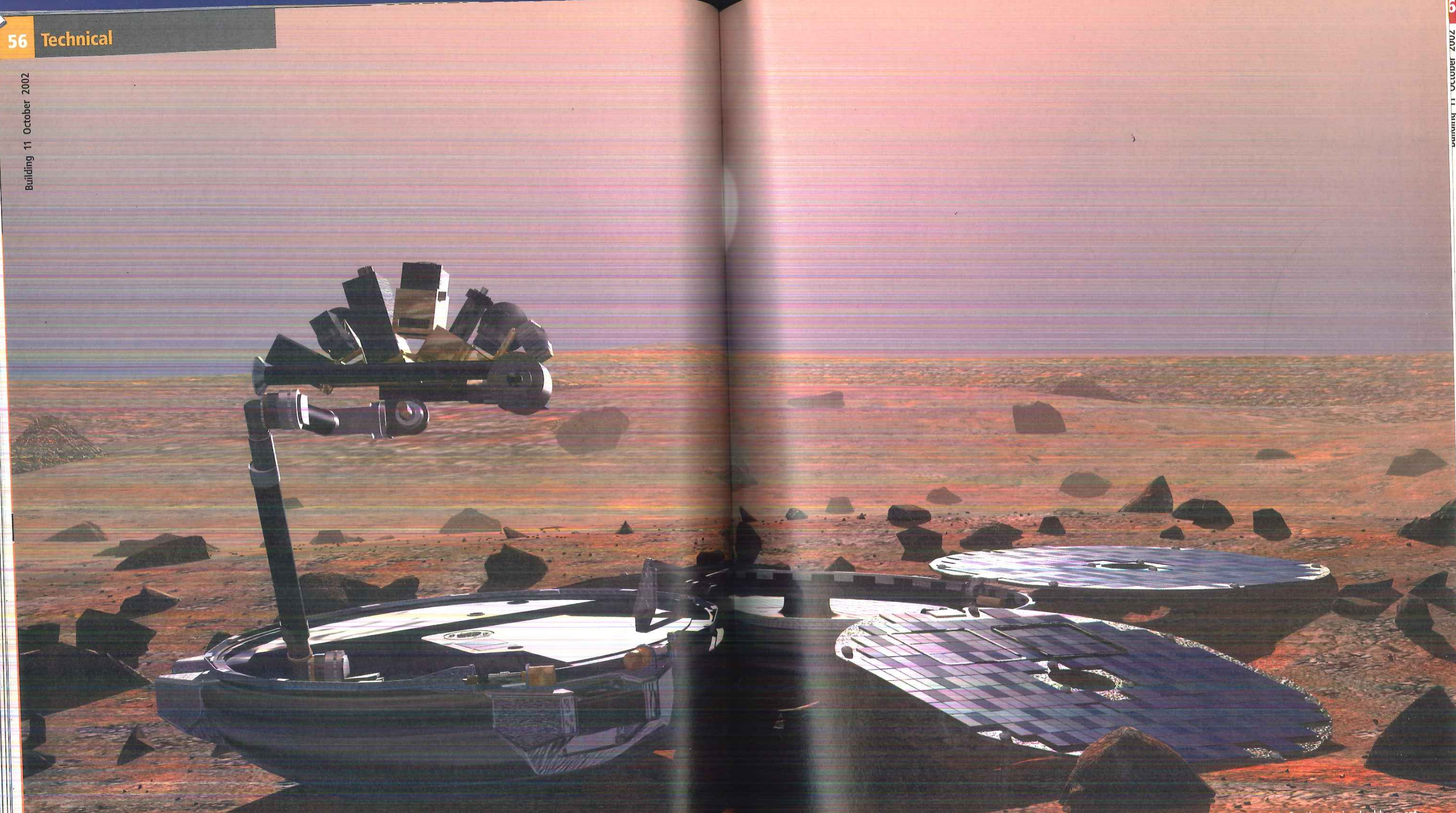


SPOTLESS ENTERPRISE

Is there life on Mars? Britain is sending a robotic spacecraft to find out. But the space experts' first challenge was to create a room so spotless, the craft could be built bacteria-free. Otherwise it might confuse Martian germs with the Milton Keynes variety … Andy Pearson boldly went to find out more

IT MUST HAVE SEEMED LIKE AN ODD REQUEST, especially for the estates department at the Open University: "Provide a room that is clean enough to meet internationally accepted planetary protection requirements." But the fact is, if you are looking for a room in which to create the first British interplanetary spacecraft, it needs to be built to some very specific criteria.

The Mars lander is being assembled to sniff out the answer to that age-old question: is there life on Mars? Called Beagle 2, it is the brainchild of Colin Pillinger, professor of planetary sciences at the Open University. A team of university and industrial partners is behind the mission, but Pillinger was adamant it be built at the Open University. "Colin was very determined," recalls David Young, projects surveyor at the university estates division.

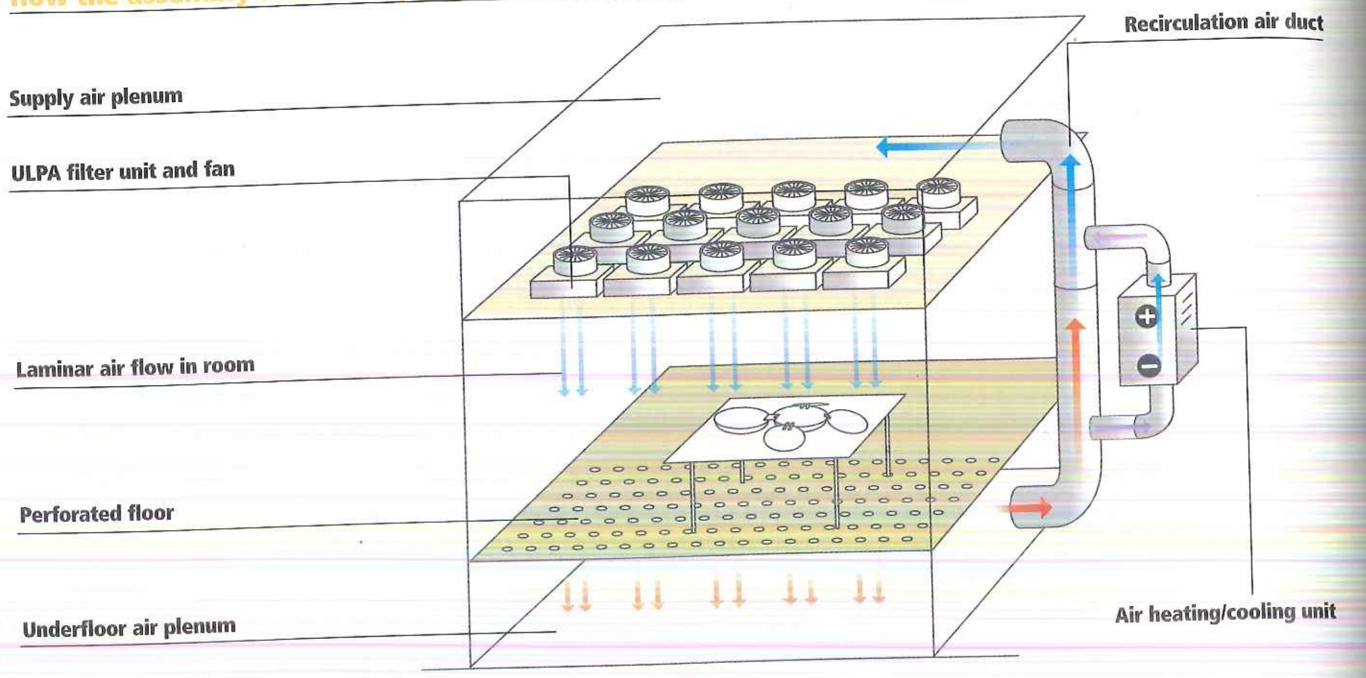
Unsurprisingly perhaps, two years ago when the request was made, no such rooms existed on the university's Milton Keynes campus. A "clean-room" would need to be specially constructed, and it was down to the estates office to ensure it materialised on time. It was a tough challenge: to assemble a spaceship, the room would have to be completely free of dust and bacteria; the environment within it would have to be capable of being maintained within strict temperature and humidity constraints. The tight budget, a fraction of the more than £30m the European Space Agency is spending on Beagle 2, put extra pressure on the team.

However, the most crucial factor was time: the launch window for the mission had been set between 23 May and 29 June 2003 – when Mars will be closest to the Earth. For the mission to blast off on time, the lander would have to be designed, assembled and tested.

"Time was against us," remembers Young. "We had a drop-dead date of 21 December 2001 to get the facility completed." This gave Young less than a year to deliver one of the cleanest places on the planet.

The first challenge was to find a suitable location for the clean-room and its support spaces. Putting up a new building on the campus was not possible in the time available – apparently even interplanetary scientists have to comply with Milton Keynes' planning laws. "Conversion of an existing building was ▶

How the assembly room is kept clean



▶ quicker, cheaper and faster," explains Young. So the team scoured the university's buildings for a suitable space. Eventually, they uncovered a large garage, which previously housed the BBC's outside broadcast vehicles but was now lying empty. With a plan area of 11 × 11 m and a height of 6.5 m, the garage was just large enough to shoehorn the clean-room complex inside.

The clean-room is not a single room but a series of rooms. The most critical space will be the room where the spacecraft is assembled, but other support rooms were also required within the complex. These included a changing room where staff could don protective suits; store rooms; preparation rooms, where sections of the craft will be sterilised to ensure they are bacteria-free before assembly; and a testing room.

It is normal for satellites to be constructed in a clean-room to avoid corrupting any of their scientific instruments with even the tiniest particle of dust. But this room had to be ultra-clean. First, to meet the internationally accepted planetary protection requirements that require any spacecraft landing on another planet not to harbour a cargo of terrestrial bacteria. And second, to ensure that the scientific equipment carried by Beagle 2, which includes an ultra-sensitive mass spectrometer to detect the tiniest residue of life, was not contaminated. The room had to be bacteria-free, which in scientific parlance meant it had to be "aseptic".

Clean-room expert Bassaire was brought on board to design the facility. The practice developed an air-pressure scheme to keep the spaces bacteria-free. Of all the rooms, the assembly room is fed with the highest volume of air to pressurise the space. The rooms surrounding the assembly facility are maintained at a slightly lower pressure, so a pressure differential is always maintained between assembly space and the surrounding rooms – the dirtier the room, the lower its relative air pressure. And the whole complex was pressurised relative to the garage in which it was housed. Because air always moves from high to low pressure, air in the building cascaded from the ultra-clean space to the less critical rooms, and finally into the garage.

As well as designing the airflow between rooms, Bassaire also designed the airflow pattern within each room. The most critical space, the assembly room, has a laminar airflow ventilation system installed. The system pushes air into the room through the ceiling and sucks it out through a perforated floor. To ensure no spec of dust or stray bacterium lingers in the room, the air is circulated through super-efficient filters 450 times an hour (see diagram above). These ULPA filters – ultra low penetration air – are so efficient at removing particles from the air that even bacteria are too large to pass through them.

The assembly room's ceiling is made up of 30 ULPA filters, each with a dedicated fan. The room is so clean that test equipment sensitive enough to measure its conditions does not yet exist. "The room is 1000 times cleaner than an operating theatre," explains Young. The room is maintained at a temperature of 20°C and 50% humidity.

Construction of the clean-room was relatively straightforward. The scheme was put out to tender and the contract was awarded to Bassaire – the company that had produced the initial designs – and work started on 1 August. Because it was being built in a garage, it was not necessary to weatherproof the room's exterior. After assembling a steel frame, the plasterboard walls, raised floor and ceiling filters were installed.

However, although the room's structural components are fairly standard, its method of construction was far from ordinary. To ensure the room was spotless on handover, site practices got progressively cleaner as construction progressed. In the early days this just meant the site was vacuumed constantly, but by the end of the scheme electricians had to don blue overshoes to work in the complex. "Thoroughly cleaning every day slows things down," explains Young. Much to everyone's relief, the room was handed over on time, and assembly of the lander will begin soon.

With the building handed over, the estates department has done its bit for interplanetary exploration. Now, if Beagle 2 does discover evidence of life, the team can be sure that it has not come from Earth.

■ For more information log on to www.Beagle2.com.

Mission to Mars: Beagle 2's journey

On 23 May 2003 the European Space Agency's rocket, Mars Express, will blast off from the Baikanour Cosmodrome in Kazakhstan. Attached to the Starsem-Fregat rocket's nose will be Beagle 2, a British-assembled landing module designed to investigate whether there is life on Mars.

The journey to Mars will take seven months. As the rocket approaches the red planet, it will spin the landing module before ejecting it like a rifle bullet on its landing trajectory. From this point onward, Beagle 2 is on its own.

Encased in a protective heat shield, the lander will hurtle through the Martian atmosphere and sprout parachutes as it nears the surface. The heat shield will be discarded and three gas-filled bags will inflate to cushion the craft's final landing at Isidis Plantitia, just north of the Martian equator.

Once on the planet's dusty surface, five photovoltaic panels will unfold, like the petals of a flower, to charge the unit's power supply so that the experiments can begin.

Beagle 2 has a robotic arm that supports a pair of panoramic cameras, a surface grinding tool, an X-ray spectrometer and a microscope. The arm will also deploy a robotic mole, which will burrow beneath the planet's surface to collect rock samples from below ground. The samples will be analysed at night when temperatures can drop as low as −70°C, so that the heat given off will help keep the lander warm.

The Beagle 2 will communicate its findings with the Mars Express rocket, which will maintain an orbit around the planet after deploying the lander.