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MARK TILDEN
FATHER OF BEAM ROBOTICS
Pg. 20

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ROBOPARADE
AUTONOMOUS ROBOTS Pg. 48

ROBOTIS GP
HUMANOID

QUADCOPTER
ROBOT AEROBATS

YOUR MINI DARPA CHALLENGE!
BUILD A ROBOMAGELLAN ROBOT
Pg. 38

MOON DIGGER COMPETITION
Pg. 64

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by Kevin M. Berry

INTELLIGENT

Plausible or Fantasy?

Dual docs duke it out

The July/August issue of Robot initiated a conversation among our readers, asking the perennial question among thoughtful, science minded people: "Can a machine ever become sentient?"

In my interview with Alexander Rose, (cofounder of Inertia Labs) a roboticist and futurist (www.longnow.org) my question about machine intelligence, quite inadvertently, coincided with two letters from readers, that same issue, Dr. Sewell and Dr. Geraci, (Robot, July/August 2010, pg 10) who weighed in on this amazingly complex topic. Here is an excerpt from Rose's interview:

ROBOT: *As a futurist and technologist, where do you think robotics will end up in, say, a thousand or ten thousand years? True artificial intelligence? Self aware machines? Or, just incredibly technologically dense human simulacrums?*

ROSE: *It is a fool's game to predict where technology will go in a decade, much less timeframes such as a thousand years. But it is clear where we humans want it to go, and these desires will certainly drive development toward robots that blur the line between the living and the machine.*

Dr. Marco Meggiolaro

Dr. Richard Catrambone

Dr. Sewell, in his letter, predicted a thinking computer system "will be a reality within 200 years." Dr. Geraci felt that Artificial Intelligence will be "pushing the cultural envelope over the next decade."

Robot continues this fascinating discussion by interviewing two prominent academics in the field of robotics and human/computer interfaces. Dr. Richard Catrambone is a Professor of Psychology at the Georgia Institute of Technology, and an Adjunct Professor in their School of Interactive Computing, specializing in human/computer interfaces. Dr. Marco Meggiolaro is a Professor and the Dean of Graduate Research of the Department of Mechanical Engineering for the Pontifical Catholic University of Rio de Janeiro, specializing in Robotics, and (elsewhere in this issue) author of a paper on direct thought control of robots.

ROBOT: First off, let's tackle the hardest one. What does "alive" mean in this sense?

DR. CATRAMBONE: I think an "alive machine" has at least two requirements. First, it has to be able to do intelligent problem solving which means that it has to be able to acquire new knowledge (i.e., going beyond whatever it was programmed with) and to apply it to novel problems. That is, problems that are not just like the ones it was programmed to solve. Second, it needs to be able to make choices (that is to say yes or no) that could not be trivially predicted based on the initial programming.

DR. MEGGIOLARO: Indeed, to become intelligent and self-aware, it is necessary to be able to learn from its own experiences. Trying to program an intelligent adult robot would be nearly impossible; it would require a huge team of humans and a much deeper knowledge of how our brains work to be able to do that. And it would be a waste of time and effort. It is much smarter to program a newborn robot with no experience and no models whatsoever of our world, and then teach it as you would do with a human, interacting with it. It would be much faster than trying to manually code all information, experiences, and even personal impressions of our world.

DR. CATRAMBONE: The challenge (to program intelligent robots) though, is understanding how we humans learn to focus on things in the environment so that robots can have that mechanism also. Clearly two people can look at the same thing and have different experiences and notice different things. The process by which we learn to focus on certain aspects of experience needs to be understood so that some basic mechanism (that can also develop) is included in the robot's operating system.

DR. MEGGIOLARO: Regarding the original question, I believe "alive" is a completely subjective term. People usually think that something is "alive" when it behaves in a seemingly unpredictable fashion, when it reacts to the environment,

when it can grow, and/or when it can reproduce itself. But robots can (or will be able to) do all that. Since the concept of being alive or self-aware is completely subjective, we'll never be able to prove or disprove that a robot gained conscience. Depending on your point of view and religious beliefs, you'll consider future robots as perfect people simulators, or consider them as living beings. But, using the exact same reasoning, self-aware robots could consider people as robot simulators! Robots will argue that free will in humans is an illusion, that two identical twins that never met and went through the exact same experiences should make the exact same decisions throughout their lives. But robots will never be able to prove that we humans are predictable simulators, because we live in a butterfly-effect-chaotic-world that doesn't allow two identical people to live

the exact same experiences.

DR. CATRAMBONE: The free will illusion is a classic issue because if we accept that human cognition is governed by lawful (not in a legal sense) rules based on maturation and experience, then a person's behavior at a given moment is the inevitable consequence of what has gone on before plus the current input/environment. The fact that we (as scientists, as society) are not in a position to fully know a person's rules (and the person himself does not know either) is what allows the illusion.

ROBOT: We all agree that the technology either exists today, or soon will, to connect enough silicon junctions to mimic the number of neu-

rons in the brain of a higher animal, say a cat or dog, if not a human. Given that, what might it take to make the jump from a pile of expensive sand to a self-aware being?

DR. CATRAMBONE: I think my answer to the "alive" question applies here too. You could argue that people start with some basic operating system and then, through experience and maturation, the person acquires more and more knowledge, more complex "rules," etc. The process by which this occurs though, is far from being well understood. There are a lot of cognitive models that attempt to capture some of this process, but I think what researchers know about this is dwarfed by what we do not know. I don't know that stringing together enough chips will be the answer, although it might be on the path to a better understanding of the process.
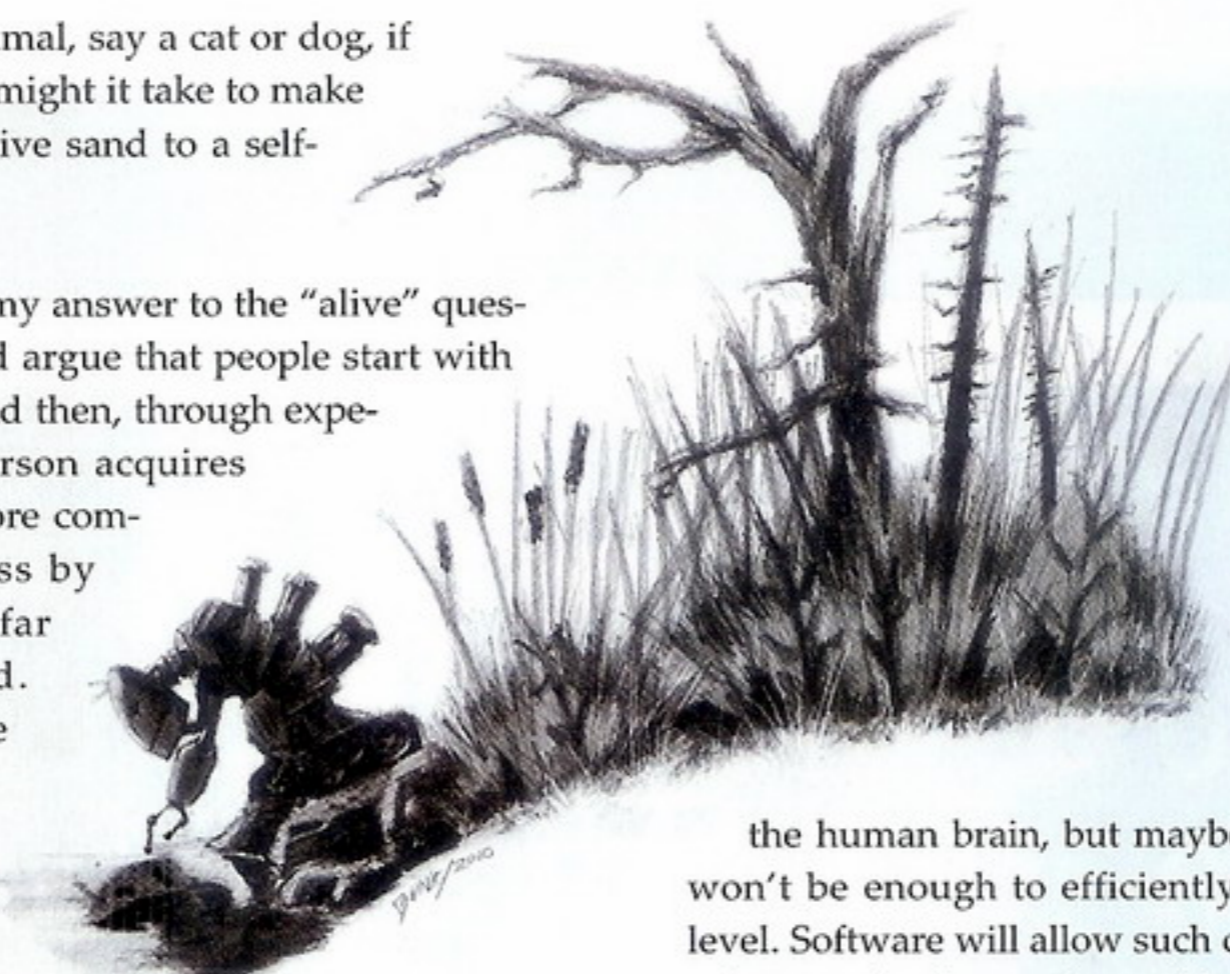
DR. MEGGIOLARO: Self-awareness or conscience level is not a discrete quantity to allow such a jump. It is a continuous quantity. Even primitive beings have some degree of conscience. As robots evolve, such conscience and self-awareness will be gradually increased from the one found in insects into the one from mammals and humans and beyond. The human brain still beats computers in several tasks because it can process thousands of pieces of information at the same time, even though each piece is processed much slower than in a current computer. But a future computer with thousands of processors will surely have a greater capacity than the human brain. If our conscience is a product of our brain, if it is the software while the brain is the hardware, then a future robot with better hardware and special software can become self-aware (or at least experience what we think it is to be self-aware).

DR. CATRAMBONE: I think self-awareness is a tough thing to define. We might be able to recognize it when we see it, but I don't know that we can provide a checklist of qualities and, if they are met, say "this entity is self-aware."

ROBOT: Let's approach this question from the other end. We've all heard about the remarkable advances in gene splicing, cellular modifications, and recently; using artificial DNA to "create" a living cell. Science Fiction authors have, for years, talked about "biological computers." So is the path to machine intelligence via biology, not materials science?

DR. CATRAMBONE: I bet that biological components ultimately can be mimicked by silicon components, and vice versa, so I do not believe that the biological/silicon issue is crucial.

DR. MEGGIOLARO: Both carbon and silicon-based beings can become alive. People will most likely believe that Craig Venter's artificial cell is a live being, but will never accept a robot as alive. If you accept that a man-made cell can be alive, then there's no reason to think a man-made robot can't. Both paths can be taken to create life (or useful computers). A good aspect about carbon-based computers is that we can learn from many examples taken from nature, from many organic sub-systems that evolved along almost 4 billion years.

ROBOT: In closing, do you care to peer into your crystal ball and predict what's next in the quest for true artificial intelligence?

DR. MEGGIOLARO: Hardware must still improve a lot to be able to code a significant level of self-awareness. Parallel processing is one of the keys to mimic the human brain, but maybe traditional silicon-based systems won't be enough to efficiently accomplish that in the required level. Software will allow such computers/robots to learn by themselves or by interacting with other people and robots (this is already happening in some extent). Some people will never acknowledge that a robot can be smarter than them; others will feel threatened by this. Brain implants will help people catch up with robots, increasing memory and processing ability, and even sharing knowledge by thought using some kind of internet. At some point every human being will need such enhancements to remain competitive and to keep up (both professionally and socially) with the robotic peers – so every human will become by definition a cyborg. As organic robots arise, the line between people and robots will start to disappear, as predicted by Alexander Rose. There will be serious ethical issues in the process. It will be an amazing but very complicated society.

DR. CATRAMBONE: I do not have a prediction but I have an opinion. I think AI can serve people effectively by developing modest tools for helping people do things like learn skills, remember to take medications, and provide advice. Computer-based tools already exist to do these things, but they are limited and not nearly as adaptable and "smart" as humans who teach, give reminders, or advise. To the extent that AI can improve these sorts of things on computers, it will promote advances in AI and help people.

DR. MEGGIOLARO: I'd go beyond that and say that it will not only provide tools and help people, but also it will change a lot in our society once the AI surpasses human levels. There are already "Expert Systems" that can, for instance, successfully diagnose several diseases based on symptoms. Now imagine a humanoid robot in a white jacket (many people won't be comfortable with robots unless they have human appearance and display human emotions), with motor skills to physically exam you, with our entire knowledge in medicine in its memory, learning skills, and an advanced "Expert System" correlating symptoms and diseases. Would you rather look for an average human doctor? Human doctors will have to catch up with robots not to become obsolete. ◎