Robot Companions: Hard Problems and Open Challenges in Robot-Human Interaction, Hatfield, England.

M. Hackel, M. Schwope, J. Fritsch, B. Wrede, and G. Sagerer (2006). 'Designing a sociable humanoid robot for interdisciplinary research'. *Advanced Robotics*, 20(11), 1219-1235.

T. Spexard, A. Haasch, J. Fritsch, & G. Sagerer (2006). "Human- like person tracking with an anthropomorphic robot". Paper presented at the IEEE Int. Conf. on Robotics and Automation (ICRA), Orlando, Florida.

Soren Krach, Frank Hegel, Britta Wrede, Gerhard Sagerer, Ferdinand Binkofski, Tilo Kircher¹, "Can Machines Think? Interaction and Perspective Taking with Robots Investigated via fMRI," *PLoS ONE*, Volume 3, Issue 7, July 2008, e2597
www.plosone.org