

ARTIFICIAL INTELLIGENCE

Robot Futures

Flesh and Machines: How Robots Will Change Us. Rodney A. Brooks. x + 260 pp. Pantheon Books, 2002.

The late 1980s to early 1990s was one of the most exciting periods in the short history of Artificial Intelligence (AI). A mild war had broken out between representatives of the AI establishment and a growing band of dissidents. The former were custodians of an essentially Cartesian view of what AI was and how it should be practiced: Intelligence was to be largely understood in terms of manipulating carefully constructed internal models of external reality; hence the quest for intelligent machines should focus on ways of building models of the world from sensor data and the development of algorithms to "reason" about the world using these models. The dissidents rejected these assumptions, regarding the major part of natural intelligence to be closely bound up with the generation of adaptive behavior in the harsh, unforgiving environments most animals inhabit; thus the investigation of complete autonomous sensorimotor systems that were strongly biologically inspired—"artificial creatures"—was seen as the most fruitful way forward, rather

than the development of disembodied algorithms for abstract problem-solving. Vested interests were threatened, emotions ran high, insults were traded.

At the center of these skirmishes, as one of the leaders of the dissidents, was the combative figure of Rod Brooks. A decade later, Brooks, now director of the fêted AI laboratory at MIT and chairman of iRobot Corporation, is one of the most important and influential people in AI. In this excellent, highly readable book he explores past, present and future relationships between humans and robotic technology.

Brooks's thesis is that we are about to be simultaneously hit by two technological revolutions that together will fundamentally change our nature and the way we live. The first, the robotics revolution, will unleash intelligent autonomous robots, descendants of the artificial creatures mentioned above, into our everyday lives, changing our society and the ways we interact with machines. The second, the biotechnology revolution, will transform both the ways we use technology in our own bodies and the way we build machines. Thus "our machines will become much more like us, and we will become much more like our machines."

In the hands of many other authors, such a provocative starting point would signal yet another farfetched trash-

science potboiler. Instead we are treated to a considered and thought-provoking work that clearly acknowledges the limitations of the current state of the art and the huge leaps that still have to be achieved.

The first half of the book is mainly concerned with Brooks's views on AI, vividly illustrating how they developed. It takes us from his beginnings in Adelaide, South Australia, growing up "a nerd in a place that did not know what a nerd was" (by the age of 12 he'd built his first successful game-playing computer), to his current position as international science star. This engaging story takes in Hollywood, the toy industry, space exploration and various classics of science fiction. Most importantly, it challenges much of "classical" AI as being misguided and opens out Brooks's vision of a widespread use of artificial creatures that will force many of us to re-evaluate the way we view our relationship with technology—and indeed our sense of self as highly sophisticated machines.

The second half is more confrontational. Brooks tussles with the likes of Roger Penrose, David Chalmers and John Searle, who have all famously argued, in different ways and to different degrees, against the likelihood of AI, as it is currently practiced, producing "truly" intelligent machines. He claims that at the heart of their arguments is an

emotional tribalism, a raw appeal to "how can machines ever be like us—we are special" sentiments. Although he is careful to qualify his arguments and double-check himself, Brooks has a tendency to lean toward computational views of intelligence, as if the schoolboy who lusted after the IBM mainframe in the financial district of his home city cannot quite be kept at bay. Hence, although he is very clear about his belief that our current understandings of intelligence are missing something fundamental (the "juice," as he calls it), it seems he more than half agrees with those who argue that "the amount of computational power in a personal computer will surpass that in a human brain sometime in the next twenty years."

Many of us in AI, and many more neuroscientists, do not buy this argument, indeed regard it as nonsensical. Not enough is yet understood about how nervous systems work to be able to make any kind of meaningful comparison. However, recent discoveries in neuroscience are starting to reveal a complex picture involving subtly interwoven electrochemical processes employing various levels of modulation and reconfiguration. It is very likely that over the next few decades important new principles underlying the brain's organization and its behavior-generating mechanisms will be found, but there is no compelling reason to believe that any

of them will be computational. However, it is probable that our best chance of discovering "the juice" is for increased collaboration between AI and neuroscience. This is bound to lead to a diminished role for the idea that intelligence is computation.

The final chapter muses on possible developments that will let us physically merge much more closely with technology; potential advances include artificial retinal implants, and robotic limbs fully integrated into the nervous system. In the closing pages, plausible future uses of biotechnology to generate organic body-machine interfaces are discussed. However, an alternative technological future would see fundamental breakthroughs in the massively funded biosciences unlocking the secrets of development and regeneration. In this future, worn out or damaged body parts could be regrown. Advanced integration of bodies and machines might then be used only for rather sinister purposes. But as Brooks rightly states, "It is too early and the present too murky to see where all this leads."

This is the best kind of popular science book: The ideas are clear and accessible but not dumbed down. It is a very welcome antidote to the rash of recent works claiming that our world will be taken over within the next 20 years by robots of superhuman intelligence. It is far more

visionary than that.—*Phil Husbands, Cognitive and Computing
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