

Unix-like operating system, now known as **Linux**. He recruited thousands of volunteers as unpaid collaborators, united by the dream of building an open-source operating system that would be free for the downloading. The extraordinary success of Linux made a revolutionary proof that an anarchistic collaboration of hackers could produce one of the most powerful and stable operating systems in history. Today, Linux is in wide use and is even the operating system for several of the world's most powerful supercomputers.

What does the future of hacking hold? Cyber warfare is likely to become an obligatory tool of future conflicts, and the migration of crackers into the criminal underground will surely continue. Meanwhile, the success of Linux suggests that hackers will continue to be a leading force in creating the computer systems of the future.

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—Carolyn Meinel

HAL

HAL is a computer with humanlike abilities that goes on a murderous rampage in Stanley Kubrick's (1928–99) classic film *2001: A Space Odyssey* (1968). The movie is based on the novel with the same title by science fiction writer Arthur C. Clarke (1917–). HAL stands for *heuristic/algorithmic*, but coincidentally, the letters H-A-L precede the letters I-B-M. In Clarke's novel, HAL became operational on January 12, 1997. In the movie, HAL's birthday was moved to 1992.

HAL had a great impact on the generation of computer scientists trained in the 1970s and 1980s. Many of the problems that fascinated **artificial**

intelligence (AI) researchers had been solved in this fictional machine. Roger Schank (1946–), a leading AI scientist, later wrote: "I began to think about all the processes and all the problems that had to be solved . . . Everything that was in [the film] was a challenge in some sense."

The cognitive abilities of HAL included the capacity to understand natural language, the ability to formulate and carry out (evil) plans, the talent to process and interpret images, the capability to control a spaceship, and even the possibility of interpreting emotions in humans and expressing his own feelings. When HAL is about to be disconnected by one of the surviving astronauts, it says "I'm afraid. I'm afraid. I'm losing my mind."

In 1997, the year in which HAL was supposedly born, a group of computer scientists teamed to write a book explaining the fascination that the fictional computer still provokes. Most of the abilities of HAL remain to a larger or smaller extent open research problems in AI. For example, processing images and recognizing everyday objects has proved to be a difficult challenge for computers. Even a restricted problem, like the recognition of faces, has been solved only for small sets of persons. Natural language recognition has been studied for decades, but the best dictation programs are still awkward to use. Recognizing emotions of the computer user is a field of research that was started just a few years ago and is now dubbed *emotional computing*.

As with good scientific results, the fascination with HAL and *2001* lies not in the solutions they provide, but in the new problems they pose. The book and the film offer a bold forecast of what the future might look like, which is at the same time profound and stimulating, since we know that this future will arrive if we can invent it, even if not in time for the year 2001.

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—Raúl Rojas