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520 days: Surviving everyday life on a mission to Mars

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*One of the most extreme psychological experiments ever is drawing to a close. **New Scientist** gets exclusive access to Mars 500's mission control*

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CHIEF engineer Konstantin Chetvergov strides into the ground control room, work boots clicking on the brown-speckled floor. The buzz of conversation halts, leaving only the sound of whirring electronics and the engineer's march. It is day 334 of a 520-day mission to Mars and Chetvergov's team has a problem.

He sits down in front of five monitors displaying life-support schematics. A warning light is flashing, telling him something is amiss with the shower cabin on the Mars crew's spacecraft. It's a worry. Small things can escalate when six astronauts are cooped up together for a year and a half.

The engineer leans forward and speaks into a camera and microphone. "Good afternoon, crew," he says. "This message is to request a check of the shower-drainage system at about" – he glances up at the clock and calculates – "6 o'clock." He adds a few more words, then signs off. For now, that's all ground control can do. The recorded message disappears into the void, starting a 9-minute journey to the crew. Chetvergov turns to us. We have a while to wait.

Chetvergov is a participant in one of the most extreme and ambitious scientific experiments ever staged: [Mars 500](#). It is the most realistic simulation of a mission to the Red Planet yet: six male "Marsonauts" from Russia, Europe and China have been shut off from the world for more than a year in a mock spacecraft here on Earth. In June 2010, they climbed into a set of modules at the [Russian Academy of Science's Institute for Biomedical Problems \(IMBP\)](#), in Moscow, and they are still inside as you read this.

It's for a good reason: if we send people to Mars, it will be the longest human space flight ever attempted. In the unimaginably claustrophobic spacecraft, [the psychological stresses](#) will be enormous, so it's vital that we know what happens to the human mind in such conditions. Discontent, arguments and misunderstandings have dogged shorter space missions and isolation experiments in the past ([see "When no one can hear you scream"](#)).



Getting to Mars is all in the mind

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So, as Mars 500 draws to a close, what have we learned? Many results will not be released until after the Marsonauts emerge, roughly 50 days from now, but *New Scientist* got exclusive access to the ground-control team interacting daily with the crew. These engineers, psychologists and doctors are as much a part of the mission as the isolated men. With great power to influence the lives of the Marsonauts, Chetvergov and his team have been trying to find out what it takes to keep their charges healthy and contented. Getting to the Red Planet will be one of the human race's greatest scientific and technical challenges, but a more fundamental question is: are we ready to put humans inside the spacecraft?

I am visiting the Mars 500 experiment three months after its midpoint, which featured a simulated Mars landing. The crew is now on its return journey to Earth. The approach to the control room takes me past bronze busts of Russia's space giants – Konstantin Tsiolkovsky, Sergei Korolev, Yuri Gagarin – and up the stairs to a catwalk, which overlooks the "spacecraft": a set of interconnected cylindrical modules. The windowless chambers are locked and soundproofed, with air and water piped in. The six volunteers inside eat only what they brought and what they can grow. They jettison their garbage via an airlock, along with flash drives and memory cards containing the results of myriad experiments. These appear daily for technicians to collect and sort. Nothing goes back in.

The experiment's control centre, on the second floor of the complex, is continuously occupied by a three-person brigade on shifts lasting 24 hours. Opposite a larger-than-life poster of a grinning Gagarin, huge flat-screen monitors display every camera angle of the inside of the modules, revealing exercise machines, a kitchen, research workstations and a "greenhouse". On the control room's windowsill is a bright red flower on a tall stalk that was tended inside the spacecraft during the pilot study. Beyond it, traffic creeps along: standard for urban Moscow.

Forty minutes after Chetvergov sent his message to the Mars 500 crew, an electronic telephone ring interrupts our conversation. A message from Mars! Well, not quite. Chetvergov pulls up the video recording of the crew commander's response: the button they press to drain the shower cabin is not responding, he reports. Chetvergov furrows his brow, closes the message, and exchanges a few words with Vladimir Gorbachev, the tall, silver-goateed duty engineer. Gorbachev grabs a radio and a flashlight. Together, they head out of the door to investigate.

Although the ground control team is around to monitor the crew's vital signs, help solve technical problems and change air canisters, on a real interplanetary mission the crew would have to fend for itself. So, unlike in real-world control rooms for shorter missions, the Mars 500 duty team members rarely interact with the crew. When they do, they certainly don't give orders. They "request".

Experience on Earth-orbiting space stations suggests that long-duration space crews do not react well to being "commanded" by ground control, says IMBP psychologist Vadim Gushin, who is conducting research on the Mars 500 crew. International Space Station astronauts are currently given two days off a week; they have a "task jar" from which they can choose experiments or chores if they wish, but they are not required to do so.

Studies from space-flight simulations such as the Mars 105 mission – a three-month Mars 500 pilot study carried out in 2008 – and NASA's underwater Extreme Environment Mission Operations (NEEMO) programme, have similarly found that [minimal interference from ground control](#) can be a good thing, putting the crew in a better mood while still accomplishing the mission.

Plus, when travelling beyond Earth orbit, real-time chats with mission control will be impossible, so crews will have to learn to deal with problems and procedures themselves.

During one of the "Mars walks" in February, for example, one Mars 500 crew member asked a question of ground control as he attempted a complicated task – but of course didn't get an immediate answer due to the communications delay. He then seemed to lose motivation, say the psychologists.

Silent running

Accordingly, Mars 500 researchers later tested the crew's ability to go it alone. During a week of simulated communication failure between ground control and the Mars crew, duty doctor Dilia Husnutdinova tells me that the crew coped with their tasks just fine. "Sometimes they made posters and held them up to the cameras" to highlight technical problems, she says. But with no threat to life or the mission, controllers decided to keep silent. "We ignored them because it wasn't a big deal."

Even on a normal day, two 2-hour windows of communication between crew and ground control are all they have to exchange official messages like engineering needs, research schedules or personal communication with family. That's stricter than for astronauts and cosmonauts on the ISS, who can call home at any time – often talking to family members twice a day. Mars 500 messages are dropped onto a local server and picked up by the crew after the appropriate time delay – anywhere from a few minutes to 12, depending on the ship's "orbit" and distance from Earth.

This is the first time an experiment has had such strict contact limits for so long, psychologist Gushin says. In the IMBP simulations that came before Mars 500 and its pilot study, test subjects and researchers peeked through airlocks at one another, waved and exchanged greetings. On a real mission to Mars, psychologists say, the harsh reality will be limited communication and sensory deprivation, and the experiment should reflect that isolation.

According to Gushin, people do eventually adapt to such deprivation. "The need for this interaction actually falls off," he says. During IMBP space-flight simulations in 1994 and 1995, for example, [correspondence with mission control decreased](#) as the experiment wore on. A [study of the Mars 105](#) crew found that, similarly, the Marsonauts communicated intensively with ground control at first, but after adapting to their isolation, they wrote shorter, less emotional reports with fewer requests for help to solve problems related to their work.

Constant contact with family and friends can also heighten stress. "Every extra word, extra worry, can become an irritant," Gushin says. Likewise, a burst of communication after not very much of it can be unhelpful. "It's like a person who has been hungry a long time allowed to eat at a big table full of food," Gushin says. "It will be bad for him."

Olga Shevchenko, who leads the psychological support for the Mars 500 crew, agrees. She makes no bones about her responsibility. It's not to coddle the crew, but to balance their psychological health with the needs of the mission. "Our job is most importantly to ensure that the experiment doesn't stop," she says. That means making sure they are not worried about solving problems at home, or asking to leave early – which they are allowed to do at any time.

Shevchenko is in her mid-50s, with a neat crop of dark hair, glasses, and a sharp, ready laugh. We are in her high-ceilinged office on the third floor. A vase of birthday flowers adorns a small side table, but the room is almost bare. A pack of cigarettes and an ashtray sit on her desk. From here, tucked away from the whirring of the control room below, Shevchenko directs the flow of information to and from the Marsonauts locked inside their craft. She has taken no vacation during the term of the experiment.

A "trusted face" for the crew's concerns, questions, and needs, Shevchenko interacts with the crew almost daily via time-delayed emails and videos. She is their link to news, books and video games, and life on the outside. She also works with the crew's families and friends to ensure that information that gets to the test subjects is good for them, and for the experiment.

It's a daunting task. She collects and sends news summaries from TV and newspapers three times a week to the local server, adding interesting programmes about science, cars, and sports events when they ask. She sends each crew member's personal mail over a private channel every day. While she cannot read that mail, she can see the results of bad news. If she sees a crew member becoming irritated, Shevchenko talks to the family to coach them on presenting information.

In more than 15 years of working at the IMBP on isolation and psychological experiments, as well as supporting cosmonauts on the Mir space station and ISS, Shevchenko has learned what kind of information is desirable, what needs to be couched carefully and what is better left unsaid. For example, she avoids sending information about criminal activity in the news. It's upsetting, she says, and there's nothing the crew can do about it.

Likewise, world events such as bombings or plane crashes must be handled delicately, she says. During Mars 105, for example, two French Airbus planes crashed. One of the crew was an Airbus instructor pilot, so before breaking that news, the psychologists tried to find out if he knew any of the victims. And when a bomb exploded in Moscow's Domodedovo Airport this January, Shevchenko held that news until she had contacted the families of the Russian crew members, ensuring that none of their friends or loved ones were hurt or killed. In the meantime, however, the Russians heard about the event from their European crew mates, who had already got the news from their private messages, and demanded to know why they hadn't been told.

Tough love

Shevchenko is adamant that she made the best choice. "We don't have the right to give that as some sensational fact," she says, raising her voice and lighting a cigarette. She explains that the precedent was set in the early days of Soviet space flight, when cosmonaut Georgy Grechko's father died while he was in space in 1978. Back then it was forbidden to give him that information, for fear it would adversely impact Grechko's mission. He was told of the death only after his return to Earth.

These days, however, news about problems back home is disseminated, but carefully. In every instance of potential stress for the crew, be it their sick child or an earthquake near their family, Shevchenko gathers as much information as possible, asking relations and friends for input about how the person might react to certain information. "Everything depends on the individual," she says.

She blows smoke toward the ceiling and leans forward. "Because we all understand," she says. "Sitting in there, they all worry. But the worry multiplies, because you can't do anything. You are powerless."

Back in the control room, evening is approaching and duty engineer Gorbachev is preparing for the long night ahead. His shift won't end until 10am tomorrow, but he's in high spirits. They have solved the mystery of the shower drain: it turns out the crew cut three people's hair in the past two weeks, so when they went to take showers, they clogged up the drain. "It's banal, everyday stuff," Gorbachev says, "but all the same we learn something. The small, routine things – they're all part of the experiment." So far, say IMBP researchers, the Mars 500 crew seem to be doing fine, with no major interpersonal conflicts, and physical and psychological strength close to baseline levels.

That's already a big result, says Gorbachev, glancing at the wall monitors, as he always does when he talks about the crew. "Look!" Two of them are talking in the kitchen, munching on fresh strawberries. "If they're still in there, still smiling and talking, still sitting together," he says, "then all is well."

Achieving harmony is no mean feat, psychologist Gushin points out. So far the crew has shown it can live and work in this environment. "That doesn't mean it's good, doesn't mean it's easy, and it doesn't mean everything will be easy from here on," he says.

To get to Mars, we will need to find suitable spacecraft, radiation shields and engines. But alongside this enormous challenge is the human one – dealing with monotony, arguments, or even a clogged shower. Happily, the lesson from Mars 500 is that we now know enough to support the isolated Marsonauts on their trip. In other words, Shevchenko says: "It means we're ready."

When no one can hear you scream

On the whole, space crews get along fine, but in a few cases it was all too much...

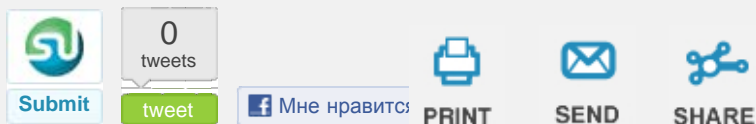
- In 1973, the crew members of NASA's experimental space station programme, Skylab, "rebelled" against mission control. All first-time astronauts, they felt stressed under the heavy workload enforced by ground control and turned off their radios for a day, refusing to talk. It worked: their workload was reduced, and they completed the mission successfully.
- During a record-length mission in 1982, two Russian cosmonauts got on each other's nerves so much that they allegedly refused to speak to each other for the majority of their 211-day flight on the Salyut space station.
- Tensions rose during a 1999 study called "Simulation of Flight of International Crew on Space Station" (SFNCSS). Held at the same complex as Mars 500 in Moscow, one aim was to study how crews from different nations mixed. Not smoothly, it turned out. Canadian volunteer Judith Lapierre claimed that she had been kissed against her will by a Russian crew member at the New Year party. The incident resulted in the four Russians being locked out from the living quarters of the others. Lapierre remained to complete the experiment, but a Japanese participant chose to leave early.

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