LETTERS

edited by Jennifer Sills

The Price of Exploration

NASA IS IN THE FINAL THROES OF IMPLEMENTING THE MOST POWERFUL SURFACE RECONnaissance mission ever undertaken to Mars. Dubbed the Mars Science Laboratory (MSL), it represents NASA's first life inference mission equipped with instruments capable of detecting the chemical building blocks of life more than an order of magnitude more sensitive than those used by the Viking mission of the 1970s. MSL will also demonstrate multiple technical capabilities needed to enable a future robotic Mars sample return mission.

In his 31 October Letter ("Viewing NASA's Mars budget with resignation," p. 672), former NASA Associate Administrator S. A. Stern suggested that excessive cost growth of MSL is deeply damaging NASA's overall planetary exploration agenda and destroying the opportunity for a future Mars sample return mission. He blames senior NASA leaders for disbanding his MSL independent technical review team, which he claims forced his resignation.

Let's roll. Wheels have been fitted to NASA's Mars Science Laboratory (MSL) rover, which is being assembled at NASA's Jet Propulsion Laboratory, Pasadena, California. The rover has a ground clearance of about 60 cm, or 2 feet, and is about the size of a small automobile.

Now is the time to set the record straight. NASA consolidated its independent standing review boards to streamline the process for all major flight programs in 2007. The MSL Standing Review Board remains in effect and was never disbanded.

Stern also claims that MSL was "assigned" a cost level of $650 million. He fails to mention when and by whom. The $650 million cost was a placeholder assigned to a medium-class Mars rover mission by the National Research Council Solar System Decadal Survey committee in 2002, before NASA had developed a basis of cost estimate for MSL. This served as input to NASA studies from 2000 to 2004 to fully define the MSL mission and culminated in the competitive selection of its science payload in late 2004.

At that time, the overall mission was baselined at a cost of $1.4 billion, not including several costs associated with the radioisotope power system. Given the experience with the cost of the Mars Exploration Rovers and the increased scientific and technical scope of the MSL mission, the so-called assigned value of $650 million is not credible. Stern's own New Horizons flyby mission to Pluto cost NASA more than $650 million; it is unrealistic to expect that a 700-kg analytical laboratory that must soft-land on Mars and drive around with 100 kg of scientific instruments could possibly cost less than a planetary flyby mission.

Indeed, MSL's 2 years of intensive surface science operations are difficult to compare to any missions in the $650 million price class given typical science-per-dollar metrics. The established NASA cost to implement MSL as of the time of its confirmation review was $1.55 billion (August 2006), which grew due to NASA-wide issues with thermal protection system materials in 2007 to approximately $1.7 billion. The total cost growth of the MSL mission development since NASA confirmed the mission is typical of other Mars exploration missions successfully flown over the past decade. The cost to fly MSL in 2009 will be less than the cost (in today's dollars) of flying a nonmobile Viking Lander laboratory to Mars, and MSL includes a whole new generation of instruments and mobility.

NASA has an exemplary record of honoring its commitments to implement flagship-class missions that frequently "rewrite the textbooks" as they discover how the universe operates. To abandon MSL at this time would represent an unprecedented break with this guiding philosophy. As President John F. Kennedy once stated, we choose to do these things not because they are easy, but because they are hard. NASA succeeded with Apollo to the Moon, Hubble to the universe, and Cassini to Saturn. The agency is ready now to assault the martian frontier with MSL.

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Note

1. The author is the former NASA Chief Scientist for Mars Exploration, NASA Headquarters, 2000 to 2005.

Research Funding: Less Should Be More

THE POLICY FORUM "STRUCTURAL DISEQUIlibria in biomedical research" by M. S. Teitelbaum (1 August, p. 644) discussed structural problems in U.S. biomedical research funding, particularly NIH funding, but neglected to mention one of the most perverse structural problems in the system: Scientists are incentivized to secure as much


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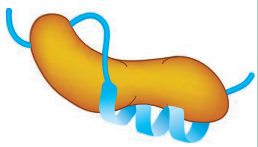
Controlling intrinsic disorder
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funding as possible for their work, irrespective of whether an increase in funding leads to a proportionate increase in productivity.

The problem can be illustrated by a simple comparison. Suppose a pharmaceutical company has hired two researchers to run two new research labs. After 6 years, both researchers are evaluated and both have been similarly productive in terms of papers, patents, and new drugs in the pipeline. However, one researcher has sustained this productivity with a modest budget of $800,000 per year, whereas the other has constantly requested funds from the company for more equipment, more technicians, and more resources and now spends $3 million per year of the company's money. Which researcher is the company more likely to reward and promote to a position of greater responsibility?

Now, let's switch to a research university or medical school and talk about two assistant professors who, at the end of 6 years, have been similarly productive in terms of papers and other achievements. One has done so with a single RO1, whereas the other has managed to secure three major grants. Which assistant professor will the deans and administrators be more enthusiastic about promoting and rewarding with raises, endowed chairs, and other perks?

The discrepancy between the financial priorities in these two settings is no mystery. At the company, the funding for research comes out of the company's pocket, and it has an interest in encouraging economic efficiency in scientific output. At the university or medical school, the funding comes from outside the institution, and there is an interest in maximizing the money secured for research, irrespective of its effect on actual productivity.

Even if the academic research model is self-correcting in the long run, would it not be more economically efficient in the first place to eliminate the incentives to secure funding over and above what a scientist feels he can most effectively use?

How can we remove these incentives? There must be a change in culture. No prestige should be attached to the level of funding that an investigator has managed to secure. The most basic of truths must be emphasized: Money is a means, not an end. We do not do science to get money. We get money to do science. Funding cannot be a measure of productivity, because scientists do not produce research dollars. Research dollars are produced by taxpayers (and to a lesser extent by philanthropists and charitable individuals). The amount of money spent by a researcher is not a measure of his productivity, but of his consumption, and might even be counted on the negative side of the ledger when he is evaluated.

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Cell Phone and DNA Story Overlooked Studies

IN HER WIDELY CITED NEWS OF THE WEEK story "Fraud charges cast doubt on claims of DNA damage from cell phone fields" (29 August, p. 1144), G. Vogel writes, "The only two peer-reviewed scientific papers showing that electromagnetic fields (EMFs) from cell phones can cause DNA breakage are at the center of a misconduct controversy at the Medical University of Vienna." Notwithstanding the allegations on both sides of the fence in this unresolved controversy, Vogel's opening comment and the title of her article are misleading. In fact, there are many other peer-reviewed papers from laboratories in at least seven countries, including the United States, showing that cell phone or similar low-intensity EMFs can break DNA or modulate it structurally [e.g., (*1*–*9*)].

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Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 3 months or issues of general interest. They can be submitted through the Web (www.submit2science.org) or by regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

Response

MY INTENTION WAS NOT TO IMPLY THAT THERE were only two papers showing any effects of EMFs. There are many publications that show effects of EMFs on DNA, but the citations listed here do not directly contradict the quoted sentence. Some see an effect in combination with other known agents that damage DNA. One finds an effect of microwaves, but in the range of microwave ovens and wireless LANs, not cell phones. Others look at DNA damage (for example, chromosome duplications), but not breakage. Several show mixed results: One finds a decrease in DNA breaks in three sets of exposed cells and an increase in one. Since the story was published, however, I have been made aware of a paper by Yao *et al.* (*1*), which also reported single-strand DNA breaks caused by EMFs equivalent to those from cell phones. I regret any misunderstanding the sentence caused.

GRETCHEN VOGEL

Reference

1. K. Yao *et al.*, *Mol. Vision* **14**, 964 (2008).

Flaunting the Feminine Side of Research Studies

BIOLOGICAL DIFFERENCES BETWEEN WOMEN and men exist in the prevalence, presentation, and response to treatment for many diseases. In 2001, the Institute of Medicine confirmed that sex is a vital variable that should be considered when designing and analyzing studies at all levels of biomedical research (*1*). To appropriately evaluate the success of women's representation in clinical trials, we must focus on the inclusion of women (and men) in studies of conditions that affect both sexes. Discussions of raw counts of overall research participation and inclusion of single-sex studies hide the fact that women's inclusion still lags in some key areas, despite the recent gains reported by C. Holden in the News story "Women abound in NIH trials" (Special Section on Clinical

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Trials and Tribulations, 10 October, p. 219).

Recently, a 2008 review of National Heart, Lung, and Blood Institute (NHLBI)–funded cardiovascular disease (CVD) randomized controlled clinical trials from 1997 to 2006 found that women were underrepresented based on general population incidence as reported by the American Heart Association's Heart Disease and Stroke Statistics report. "The mean percent of women enrolled in all trials was 27% versus 53% of all patients with CVD who are women" (*2*).

Moreover, studies that include similar numbers of men and women rarely analyze or report the results by sex (*3*). This hampers our ability to understand the differences between men and women and to use this knowledge to improve health care outcomes.

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CORRECTIONS AND CLARIFICATIONS

This Week in *Science*: "Oxygen torn apart" (14 November, p. 1021). In the fourth sentence, O^{2+} should have been O_2^+. The HTML version has been corrected.

Special Section on Genetics of Behavior: News: "Wanted: Math gene" by C. Holden (7 November, p. 894). The link between the *CHRM2* gene and IQ was incorrectly represented. That link was first established by Danielle Posthuma and colleagues at Vrije University, Amsterdam, in 2006 and reconfirmed in follow-up studies. The work by Danielle Dick replicated those findings.

TECHNICAL COMMENT ABSTRACTS

COMMENT ON "Climate-Driven Ecosystem Succession in the Sahara: The Past 6000 Years"

Victor Brovkin and Martin Claussen

Kröpelin *et al.* (Research Articles, 9 May 2008, p. 765) interpreted a sediment record from Lake Yoa in the east-central part of North Africa as support for a weak biogeophysical climate-vegetation feedback in the Sahara during the mid-Holocene. We argue that the new data do not invalidate earlier modeling results on strong land-atmosphere coupling in the Western Sahara for which the Lake Yoa record is far less representative.

Full text at www.sciencemag.org/cgi/content/full/322/5906/1326b

RESPONSE TO COMMENT ON "Climate-Driven Ecosystem Succession in the Sahara: The Past 6000 Years"

S. Kröpelin, D. Verschuren, A.-M. Lézine

The Lake Yoa record and archaeological data provide adequate evidence that mid-Holocene aridification did not occur abruptly across all of North Africa. Modeling results on the issue of abrupt versus gradual desiccation of the Sahara are sufficiently diverse that paleoecological data from a continuous natural archive can usefully guide the evaluation of model parameters responsible for this diversity.

Full text at www.sciencemag.org/cgi/content/full/322/5906/1326c