Using zero gravity to combat creep

An Irish researcher is optimistic that experiments he is planning for space will go ahead despite the fatal shuttle accident earlier this year, writes **Andrew Read**

Gravity can reduce the strength of aircraft and car parts as they are made, and Dr David Browne, a Dublin-based materials scientist, wants to exploit the near-zero gravity of space to help earth-bound industry solve the problem.

Experiments he has been planning for the International Space Station were due to begin next year, but NASA's suspension of shuttle flights after the *Discovery* accident made the future very uncertain. Last week's report on the accident by NASA "is good news for us", says Browne. "My reading of it is that the shuttle will fly again next year," he says.

Browne, of the mechanical-engineering department at University College Dublin, is part of a Europe-wide group planning experiments for the European Space Agency's Columbus lab, which was due to be attached to the space station next year.

"*Soyuz* [the Russian launch vehicle] delivers fewer people, so without the shuttle the scientific work has to slow down," he says.

"The shuttle is also due to bring our samples back to Earth for further analysis. I am optimistic the shuttle will fly again next year if it is prepared for in-flight repairs. NASA will probably use it for more space-station work too. The station gives the shuttle a haven, a place where running repairs can be done."

Browne is studying the way molten alloys cool when they are poured into a cast.

"The crystal microstructure that forms as it cools is critical to the quality of the final product," he says.

Different microstructures are required for different uses. Turbine blades in jet engines have to function at temperatures of up to 1,000 degrees. Creep, or stretching, of the blades can occur at these temperatures, with catastrophic consequences.

"Creep is best minimised with elongated crystals aligned along the blade," he says. "In contrast, suspension parts for a car need to have maximum strength at room temperature. This is best achieved with small, jumbled-up crystals."

A cooling alloy solidifies from the outside, like a freezing ice cube. The temperature difference generates natural convection, with the liquid in the middle flowing of its own accord. "This flow can prevent the optimal microstructure forming," says Browne.

In space there is no convection, because there is no gravity to make the liquid flow, he says.

"We can generate convection by rolling or shaking or stirring with electromagnets.

"So in space we can play about with convection without gravity masking it. Our aim is to design better casting systems for use on Earth."

Experiments in space cost millions of euro, so you can't do what-if?-type experiments.

"The suck-it-and-see approach won't work," he says. Browne's group makes computer models of cooling alloys. "We're searching for the definitive experiments to do in space. We advise on the alloys to use, what temperatures and so on."

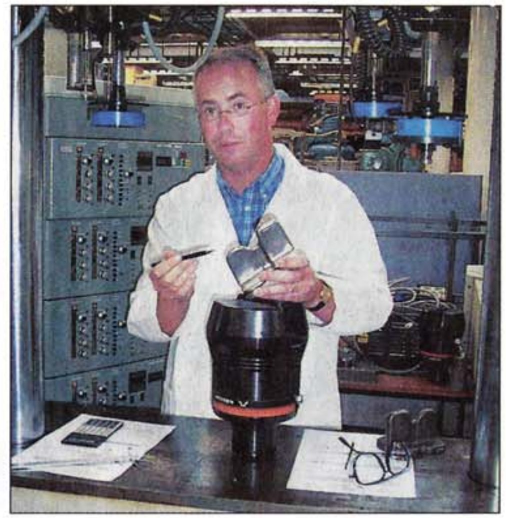
The easiest computer models deal only with heat loss by conduction. "Including convection requires fluid-dynamics equations, and that makes the models much more difficult," he says. "The easiest models are fundamental, but we can't test them on Earth. In space we can verify them and then put in convection in a controlled way."

Browne's modelling project has been going for two years. "We've been working on the assumption that *Columbus* will go up next year.

The European Space Agency takes the view that they couldn't second-guess what NASA would do after the accident.

"There are good prospects for very real improvements in Earth-based work within two years or so of *Columbus* going," says Browne. "I expect it to give the countries involved a real industrial edge and improved performance."

Work will begin shortly on the computer models to design space experiments testing the next generation of alloys, called intermetallites.



Proving his metal: Dr David Browne