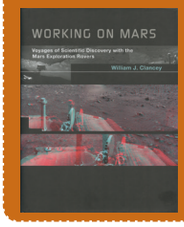
Working on Mars: Voyages of Scientific Discovery with the Mars Exploration Rovers



Author:
William J Clancey
Publisher:
The MIT Press
ISBN:
978-0-262-01775-6
Price:
£20.95 (Hb) 310pp

Before delving into details, this book best sums itself up with a direct quote from the author:

"The overarching theme of this book is how investigating a planetary surface through a robotic laboratory changes the practice of field science, and in terms of an 'exploration system', how the relation of people and machines enables scientific fieldwork to be conducted remotely." (Page 224)

What this book is not is a detailed account of scientific results made via the two MERs (Mars Exploration Rovers, Spirit and Opportunity), which landed on Mars in early 2004. Instead it documents ethnography: a description of the people and evolving human working processes that allowed the planetary science – of which you can no doubt read more about elsewhere, in other contemporary Mars books – to be undertaken.

The author is described (take a deep breath now) as Chief Scientist of Human Centered Computing in the Intelligent Systems Division at NASA Ames Research Center, and Senior Research Scientist at the Florida Institute for Human and Machine Cognition.

William Clancey writes in an anthropological style when examining the scientists and engineers involved operating the MERs. One thing that does come across well is the way conflicts are handled between what scientists would like to look at in terms of greatest scientific gain on the Martian surface and where engineers are prepared to allow them to go without endangering the vehicles. Also interesting is the contrast between orbital and surface astrogeology, when adherents of one discipline found themselves forced to interpret surface geology from a scale perspective they were hitherto unfamiliar with.

For a book of its size and number of pages, many of the illustrations are 'doubled up', i.e. they are referred to in the text once in black and white and the same pictures reproduced in colour, in the centre of the book. I am not sure this is the most efficient use of the pages or illustrations but assume printing constraints led to the use of this technique.

Not really a book about science on Mars, but how science is done back on Earth!

Malcolm Smith

INTERVIEW

What is it like to command a Mars rover, or direct observations from a satellite orbiting the red planet? How does the interface between man and machine affect how planetary scientists conduct their work? In his fascinating new book, *Working on Mars* William Clancey describes the very human aspect of our robotic exploration of the red planet. *Astronomy Now* caught up with him to ask what the major lessons of controlling rovers many millions of miles away have been.

If human exploration of Mars ever does take place, will the skills learned while doing the rover missions be discarded?

The skills required to operate the rovers relate to planning, setting priorities and collaborating with scientists in multiple disciplines — all of these are of general value, whether the scientists are on Earth programming robotic laboratories or on Mars living together in a base camp like those in Antarctica. More specifically, robotic laboratories will be of great value for surveying remote regions not yet explored by people, and they will be more capable, looking for specific chemicals, mapping sedimentary deposits and so on. These robotic systems will be operated from base camp or perhaps in orbit from the tiny Martian moon, Phobos. But robotic laboratories might also be placed by scientists in strategic locations on Mars and then operated from Earth by the many more interested explorers who can't come to Mars. The skills to operate them might only vaguely resemble what the Mars Exploration Rovers require because of advances in programming and automated investigations, like the advances since the Viking landers in the 1970s.

Are the skills learnt whilst conducting the rover missions being applied elsewhere on Earth?

The overall 'concept of operations' as we call it at NASA is quite general and useful: a scientific team collaborates with an engineering team to operate a robotic system in extreme conditions to investigate some region or structure. We find analogous operations in deep sea archaeology (like the exploration of the Titanic), inspecting a disaster area (such as Fukushima's nuclear power plant) and, perhaps someday, in robotic mining (such as gold mines that are so deep and hot it's not practical to transport teams of people and keep them comfortable). It must be remembered that in all these examples, the robotic system can be commanded directly ('joy-sticked') with feedback allowing direct rather than programmed control. The greatest challenge for operating robotic systems on Mars is that even at the speed of light it requires five to twenty minutes to send a command and then a similar wait to get a photograph to confirm the action was correct. For Mars we send a program for the entire day's operation, which occurs without human supervision — and that's very different from how we can operate robotic systems on Earth.

By adapting to explore Mars via rovers and orbiters, are scientists able to broaden the way they interpret their work?

What we can detect and learn from orbit and from the surface are complementary and allow an important synergy. After all, we have chosen to place Curiosity in Gale Crater because of what we know about its topography and geochemical composition from orbiting satellites. By and large, these are different instruments – consider comparing a telescope to a microscope – allowing different kinds of analyses that bring into play different specialised knowledge. So for example, we can see the alluvial fan and speculate the source of materials at the low region where Curiosity landed; but on the surface we will be analysing exact chemical make-up, in particular whether materials identified from orbit contain organics. So practically speaking, the adaptation is perhaps that of collaborating with other specialists, devising synergistic instruments and thinking more holistically about the macro and micro scale of geology, atmosphere, and climate. So yes, this can viewed as a form of broadening, but as a team rather than an individual making a dramatic shift as Michael Carr describes in my book.

What kind of personal connection do scientists have with the rovers?

The 'blur' a scientist might experience is sometimes called 'embodiment' in cognitive science. Specifically, this 'personal connection' involves the imaginative projection of orienting oneself to the rover's physical surroundings and capabilities—on a steep slope in a crater, its micro-imager on its arm a few centimetres from a smooth surface, unable to backup and so on. This projection is constructive and arguably necessary for doing field science on another planet. Personal concern is probably not quite like you might feel for an injured pet, say, but perhaps more a matter of familiarity, like the way you might feel about an old car you've nursed along for many years. The poetry of the mission is indeed remarkable, but the lesson is that there is a time and place for different ways of talking about and relating to the rovers and the scientists are never in the least bit confused about what is scientifically astute and their personal expressions of what the mission means historically or to what may be lifelong ambitions to solve the mysteries of Mars.