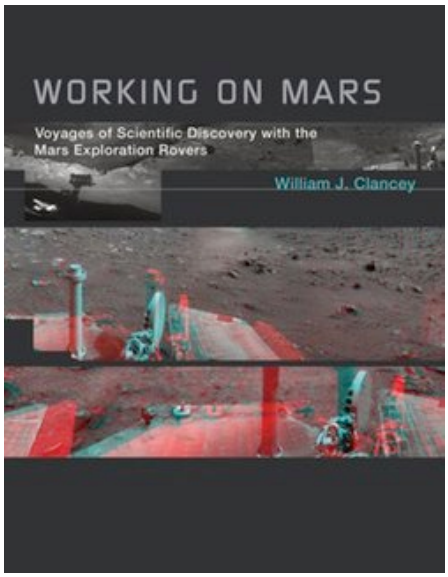

Review: Working on Mars

by Jeff Foust
Monday, September 24, 2012
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Working on Mars: Voyages of Scientific Discovery with the Mars Exploration Rovers
by William J. Clancey
MIT Press, 2012
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Seven weeks ago, NASA's Curiosity Mars rover successfully landed on the floor of Gale Crater on Mars, to the delight and even surprise of those working on or following the mission (see "From terror to triumph", The Space Review, August 6, 2012). Since then rover engineers have been putting the $2.5-billion vehicle through its paces, checking out its suite of instruments and starting to move the rover towards a site called Glenelg a few hundred meters away. Meanwhile, largely behind the scenes, the mission's science team has been studying the data collected to date and planning future studies, all the time working on a schedule synchronized to Mars time, where each day, or "sol," is nearly 40 minutes longer than its terrestrial counterpart.

The Curiosity team is, from an operational sense, following in the footsteps (tire tracks?) of NASA's Mars Exploration Rovers (MER) mission. Spirit and Opportunity landed on Mars in January 2004 for what were planned to be 90-day missions; both long exceeded that goal, and

Clancey was an observer in the early days of the MER mission, sitting in on meetings as the science team planned the activities of the twin rovers.

what were planned to be 90-day missions, both long exceeded that goal, and Opportunity continues working today (if overshadowed a bit now by the arrival of the new-and-improved Curiosity). In addition to the science these rovers performed, the mission also provided lessons on how to run such a mission and even insights regarding what it means to explore, all topics examined in William Clancey's book *Working on Mars*.

Clancey, the chief scientist of the Human-Centered Computing group at NASA's Ames Research Center, was an observer in the early days of the MER mission, sitting in on meetings as the science team planned the activities of the twin rovers. The book is about the insights he gained from those observations, plus later interviews with scientists and engineers involved in the project, about the similarities and differences between conventional field geology on Earth and what Spirit and Opportunity—often billed as "robot geologists"—were doing on Mars under the guidance of the project team back on Earth.

While it's tempting to consider Spirit and Opportunity as something like a terrestrial, human field geologist, Clancey notes there are some major differences. On Earth, geologists work in the field alone or in small groups, quickly going across the terrain looking for something interesting. The operations of the MERs, by contrast, were controlled by a team of dozens of scientists, meeting daily to discuss the latest findings and plans for the next day's work. In addition, those on the MER team with experience as field geologists would sometimes get impatient with the slow pace of the rovers, noting they could cover the ground a rover did on a good day in minutes. Yet no geologist had the patience to hold an instrument in place over a rock for hours to get data, as Spirit and Opportunity routinely did.

Clancey, while a computer scientist, is in *Working on Mars* more of an anthropologist at times, comparing and contrasting the people working on the mission. There are the differences between the scientists using the rovers to study Mars and the engineers who built and operate the rovers, roles that can lead to conflict but also cooperation, as he notes. There's also differences within the science team, particularly between those whose background is working in the field and those who primarily work in the lab. The former often wanted to quickly move on to the next destination, while the latter often wanted to linger and perform more observations with their instruments.

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Clancey even delves into the nature of "exploration" itself: what does exploration mean, particularly in the context of this mission, which has exploration in its name? He argues that MER was doing "scientific exploration" as first described by 18th century explorer Alexander von Humboldt, which sought to go beyond simply observing to more methodically, scientifically recording data in a systematic way. This is supported by Clancey's observations of the MER science team meetings, where members who proposed a particular observation, like taking an image or collecting a spectrum, had to explain what hypothesis that observation would answer.

The lessons of MER, particularly in the interactions among team members, have presumably transferred over to the Curiosity team. (One likely difference is the time pressure the MER teams felt: some described having a "sniper mentality" because, with a prime mission of only 90 days, they worried the rovers could die at any time. Curiosity, though, has a prime mission of at least two years.) *Working on Mars* provides an enlightening look at running a robotic exploration mission like Spirit and Opportunity—and now Curiosity—and its implications for the future of space exploration itself.

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Derek Lyons · *6 days ago* +2

"Yet no geologist had the patience to hold an instrument in place over a rock for hours to get data, as Spirit and Opportunity routinely did."

That's because they don't need to - duh. If they want that level of data, they take it back to the lab and let the gear there hold it for hours. Geology isn't just about field work, and hasn't been for a very long time.

Reply Report

Dave Huntsman · *6 days ago* 0

I think Steve Squyres, the lead scientist for MER, said it best, when asked about human versus robotic rover exploration of Mars. He said that given the choice between two rovers working for two years each, and a single trained geologist walking around for just two weeks, he'd pick the geologist any day. (Presumably, especially if it were him!).

Reply Report

Noel Hinners · *6 days ago* +3

All else being equal, I would tend to make the same judgement between two rovers vs a single trained geologist. However, all is not equal. The cost of the MERs was, if I recall correctly, roughly $1B. The cost of a geologist on Mars is more likely to be of the order of several hundred $B. Another interesting comparison is to look at the Apollo missions and ask what we could do today robotically. The answer is "most". Robotic capability keeps improving. Human capability is rather stagnant except as aided by modern robotics (it is instructive to look at deep ocean exploration to see the interplay of robotics and human in-situ exploration). I also fully appreciate that human exploration in space is not done primarily for the sake of conducting science; science is a useful by-product.

Reply **4 replies** · *active 5 days ago* Report

Dave Huntsman · *6 days ago* 0

I agree with Noel. That's why exploration decisions can't be left solely to the scientists. There are times when other things need to be weighed as well, including interests in resources whether or not they are 'scientifically interesting', etc.

Reply Report

Jon Clarke · *6 days ago* +1

Resource decisions are best made by resource scientists. Making a decision about a resource in any environment without science is a short gut to economic failure

Reply Report

YetAnotherBob · *5 days ago* -1

There are three stages of exploration.

First stage is initial survey. This is where the Science is done. The question is "What is there, anyway?

First stage is initial survey. This is where the Science is done. The question is "What is there, anyway? Why is it there?"

The second stage is exploitation. This is where the initial Engineering and settling come in. At this stage, people can live, but, don't intend to stay for the rest of their lives. The question is "What can we do to make it profitable? or How can this be used to help us somewhere else?"

The third stage is settlement. This is where people make their homes and raise families in the new frontier. The question at that time is "why do I want to live here? or How can I support my family to get the things we want?"

In Space, we are still in the first stage except for Earth Orbit, where we are in the second stage. By letting Scientists make all the major decisions, we are assuring that we will only be in the first stage.

However, there are precedents. England was in the First Stage with America for over 100 years. Spain was in the First Stage in the New World for only about 10 years. Spain entered the Third Stage by the mid 1500s, less than America has been in the second stage with satellite communications.

The thing to remember is that in the First Stage, all the expenses are made with none of the gains. The gains come later with the second and third stages.

Science in and of itself doesn't really give us anything. The gain for Science comes by opening up the Engineering and Production that follow with the second stage. This is true of anything. Space people tend to forget that.

Reply Report

Jon Clarke · *6 days ago* 0

There is no way that we could today duplicate most of what the Apollo astronauts achieved on the Moon robotically. Astronauts today would achieve even more, because of the improvemnts in instrumentation. The differential between direct human presence with astronauts and indirect human resence via unmanned missions for such detailed surface exploration has, if anything increased, even for the Moon. For Mars, it is probably a factor of at least a thousand, even for those areas of science where capabilities overlap. There are whole discplines of research than unmanned exploration will never be able to address.

Reply Report

Fred Willett · *6 days ago* +2

All of which is why NASA sould be concentrating on getting the cost down so we can start sending the odd scientist.

Reply **1 reply** · *active 4 days ago* Report

ken anthony · *4 days ago* 0

Hey Abbott, why is it only the odd scientists would go?

Reply Report

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