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Terminator robot shakes a leg to complete its mission

James Randerson, science correspondent**Friday November 17, 2006**[The Guardian](#)

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It is a cross between a Terminator and the tenacious black knight from Monty Python and the Holy Grail. Chop its leg off and it just keeps coming at you, even if it's limping. But Starfish, as its creators have called it, is more than simply an amusing technological curiosity.

Robots like Starfish, which can adapt to damage without human help, are the future for missions in remote places such as disaster zones and outer space, they say.

"Having a system which is able to adapt to new conditions - which might be because one of its legs have dropped off - would be extremely valuable," said Chris Melhuish, a robotics expert at the University of the West of England, Bristol.

Starfish, which was put together by Josh Bongard and his team at Cornell University, looks like a conventional robot. It scuttles around on all fours; it can raise a leg on cue and lie down. But the clever stuff happens if you break it.

Professor Bongard said: "The idea is to have a robot that can recover from damage. But this robot does not have a camera so it can't see and it can't directly sense the fact that it has been damaged."

The team programmed Starfish so that if they remove part of one of its legs, for example, it is able to work out what has happened and learn to walk in a handicapped state. The robot first lies flat then performs what Prof Bongard calls "a playful series of actions" such as wiggling a joint. It uses tilt sensors to work out the effect of these movements, and it infers what the damage is.

"The robot actually builds up a sense of its own body," said Prof Bongard, whose study is featured today in the journal



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Science. "It can use its internal sense of self to rehearse new ways of moving that will allow it to continue with its mission."

When the robot hits on something workable it tries out the new gait for real.

Prof Bongard said that colleagues had made comparisons with Hollywood's Terminator robot. But unlike Arnold Schwarzenegger's soulless killing machine, Starfish is firmly under human control. "We are still telling the robot what we want it to do, but the robot is free to figure out how to actually do it."

The team's aim is for the robot to build up an accurate model of the damage it has suffered to avoid an unsuccessful and potentially disastrous attempt to move.

Mark Sims, at Leicester University, was one of the team behind Bridget, the European Space Agency's prototype Mars rover. He said: "If we want to explore inaccessible areas like deposits on the side of cliffs, walking robots would be more suitable."

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