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**Scholars and Scandal**

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In Nov. 2009, the unauthorized release of 1,000 e-mails between British and American climate scientists soon metastasized into a media (and, many say, manufactured) event. By seizing on two turns of phrase in one e-mail -- that a "trick" should be used to "hide the decline" in a graph used in a 1999 World Meteorological Organization report -- global warming skeptics painted a picture, largely successfully in some precincts of public opinion, of climate scientists as biased and the underlying science of global warming as in doubt.

Three separate inquiries into what became known as "Climategate" analyzed the allegations and -- with some caveats about the scientists' openness and transparency in how they presented data -- backed the researchers' representations and found nothing to cast doubt on the scientific consensus that climate change is real, driven largely by human activity and a matter of urgent concern. "We saw no evidence of any deliberate scientific malpractice in any of the work of the Climatic Research Unit," wrote the authors of a report that examined whether the unit performed its research with integrity. It was chaired by Lord Ron Oxburgh, a geologist, former chief scientific adviser to the Ministry of Defense in Britain and a non-executive chairman of Shell. "Rather," they continued, "we found a small group of dedicated if slightly disorganized researchers who were ill-prepared for being the focus of public attention."

The intense public attention that swirled around these researchers gave rise to an important lesson, according to the authors of a report produced by a panel chaired by Sir Muir Russell, former principal and vice-chancellor of the University of Glasgow and now the chair of Scotland's Judicial Appointments Board. That lesson has resonated well beyond climate science and into other disciplines. It is a lesson about the changed landscape in which scientists -- and, by extension, all scholars -- now operate.

"One of the most obvious features of the climate change debate is the influence of the blogosphere," wrote Russell's panel. "This provides an opportunity for unmoderated comment to stand alongside peer reviewed publications; for presentations or lectures at learned conferences to be challenged without inhibition; and for highly personalized critiques of individuals and their work to be promulgated without hindrance. This is a fact of life, and it would be foolish to challenge its existence."

This environment, the panel noted, should prod scientists to be more open with their data and to communicate their work in more accessible ways. "A failure to recognize this and to act appropriately can lead to immense reputational damage by feeding allegations of cover up," Russell's panel continued. "Being part of a like-minded group may provide no defense. Like it or not, this indicates a transformation in the way science has to be conducted in this century."

It is not clear that the panel's urgings have truly been heeded by scholars. And the conditions that gave rise to Climategate are still very much in play; some see similar dynamics in the open records request for the e-mails of a professor at the University of Wisconsin at Madison who has been critical of the Wisconsin Governor Scott Walker's policies on public employee unions (those supportive of the request say it is meant to determine whether the professor breached laws barring public employees from politicking using public resources). Many of the same issues also have surfaced in the demand by Virginia's Attorney General for documents related to the research of a former University of Virginia climate scientist (the Attorney General says his goal is to provide oversight of a state institution). A state judge blocked an earlier request, and the scientist's current employer, Pennsylvania State University, cleared the scientist of any scientific misconduct.

But the panel's warnings raise a host of questions: What is the best course of action when scholars' motives and research are attacked? How quickly should they respond? Who should vet such allegations -- universities, disciplinary societies, or some other entity? If scholars move too hastily, do the risks of getting it wrong (or of being later disproven) outweigh the damage of letting allegations fester without rebuttal?

As Russell's panel suggested, the means of argument and debate, the treatment of uncertainty and the appearance of authority differ greatly between the blogosphere and academe. The blogosphere has many virtues: it is egalitarian, democratic, decentralized and quick. But, some scholars note with dismay, it also allows anyone with an Internet connection to publish his or her views and to find a platform to cast doubt on others, often without being held accountable.

In addition, some worry that the current media environment has exacerbated partisanship; people can simply pick and choose among sources of information that reinforce their existing world view. The web can advance, for lack of a better word, "truthiness," the term used most famously by the comic pundit Stephen Colbert. In

2006, the American Dialect Society named it the word of the year and supplied a definition: "the quality of preferring concepts or facts one wishes to be true, rather than concepts or facts known to be true."
On the other hand, academic research, at least ideally, is supposed to pursue truth instead of truthiness. It is conducted methodically, with attention to context and scholarly standards, and is at its best when held accountable through such vehicles as peer review. But it also can be slow-moving and, to the uninitiated, opaque.
In the case of Climategate, truthiness seems to have prevailed. Forty-seven percent of Americans polled soon after the story broke in the mainstream media said that news coverage of the e-mails had made them either somewhat (18 percent) or much more (29 percent) certain that global warming was not happening, according to a working paper by Anthony Leiserowitz, a research scientist and the director of the Yale Project on Climate Change Communication (an updated version is due to appear in an upcoming issue of *American Behavioral Scientist*).
He and his fellow researchers surveyed a nationally representative sample of 1,001 adults between Dec. 24, 2009, and Jan. 3, 2010 -- nearly two months after the scientists' e-mails were first posted online and about a month after the story became widely known. More than half, or 53 percent of respondents, said that the stories had caused them have less trust in climate scientists.
Leiserowitz said recently via e-mail that it is unclear how long the damage has lasted, though he and his colleagues are about to do another survey. Many scientists felt stung by the episode, to be sure. But the issue has faded from memory for all but the most skeptical members of the general public, Leiserowitz said, with some who were on the fence indicating that their opinions had hardened. “Probably some people who were formerly doubtful became dismissive because of Climategate,” he said. “It will be hard to win back their trust."
The University of East Anglia, where the Climatic Research Unit is housed, waited too long to respond once the e-mails were released, Leiserowitz added. In those weeks, the story gained traction and was firmly framed by climate skeptics. "We now live in a 24/7 news cycle -- the story went through multiple iterations before they said anything," he said. "The community was caught flat-footed."
Something, then, should be done to better respond. But what?
Typically, universities -- which have legal departments, review boards and other resources (as well as ultimate responsibility for federal grants, if the research funded by such sources is implicated) -- are best equipped to handle allegations of research misconduct or unethical behavior, said Mark Frankel, director of the Scientific Freedom, Responsibility and Law program at the American Association for the Advancement of Science. But such processes also tend to be far more clearly codified for the physical and natural sciences than for social science or the humanities, say many observers.
These inquiries can take several months to properly gear up, and many more to render findings. For example, Harvard University seized the hard drives of Marc Hauser, a professor of psychology and human evolutionary biology, in order to investigate suspected research misconduct. That probe took three years to determine that Hauser had committed eight instances of scientific misconduct. Harvard also retracted or corrected three of Hauser's scholarly publications and indicated that he would be sanctioned but allowed to teach again after a year. After word first leaked of Hauser's punishment, scholars pressed Harvard to give a more detailed account of exactly what parts of his published research had been found wanting.
Frankel wondered whether methodical time frames were still practical in the current information environment. “To some extent, it changes the rules of the game,” he said of the blogosphere. And it is not yet evident, he said, that universities or disciplinary societies have developed processes or mechanisms to respond to rapidly proliferating, diverse and unfamiliar sources of information from which allegations spring forth.
“This is a different world from even 10 years ago,” said Frankel. “Moving with all deliberate speed is not going to be fast enough in the 21st century.”

**But Is Speed Always Best?**

Claims of fraud, fabrication and ethical breaches in research in the social sciences and the humanities rarely tend to surface as publicly or as explosively as they did in Climategate (claims of plagiarism are another matter). But such controversies garner great attention when they do occur. In 2000, the journalist Patrick Tierney published a book, *Darkness in El Dorado* (which was also excerpted in the *New Yorker*), in which he claimed that the indigenous Yanomami people of South America had been greatly harmed by the anthropologist Napoleon Chagnon, biosocial professor emeritus at the University of California at Santa

Barbara, and by James V. Neel, who before his death was a physician and geneticist at the University of Michigan.

In contrast to Climategate, in which scholars were caught unawares, the *El Dorado* controversy was anticipated, if not perhaps exacerbated, by those within the discipline. “We write to inform you of an impending scandal that will affect the American anthropological profession as a whole in the eyes of the public, and arouse intense indignation and calls for action among members of the association,” Leslie E. Sponsel and Terence Turner, emeritus professor and professor of anthropology, respectively, at the University of Hawaii and at Cornell University, wrote in a memo to the president and president-elect of the association, and to the heads of four units within the American Anthropological Association. “In its scale, ramifications, and sheer criminality and corruption it is unparalleled in the history of anthropology.”

Turner and Sponsel had read galleys of Tierney's book and urged the association to begin planning a response before it was released, including taking “appropriate redressive actions” on some of Tierney's claims. They called for a public airing of the scandal at the association's next annual meeting, and to involve several subcommittees of the AAA, including those dealing with human rights, ethics and Latin America. “Our point is simply that the time [to] start is now,” they wrote.

The AAA took on the task of conducting an inquiry into Tierney's claims -- to the detriment of that association, said Alice Dreger, a professor of medical humanities and bioethics at Northwestern University's Feinberg School of Medicine. “The AAA behaved as if it was a company and it was doing damage control,” said Dreger, whose article, “*Darkness*'s Descent on the American Anthropological Association,” appeared in the February issue of *Human Nature*. The article amplifies a presentation she made to the association in 2009 and will be covered in a book she is writing on scientific controversies in the Internet age.

The *El Dorado* controversy has proven to be enduring, at least among some factions of anthropologists. Each side accuses the other of cherry-picking certain facts while ignoring others. And each side draws from the affair its own set of lessons -- about ethics, the dangers of ideology trumping scholarship, and many other considerations. (Those interested in plumbing the depths of the controversy and following the volleys of argument and counterpoint can dive into a website maintained by Douglas W. Hume, assistant professor of anthropology at Northern Kentucky University.)

*El Dorado* also raises questions, not just about the speed with which scholars should respond, but also about who should be the one to investigate allegations of misconduct -- and how such allegations are aired in the first place.

Sponsel and Turner have said that their letter was meant only for the heads of the AAA and its relevant committees -- and that it was distributed widely through the Internet without their consent. “We never intended or anticipated that our letter would go any further than these six individuals,” they wrote in a letter to Nancy Cantor, who was then provost at Michigan and led a panel that investigated some of the claims. “Once someone leaked our letter into cyberspace,” they continued, “it was quickly out of control.”

At the same time, Sponsel stands by the original purpose of the memo, though he said he would have tempered some of its language and marked it "confidential." He says its purpose was to alert the AAA to an impending public relations catastrophe and ask the association to investigate. “We did not first take time to scrutinize everything that Tierney wrote,” he wrote in a response to Dreger's work, “but asked the AAA to do so, given their far greater resources.”

The blogosphere was not to blame in this case, of course. *The New Yorker*, which is known for its scrupulous fact-checking, no doubt lent gravitas to Tierney's claims. The structural changes to the media that have taken place since Tierney's piece was published 11 years ago -- fewer reporters and editors, and wider and more immediate dissemination -- make it more likely that sensational or spurious allegations will travel very far, very fast.

While universities may be well-equipped to pick through the sorts of issues that tend to come their way -- typically allegations of fraud, fabrication and plagiarism -- it is unclear how more ambiguous breaches of disciplinary ethics, like many of those taken up by the AAA, can best be investigated. Ethical standards tend to be unique to each field of study and more nuanced than, say, determining whether plagiarism occurred. While disciplinary societies would seem to be the standard-bearers of ethical practice, it is not clear that they have the resources or temperament to rule on them.

In the case of *El Dorado*, Dreger is not the only critic to say that the AAA mishandled the controversy by treating it, chiefly, as a public relations problem. “They were more concerned with protecting the discipline’s

image than with dealing directly with the issues Tierney had raised," Robert Borofsky, professor of anthropology at Hawaii Pacific University, wrote in his book, *Yanomami: The Fierce Controversy and What We Might Learn From It*.

"The AAA can't do ethical evaluations because it will upset the membership," he told *Inside Higher Ed*. "They have an investment in keeping members. Speaking truth to power doesn't fit that agenda." The AAA declined to comment, but said through a spokeswoman that it is "still very interested in the topic of how associations move forward after controversial issues."

Nonetheless, Borofsky said the AAA was justified in deciding to look into Tierney's claims. "I don't think they had a choice not to get involved," he said. "The publicity was so momentous and so broad and pervasive, they had to." He also thought the task force's report was ultimately credible -- and that the later vote by members to rescind acceptance of the report was a case in which the AAA got "unfairly banged down."

Dreger, on the other hand, faulted the AAA for taking the charges seriously when some, such as Jane Hill, the head of the association's task force, privately called the book "a piece of sleaze," and some of its most explosive claims had been rebutted.

"One must wonder what scholar will want to belong to a professional organization which, rather than protecting her right to be fairly represented in the press, launches an investigation into her life's work," Dreger wrote. "I can't imagine how any scholar now feels safe at the hands of the AAA, except insofar as the voting membership seems to have some sense of fair play."

Sponsel, who urged the AAA look into the allegations, also was critical of the association's final product. "Tierney's book was unprecedented in its multitude of diverse allegations," he wrote in an e-mail to *Inside Higher Ed*. "(It) deserved a far more thorough and competent investigation than it received from the AAA or any other organization and from Chagnon's defenders."

**Disciplinary Society As Moral Authority**

If the *El Dorado* controversy suggests the perils of disciplinary societies deciding to look into allegations of misconduct, is there any role for them to play at all? A controversy that arose in another field at around the same time offers a different road map.

Michael Bellesiles's 2000 book, *Arming America: The Origins of a National Gun Culture*, garnered high praise -- and the prestigious Bancroft Prize -- as well as virulent criticism from, among others, the National Rifle Association. His provocative thesis was that gun ownership in Colonial America was actually far less common than typically assumed. If true, his argument would seem to undermine the notion that the prevailing culture of gun ownership during the time of the Founding Fathers would tend to bolster an expansive interpretation of the Second Amendment.

Historians were disquieted by the fervor of the criticism the book inspired. Though they supported critical evaluation of scholarship, the members of the elected council of the American Historical Association passed a resolution decrying the personal attacks and harassment of Bellesiles as "inappropriate and damaging to a tradition of free exchange of ideas."

But questions arose about Bellesiles's scholarly methods, and some of those questions turned out to be well-founded. Many wondered how the Emory University historian had reached the conclusions he did based on his analyses of probate and militia records. An investigation carried out on behalf of Emory by a panel of three distinguished historians rendered its report in 2002: "The best that can be said of his work with the probate and militia records is that he is guilty of unprofessional and misleading work. Every aspect of his work in the probate records is deeply flawed," the historians wrote. Finding evidence of falsification on a key table of data that Bellesiles compiled, the panel of historians wrote that "his scholarly integrity is seriously in question."

The Bancroft was revoked, though some of Bellesiles's supporters say that the sloppiness of his record-keeping and other flaws do not invalidate his entire argument. But, more broadly, questions remain about how such scandals can best be handled by scholars and their societies.

To the current executive director of the AHA, Jim Grossman, it is far from clear that professional associations are best-suited for such investigations. In fact, the AHA in 2003 stopped hearing complaints about allegations of misconduct because such probes proved time-consuming, and -- due to confidentiality considerations that required the association to keep quiet about their findings -- they seemed to have little public impact. "I think that what professional associations are the appropriate venue for is establishing the standards," said Grossman.

Those standards proved useful to the panel of historians judging the Bellesiles allegations on behalf of Emory. The historians had been asked by Emory to determine unanswerable questions, such as whether Bellesiles had intentionally falsified data. They also said that Emory's procedures were not entirely adequate in guiding their inquiry, "since it seems basically designed for the investigation of alleged misconduct in the life and physical sciences," they wrote. So they relied on AHA standards as a kind of moral authority.

"This was the service that the AHA provided to the profession," Grossman said.

The process of scholarship itself serves as another sort of bulwark -- though it is more by force of example -- against both valid and false allegations, said Tony Grafton, Henry Putnam University Professor of History at Princeton University and president of the AHA. "We're modeling honest, firsthand inquiry," Grafton wrote in January. "That austere, principled quest for knowledge matters: matters more than ever in the current media world, in which lies about the past, like lies about the present, move faster than ever before."

Grafton agreed that disciplinary societies would not be well served adjudicating claims, saying that what seems clear on the outside is murkier once you delve in. But he also concurred that some kind of scholarly response is needed in a world of accelerating information. He hoped that civic-minded scholars would wade into controversies to debunk falsehoods. "You can't legislate this, but you depend on people to have sharp eyes and notice things," he said, citing as an example Carol Sheriff, a history professor at the College of William and Mary who debunked a claim published in a Virginia fourth-grade textbook that thousands of black soldiers fought during the Civil War for the Confederacy.

"[We] want to encourage historians to engage themselves in communities -- state and local," said Grafton. "There's a million ways of reaching the public."

**Whose Job Is It?**

Recently, two research fellows at the American Council of Trustees and Alumni proposed still another route for scholars to police ethical breaches. While Erin O'Connor and Maurice Black advocated in *Inside Higher Ed* for disciplinary societies and others to play a role in such matters, the majority of their argument centered on the American Association of University Professors reviving what is known as "Committee B," which would police abuses of academic standards.

"Like Committee A [which investigates alleged breaches of academic freedom], Committee B should investigate cases, issue statements, and set standards," O'Connor and Black wrote. "It should censure institutions that don't enforce those standards -- and, when appropriate, professors who violate them."

But even some longstanding advocates for Committee B acknowledge that such a body might not offer an effective remedy. "I'm not sure there is any optimal channel," said one such advocate, Robert M. O'Neil, the former president of the University of Virginia and University of Wisconsin who is serving his third term as the general counsel for the AAUP. "It's difficult to formalize and apply standards in the realm of ethics."

He added that, for most people in academe, reestablishing Committee B may not be a terribly high priority, "in part because the transgressions are likely to be infrequent, highly fact-intensive and therefore not readily capable of comprehensive resolution under a standard of code of ethics."

Stanley N. Katz, Lecturer with the rank of Professor and director of the Center for Arts and Cultural Policy Studies at Princeton's Woodrow Wilson School, said that the web can be harnessed in service to scholarship: scholars linked to each other via the web might deploy to respond quickly to emerging controversies. The larger risk of the current media environment, he said, is the weakening or destruction of academe's best tool: peer review. "If everyone is a publisher, that's a disaster," he said. "That's a real threat."

Also troubling, he said, is the changing relationship of scholars to their institutions. The free market ethos that is becoming more prevalent in higher education has encouraged individual professors to see themselves as entrepreneurs, not as members of an institution.

"Some say the primary obligation is shifting from the institution to the discipline," said Katz. "It's every man on his own and every woman on her own. It's in nobody's corporate interest to police activity."

— Dan Berrett

http://www.insidehighered.com/news/2011/04/062/how_should_college_professors_respond_to_allegations_of_research_misconduct_in_the_age_of_the_internet

**Skimming the Surface**

April 11, 2011
ATLANTA -- An analysis of research papers written in first-year composition courses at 15 colleges reveals that many students simply copy chunks of text from the sources they cite without truly grasping the underlying argument, quality or context.
"The findings are not happy news for how writing is taught," Rebecca Moore Howard, an associate professor of writing and rhetoric at Syracuse University, said here Thursday at the annual meeting of the Conference on College Composition and Communication. "[Students] are not selecting authoritative, meaningful sources and not reading them carefully. They are not, in a word, engaging."

Howard's presentation -- with her co-principal researcher, Sandra Jamieson, professor of English, director of composition and department chair at Drew University -- of the initial findings of the Citation Project could carry broad implications for how writing is taught at the college level, not just in composition courses, but across disciplines.
"We were often stunned by what we found," Jamieson told the standing-room crowd Thursday, adding that the biggest shock often came when researchers reviewed papers from their own institutions. "What we can say with confidence is that the trends cross school types and student types."
Howard and Jamieson led a team of 20 researchers in analyzing 164 student research papers produced in first-year composition classes. They studied a range of institutions in 12 states from diverse regions of the country, culling work from community colleges and four-year public universities, private colleges and universities, and religiously affiliated and Ivy league institutions.
The researchers analyzed the students' 1,832 research citations and assigned each of them to one of four categories:

- Exact copying -- a verbatim cut-and-paste, either with or without quotation marks.
- "Patchwriting" -- the copying of the original language with minimal alteration and with synonyms substituting for several original words (patchwriting is often a failed attempt to paraphrase, they said).
- Paraphrasing -- a restatement of a source's argument with mostly fresh language, and with some of the original language intact; it reflects comprehension of a small portion, perhaps a sentence, of the source material.
- Summary -- the desired form of citation because it demonstrates true understanding of a large portion, if not the entirety, of the original text; summarizing was identified by the researchers when student writers restated in their own terms the source material and compressed by at least 50 percent the main points of at least three consecutive sentences.

Only 9 percent of the citations were categorized as summary. "That's the stunning part, I think: 91 percent are citations to material that isn't composing," said Jamieson. "They don't digest the ideas in the material cited and put it in their own words."
The researchers acknowledged that the act of classifying the citations is inherently subjective, and said that, if anything, they tended to err on the side of the most generous interpretation when assigning the citation to a category. They are also still refining their classifications and coding the data from one more institution. Still, Howard said, such adjustments are unlikely to alter their basic findings.
While many inside and outside academe might see the Citation Project's initial results as further proof that most students cut and paste from the Internet (indeed, the researchers found that 44 percent of citations fit that description) or that students plagiarize rampantly, Howard cautioned against falling back on such simple conclusions.
"We don't think we have lazy, fraudulent students," said Howard, who has written extensively about plagiarism, arguing that teachers should not just adopt a tough posture, but should instead be far more

nuanced in instructing their students in how to avoid it. “We think we have students working for efficiency and doing efficient writing.”

The researchers also aimed to do more than identify proper citation (or come down hard on apparent plagiarism). They wanted to tease out a subtler dynamic: how the students use, relate to and understand their sources. The research team looked at how the students demonstrated their comprehension of their sources' underlying arguments, as well as what kinds of materials they used and from what parts of the text they quoted.

Most sources were cited only once, they found. In addition, more than half of the 1,832 citations were to source material that was five pages or shorter, and more than three-quarters of the citations referred to information that appeared on the first three pages of the original material, which suggests that students tend to rely on short sources and may fail to read to the end. That so few citations were classified as summaries -- 164 out of the 1,832 -- also indicates that many students are alighting on several different sources without spending much time reading them, then cobbling them together into what Howard called “an incomprehensible pastiche.”

There were exceptions to the rule of one citation per source, though these weren't exemplars either. In an example that drew gasps from some in the audience, about 90 percent of one page in a student's research paper was either a direct quote or patchwriting -- and 9 of its 17 citations referred to the same page of the same source: a single entry on WebMD. While the paper was an extreme and atypical example, it also demonstrated a common trend: students tended to rely heavily on their sources -- so heavily, in fact, that students rarely seem to fully own the material and marshal it to form a novel argument, the researchers said.

“The compelling, unnerving issue is that the student has nothing to say,” said Howard of the piece that drew so heavily on WebMD. “How could she, since she's writing a research document from reference materials?”

Several audience members, and the researchers themselves, grappled with the pedagogical implications of the findings. Jamieson wondered whether the long-held standards for research papers, which were articulated in 1959 in the *Writer's Guide and Index to English* by Porter Perrin and Karl W. Dykema -- that students should read and digest material so they can talk about the subject before writing about it (they called it “part of the morality of writing”) -- still apply in today's world.

The idea that summarizing should be the goal of most citations may have held in a different era, said Jamieson, “before the Internet culture of Tweeting and sampling, in which all the rules have changed -- aside from ours.”

“Whatever else the Internet has done," Jamieson continued, "it has made it easier to find sources and harder to tell what's junk.”

Some in the audience said the findings point to the need to place greater emphasis on teaching students how to select proper sources. “It's probably not far off to say that their sources are the first hits on Google,” one audience member observed.

Another commenter was not prepared to give up on the 20th-century expectations of student research and citation. “There's some value to reminding students about the authority on certain subjects that are not in a digital archive,” she said. “What we've forgotten is that libraries were the repositories where people made judicious claims about what sources are worth reading.”

— Dan Berrett

http://www.insidehighered.com/news/2011/04/11/study_of_first_year_students_research_papers_finds_little_evidence_they_understand_sources

**Basic, But Vital**

April 11, 2011
ATLANTA -- The annual business/town meeting at this year's Conference on College Composition and Communication (CCCC) was perhaps most notable for its speed and brevity, moving at a brisk pace through a routine 13-item agenda.
But the meeting's rather prosaic mood took a turn toward the end, when William Lalicker, professor of English at West Chester University, in Pennsylvania, took the floor to propose a "sense of the house" motion on the importance of basic writing. Lalicker is a former chair and executive board member of the Council on Basic Writing (CBW), whose members organized a hasty but energetic last-minute push to compose their motion and propose it at the business meeting.
"Be it resolved," Lalicker read aloud, "that basic writing is a vital field and its students and teacher scholars a productive force within composition; is under attack by exclusionary public policies; and therefore must be recognized publicly and supported by CCCC as a conference cluster and with featured sessions."
Basic writing, perhaps more commonly known as remedial or developmental English, is certainly less sexy, and arguably less prestigious, than many of the other subfields of composition and communication, such as theory, creative writing, and rhetoric. But, Lalicker and his CBW colleagues argued, it is not only a crucial part of composition, but a nexus of broader social issues: "Labor, justice, access and equity all come together around basic writing," Lalicker told *Inside Higher Ed.* (The relationship between basic writing and social justice is an ongoing topic of discussion among CBW members.)
But the field has been marginalized, the CBW's members say, by a confluence of ill political and social winds -- with the result that many four-year institutions no longer offer basic writing, and the two-year colleges that do don't have space (or funding) for all their would-be students. "If there's anything good about the American education system," said Lalicker, it's that, for students whose high school education didn't provide them with all the competencies they need, "there's always been the notion that you can get into a community college or a state four-year school and make it up there. And now you can't."
The pattern is one of ever-decreasing access for the students with the most need, and ever-decreasing visibility for those who teach them -- since two-year college faculty are less likely than their four-year counterparts to be able to attend meetings like the CCCC, and tend to command less attention in the public discourse, as well.
This reduced visibility is what the CBW now hopes to combat, with Saturday's sense-of-the-house motion being the first step. While basic writing has been under deliberate attack in the public policy sphere, its fading influence at the CCCC has been more a matter of neglect, said Peter Adams, a CBW executive board member and professor of English at the Community College of Baltimore County. "Basic writing isn't nearly as chichi as it was back in the '80s," Adams said, and the CCCC's "attention has gone to other -- very worthwhile -- activities."
Thus basic writing has not had, for a number of years, its own "conference cluster" -- conference clusters being the 13 or so subgroups around which the CCCC is organized, with every proposal required to fall under one of them. (Lynn Quitman Troyka, adjunct professor in the graduate program in language and literature at the City College of New York, noted that in the CCCC's 2012 call for program proposals, basic writing, which is part of the area cluster of "Teaching Writing & Rhetoric," isn't even listed as a separate category within that cluster, but is rather in the category of "Basic, first-year, advanced, [and] ESL." "Basic writing is meshed into ESL?" Troyka said, noting that the two are very distinct fields. "Come on. What's *that*?")
Basic writing has also not been the subject of any "featured session" -- one listed in the program with a separate box of at least a full page, including photographs and background information -- in some years, the CBW members said.
A cluster of its own at an annual professional conference, and maybe a page or two in the program, might seem like trivial goals for a group that sees its work as a force for justice, access and equity. But these changes would in fact have a great impact, said Seth Kahn, an associate professor of English at West Chester. "Everything that happens at these conferences is so catalyzing," Kahn said. "It's what sets the agenda for a lot of what we do ... just to have the authorizing move of saying, 'Yeah, you count,' is very important.
"The most important thing about visibility is that it helps people find you."

The CBW's motion certainly got plenty of visibility at Saturday's business meeting. After Lalicker proposed it, three other CBW members spoke in support; several more were lined up to do so when CCCC chair Gwendolyn Pough, associate professor of women's and gender studies, writing, and rhetoric at Syracuse University, who was presiding over the meeting, broke in to ask whether there was anyone who wanted to speak *against* the motion. There wasn't. So Pough put the motion to a vote; it passed, unanimously.

Upon the motion's passage, Chris Anson, CCCC assistant chair and University Distinguished Professor of English at North Carolina State University, said, "I have no objections at all to a stronger focus on basic writing, and we can work that out in the [conference] planning process." The audience responded with enthusiastic applause, and Pough moved on to the next item of business.

"I teach anywhere from two to four basic writing classes a semester," Michael Hill, an instructor in the English and world languages division at Henry Ford Community College, in Dearborn, Michigan, told *Inside Higher Ed* after the meeting. "And the real importance of this resolution today is that it's asking this community to support basic writing teachers.

"When I'm in that classroom, I need that sense of support. This organization can provide that support."

— Serena Golden

http://www.insidehighered.com/news/2011/04/11/professors_of_basic_writing_seek_more_focus_on_their_field_at_composition_conference

**Quantifying Study Abroad's Impact**

April 11, 2011
BOSTON – The Forum on Education Abroad conference, which ended Friday, featured a dizzying array of sessions on evaluating student learning overseas and the impact of the study abroad experience.
Panelists discussed the use of various standardized assessment tools, like the Intercultural Development Inventory and the Beliefs, Events and Values Inventory, and ongoing large-scale research projects, like the California Community College Student Outcomes Abroad Research Project, and the Teagle Foundation-sponsored initiative on study abroad and liberal arts learning outcomes. The latter aims to test how specific program elements -- such as program duration, housing type, and language requirements -- affect student learning.
Three associations of liberal arts colleges – the Associated Colleges of the Midwest, Great Lakes Colleges Association and Associated Colleges of the South – developed the Learning from Study Abroad survey instrument, which is designed to test eight outcomes:
***The ability to reason by developing an understanding that:***
1. Culture influences how one thinks and reasons.
2. There are differences between cultures that influence norms.
3. Without being judgmental, cultural similarities and differences can be analytically compared and contrasted.
4. Certain universals of human existence transcend cultural differences.

***Self-reflective insights that:***
5. Allow one to understand that one's culture has shaped his/her values or beliefs.
6. Allow one to continue the development of his/her personal identity (values, beliefs, goals, etc.) based on a multicultural perspective.

***A capacity for effective action, which includes:***
7. The skills to operate effectively in multicultural and intercultural situations.
8. The motivation to address issues of contemporary global concern.

The survey asks for information about demographics, previous foreign language experience, interest in and motivation for study abroad, and prior study abroad experience (including familiarity with the site of study). Students are also asked to respond to a series of hypothetical scenarios and statements designed to measure their achievement of the above learning goals. For example, students would rate whether they agreed or disagreed, on a 1-7 point scale, with the item, "I make judgments about other people's customs based on historical and political context."
The survey is administered pre- and post-study abroad, and the post-test includes the same scenarios and statements, in addition to a self-assessment section and a series of questions about program components -- location, length, language requirements, the nature of the orientation (its length, timing, content), the nature of courses, evaluation of student work, educational relationships, out-of-class interaction, housing arrangements, post-experience debriefing, etc.
John Ottenhoff, vice president of the Associated Colleges of the Midwest, said the association began to administer the online survey to all students enrolled in ACM programs last fall, but given the length of the survey and the need for a pre- and post-test, obtaining a good response rate remains a challenge.
Helena Kaufman, director of off-campus studies at Carleton College, has administered the survey to Carleton students. While she hasn't yet mined the data on intercultural learning outcomes, she has found some interesting preliminary results just in terms of demographics. Notably, 85.5 percent of Carleton students going abroad had previous international experience, and 40.6 percent had previously studied abroad.
The number-one reason for participation was to learn another language or culture, but number two had more to do with the climate at home -- the idea that study abroad was expected at Carleton. As Kaufman put it, "It's expected that at one point or another you will go." About three-quarters of Carleton students study abroad.
Outside the arena of liberal arts colleges, another major research project, discussed at the Forum conference, involves the California community colleges, and is focused in large part on academic outcomes once students return home. The California Community College Student Outcomes Abroad Research Project (CCC SOAR) is funded by a U.S. Department of Education grant, awarded to Gary Rhodes, at the Center for Global

Education at the University of California at Los Angeles, and it aims to determine the profile and academic outcomes of two-year college students who study abroad.

Other studies, including the systemwide GLOSSARI Project, in Georgia, have found higher grade point averages and graduation rates among students who study abroad, but the question is, what is the effect for community college students specifically? And, to take a step back, what are the characteristics of community college students who choose to study abroad in the first place? "We're going to have a really good understanding of who these students are," said Rosalind Latiner Raby, the director of California Colleges for International Education and co-principal investigator. "It's really an understanding we don't have now."

As Raby explains, by working with the California Community College Chancellor's Office, the researchers will be able to track measures of academic success, as well as obtain data on demographics and previous coursework, for all California community college students who studied abroad on faculty-led programs from 2002 to 2010 (on average, about 3,500 students from across the system study abroad each year, Raby said). They will also be administering a qualitative pre- and post-study abroad survey, to be piloted this summer or fall, focused on the attainment of student goals and international learning outcomes.

The final question is, what does success even mean in the context of community colleges? In the quantitative analysis, the researchers aim to consider a variety of different measures of success – GPA and transfer to and graduation from a four-year institution, but also, for example, completion of a certificate or vocational program, or persistence (such as through a remedial course sequence). "The community college mission is wide; there are so many components to it," Raby said. "We're going to be breaking it down."

— Elizabeth Redden

http://www.insidehighered.com/news/2011/04/11/scholars_document_the_learning_outcomes_produced_by_study_abroad

**Words From Wartime**

April 8, 2011
ATLANTA -- Robert M. Hazard, an assistant professor of English at the College of DuPage, outside Chicago, recently had a student named Tim who seemed, at first, to be thriving.
"He was a great student," Hazard said of the pupil who had cruised through his literature course. "He smiled and said all the right things in class."
But when Tim, who is in his 30s and came to college to earn a degree in automotive technology after serving two tours in Iraq, enrolled in Hazard's composition class, things changed, the assistant professor said here Thursday during a packed session, "Generation Vet: Composing with a New Student Population," at the annual meeting of the Conference on College Composition and Communications.
Tim stopped coming to class. Hazard, who also serves as the faculty adviser for the veterans' association at DuPage, reached out to him. He cajoled and pleaded for his student to come back to class, but it was too late: Tim had lost interest. "He just disappeared," said Hazard.
While it is almost certainly a coincidence that Tim dropped out of college at the same time he was in Hazard's composition course, the confluence nonetheless illustrates the complicated reaction that student veterans can have to classes that require them to write about their personal experiences.
For some students, it can be therapeutic to write about life-or-death incidents and emotions that few who have never seen war could understand, some speakers said. But for others (including Hazard, who, for the record, does *not* require his students to write about their personal experiences), giving such an assignment can seem intrusive. Moreover, what student veterans write can bring to the surface larger tensions between the ethos of the military and that of higher education.
More than 220,000 veterans of the wars in Afghanistan and Iraq are enrolled in colleges across the U.S. thanks to the Post 9/11 GI Bill, according to the U.S. Department of Veterans Affairs.
Many colleges are keenly aware that student veterans are coming to campuses with backgrounds and needs that differ greatly from those of their traditional peers. Hazard described how some of his students, while they were on active duty, had to pick up the body parts of their fellow soldiers who had been attacked by a car bomb so that the next of kin could bury the remains back home. "Those students are bringing those experiences into our classrooms," Harzard said. "Other students are bringing the experience of getting drunk on prom night."
To help smooth the transition from battlefield to classroom, some institutions have started veterans' associations, established special offices staffed by student veterans, held orientations geared solely to them or experimented with veterans'-only cohorts that proceed through their initial semesters as a group. Others have focused on addressing the unique administrative headaches that can confront student veterans in the admissions, financial aid and enrollment processes.
And, while many in higher education point to the valuable leadership skills, maturity and diversity of experience that veterans can bring to their campus, veterans can also face academic challenges. Research suggests that student veterans tend to enter college with weaker records of achievement in high school. When they were in high school, 11.5 percent of the students who later entered the military had A or A+ averages, which was less than half the percentage of non-veteran students who had earned those grades. Nearly 1 in 5 students who later joined the military had a C+ average or lower in high school, or more than quadruple the rate of their non-military peers, according to 2009's American Freshman Survey, which is produced by the Cooperative Institutional Research Program at the University of California at Los Angeles (and which only surveys students entering four-year institutions).
If more and more student veterans are entering college, and many of them will pass through at least one composition course on their way to graduation, it can prove tempting to help them succeed by trying to make course work relevant -- and by encouraging students to write what they know.
For Sandra Jang, an instructor at the U.S. Military Academy Prep School, in Fort Monmouth, N.J., having her students write what they know has proven to be positive. Her students attend West Point Prep, as it's known, to beef up their grades in order to gain acceptance to West Point. Many, but not all, of her students have seen active combat, she said. Those who have fought bring with them a hunger to learn, she said, an impatience with their fellow students' complaints, and a willingness to read the essays of Montaigne and Bacon.

"You can definitely see the maturity and human experience really being exposed," Jang said of their writing. "These guys have a lot to say and what they have to say is pretty deep. They're writing about tagging bodies and attending funerals."

A sampling of her students' writing included just a few pieces that dealt directly with their time on active duty. But those that did might be arresting to the uninitiated composition teacher.

"He can joke around with the best of us, but the minute it is time to work his face turns to stone and he is all business," one of her students, Alex Brammer, wrote in describing a first sergeant who led him in battle in Tikrit. "On target he is an efficient killing machine, executing his duties with a calm fury and directing the tempo of the battle with the finesse of a choir conductor. With a quick bark he gives commands in a tone that sends chills down the most hardened killer's back."

Writing frankly about combat and killing has proven vexing on campuses in which the military culture is not as firmly rooted as it is at West Point Prep. In November, Charles Whittington, a veteran of the Iraq War who attended the Community College of Baltimore County, was barred from class and forced to submit to a psychological evaluation after writing an essay describing the rush he felt from killing enemy soldiers. He didn't return to the college.

Whittington's experience became the subject of a lesson thousands of miles away, in the class of Lisa Langstraat, associate professor of English at Colorado State University. They read his essay, "War is a Drug," and discussed whether veterans should be made to write about their experiences in battle.

Responses split down the middle, she said, with some saying they shouldn't be forced to write about it if they don't want to, while others at least wanted the opportunity. Others said that the task of writing about battle provided them with the first opportunity to talk about their experiences, and that it had proven therapeutic.

Still, some in the audience warned -- and many on the panel agreed -- that a certain degree of caution is in order when asking students, not just veterans, to delve into their painful memories. "English teachers are not psychologists or priests," one audience member observed. "We sometimes have a voyeuristic motive in this."

Langstraat's experience also demonstrates how difficult it can be to assign the right kind of writing to veterans. Assigned to teach a class made up entirely of veterans (the majority of whom were just four months removed from combat), Langstraat said she pitched her students the idea of writing a campus handbook geared especially to their fellow veterans.

To her surprise, they balked. "How can it be that these guys, who found so much solace in a community of fellow veterans, were resistant to opening up to other veterans?" she asked.

— Dan Berrett

http://www.insidehighered.com/news/2011/04/08/veterans_in_college_have_vexed_relationship_to_writing_assignments

**Heading for a Crash?**

April 8, 2011
ARLINGTON, Va. — Maybe what the liberal arts needed was a full-blown depression.
"A couple of years ago I had great hope, because of the externality of the economic situation," Martin Ringle, the chief technology officer at Reed College, told a room full of fellow audience members at a summit of the National Institute for Technology in Liberal Education (NITLE) on Thursday.
"I was really hoping, contrary to all of my better judgment, that things would really go into the toilet," Ringle continued. "Because if we didn't stop at recession -- if we went all the way down to depression -- maybe that would be enough for the economic forces to require us to change."

That is how bad it had gotten in the liberal arts, an area of higher education whose business model has outgrown its viability, according to many conference attendees.
"Our business model is built on all kinds of assumptions that don't hold anymore," said Richard Holmgren, associate dean and CIO at Allegheny College. "Over the last 40 years of the last century, we built a model based on the assumption that net revenues per student would go up every year.…We have a culture built on that assumption," Holmgren said. "Over the last 10 years, we've been struggling because net revenues have been flat."
None of the participants in the daylong business-model workshop that followed seemed to dispute the basic premise that liberal arts programs are plagued by twin threats of inertia and economic unsustainability. To make matters even more grim, one self-described envoy of "the corporate world" -- Kit Stinson, a vice president at the telecommunication giant Avaya -- spoke up early on in the conference to testify against the truism that liberal arts graduates make for more creative and critical-thinking workers, setting off a parallel discussion about whether today's incarnation of liberal education, sacrosanct to many, actually increases students' employability outside academe.
The business model workshop, one of four breakout sessions at the conference, sought to explore how liberal arts institutions might change their infrastructure to adapt to economic realities without sacrificing the ideals that infrastructure was originally erected to support.
The participants -- most of whom were from small, private residential colleges -- seemed to agree that a major impediment to change was the attitude of faculty, who form a powerful bloc at such institutions.
Liberal arts colleges have erred in insulating professors from the business side of running the college, said Ringle. In order for shared governance to work, administrators and faculty need to have a "shared understanding" of a college's yearly struggle to sustain its lofty mission in the face of unsympathetic economic realities, he said.
Eugene Tobin, a program officer at the Andrew W. Mellon Foundation and former president of Hamilton College, agreed that faculty members tend to hold relatively unsophisticated views of the business of higher education until their children begin applying to college. (If there were any current faculty present at the workshop, they did not speak up to defend themselves.) Tobin, who was a longtime professor at Hamilton before crossing over into administration, suggested that colleges -- possibly with foundation support -- develop primers or seminars designed to help faculty more fully appreciate the balancing act inherent in managing the college's finances.
Whether by seminars or some other means, liberal arts colleges need to convince faculty members that they need help to figure out how to bring down the costs of delivering small-scale, high-touch liberal education, said Holmgren, the Allegheny CIO. That means getting together and discussing, "in real, concrete terms," what constitutes the value of liberal arts education for the students who pay top dollar for it.
"We all say we deliver the best education," Holmgren said. "But sit down with three faculty in a room and have them define 'best.' They teach writing and argument; the first thing you have to do when writing an evaluative argument is define your criteria … for what makes the 'best education.' And you can't get three of them to agree on what those criteria are."
Once colleges and their faculties can successfully lay down a set of criteria for what makes a great liberal arts education, they can start figuring out what parts of the institutional infrastructure are load-bearing and which ones are not and begin remodeling from there, Holmgren said.

And although some of the workshop participants bristled at the idea of students as "customers," the Allegheny CIO noted that colleges would be wise to find out the criteria students and their parents are using as well. "We can't assume that we somehow have this vision of the world and we can just tell people it's true and they'll believe us," Holmgren said. "You have to be willing to give up a little bit to have that conversation."

Even if administrators and faculty get that far, any change is bound to be gradual, said Ringle. For example, if the bean-counters manage to persuade professors that the tenure system currently costs more than it is worth, it is still unlikely that tenured faculty would relinquish their privileges in the name of some "grand experiment," he said. However, they might assent to a long-term plan that would eliminate certain tenure privileges for later generations. "The problem is, maybe the world isn't going to wait a century for this to happen," Ringle said.

Professors do not bear all the blame for inertia in the liberal arts business model, the NITLE discussants agreed. Administrators who fear that radical changes might harm their *U.S. News and World Report* rank, and hamper their institutions' ability to lure students who can pay full tuition, are just as culpable, they said.

It does not help, several of them noted, that those colleges that have bucked the norm on curriculum, such as Goddard College and Hampshire College, or tenure policy, such as Warren Wilson College, are considered too lightweight to disrupt the "arms race."

For an event sponsored by a technology group, the business model workshop included minimal discussion of technology. Perhaps that is because, in the context of liberal arts colleges, technology is rarely deployed as a tool to cut costs, Ringle said. "I have yet to see one institution in this sector bring in a technology that has made a dramatic difference in their budget," said the Reed CIO, who moonlights as a consultant for other liberal arts colleges.

Or maybe it is because the key to solving the problems with the liberal arts business model has less to do with servers and networks and more to do with hearts and minds, said Tracy Mitrano, director of I.T. policy at Cornell University. "Technology," Mitrano said, "will never be the thing that is going to bring about the change we're talking about."

*For the latest technology news and opinion from Inside Higher Ed, follow @IHEtech on Twitter.*

— Steve Kolowich

http://www.insidehighered.com/news/2011/04/08/college_technology_experts_discuss_broken_business_model_in_liberal_arts

**Gates Goes Open**

April 7, 2011
Proprietary in his beta phase, Bill Gates 2.0 is all about sharing the wealth. And he is asking his latest crop of higher ed benefactors to do likewise.
Next Generation Learning Challenges, or NGLC -- a grant program run by Educause and fueled mostly by the Bill & Melinda Gates Foundation -- gave the bulk of its first round of "challenge grants" to university-led projects aimed at either increasing access to college degree programs or supplying free, top-flight online learning materials to colleges that could not otherwise afford them.
About half of NGLC's $10.4-million pie went to seven applicants tagged as "open core courseware" projects, which include institutions involved in lowering barriers to college degrees as well as university-based efforts to develop high-quality course modules for institutions working with underprepared students and scant resources, so as to usher more students through to graduation. NGLC gave each of the "open core courseware" projects $750,000 -- three times as much as it gave any other type of project.
Netting the second largest piece of the pie were the nine "blended learning" projects, many of which also focus on broadening access to online courses and course materials. The "learner analytics" category had six winners, and the "deeper learning and engagement" category had seven. With one exception, each winner in these categories got $250,000.
Ira Fuchs, the executive director of NGLC, told *Inside Higher Ed* that the distinctions were sometimes arbitrary, given how many of the winning projects could fall in more than one category. Some -- such as Carnegie Mellon's Open Learning Initiative -- fit the criteria of all four. But projects heavy on the development of open courses got more money than the others because building quality courses costs a lot, Fuchs said.
The University of California, one of the open core courseware grant winners, plans to use its $750,000 to bolster a current effort to develop 50 credit-bearing online courses designed to bridge the gap between community colleges and four-year degree programs in California. That university system, which is facing $500 million or more in budget cuts, has talked about expanding its online offerings in order to close an expected "enrollment gap" that could soon force the system to shut out qualified students.
Like the other winning projects, the University of California effort was already under way. More than to jumpstart new ideas, the objective of the grants was to draw out existing projects that have smart plans for increasing college completion and give a boost to those that are most likely to go viral, Fuchs said. For example, as a condition of taking the NGLC money, California had to promise to make its courses openly available once they are built.
One of the goals of the NGLC grants is to eliminate the bias at many colleges against using courses and technology that they did not invent themselves, said Fuchs. The winning projects represent innovations that Gates and the other sponsors think will not only get students into college and out with a degree, but will also be adopted by many different institutions, he said. Hence the emphasis on "open" projects.
Perhaps in part because of this emphasis on openness, NGLC says that very few of the 600 applications it fielded last fall came from for-profit companies. While some commercial technology vendors stand to benefit from the grants by virtue of their contracts with the winning colleges, only one for-profit company managed to win a full grant all for itself.
Inquus, a software company, will get $250,000 from NGLC for a project it says will make existing open educational resources, such as MIT OpenCourseWare, more valuable to users. Its plan is to build out to do this by building out a courseware-oriented social network that "enable[s] students to connect, collaborate, mentor, and study together" around otherwise static syllabuses, worksheets, and instructional texts, the company says.
Inquus's theory is that even if people cannot earn degrees by using open courseware outside of a university setting, they will at least learn more if they are able to discuss the materials with other users as though they were members of a virtual classroom. "Online courseware alone does not offer a supportive learning experience or the engagement and motivation needed for retention and effective learning," Inquus said in its proposal. The company says it hopes to pick up as clients the various universities that use open courseware, and triple its current 30,000-student user base on the strength of its challenge grant.
A full list of the grant winners in each category is available on the NGLC website.

NGLC plans to "double down" on the most successful projects eventually, although Fuchs said there is currently no plan for how many of the projects will get a second infusion of grant money. But he said the program will favor those projects that can prove they can get a lot of colleges to adopt them and continue to demonstrate effectiveness at scale. For such projects, NGLC has another $10 million of Bill Gates's money in its other pocket.

*For the latest technology news and opinion from Inside Higher Ed, follow @IHEtech on Twitter.*

— Steve Kolowich

http://www.insidehighered.com/news/2011/04/07/gates_foundation_announces_higher_education_technology_grant_winners

**Retrieving the Dream**

April 6, 2011
Champions of Achieving the Dream, a nationwide initiative designed to boost the academic success of community college students, received some humbling news last month, when an independent evaluation revealed that overall trends in student outcomes at the first 26 institutions to join the effort remained relatively unchanged after five years, despite the use of a variety of strategies to improve them. The critical appraisal also suggested that the participating institutions need to do more to involve adjunct and full-time faculty in their efforts, concentrate more on teaching and learning in the classroom, learn to scale up promising strategies to reach more students, and help institutions that have "very weak data capacity" assess their work.
In response to the critique, Achieving the Dream is releasing a series of guides and workshops designed to "provide a framework, principles and practices" to help community colleges overcome the four major challenges to reform identified in the recent evaluation. Last week, it released a publication and held a national workshop to discuss how its institutions can work to engage more adjunct and full-time faculty in their student success-driven initiatives. Though Achieving the Dream officials admit that their new suggestions may not engage many more professors overnight or win over the persistent skeptics among their ranks, they argue that they are learning from their project's "struggles" and are more cognizant than ever that "moving the needle" is hard work.
"When we saw that [the evaluation] was pointing out weakness of our round-one colleges that we're still dealing with after four and five years, that definitely caught our attention," Carol Lincoln, senior vice president of Achieving the Dream, said of last month's evaluation by MDRC, a nonprofit education and social policy research organization. "Still, those things that it identified don't sound to us like those are exclusively Achieving the Dream college challenges; they are problems all community colleges face. So we decided, 'Let's use this moment to call attention to those big challenges.' "
The MDRC report suggested that participating institutions should seek more involvement from their faculty and staff members. "Given the primary role that faculty and staff play in teaching and supporting students' learning, the initiative should focus more attention on directly engaging these personnel as leaders in the colleges' reform process," reads the report, asserting that many participating institutions have not made enough effort to involve adjunct faculty in their efforts. This goal is especially important, it argues, since many of these faculty members teach remedial coursework that enrolls high-risk students.
"The report wasn't saying that there aren't stories of ways to engage faculty," Lincoln said. "It was just saying that the faculty that are being engaged in Achieving the Dream are the ones closest to the initiatives. But, when you look across out campuses, you won't see a lot of faculty in other disciplines involved. We had the vision that this would spread to all faculty writ large, but we're still trying to figure out, 'How do you get all faculty involved?' "
The new publication offers a few broad themes for institutions to consider. It suggests that administrators should come to full- and part-time faculty "with questions, not answers," and view them as "expert resources" for improving student success. To develop "transparency and trust in the data" used in the project, it recommends taking time to show faculty how data are collected and analyzed. Further, it notes that administrators should offer faculty professional development opportunities in areas like data analysis or reward them for their involvement in projects with release time and stipends.
To encourage long-term change, the publication recommends establishing the "expectation for faculty involvement in student success initiatives" at the hiring stage for both full-timers and adjuncts. It also suggests that formal dialogues should be established between groups that often are at odds with one another, such as development and general education, and full-time and adjunct faculty.
The publication identifies a few Achieving the Dream institutions that are already doing a good job of engaging faculty members. Sinclair Community College, in Ohio, took its faculty and staff on a "data retreat" to look at student success data together. It also gathered quantitative and qualitative information from professors and students in developmental math courses to use to improve the courses in later years. Meanwhile, Houston Community College, in Texas, and Valencia Community College, in Florida, hold large meetings with all faculty and staff members annually to discuss their Achieving the Dream goals and strategies.

Luzelma Canales, director of grant development at South Texas College, noted that her institution has always had a faculty-led process for all Achieving the Dream related changes, such as those in advising, assessment, placement, matriculation and student accountability. She said that her institution's faculty was able to successfully push for a program to train all faculty members in advising. Since 2006, more than 400 faculty members have completed at least one level of advising training.

"You can't look at student success without fully engaging faculty," said Canales, admitting there will always be some faculty who don't buy into projects like this. "We've had a bottom-up approach to this at our college…. The advice I give to colleges is that you have to, literally, find your champions amid the faculty. There are folks who will champion this and make it their own out there. The biggest road bump we have is for us not to become complacent."

Lincoln, for one, is optimistic that the lessons Achieving the Dream institutions have learned so far are making a difference in "moving the needle" in measurable ways, such as graduation and retention rates. She acknowledged that Achieving the Dream will have to work on better ways to measure the success of its growing list of member institutions. She noted that last month's report from MDRC on the first cohort of institutions to join the project was mainly pushed by the Lumina Foundation for Education, which predominately funded this first cohort.

"One of the limitations of that report is that it just looked at the first cohort," Lincoln said. "People are starting at a quite different spot with Achieving the Dream now than they were before. We've learned. We see the struggles of having a highly targeted pilot and trying to grow it from there. Newer generations of colleges are jumping to scale and not messing around as much at the pilot phase. That's our expectation for our newer colleges."

Further Achieving the Dream publications and workshops for how to address the other challenges identified by last month's MDRC report are planned for later this spring and summer. The next topic is scheduled to be how to bring strategies to scale.

— David Moltz

http://www.insidehighered.com/news/2011/04/062/achieving_the_dream_regroups_after_critical_evaluation

**The Enduring Gender Gap in Pay**

April 5, 2011

The gender gap in faculty pay cannot be explained completely by the long careers of male faculty members, the relative productivity of faculty members, or where male and female faculty members tend to work -- even if those and other factors are part of the picture, according to research being released this week at the annual meeting of the American Education Research Association.

When all such factors are accounted for, women earn on average 6.9 percent less than do men in similar situations in higher education, says the paper, by Laura Meyers, a doctoral candidate at the University of Washington. The finding could be significant because many colleges have explained gender gaps by pointing out that the senior ranks of the professoriate are still dominated by people who were rising through the ranks in periods of overt sexism and so are lopsidedly male, or that men are more likely than women to teach in certain fields that pay especially well.

Meyers found not only that gender-neutral characteristics do not explain away the gaps, but also that they may play out in some ways that benefit men more than women when it comes to faculty salaries -- even for women who are on similar career trajectories to men. A few other studies, praised by some and doubted by others, have also found pay gaps after adjusting for a range of factors -- and the Meyers work may add credence to them as well.

Meyers based her research on the 2004 National Study of Postsecondary Faculty, which includes extensive data on faculty members at two-year and four-year, public and private (nonprofit) colleges. Of all the faculty members in the survey, women earn an average full-time salary of $56,100, more than 18 percent less than the male average of $68,900.

Some of that gap is explained, Meyers notes, by the sorts of factors that have been used in the past to explain disparities. But her paper notes a variety of situations where men and women do not appear to fare the same financially -- even with comparable levels of experience, institutional homes and disciplines.

For instance, part of the gap is explained by women being more likely than are men to teach at institutions that value teaching over research -- and pay favors those at research universities. But women gain less of a pay bump than do men for working at research universities, even when controlling for other factors, Meyers found. This leaves women "essentially at a loss when trying to improve their salary through research orientated positions," she writes.

Some of the paper explores the applicability of "comparable worth" theory to academic jobs. That theory holds that some jobs are devalued precisely because women hold them, not because they requires fewer skills or less experience than do comparable jobs that tend to be held by men. Here, Meyers found "a significant and negative connection" between increases in the percentages of a discipline's faculty members who are women, and salary relative to other disciplines. (While the paper cites these and other trends as evidence that comparable worth theory may well apply, it cautions against expectations of applying the theory in lawsuits over salary gaps.)

By using information in the database about how faculty members use their time, Meyers also suggests that some activities that both men and women perform seem to have different results. For instance, men who spend significant time on professional service activities that are not based at their institution (say, working with a disciplinary group) do not see any negative impact on their salaries. Women, however, see a consistent, negative impact on their salaries from similar contributions to their professions.

Meyers argues in the paper that the presence of unexplained pay gaps by gender -- and of differential treatment of men and women who make similar choices about their careers -- should be cause for concern. "Understanding and responding to gender wage gaps in the academy is critical for policymakers who are interested in ensuring that all faculty members are compensated in an equitable manner," she writes. "That fact that female faculty continue to experience a wage gap even after controlling for disciplinary and institutional characteristics, individual factors, human capital, principal activity and demographic factors is problematic. Faculty members should not be paid differently based on their gender."

— Scott Jaschik

http://www.insidehighered.com/news/2011/04/052/the_enduring_gender_gap_in_faculty_pay

**Clean Stoves for the Third World**

**Millions of people worldwide die every year because of primitive cooking stoves. Around the globe, helpers ranging from Hillary Clinton to African entrepreneurs are making inroads.**

By John Greenya

*Ghana's Toyola Energy in its first three years sold 64,000 stoves — and offset more than 44,000 tons of carbon dioxide. (Toyola Energy Ltd)*

When the United Nations, Hillary Clinton and Glenn Beck are exercised over the same idea, something must be cooking. Bad pun aside, that's what it is — cook stoves for the Third World that protect life, health and the environment, while answering the age-old question of what's for dinner.

In September, the U.N. General Assembly kicked off the Global Alliance for Clean Cookstoves, a part of the Clinton Global Initiative promoted by the U.N. Foundation. As for Beck, the Fox News Channel talk show host who is neither for nor against the stoves, he sees Clinton's spending $50 million on promotion and production as part of an elitist plot to redistribute the world's wealth.

Back to the stoves. According to the U.N. News Centre, this action, backed by U.N. Environment Programme, "holds the promise of saving lives, uplifting health, improving regional environments, reducing deforestation, empowering local entrepreneurs, speeding development, and helping to stem global climate change" by dramatically boosting the efficiency of "some 3 billion cook stoves across Africa, Asia and Latin America."

The reduction in global deforestation would be a result of felling fewer trees for the wood and other biomass used in the Third World's primitive cook stoves. The environment would also benefit in other ways. Research conducted by the Atmospheric Brown Cloud Project, also UNEP-supported, indicates that black carbon — a suspected villain in the accelerating melting rates of glaciers in mountain ranges like the Himalayas — could account for 10 to 40 percent of climate change.

The biggest threat from primitive stoves is to humans. In addition to killing almost 2 million people annually, it is estimated that constant exposure, especially that of women and young children, to smoke from poorly ventilated areas causes non-fatal, or at least not as quickly fatal, illnesses such as cancer, tuberculosis, pneumonia, asthma and lung and eye diseases.

In sharp contrast to the life and environment-threatening damages of wood and carbon burning cook stoves, their clean cousins run on the energy from plants and materials derived from plants (biomass), gas, or solar

power. The new-generation clean stoves also create room for local small businesses to develop and market the products. Ghana's Toyola Energy, for example, in its first three years sold 64,000 stoves — and offset more than 44,000 tons of carbon dioxide.

Just as Secretary Clinton's initiative is not brand new — it builds on existing national projects in India and Peru, to cite two examples, and is directly related to individual efforts like those of 29-year-old Peter Thuo in Kenya — the clean stove concept is itself an old one.

In the 18th century, Swiss physicist Horace de Saussure invented a "hot box" that used the rays of the sun to heat water to 228 degrees F. And in the next century, while on an expedition in South Africa, English astronomer John Herschel used a similarly constructed device to cook his meals. As John Perlin noted in an earlier Miller-McCune article, a cardboard version of this solar stove won the Financial Times Climate Challenge in 2009.

While today's clean stoves may serve the same function as the hot box of yesteryear, any resemblance ends there. Available in a variety of sizes, shapes and colors, they come in five different types: natural draft rocket stoves; fan stoves; semi-gasifier stoves; natural draft top lighting stoves; and institutional stoves.

Proponents of the new clean stove concept also represent a wide variety of interested parties. In 2010, super chef José Andrés, a firm believer in the principle of teaching people to fish rather than giving them a fish, made several trips to beleaguered Haiti to peach the gospel of solar-powered stoves.

"The kitchens, called parabolic, look like metal beach umbrellas," Andres explains. "A rack in the middle holds a large pot. I showed the village women how to direct the concave panels toward the sun and harness the energy required for long, continuous heat."

Given that Haiti, besides recovering from the devastating 2010 earthquake, is almost totally deforested, the attraction of the solar stove is magnified. As the U.N. put it, "Less than 2 percent of the Haiti's original forest cover still exists. One major reason is Haiti's dependence on wood and charcoal for cooking. Improved stoves, training and education can help alleviate this domino-effect problem."

The Global Alliance for Clean Cookstoves hopes to put new, clean stoves in 100 million homes. When Clinton announced the Alliance in September, she said, "Today, because of technological breakthroughs, new carbon financing tools and growing private sector engagement, we can finally envision a future in which open fires and dirty stoves are replaced by clean, efficient and affordable stoves and fuels all over the world — stoves that still cost as little as $25."

"The next time you sit down with your family to eat, take a moment to imagine the smell of the smoke, feel it in your lungs, see the soot building up on the walls. Then come find us at the Global Alliance for Clean Cookstoves."

http://www.miller-mccune.com/environment/clean-stoves-for-the-third-world-29745/?utm_source=Newsletter155&utm_medium=email&utm_content=0405&utm_campaign=newsletters

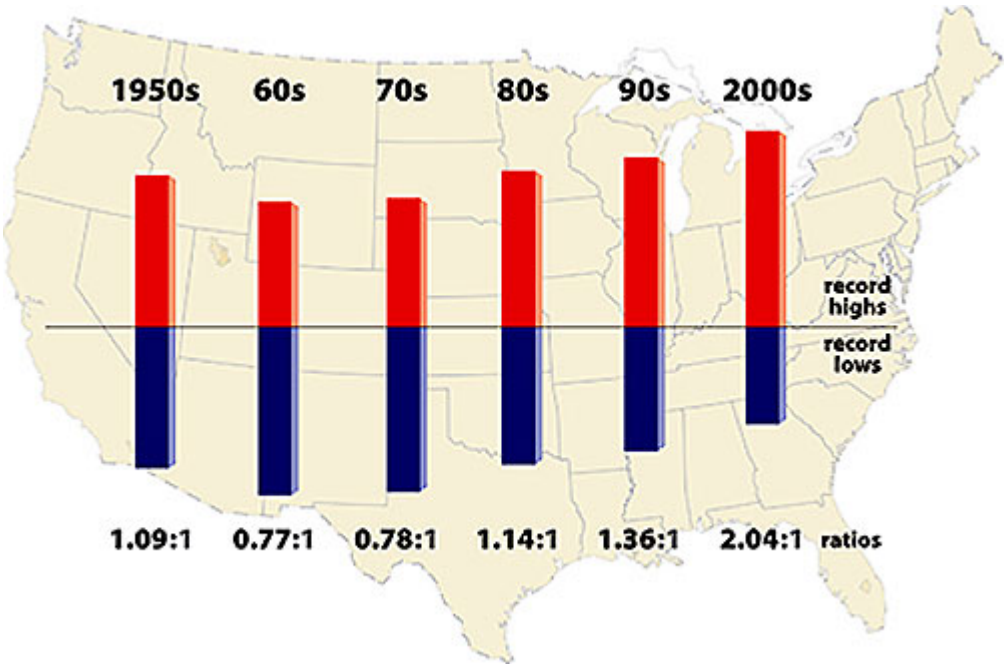
**Crazy Weather and Climate: Do Dots Connect?**

**In an interview with Miller-McCune.com, meteorologist Kevin Trenberth examines the world's recently wacky weather and whether it's a sign of climate change or just routine variability.**
By Bruce Dorminey

*Australia's recent flooding can be seen in this NASA image. IPCC meteorologist Kevin Trenberth answers questions about the world's recently wacky weather and its connection to climate change. (NASA Goddard Photo)*

At the end of one of the Northern Hemisphere's wildest winters in memory, we thought it would be a good time to ask a climatologist what's up with such extreme weather. Even, Australia's normally calm summer has been anything but: First there was drought, then typhoons and then floods of biblical proportions.
Granted, such extreme weather has been exacerbated both by recent El Niños (warmer-than-normal sea surface temperatures) and La Niñas (colder-than-normal sea surface temperatures) in the equatorial Pacific. But it does give pause to wonder: Is this global warming on steroids, or are we merely seeing natural cyclical weather variations?
For answers, we turned to Kevin Trenberth, head of the Climate Analysis Section at the National Center for Atmospheric Research in Boulder, Colo. The climatologist, a leading member on the Intergovernmental Panel on Climate Change, shared the Nobel Peace Prize in 2007 when it was awarded to the IPCC.
He recently addressed this strange weather in a question-and-answer session with Miller-McCune.com.
***Miller-McCune:*** What's causing the sudden winter weather extremes we've seen both here in the U.S. and in northern Europe over the last two winters, as well as in Australia?
**Kevin Trenberth:** Natural variability plays a major role along with human-induced climate change. There have been strong El Niño to La Niña transitions and natural modes of variability, such as the North Atlantic Oscillation, that have played major roles. During the latter part of El Niño and the following five months, heat comes out of the ocean and contributes to warming and is working in the same direction as global warming from humans. The result has been record-breaking sea surface temperatures and thus moisture in the atmosphere.
***M-M:*** Is this related to a more southerly trajectory of the Northern Hemisphere's jetstream?

**KT:** That's correct. It is related to the negative phase of the NAO, which allows cold polar outbreaks to occur more readily. The NAO largely varies through natural processes on weekly, monthly or even longer timescales.
***M-M:*** Does this negative phase of the NAO allow colder air to come to more southerly latitudes?
**KT:** In the negative phase, the westerlies [anti-trade winds] across the North Atlantic are weaker than normal and the cold air over the Arctic can flow more readily into lower latitudes and vice versa. In particular, there are often cold outbreaks over Europe with high temperatures over northeastern Canada and Greenland. That was the case in early January.
***M-M:*** What's causing the NAO's negative phase?
**KT:** That's largely a natural variability, relating to interactions between individual storms and the overall westerlies in the atmosphere. There is a region of stronger westerlies in the positive in the NAO's positive phase and weaker westerlies in the NAO's negative phase.
***M-M:*** Does climate change or global warming exacerbate these NAOs?
**KT:** That's a $64,000 question. In general, under global climate change, it's suspected that the NAO becomes a little more positive. But in the last two years, it's become quite negative, and so the speculation is about whether the negative phase is in any way related to the decrease in Arctic sea ice.
***M-M:*** Are these current weather events anomalous?




Temperature gradients for the U.S. over the last 50 years. By the first decade of the 21st century, record-breaking hot temperatures were running at more than a 2-to-1 ratio to record-breaking cold temperatures. (Meehl et al 2009; National Center for Atmospheric Research)
**KT:** One measure of how anomalous things are is whether you're breaking records. There have been more record-breaking events than expected. In the U.S., for instance, the number of high temperature events has more than doubled [in the first decade of the 21st century]. What's happened is that the ratio of record-breaking hot events to cold events is about 2 to 1.
***M-M:*** At what point would you be concerned about the freak weather signaling something truly deleterious about our climate?
**KT:** I already am. Natural variability is going on all the time and the biggest effects are from the El Niño. Between May 2009 and May 2010, we had quite a strong El Niño. When the mini-global warming from El Niño is added on, we really start to break records when the heat starts coming out of the ocean, as in July of last year. There was record-breaking flooding in China and India and then in August in Pakistan. Last

September was the wettest on record in Australia. Then there was record-breaking flooding in Queensland, Australia, from December 2010 into January 2011. Those events were associated with quite high sea surface temperatures in the Indian Ocean and were partly a consequence of the El Niño and the change in ocean circulation. The residual effects of the El Niño meant there was extra evaporation and extra moisture available for the monsoons — first in Asia and subsequently in Australia.

***M-M:*** Have these El Niños become more pronounced due to global warming?

**KT:** We have records of El Niño going back some 150 years, and there was a change in how it evolved starting somewhere around 1976. Today, the impacts of El Niño due to the floods and droughts around the world are certainly bigger. So while there are floods in South Asia and Australia, there are droughts in Africa and Peru and Equador. During El Niño, it tends to be wetter across the southern U.S. and drier in the north.

***M-M:*** So, climate change really manifests itself with more weather extremes?

**KT:** Because water vapor in the atmosphere acts as a fuel for weather systems, the weather systems can get stronger. We can get heavier rains out of it. The two-day rains last May in Nashville, Tenn., were astounding. As for snow, if it's a bit warmer but still below freezing, you can actually get more snow, as with some of the East Coast snow storms. Because there's more moisture in the atmosphere, it gets dumped down in the form of snow instead of rain.

***M-M:*** And you're saying there's more moisture in the air because globally the air is warmer?

**KT:** That's correct — in particular over the oceans. The main hydrological source of moisture is the oceans. The fact that sea temperatures are half to one degree centigrade above what they were 30 years ago is enough to bolster the snow amounts by at least 10 percent, if not more.

***M-M:*** Are you at all wary of interpreting extreme weather events as evidence for longer-term climate change?

**KT:** Yes, but it is the main way climate change is expressed.

***M-M:*** How effective is comparative paleo-climatology, in other words, the study of ice cores and historical records, in helping your group understand the current climate?

**KT:** It helps, but the paleo data have large uncertainties and require careful interpretation. There's an infinite variety in weather, and some of it occurs on relatively long timescales. The thing that is most clear is the increasing temperatures. Along with that, there's more water vapor in the atmosphere. Beyond that, we can look to sea levels rising, Arctic sea ice and glaciers melting. All this is consistent with this warming. There's also pretty good evidence that when it rains, it rains harder than it used to especially across the U.S. That's due to anthropogenic climate change, and that's only going to get bigger.

***M-M:*** Is the climate definitely changing?

**KT:** The climate is continuing to change. One way change is manifested is through these extreme events. These are the ones that impact ecosystems and society. But because they are extreme, they are relatively rare and statistics on them are not good, but they are consistent with climate change. Because of that warming, there's more water vapor in the atmosphere.

***M-M:*** What's needed in terms of resources or technology to improve long-term climate models?

**KT:** Warming has been well verified, but the models have major limitations, and regional climate is not very predictable. So, we need better observations and treatment of them. This includes assimilation of the data and its analysis into global gridded fields. The models also need to be improved.

***M-M:*** What can we expect in the next couple of years?

**KT:** Because these extreme events lie outside what has been planned for, things like water systems and dikes and dams can be broken, as [seen] with Hurricane Katrina. The rains now are heavier than they used to be, so levees along the Mississippi and in California have also been breached. I expect that we will continue to see things we've never seen before.

http://www.miller-mccune.com/environment/crazy-weather-and-climate-do-dots-connect-30059/

**As Environment Degrades, Our Well-Being Grows?**

**The environment is faltering even as measurements show human well-being is improving. How long can that last?**

By Arnie Cooper

*Though it seems counterintuitive, one researcher says metrics show that in spite of environmental degradation, human well-being remains high. (LordRunar / istockphoto.com)*

Earth's ecosystems are steadily deteriorating thanks to unsustainable practices like overfishing, rainforest clearing and natural gas "fracking." So, wouldn't it follow that human beings around the globe are getting sicker, poorer and less satisfied with their lives?

Not so, according to Ciara Raudsepp-Hearne, an environmental consultant and part-time lecturer at Montreal's McGill University. In "Untangling the Environmentalist's Paradox: Why Is Human Well-being Increasing as Ecosystem Services Degrade," published i n the September issue of *BioScience*, Raudsepp-Hearne and colleagues found that global decreases in ecosystem services like carbon sequestration, water purification and photosynthesis coincided with an unexpected improvement in a wide variety of human progress criteria.

Of course, global trends may not show up everywhere. As *BioScience*'s editor wrote in a letter accompanying the issue with Raudsepp-Hearne's paper, "Aggregate global human well-being is, apparently, growing — though it is obviously declining in some places."

Raudsepp-Hearne began the project after working on the 2005 Millennium Ecosystems Assessment. Sifting through the results, she realized that the information had not been fully analyzed. "There were thousands of pages of great findings," she says, "but we hadn't really come to a major conclusion about the relationship between ecosystem services and well-being."

A closer look revealed that the key indexes of human development — education, health, water, sanitation and even happiness factors — were increasing around the globe. And, says Raudsepp-Hearne, the latest United Nations Human Development Report, published in late October, substantiated the environmental paradox her team uncovered.

Evaluating the intermingling of human advancement and the environment cannot be addressed through a single explanation, so Raudsepp-Hearne focused on four hypotheses:

1. Well-being was simply measured incorrectly. "Of all the global data sets available today, not one supports the hypothesis that human well-being is actually decreasing," she says. "People's gut reaction is that it's not

possible; of course human well-being is decreasing." And though she says global security and the mounting occurrence of natural disasters have raised some concerns, these aren't significant enough to cancel out the overwhelming evidence presented by surveys like the Human Development Index. Raudsepp-Hearne and colleagues reject this hypothesis outright.

2. Well-being depends on food services, which happen to be increasing. For Raudsepp-Hearne, of all the ecosystem services, food production is so important for human well-being that it effectively compensates for any decline in other services. The authors point to a study showing that when small areas of coastal mangrove forests are converted to shrimp farming there's a net benefit — although there is a dampening effect once a certain threshold is crossed. "I wouldn't say the food hypothesis is the one we feel most strongly about," says Raudsepp-Hearne, "it's just that we think food systems is where one of the frontiers of research should be."

3. Technology has "decoupled" well-being from nature. In other words, thanks to innovation, humanity has grown less dependent on ecosystems. As Raudsepp-Hearne wrote: "Improvements in energy-use efficiency, transportation, logistics and preservation have enhanced the benefits that people can gain from ecosystem processes. Perhaps one of the clearest examples of this progress is humanity's rising ability to grow more food on smaller amounts of land." Even so, the authors go on to explain that despite increasing efficiency, the "decoupling" is partial at best.

4. There's a time lag in the deterioration of ecosystem services. Indeed, things may appear rosy now, but our future could very well become grim once we begin to experience the impacts of human-caused transformations of the ecosystem. However, as the authors wrote, "…uncertainty about the duration, strength, and generality of this lag prevents us from providing strong support for this hypothesis."

Raudsepp-Hearne is not downplaying the effects of environmental degradation. But when the study first appeared, she says people read the first paragraph and reacted strongly, saying, for example, "human well-being is increasing because we're changing ecosystems to suit our needs and there's no paradox there."

For example, Matt Ridley, former science and technology editor for *The Economist* and author of *The Rational Optimist*, blogged that the authors have it backwards.

"But of course the whole paradox is misconceived," he wrote. "Human beings do not just live off ecosystems. They garden and nurture them so that they are more productive — and sometimes so boost their productivity that they support still more wildlife as well." For Ridley, modern building materials like plastic, steel and concrete constitute an improvement over the centuries-old use of wood. As the title of his book (and blog) suggests, Ridley believes humanity will likely be much better off in, say, 2111.

But Gerald Nelson, a senior research fellow at the International Food Policy Research Institute, is more cautious about the future. "The reason to be pessimistic is that we are having just quantitatively a larger impact on the Earth than we were even 50 years ago. There's more of us and we demand more resources, and the demands are growing rapidly in some parts of the developing world. You know the classic problem, dumping CO2 into the atmosphere. It's not a big deal when there aren't very many of us, right?"

Nelson responded to the Environmental Paradox paper in January with "Untangling the Environmentalist's Paradox: Better Data, Better Accounting, and Better Technology will Help," which also appeared in Bioscience. He wouldn't call his paper a "critique," but his commentary does take issue with several of Raudsepp-Hearne and her colleagues' observations.

"I agree," he wrote, "with this description of the environmentalist's expectation with a slight but significant word change: Ecological degradation and simplification will eventually be followed by a decline in the provision of ecosystem services, leading to a decline in human well-being."

He notes Raudsepp-Hearne's failure to directly discuss the drawdown of resource stocks, which Nelson says would eventually resolve the paradox. And though he agrees the issue is alluded to in the time lag hypothesis, Nelson says the process of drawing down makes it possible for a given ecosystem service to be provided over extended periods.

Perhaps more significantly, Nelson disputes Raudsepp-Hearne's premise that psychological well-being can be measured. "The economist in me says that well-being has many different dimensions, but the ones I can measure are physical. There are cultural and geographical elements, both of which are mutable across at least generations," he says.

But Raudsepp-Hearne affirms the impact of the environment on people's health and, hence, on their psyche. "Studies show the value of eco-system service to healing patients for example, which is a psychological contribution. People feel better and improve their health if they are in a beautiful place or have access to

nature. There are few studies like that but they do exist and they do suggest you can measure psychological components of eco-system services."

Nelson also disputes the paper's automatic connection of food availability to well-being, pointing out the increasing rates of obesity in the United States and Europe. Raudsepp-Hearne, however, sees obesity as a separate issue. That problem, she says, "is politics and policy and what food is available for different demographics."

As for her hypothesis that "human ingenuity has decoupled us from dependence on ecosystems," — a theory she herself is lukewarm about — Nelson insists that every species modifies its environment to optimize its survival.

The question remaining is just how many natural systems and processes will undergo irreversible damage and how soon all of this might occur. Says Raudsepp-Hearne, "We need to figure out where in the world we're most at risk, what systems are most at risk, what ecosystem services are most at risk and how to adapt to that and manage it better so we can improve the way we live on the planet."

http://www.miller-mccune.com/environment/as-environment-degrades-our-well-being-grows-29812/

**Bedbugs Have Evolved to Live With Mankind**

**The rise of bedbugs has followed the rise of mankind living indoors; their latest resurgence illustrates the survival of the fittest.**
By Rob Dunn

*We only have ourselves to blame for bedbugs' fitness for survival. It followed the rise of mankind living indoors: We moved into caves, and bedbugs, which feasted on bats, began feasting on us with great success. (Dblight/istockphoto)*

*"Bedbugs sure is evil, they don't mean me no good. Yeah, bedbug sure is evil, they don't mean me no good. Thinks he's a woodpecker and I'm a chunk of wood."* — Bessie Smith ("Mean Old Bedbug Blues")
Bedbugs are small and sneaky. Bedbugs do nasty things. Bedbugs are also becoming more common, a trend likely to expand and worsen this spring. But none of this is new, not really. The story of the bedbugs in our lives begins no less than 4,000 years ago. It is a kind of parable about the difference between what we want and what we make. We wanted a realm inside our houses, where we would always be happy and might live forever.
Instead, we made the bedbug, a modern chimera we seem unlikely to ever really escape.
It began innocently. Once we were like the birds. The rain fell on our naked shoulders. The sun beat down on our heads. There was no inside or outside. We built our nests of sticks and mud. Then we moved out of the trees. On the ground, the world was more dangerous. Leopards crouched in the darkness between resting spots, venomous snakes hid under leaves. We sought safety, shade and cover and found them all in caves. Caves changed the world. In moving into caves, we invented the more constant conditions of the "indoors." No matter that this particular indoors lacked an actual door, it was still the rough seed of what would come. It was the beginning of our efforts to make the place we lived "better" than everywhere else.
It was when we began to try to find even more favorable conditions for ourselves, to engender them even, that we began the process of making bedbugs from the sticks and mud of natural selection. Bedbugs belong to two or three species, depending on exactly how you are counting and who is counting. The most common species is — thanks to a modest failure of scientific creativity — the common bedbug (*Cimex lectularius*). Bedbugs were originally bat bugs. Their ancestors lived in caves, on bats (where most of their kin still live), and when our ancestors moved into caves, they jumped down onto us. A few found us where we slept. Those that did prospered on our blood as we prospered.

When they moved onto us, many things would have had to change for these bat/cavemen bugs. The platelets in our blood, for example, are wider than those of bats, and so the mouthparts of the bedbugs had to widen so that they wouldn't clog up with blood. Their mouthparts changed in length, too, because of the thickness of our skin, a thickness through which their mandibles must meander to find blood vessels. Their activity patterns changed, too. Bat bugs feed during the day, when the bats are sleeping. Bedbugs, well, they had to feed at night, when we were sleeping.

Bedbugs changed so much in moving onto us, in fact, that now they are stuck. They can't easily go back — and why would they want to? They ride us wherever we might lead them, which, it turns out, is all around the world.

Bedbugs evolved more as our culture evolved, changing as we changed and moving as we moved. Early Egypt was dense with bedbugs. Cleopatra would have had them. Aristotle definitely did. Socrates whined about them frequently.

Bedbugs came to take advantage not just of our abundance but also of the new environments we created inside our houses, environments that are similar realms of warmth and predictability whether we live in New Jersey or Cairo. Many valiant attempts were made to control bedbugs. Democritus recommended hanging the feet of a hare at the foot of the bed, presumably with no effect on bedbugs, though with negative consequences for the hare. Cyanide was sprayed around rooms. Rooms were heated to 45 degrees C, all to relatively little permanent avail.

Then, during World War II, scientists pioneered new chemicals for warfare. We used some of those chemicals, in particular DDT, around our apartments and houses in our war with pests. These pesticides appear to have controlled the bedbugs by making the indoor environment more toxic than *most* bedbugs could stand. This, we hoped, would be good for us. It was certainly bad for the bedbugs, for a while.

It was clear as early as 1947 that bedbugs could evolve resistance, first to DDT and then, one by one, to its chemical descendants. They evolved similar but sometimes unique forms of resistance in many different places all around the world (and in each bedbug species), which is to say that genetically they may have actually diversified. This was possible because we never, ever killed them all. We only killed the weak, and so, just as in those first caves, they evolved once again: They changed when we made them change. Recently, the inevitable has happened. These survivors have started to become abundant again, separately, in different regions of the world. We made our bed and they slept in it.

This is where we find ourselves now, reunited again with the species we have been shaping all these years, our evolutionary masterwork. The bedbugs, after their brief hiatus, seem foreign to us now. News stories call them strange or unusual, which they certainly are. The males have sex with females traumatically (by penetrating their bellies). They smell bad (an odor one scientist described as "an obnoxious sweetness") so that even if we find them we are unlikely to try to bite them back (speaking for myself, I was never really tempted). Male bedbug nymphs compete with each other by trying to block each other's sexy smells.

Bedbugs smell us, on the other hand, by the scent of our bodies but also, probably, the scent that the microbes on our bodies emit. All of that is weird, but it is also our fault, the consequence of the world we have created around ourselves, a world just right for us and, once again, for them.

But … you might reasonably contend that we try to control bedbugs. We chase and kill them. That's true. But all this chasing has not done away with them. It has made them stronger, or better adapted anyway, to our ways and lives. In the process, it may have actually made them more common than they would have been otherwise had we never tried to beat them away. They may be more common because our houses have become ever more warm and because we have become ever better at ferrying them from one place to another. Also, we seem to be getting better and better at killing the other species that live around us, species other than the bedbug (and a handful of other equally sneaky beasts) that have learned to love it this way.

All things being equal, bedbugs would probably be more rare if we were just a little bit sloppier in controlling our environments and keeping species from coming in our door. Take the example of the Pharaoh ant.

The Pharaoh ant, *Monomorium pharaonis*, like bedbugs, spread with us all around the world and is now on every continent except Antarctica (though it may be there). The Pharaoh ant is a species that we have been able to exclude from our houses relatively well. It is present here and there, but no longer ubiquitous. That is bad news, bad news because the Pharaoh ant is very good at eating bedbugs. During the U.S. Civil War,

Pharaoh ants cleaned a camp in Meridian, Miss., of bedbugs “in a single day.” The ants could be seen carrying the bedbugs back to their small, dark queens.

Nor is this ant the only species that is good at eating bugs. So, apparently, are other species of ants, including Argentine ants (*Linipithema humile*), species of the ant genus, Formica, a fire ant, Solenopsis geminata, and, one presumes, many other species. Nor are the ants alone. Several species of spiders have been reported as bedbug decimators. Then there is the masked assassin bug (*Reduvius personatus*) that appears to turn up in houses only when bedbugs are present. It may well be a bedbug specialist, feeding specifically on the species that feed specifically on us.

In the caves of our ancestry, Pharaoh ants, masked assassins, spiders and predators more generally were present. With their small arms and mouthparts they ate at bedbugs. In doing so, they may not have gotten rid of them, but they almost certainly made them less common. They were part of a diverse food web that kept the life that plagued (and plagues) us in check, the way the mountain lions, coyotes and their kin once ate the deer that now graze densely in our yards.

This is the secret about bedbugs: From the perspective of our broad history, they are common because we are common but also because we have made decisions that have made them more common, more specialized on us and more uniquely part of our lives. They are common because we have inadvertently given them a place to live, free of parasites or predators, to dine on our ankles and then return to their hiding places, to sleep and mate in their complicated, awful ways.

What we will undoubtedly try to do when the bedbugs begin to unfold out of their eggs in the spring is to figure out new ways to spray our lives down and make the door separating inside from outside more exclusive. I would argue for the opposite, leaving the door just a little more open so that the Pharaoh ants and their kin might walk inside and do what they have been doing since long before we had coffee makers, indoor plumbing or even houses — gathering what they find, one piece or body at a time. To crudely paraphrase the Japanese poet Issa, don’t worry Pharaoh ants, I keep house easily.

In the end, we made the bedbug, generation by generation, what it is today. But we could choose to make something else, a more diverse world around us, whether in our backyards or bedrooms, a world in which there are bedbugs sometimes, yes, but also the predators that chase them from corner to corner hunting them down, the way leopards once pursued us, into caves, where this whole story started.

http://www.miller-mccune.com/science/bedbugs-have-evolved-to-live-with-mankind-29345/

**Marijuana Use Hastens Onset of Schizophrenia**

**A review of 83 studies provides strong evidence that reducing marijuana use could delay or even prevent some forms of psychosis.**

By Melinda Burns

*There is strong evidence to suggest that marijuana use can speed up onset of schizophrenia, and the loss of these years can worsen a patient's ability to cope with the disease later in life. (istockphoto.com)*

Honing in on the risks of cannabis, scientists have found that marijuana use hastens the onset of schizophrenia by nearly three years for those already at risk for the disorder.

In the Archives of General Psychiatry, a team of researchers reports that the onset of psychosis occurs about 2.7 years earlier for people who use marijuana than for those who don't. And the loss of even 2.7 symptom-free years can worsen a patient's prognosis for life, they say.

"We've known for many years that people who develop schizophrenia earlier have a number of poorer outcomes," said Michael Compton, a co-author of the report and a professor of psychiatry and behavioral science at George Washington University. "The earlier the disease starts, the greater the social disruption it causes. You're less likely to finish high school, go off to college, get your first car and get married."

Schizophrenia is a disease characterized by severe hallucinations and delusions. Typically, it begins between the ages of 18 and 28 — slightly younger for men and older for women. Between 80 and 85 percent of the time, genes are the cause. The findings of an earlier onset for marijuana users have obvious implications for young people who have a family history of schizophrenia or who are beginning to show signs of the disease — but doctors caution that people may be at risk and not know it. Most schizophrenics don't have relatives who are afflicted.

"The risk is hidden," Compton said. "We usually don't know who is at risk until they have developed the disorder."

National health surveys show that about 16 million Americans regularly use marijuana. It is the third most widely used addictive drug, after tobacco and alcohol. Most people begin using marijuana in their teenage years. Surveys also repeatedly have found more substance abuse, especial with marijuana, among people who have been diagnosed with a psychotic disorder. As reported previously in *Miller-McCune*, some studies suggest that people who are more vulnerable to psychosis are more likely to use marijuana, which in turn could contribute to an increased risk of developing mental illness.

Compton's team, which included researchers from the Prince of Wales Hospital and the University of New South Wales in Sydney, Australia, looked at 83 studies on the onset of psychotic disorders, comparing 8,200 patients who were using alcohol and illegal drugs, including marijuana, with 14,350 patients who were not. Most of the participants had been diagnosed with schizophrenia.

Among the samples of marijuana users, the team found, the onset of psychosis was 2.7 years earlier than among patients who did not use drugs, although it varied according to gender. For the men, onset was 1.9 years earlier and for women, it was 3.4 years earlier. For substance abusers in general, the onset of psychosis was 2.0 years earlier than for people who did not drink or use drugs. The team did not find a connection between alcohol use alone and an earlier onset of psychosis.

In the context of a growing body of literature on the risks of marijuana, the team also suggested that for some people using it less or not at all might even prevent psychosis from developing in the first place. Scientists believe that marijuana may precipitate or even trigger schizophrenia by disrupting brain development during the period of neurological maturation in adolescence.

"That's our leading hypothesis," Compton said. "We know that adolescence is a critical time of brain development, so marijuana use during that time may have an effect on certain pathways in the brain that are involved with schizophrenia."

Even if the onset of psychosis is genetically inevitable, Compton said, an extra two or three years without the disease could allow many patients to achieve some of the important milestones of late adolescence and early adulthood — important steps that could help them live with their disability later on.

"I don't think that the news about marijuana as a potential risk factor for schizophrenia has been publicized," Compton said. "The literature is accumulating, and it's time to let the public know of this potential risk."

http://www.miller-mccune.com/health/marijuana-use-hastens-onset-of-schizophrenia-29515/

**Breastfeeding Women Viewed as Less Competent**

**New research finds both men and women tend to harshly evaluate breastfeeding mothers.**
By Tom Jacobs

*The research included one study that found breastfeeding is a handicap for women hoping to be hired for a job. (michellegibson/istockphoto)*

A study emerged out of Oxford University last week suggesting babies who are breastfed end up doing better in school. Yet despite such well-documented benefits for both mother and child, the percentage of American breastfeeding women remains "stagnant and low," according to the federal Centers for Disease Control and Prevention.

Why are only one-third of American mothers exclusively breastfeeding at three months, and only 43 percent breastfeeding at all at six months? Perhaps because they've gotten a sense of how harshly they are being judged.

Research just published in the journal *Personality and Social Psychology Bulletin* ("Spoiled Milk: An Experimental Examination of Bias Against Mothers Who Breastfeed") reports mothers who breastfeed are widely viewed as less competent than otherwise identical females. This disturbing finding was obtained in three separate studies, one of which also found breastfeeding is a handicap for women hoping to be hired for a job.

"Importantly, we did not find evidence that gender of the participant influenced perceptions of the breastfeeding mother," notes the research team led by Montana State University psychologist Jessi L. Smith. Women, it seems, are just as likely as men to hold this bias.

In one experiment, 30 students told they were engaging in an "impression formation study" were given biographical information on actress Brooke Shields, including the fact she had just written a book about motherhood. Half were told the volume included information on her "experiences with breastfeeding, bathing and overall care of a newborn;" for the other half, the word "bottle-feeding" was exchanged for "breastfeeding."

Afterward, the participants answered a series of questions gauging their overall assessment of the actress. Those who read she was breastfeeding her baby viewed her as "significantly more warm and friendly compared to the bottle-feeding mother, but significantly less competent in general, and less competent in math specifically," the researchers report.

In another experiment, 55 students were told they were participating in a study of how people form impressions of others in the face of limited information. They were asked to judge a woman they got to know by listening to her telephone answering machine.

Specifically, they heard a message in which a man talks about changing the time of their dinner date. The rest of the message varied: Some participants heard a neutral conclusion, while others heard a reference to breastfeeding ("I figured you would want to go home and breastfeed the baby"), motherhood ("I figured you would want to go home and give the baby a bath"), or sexuality ("I figured you would want to go home and change into your strapless bra").

The breastfeeding woman "was viewed significantly more negatively compared to the neutral voicemail on all measures of competence," Smith and her colleagues found. The woman in the strapless bra was also labeled as less competent, suggesting that the bias faced by breastfeeding woman "is similar to the once experienced by a woman for whom the breast is sexually objectified," the researchers add.

Asked if they would hire this woman for a job, the participants gave the lowest ratings to the breastfeeding woman — even below that of the woman with sexualized breasts. Interestingly, the woman giving her baby a bath was not penalized in this respect, suggesting it isn't parenthood per se that makes her less desirable as an employee.

Rather, the culprit seems to be the mental image of her breasts, whether they're being used as instruments of sexual allure or infant nutrition.

"A woman may not breastfeed because of worry over how she will be evaluated by other people," the researchers conclude. "Data from the current project suggest this worry may be warranted, to the extent that breastfeeding is a devalued social category."

Smith and her colleagues suggest that health professionals should "teach pregnant women about the sexism they might encounter" when they choose to breastfeed. In terms of society as a whole, they argue the only way this bias will diminish is for more women to breastfeed openly.

"More visible breastfeeding mothers should prompt people to wrestle with and debate the issues," they write. "With time, greater numbers of women who breastfeed translates to less prejudice."

http://www.miller-mccune.com/health/breastfeeding-women-viewed-as-less-competent-29338/

**Making Medical Miracles With Inkjet Printers**

**Bioprinting allows researchers to create replacement human tissue and output it on equipment similar to what came free in your desktop bundle.**
By Michael Haederle

*University of Texas at El Paso's Tao Xu helped to pioneer ways to use inkjet devices to "print" cardiac tissue to repair a sick heart.*

You've probably owned an inkjet printer or two — one of those homely plastic boxes that performs mundane functions like scanning pictures and spitting out boarding passes while running through pricy ink cartridges like nobody's business.
Where most of us behold an unremarkable piece of office equipment, Tao Xu sees a mechanical marvel. He has helped to pioneer ways to use those same inkjet devices to "print" cardiac tissue to repair a sick heart or create precise micro-assays that will slash the cost of testing new drugs.
Xu, an assistant engineering professor at the University of Texas at El Paso, is one of a growing number of scientists experimenting with the technique known as bioprinting. Researchers at the Medical University of South Carolina are trying to grow kidneys with printers, for example, while a team at Wake Forest University is developing a printer-based method to grow new tissue in burn wounds.
Xu recently received a three-year $423,000 grant from the National Institutes of Health to perfect cardiac patches containing cells cultured from a patient's own tissue and tiny oxygen-releasing particles that should promote their growth. If they work, these patches could be an important new treatment for people suffering from cardiomyopathy, a disease process that weakens the heart's pumping ability.
Damaged heart cells don't regenerate well on their own, so they need an external cell source, Xu explains. Earlier research that involved injecting stem cells directly into the heart didn't work because there wasn't enough oxygen or nutrients for them to thrive, he says.
Enter the cardiac patch (which, Xu hastens to add, is still in the testing stage).
"We're trying to fabricate the patch with a scaffold," he says, explaining that inkjet heads can precisely deposit tiny droplets containing stem cells and oxygen particles onto a biodegradable substrate woven from nanofibers spun out of polylactic acid.
After the inkjet deposits a layer of cells and oxygen, another layer of substrate is added, then more cells and so on, creating a multilayer sandwich of organic material that could be implanted in a patient suffering from heart failure.

"We can keep going to however many layers you want," Xu says, noting that a 10-by-10-by-2-millimeter cardiac patch might contain 5 million stem cells. Having an adequate supply of cells is important, "otherwise it won't work at all."

Xu hopes to have a patch available for animal testing by the end of his three-year grant. If all goes well, he plans to mount human trials in collaboration with researchers at Texas Tech University.

Biomedical researchers first saw the potential of thermal inkjet technology as it came into widespread use back in the 1990s, Xu says. But early experiments focused on printing organic molecules like DNA, not living cells.

When he arrived at Clemson University for his Ph.D. study nine years ago, Xu used ordinary off-the-shelf printers made by Hewlett Packard and Canon. Some inkjet nozzles can pass droplets as small as 10 microns (a micron is one-millionth of a meter), but most cells are in the 40- to 50-micron range, so different size nozzles are used for different purposes.

A key proof of concept, Xu recalls, came when the Clemson team showed that most of the cells could survive being squeezed through the ink jet heads, which can fire 15,000 times per second and operate at temperatures of 250-350 degrees Celsius.

Cells show "a little bit of heating, but it's only on the surface," he says. About 90 percent of cells remain viable after they are deposited on the substrate.

Researchers start with ordinary ink-filled cartridges, which are emptied, cleaned and sterilized before being refilled with cell-rich liquid solutions — a kind of "bio-ink." Meanwhile, Xu confesses to prowling eBay looking for used, older-model printers suitable for his experiments.

After earning his doctorate, Xu did post-graduate research at Wake Forest University's Institute of Regenerative Medicine, headed by Anthony Atala.

There, "we advanced the technology and tested quite a lot with animals," Xu remembers. He also figured out how to print stem cells taken from amniotic fluid. "I demonstrated it was able to form bone tissue in animal models," Xu says.

Atala, who has made headlines with his lab's bold efforts to engineer replacement organs, such as bladders and heart valves, is developing a bio-printing method to repair burned skin. This approach starts with an infrared scanner that hovers over the wound, measuring the depth and dimensions of the crater-like injury.

Burn wounds need daily debriding for the first few weeks to remove dead and dying tissue, Atala says.

Meanwhile, samples of the patient's skin cells are cultured to make new cells. "Within two to three weeks you can have enough cells to cover the patient," he says. "You can cover large areas with it."

Once the wound's healthy edges are apparent, the printing device deposits new cells in discrete layers.

"We've actually already done it in rodents," Atala says of the technique. Their wounds take three weeks to heal, whereas it takes five weeks to heal from a conventional skin graft.

He estimates the technology could be commercially available for human use within five years.

Meanwhile, Atala is also using the scan-and-print method to reconstruct solid organs. "That's where this technology is very amenable to its application," he says.

UTEP's Xu sees other potential applications for bioprinting, such as screening new pharmaceutical compounds for their efficacy.

Current approaches to testing promising-but-expensive new compounds (which might cost as much as $100,000 a nanogram) employ a robotic system that deposits microliter-sized droplets onto cells to see whether it has any effect.

But because inkjet nozzles are so small, they can deliver candidate drugs in picoliters — billionths of a liter — onto equally small cell samples.

The cost comparison: $200 per dot using the robotic method versus mere pennies per sample using bio-printing, Xu says. He says he has received inquiries from printer manufacturers about commercializing the technology. "We know each other pretty well. They know what we are doing."

http://www.miller-mccune.com/health/making-medical-miracles-with-inkjet-printers-26770/

**Song Lyrics Reflect Our Narcissistic Age**

**New research finds a shift in emphasis in pop song lyrics over the decades, from "we" to "me."**
By Tom Jacobs

*An academic look at top 10 songs over the last 30 years shows that pop music lyrics have veered steadily toward the narcissistic. (Mario Alberto Magallanes Trejo / stockxchange.com)*

Vocalists often warm up by singing "Mi, mi, mi, mi, mi." But increasingly, the songs they perform — or at least those that make the top 10 lists – are odes to "Me, me, me, me, me."

Clear evidence of American society's increasing narcissism can be found in our best-selling popular songs. That's the conclusion of a study just published in the journal *Psychology of Aesthetics, Creativity and the Arts.*

Compared to a quarter-century ago, "Popular music lyrics now include more words related to a focus on the self," reports a team of researchers led by University of Kentucky psychologist C. Nathan DeWall.

Curious to find whether the increasing levels of narcissism documented in previous studies would be reflected in the music young people listen to, DeWall and his colleagues analyzed the top 10 songs in the U.S. for each year between 1980 and 2007 (as measured by *Billboard* magazine).

Using the Linguistic Inquiry and Word Count program, which "counts the percentage of words in a body of text that correspond to various categories," they analyzed the content of the lyrics in several related ways.
The researchers found the use of first-person plural pronouns (we, us, our) declined over the years, while the use of first-person singular pronouns (I, me, mine) increased. Words reflecting anger or antisocial behavior (hate, kill, damn) became more prevalent over the 28-year period.
Conversely, terms depicting social interactions (talking, sharing) became less common, as did the use of words conveying positive emotions (love, nice, sweet). These findings mirror "recent evidence showing increases in U.S. loneliness and psychopathology over time," the researchers write.

This is troubling in the light of other recent research that found songs conveying antisocial messages tend to promote aggressive thoughts and hostile feelings, while those with lyrics promoting peace and love can increase empathy and encourage selflessness.

DeWall doesn't view pop music as a cause of increased narcissism and social isolation, but he and his colleagues do see it reflecting and supporting this societal trend. Psychological processes and pop-culture products "mutually reinforce each other," they write.

At the moment, the attitude they're mutually reinforcing seems to be self-centeredness. We'd might as well face it: We're addicted to self-love.

http://www.miller-mccune.com/culture-society/song-lyrics-reflect-our-narcissistic-age-29644/

**Military Gender Roles Still Thorny Problem**

**Despite decades of official attention, women in the military face pervasive sexism and surprisingly frequent sexual assault from within the ranks, noted speakers at the recent Gender Justice conference at West Point.**

By Ben Preston

*Women in the armed forces still face sexism and sexual assault despite decades of attention to the problem by military brass. Recently, noted speakers addressed the gender inequality issue at a conference at West Point. (MTMCOINS / istockphoto.com)*

Gray skies covered the cluster of gray stone buildings and perfectly manicured fields at the United States Military Academy at West Point, N.Y. last Friday as a group of about 50 students — cadets and midshipmen from all the U.S. service academies, as well as some students from other universities — gathered inside the brightly lit main library for an earnest discussion on gender issues in the U.S. armed forces.

Speakers at the two-day Gender Justice conference — hosted by the West Point Center for the Rule of Law — tackled a tight range of sober topics, and the Friday morning speaker presented the results of three years of research about a particularly troubling subject: rape and gender inequality in the military.

According to her research, said Helen Benedict, a professor at the Columbia University Graduate School of Journalism and author of the book *The Lonely Soldier: The Private War of Women Serving in Iraq*, 1 in 3 women in the U.S. military is raped by another service member.

Mickiela Montoya, one of the female Iraq veterans Benedict interviewed for the book, explained her experience of men's treatment of women in the military: "There are three things they'll let you be: A bitch, a ho or a dyke. You're a bitch if you won't sleep with them; you're a ho if you have only one boyfriend; and you're a dyke if you don't like them."

While many of the women Benedict interviewed while researching her book had not been sexually assaulted, she was struck by the number and severity of sexual assault cases she did encounter. As she spoke with more and more female Iraq veterans, she began to consider the differences between soldiers who commit assault and the ones who don't. More than the problem being "a few bad eggs," she suggested that a permissive culture allows assault cases to go unnoticed and perpetrators unpunished and has encouraged the continuation of inappropriate behavior.

Benedict called upon the audience — the armed forces' future leaders — to change what she said is a culture that promotes gender inequality and violence toward women.

While all of Friday's panel speakers agreed with Benedict's assertion that the military establishment needs to change its treatment of women, not everyone agreed with her bleak assessment of the status quo. Col. Charles Pede, chief of the Criminal Law Division at the U.S. Army's Judge Advocate General Corps, asserted that his office has been working hard to combat sexual assault cases. Condemning what he said was the book's dim picture of a career in uniform, he asked how many resignations would follow Benedict's sobering presentation.

The military has been aware of the sexual harassment (and worse) problem — in the academies, in the ranks and even in the reserves — for decades. Besides its moral dimension, leaders have long cited the harm it does to mission readiness and even the bottom line.

The Department of Defense's office of Sexual Assault Prevention and Response is mandated to report to Congress on the issue and has since 2004; "the data provided in such reports serve as the foundation and catalyst for future sexual assault prevention, training, victim care and accountability goals," it says.

The problem, Col. Pede said, lay in recruiting military enlisted personnel from a misogynistic street culture. Referencing a poster of a scantily clad woman surrounded by profane slogans he had seen in a base medical clinic in Iraq, he called for better leadership to combat inappropriate sexual attitudes.

"The young soldier [who put up the poster] thought it was OK," he recalled. "How does that happen?"

An expert at helping managers try to solve seemingly insurmountable conflicts posed another question. "How is it that some women come [to West Point], meritorious in every way, and become collaborators in their own oppression?" asked Mark Munger, senior associate at Tufts University's Positive Deviance Initiative.

He suggested a unique approach to closing the military's gender gap. Instead of focusing solely on the perpetrators of sexual assault, as is more traditional, he proposed studying the behavior of people who already extend respect and inclusion to female personnel. He added that female cadets and female soldiers should look at the women who don't fall into that collaboration trap as positive examples.

Cadet Alex Panosian, a senior at the academy, presented some of the findings from research he had conducted into how vocabulary affects gender attitudes at West Point. Examining the word "trou" — a derogatory term created to describe how female cadets looked in their uniforms after they were first admitted in 1976 — Panosian said that while younger male and female cadets he had interviewed identified the word as more of a joke, upperclassmen attached more significance to it. He explained that by its definition and use, trou implies that the female cadet is overweight, unattractive and lazy — which he found affected some female cadets' eating habits. Half of the female cadets he interviewed reported hearing the term several times per day and that it created in older cadets a "sense of other," or a distinct separation between males and females enrolled in the corps of cadets.

As an outsider to the military establishment, Benedict's work may always be viewed by some with a degree of skepticism, but several speakers — including an active-duty lieutenant colonel and a retired brigadier general, both female — supported her claims that gender division is a cultural phenomenon rooted deep within the military establishment. Part of that, said retired Brig. Gen. Rebecca Halstead — a 1981 West Point graduate — can be seen in the military's policy excluding women from combat. That policy is currently under review.

"It's OK to be with the team, but it isn't OK to be on the team," she said. "I think that leaders have a responsibility to make policy that reflects reality. If someone wants to serve their nation, let them serve their nation."

While Benedict's book relates several long, cheerless tales of women who had suffered severely within military culture, she offered advice to students as to how they could change that structure.

"You have to decide what kind of a leader you want to be," she said. "When you hear of wrongdoing, will you be one of those officers who protects your career by turning a blind eye, or will you speak up and protect your subordinates? The answer seems easy from afar, but you're entering a highly competitive structure."

http://www.miller-mccune.com/culture/military-gender-roles-still-thorny-problem-30079/

**Cleanliness Cues Activate Conservative Attitudes**

**New research finds subtle reminders of cleanliness seem to shift people to the political right.**
By Tom Jacobs


*Republicans may have a secret weapon in their attempt to convince Americans of the correctness of their cause: Hand sanitizers. (hodag/Flickr)*

They may not know it, but Republicans have a secret weapon in their attempt to convince Americans of the correctness of their cause: hand sanitizers.
Such commonplace reminders of the concept of physical cleanliness can influence moral and political attitudes. That's the conclusion of Cornell University psychologists Erik Helzer and David Pizarro, who report this effect is particularly strong in the arena of sexual morality.
Their study, just published in the journal *Psychological Science*, brings together three interesting threads of recent psychological research:
1. The notion that environmental cues can influence political attitudes. One recent study found people who cast ballots in a church were more likely to support an initiative endorsed by social conservatives.
2. The deep symbolic nature of hand washing. Studies have found cleaning our hands helps us emotionally disconnect from past decisions, as well as increase feelings of moral superiority.
3. The strong link between social conservatism and the concept of purity. Studies have found conservatives are more easily disgusted than liberals, and that people who feel disgust tend to judge the moral transgressions of others more harshly.
Helzer and Pizarro describe two experiments. In the first, 52 students were approached as they entered the main hallway of a campus building. They were asked to complete a quick survey in which they gave some basic demographic information and described their political beliefs.
Half of the encounters took place within 10 feet of a hand sanitizing station. The participating students were instructed to "step over to the hand-sanitizer dispenser to complete the questionnaire." For the other half, the hand sanitizer was removed; the students were asked to "step over to the wall to complete the questionnaire."
"Participants who reported their political attitudes in the presence of the hand-sanitizer dispenser reported a less liberal political orientation than did participants in the control condition," the researchers report. "Despite the noisy nature of the public hallway in which we collected the data, it appears as if a simple reminder of

physical purity was able to shift participants' responses toward the conservative end of the political spectrum."

The second experiment, featuring 61 undergraduates, took place in a laboratory. Half the participants filled out that same questionnaire. They then read 12 mini-vignettes and rated their moral approval or disapproval of the characters' behavior.

Four of the items specifically dealt with sexual purity (Example: "While house sitting for his grandmother, a man and his girlfriend have sex on his grandmother's bed"). Others dealt with nonsexual notions of purity ("As a practical joke, a man unwraps his office mate's lunch and places it in a sterilized bedpan"), while others weren't about purity at all (describing breaking a promise or cheating on taxes).

For half the participants, "the experimenter stood in front of a sign on the wall (8½ by 11 inches) that read: 'Experimenters: Help keep the lab clean by using hand wipes!'" After those students completed the questionnaire, but before they filled out the moral-values survey, the experimenters presented them with a box of antiseptic hand wipes, pointed to the sign and asked them to "keep the lab clean by wiping their hands before using the computer keyboard."

Once again, the participants who were exposed to a cleanliness reminder expressed more conservative political leanings than those who were not. But when it came to specific ethical values, the only ones where the hand wipes led to harsher judgments were those dealing with sexual morality.

"The extreme visceral nature of sexual behavior may make it a particularly salient source of potential contamination," Helzer and Pizarro write.

The researchers note that while activation of the mental concept of cleanliness (and its opposite, impurity) seems to pull people to the political right, it's impossible to say whether it impacts views on specific, non-sex-related issues as immigration or taxation.

However, it's an easy metaphorical leap between contamination of the body by germs and contamination of the body politic by undocumented aliens. A 2008 study found many instances of the "immigrant as pollutant" metaphor in media coverage of the issue.

Returning to this study, Helzer and Pizarro note that the cleanliness reminders they utilized were "quite subtle." They found that "simply reminding participants of physical cleanliness, rather than involving them in direct physical cleansing, was sufficient for the effect to emerge."

"These results suggest that everyday reminders of cleanliness may have unintended effects on people's attitudes," they add, pointing to the aforementioned hand sanitizer stations, as well as those printed admonitions found on the walls of public restrooms.

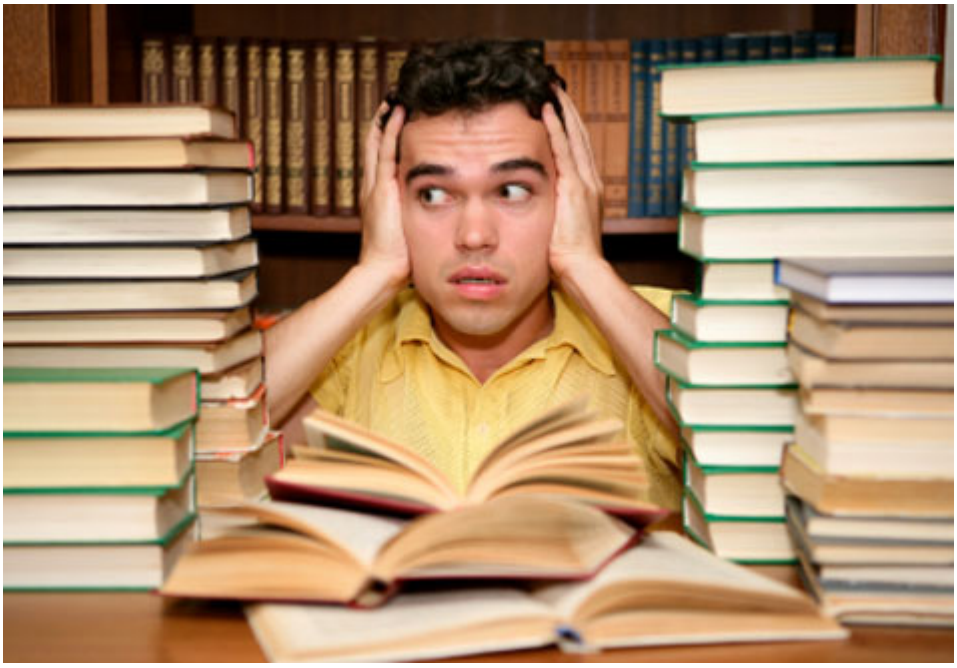
Who knew "Employees must wash hands before returning to work" had a political subtext?

http://www.miller-mccune.com/culture-society/cleanliness-cues-activate-conservative-attitudes-29718/

**Derek Bok on Fixing College Failure**

**Harvard University President Emeritus Derek Bok says college professors don't challenge their students because they don't know how.**

By Melinda Burns



*Derek Bok says teaching college professors how to teach and not merely lecture is the key to promoting critical thinking on college campuses. (Viorika/istockphoto)*

A longtime critic of higher education, Derek Bok is the author of six books on the ivory tower, most recently *Our Underachieving Colleges: A Candid Look at How Much Students Learn and Why They Should Be Learning More*, published in 2005. Bok has an insider's view: He was president of Harvard from 1971 to 1991 and acting president from 2006 to 2007, the only person to serve twice in the job.

During his first stint, Bok established what is now the Derek Bok Center for Teaching and Learning to help boost the quality of instruction at Harvard. Today, at 80, he is a research professor at the Harvard Kennedy School. His latest book, *The Politics of Happiness: What Government Can Learn from the New Research on Well-Being*, was published last year. Bok spoke recently to *Miller-McCune* about his hopes for undergraduate education in America.

***Miller-McCune:*** Professor Bok, you've written that teaching students to think critically is the principal mission of a university. What do you make of the fact that college students today study half as much as they did 50 years ago?

**Derek Bok:** I think you have a lot of students out there who look upon college as a way of getting a necessary credential in order to get a good job. So, they take vocational courses, and they don't put a great deal of effort into them. They don't really see the importance of studying hard. That could be hard for professors to deal with. Sometimes you end up saying, "Oh heck, if they're not going to do the homework, I just can't assign as much, because it doesn't do any good." So you get into this kind of tacit agreement: The students don't make trouble, and the professors don't demand enough work.

***M-M:*** Are professors too preoccupied with research to pay much attention to undergraduates?

**DB:** I don't think you can put the blame too easily on research, even though I know it's popular to do so. The authors [of *Academically Adrift: Limited Learning on College Campuses*] found that the highly selective colleges were the ones where the most learning went on. The selective colleges are also the ones where most of the research goes on. Also, faculty surveys show that even in research universities, professors spend twice

as much time on their teaching as they do on their research. The great majority of American professors — about 75 percent — say they're more interested in teaching.

***M-M:*** How do you explain the poor performance of so many college students on tests of critical thinking and complex reasoning?

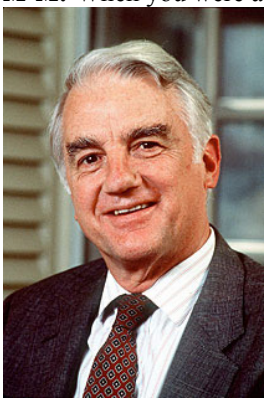
**DB:** Colleges are in a kind of competition with some extremely smart people who are working very hard to capture the time and attention of undergraduates. I'm referring to the people who make iPhones, television sets, computer games, Internet, Facebook — a whole set of things that are designed to soak up the time. Meanwhile, colleges go on doing very much the same thing they've been doing forever and ever.

There's a problem there, but I don't think it's that professors are involved in their research. Faculties have to recognize that this problem exists and that different kinds of teaching are going to be required — not just spending more time preparing your lectures in the same old way but really different kinds of teaching that are more likely to challenge and motivate students in the classroom.

***M-M:*** College students have always had social distractions.

**DB:** Quite true, and they've always been quite potent, but not in the volume and not with the sophistication that they exist today. I think they're becoming more numerous and more effective.

***M-M:*** When you were a professor, how did you engage your students?



Derek Bok

**DB:** Well, I had a completely different orientation because I taught in Harvard Law School. In the late 19th century, Harvard Law School invented the whole idea of Socratic teaching so that we didn't lecture at all; it was all making students think. And that's one reason I believe in it so strongly, because it just transformed my way of thinking about problems. I've been feeding off it ever since, not just in my brief career in law or as a law teacher but in academic administration. It's the same kind of thinking clearly about human situations and taking account of arguments on both sides and figuring out what evidence is relevant and how to get it. Those are universal skills, and they were drilled into me as a student, and I carried it over into my teaching, as we all did.

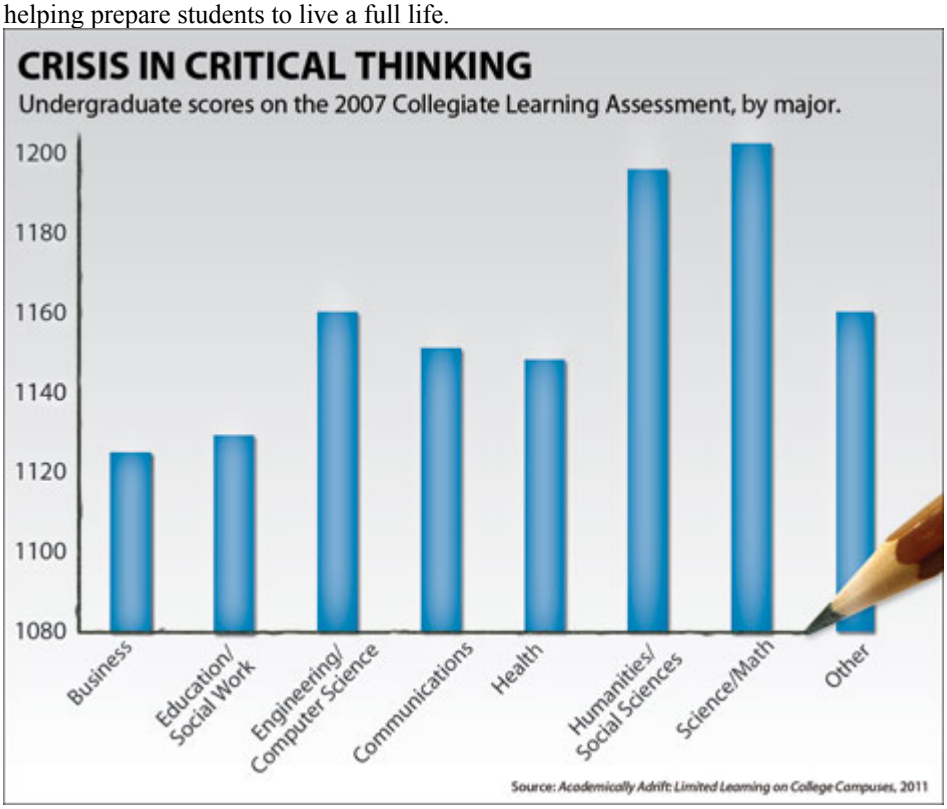
***M-M:*** What changes did you make to promote undergraduate learning when you were president of Harvard?

**DB:** We revised the undergraduate curriculum the first time I was president, and we revised it again when I came in for a year to keep things going between Larry Summers and the current president, Drew Faust. Both times, we completely revamped the curriculum to make it more interesting and effective. When you change a curriculum completely and have all the faculty debates that go into that, you not only create a new structure that you hope will be better than what it replaced, you also focus the faculty's attention and get them involved in the structure and the meaning and the purpose of undergraduate education. And so you release a lot of new energy and a lot of new courses get created and a lot of senior professors get more involved. That's why you need to change your curriculum every generation.

Also, we introduced student evaluations, which are very old hat now. We introduced a certain amount of assessment, including the [Collegiate Learning Assessment] test. We took surveys of how students had improved in their writing. You have to keep doing a lot of things. We've been hampered in the past by the fact that we didn't have very good instruments for measuring student progress. You can innovate all you want, but if you don't have a good yardstick to measure whether your innovations are actually producing improvements in student learning, it's hard to get very far. Even the CLA test that these authors use has some very significant problems in terms of its validity.

***M-M:*** The CLA is a test of undergraduate writing and reasoning ability used on a voluntary basis by only 219 colleges, a fraction of the more than 5,000 colleges in the United States. In the past, you've spoken out against a federal mandate for standardized tests of college learning, a proposal that was under consideration during the administration of former President George W. Bush.

**DB:** If the government tried to do to colleges what they have done to K-12 schools, it would really be quite disastrous. We don't have adequate tools for it; it wouldn't work the way they think it will work, and it would tend to have a dampening effect on the search for better measures, because the ones that were mandated would tend to get frozen in place. In the public schools, they've done studies showing that the effect of the standardized tests is to take time away from physical training and exercise, to take time away from music and arts, to take time away from civics. Those are all losses. We shouldn't get so hung up on the workplace skills of critical thinking and communication that we neglect the other aspects of college, which are important to helping prepare students to live a full life.




***M-M:*** What about attaching conditions to federal financial aid to universities in order to encourage more investment in undergraduate education, as some reformers suggest? What about raising the taxes on the investments of wealthy institutions if they fail to make undergraduate education a priority?

**DB:** [Laughs] You're going to get the federal government deciding what proper investment in education is? We've never gotten into that. I don't think the federal government wants to get into it. I don't think they'd be very good at it. I think it would result in standardized, one-size-fits-all solutions, which would cut against one of the great advantages of our system, compared to that of other countries, which is that our system has a lot of variety and experimentation and different approaches. The moment you start saying we're going to condition financial aid, on which every college in the United States depends, on living up to a set of standardized indicators promulgated by the federal government, you have taken a big bite out of the kind of diversity and complexity of American higher education. That would be a very great error indeed.

***M-M:*** When you stepped down as president of Harvard in 1991, you said that the moral development of students was being neglected in the rush to obtain scientific knowledge. What did you mean?

**DB:** Moral education, and reasoning about ethical problems and trying to build character in the students, used to be a much more prominent part of undergraduate education. Back in the time of the ancient Greeks, it was the most important aim of higher education. At the end of the 19th century, it began to go into eclipse,

because we began to become enamored of something that is usually called positivism, in the sense that real scholars should not deal with questions of value but rather should concentrate on getting determinative answers based on data and logic. And that kind of put moral education into an eclipse. In colleges as a whole, these courses went out of fashion. They've come back somewhat more recently, as everyone has become more interested in ethical issues like abortion and stem cells. But they still are not required on a great many campuses. In my opinion, not only in college but very much in professional schools as well, we have some work to do in giving moral education the place that it deserves as part of a well-rounded education.

***M-M:*** Are you optimistic about the possibility of university reform?

**DB:** Yes, and that's a bit recent. I was quite pessimistic in *Our Underachieving Colleges*, but I have been looking closely at the problem ever since. Better methods, more active methods of teaching have clearly been slowly but steadily increasing. The one thing people are kind of united on is that if you really think critical-thinking and problem-solving and higher-order reasoning skills are important, what you don't want to do is just get up there and give lectures. That's a passive form of education that's not very good at teaching people how to think clearly or communicate clearly.

Accrediting organizations are putting a lot of pressure on institutions to rethink their methods and get into the business of assessing. When you start to assess, you become aware of the things that these authors bring out in their books: The students aren't learning as much as you thought they were. That is a powerful motivation to colleges to look for more effective methods of instruction. I see that happening now to a much greater extent than I did five years ago. So, my own guess would be that if we don't muck it up, if we try to encourage it and we don't try to stifle it by imposing some omnibus solution from above, we're going to make a lot of progress.

http://www.miller-mccune.com/culture-society/derek-bok-on-fixing-college-failure-27870/

**How Did Students Become Academically Adrift?**

**"Academically Adrift," a new book on the failures of higher education, finds that undergrads don't study, and professors don't make them.**
By Melinda Burns

*The book "Academically Adrift" claims undergrads are too busy to study, and their professors are too busy to demand much of them. (gocrawford/istockphoto)*

Here's the situation. You're an assistant to the president at DynaTech, a firm that makes navigational equipment. Your boss is about to purchase a small SwiftAir 235 plane for company use when he hears there's been an accident involving one of them. You have the pertinent newspaper clippings, magazine articles, federal accident reports, performance graphs, company e-mails and specs and photos of the plane.
Now, write a memo for your boss with your recommendation on the SwiftAir 235 purchase. Include your reasons for finding that the wing design on the plane is safe or not and your conclusions about what else might have contributed to the accident.
You have 90 minutes.
Whew. That's a sample "performance task" from the three-hour Collegiate Learning Assessment, a national test used by more than 200 colleges and universities to measure whether their undergraduates are learning to think critically in real-world scenarios and communicate effectively in writing.
Given the average cost of an undergraduate college education today — $16,000 per year for tuition, room and board at public schools and $37,000 at private institutions — one could be excused for believing that college students must be learning how to think.
But according to a new book, *Academically Adrift: Limited Learning On College Campuses*, they're frittering away their time at an astonishing rate. And the result, it shows, is that 45 percent of undergraduates in a survey of 29 colleges and universities nationwide showed no improvement in critical-thinking scores at the end of their sophomore year in 2007, compared to their scores as entering freshmen. At the end of their senior year, after four years of college instruction, 36 percent still had made no gains in critical thinking.
"Slacker" students are nothing new. But the picture from Academically Adrift is one of pervasive distraction in the halls of higher learning, of disengaged students and a faculty too busy with research to demand much of them.

"We found a set of conditions suggesting that something indeed is seriously amiss in U.S. higher education," says Richard Arum, a co-author and a sociologist at New York University. "We found that gains in student performance are disturbingly low. Students and faculty and administrators share equally in the blame. "It's a serious social problem that threatens the foundation of our society, our economic competitiveness and our ability to govern ourselves democratically."

Arum and co-author Josipa Roksa, a sociologist at the University of Virginia, found that undergrads study only 13 hours per week, on average, or less than two hours per day in a typical semester. That's half as much as their peers studied in the early 1960s. Today's college students spend more than 80 percent of their time, on average, on work, clubs, fraternities, sororities, sports, volunteering, watching TV, exercising, socializing, playing on their computers and sleeping.

Of more than 3,000 full-time undergraduates in the study, 50 percent took five or fewer classes over their entire four years of college in which they were required to write more than 20 pages per semester. Twenty percent took five or fewer classes requiring more than 40 pages of reading per week. They met with a professor outside of class only once a month, on average.

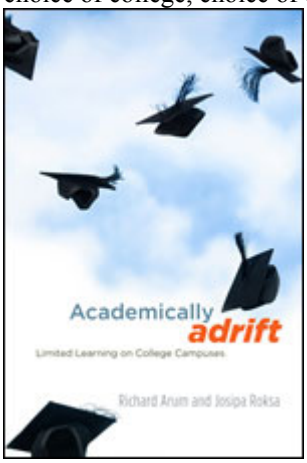
Of course, not all students or professors are neglecting academics: Arum and Roksa found a wide variation in scores among colleges and even wider variation among students at the same colleges. But in an era when elementary and secondary schools are being held strictly accountable for student learning, Arum says, the absence of accountability at the college level is glaring. It's not that faculty doesn't care, he says. It's that the system rewards research, not teaching. "College presidents have to assume the responsibility to provide leadership for improving instruction and measuring learning," Arum said. "They have trustees and regents that report to, and they should be held accountable. Let's start there."

*Source: Academically Adrift: Limited Learning on College Campuses, 2011*

Arum and Roksa's findings, as reported in their book and an accompanying update, largely confirm the work of other scholars. In 2009, for example, Philip Babcock and Mindy Marks, two University of California economists, reported that full-time students in 1961 invested 40 hours per week attending classes and studying, compared to 27 hours per week for students in 2004.

"Study time fell for students from all demographic subgroups, within race, gender, ability, and family background, overall and within major, for students who worked in college and for those who did not, and the declines occurred at four-year colleges of every type, size, degree structure and level of diversity," Babcock and Marks found.

But Arum and Roksa break new ground, too, delving into the past of individual students and following the same individuals through four years of college. To find out how and why they learn, the sociologists tracked their family backgrounds, high school characteristics, advanced placement courses, SAT and ACT scores, choice of college, choice of college major, college coursework, study habits and professors' expectations.

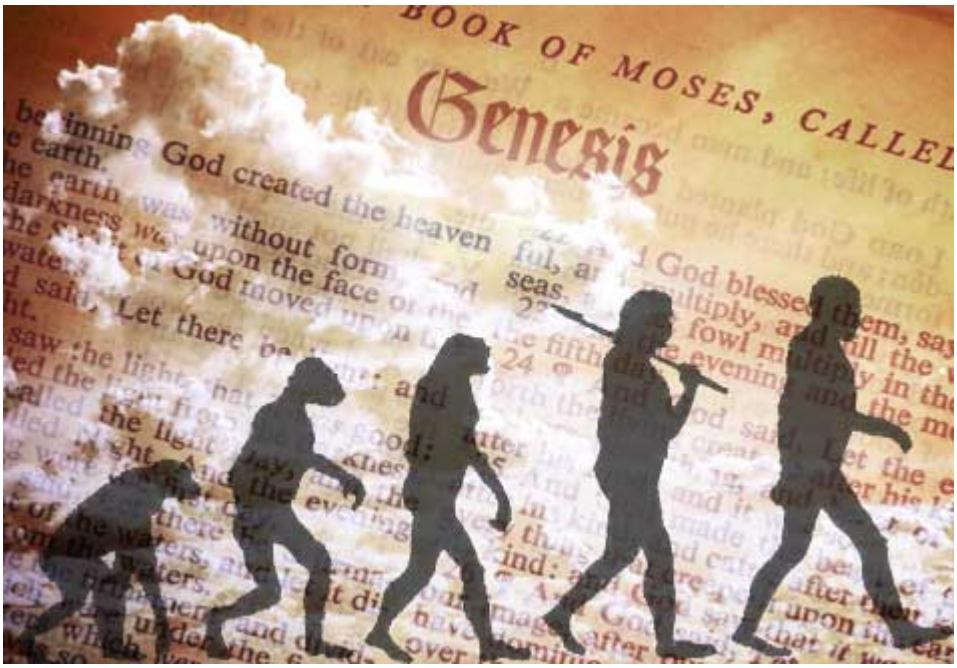



High school preparation counts, their book shows, but the college experience counts just as much. Students who take multiple advanced placement classes in high school and have high SAT and ACT scores perform notably better on the test for critical thinking and complex reasoning, but so do students who enroll in highly selective colleges, pursue demanding majors, take rigorous courses and spend 15 or 20 hours per week

studying alone. (The average college student spends eight hours per week studying alone, and more than a third of undergrads spend five or fewer hours per week studying alone, the authors found.)
Students' majors matter, too. Those in traditional liberal arts fields such as social science, humanities, natural science and mathematics show much higher gains on the critical-thinking test than students in the less demanding "practical arts" – business, education, social work and communications.
Academically Adrift shows that the achievement gap between white and minority students persists at the end of four years of college, and, for African Americans, it widens. "This pattern suggests that higher education in general reproduces social inequality," the authors say.
Finally, Academically Adrift debunks the view, promoted by some colleges, that group studying, working on campus and joining a fraternity or a sorority helps keep potential dropouts in college and therefore enhances learning. Unfortunately, the more time students spend in these activities, the worse they do on the tests for critical thinking. Overall, undergraduates are working at jobs 14 hours per week, on average — more time than they spend preparing for class.
"The simple act of staying enrolled does not ensure that students are learning much," the authors conclude.
What are college students thinking? For a glimpse, Arum and Roksa cite from *College Life Through the Eyes of Students*, a 2009 book about the lives of 60 students during four years at an unnamed public university in the Midwest. Of the 60 undergraduates who were interviewed by Mary Grigsby, a sociologist at the University of Missouri, only four, or 7 percent, regarded academics as their top priority. Seventy percent viewed "social learning" as more important.
"Honestly, I feel like nothing I've learned in the classroom will help me do what I want to do in the end," one coed says. "I think it's the people I meet, the friends I make, that really matter. …"

http://www.miller-mccune.com/culture-society/what-happened-to-academic-rigor-27874/

**Death Anxiety Shapes Views on Evolution**
**New research suggests people reject evolutionary theory because, as a way to think about life and death, it doesn't provide the emotional solace we seek.**
By Tom Jacobs




*Researchers find that people reject the theory of evolution because it doesn't provide a sense of meaning in the face of absolute mortality. However, one study suggests the gap between science and faith can be bridged. (stockxchange.com)*

It may be the foundation of modern biology, but fewer than 40 percent of Americans say they believe in the theory of evolution. While frustrated scientists sometimes blame religion for this knowledge gap, newly published research suggests the key factor isn't faith per se but rather a benefit it provides that Darwin does not: A sense that our all-too-short lives have meaning.

A Canadian study just published in the journal *PLoS ONE* finds a strong link between existential angst and reluctance to embrace the theory of evolution. A team of researchers led by University of British Columbia psychologist Jessica Tracy report reminders of our mortality apparently inspire antagonism toward this basic scientific precept.

Tracy and her colleagues use the framework of terror management theory, which is based on the seminal theories of anthropologist Ernest Becker. According to this extensively researched school of thought, humans buffer their fear of death "by construing the universe as an orderly, comprehensible, predictable and meaningful place, where death can be literally or symbolically transcended.

"For example, a sense of literal immortality may be provided by religious belief in an afterlife, and a sense of symbolic mortality may be provided by 'living on' through one's accomplishments, offspring or cultural affiliations," the researchers write.

Reminders of death tend to evoke "enthusiastic adherence" to our religious and political belief systems, since they are the mechanisms that promise us either literal or symbolic immortality. (This dynamic — the threat of annihilation by an enemy leads us to pledge allegiance to our nation or faith even more vigorously — provides another plausible explanation for the prevalence of war.)

As Tracy and her colleagues note, evolutionary theory, which views human life as the product of a lengthy chain of natural events, seems "existentially bleak" to many people. In contrast, the relatively new notion of intelligent design theory implies "there is a purpose to the human enterprise."

Although there is little evidence to back it up, intelligent design has a strong emotional pull: It "may calm existential concerns through the implication of its assertion that human life was intentionally created, rather than resulting from seemingly random and meaningless forces of nature," they write.

In five experiments, the researchers presented participants with a passage arguing for evolutionary theory and/or a passage arguing for intelligent design theory, then assessed their views of the concepts and the author of each statement. For each study, half of the participants were asked at the outset to imagine their own death, while the others were asked to imagine dental pain (a control condition chosen to elicit negative feelings but not life-threatening ones).

Most of the participants were college students, but one study featured 832 people living in the U.S. who were recruited through an online survey research company. Although not scientifically selected, it was a highly diverse group, in terms of income, age and education level.

Their responses were very much like that of the students. Those who had been contemplating their own mortality expressed relatively more positive reactions to intelligent design theory and its proponent, Michael Behe, and "significantly greater negativity" toward evolutionary theory and its proponent, Richard Dawkins. "Individuals respond to existential threat by becoming more accepting of a theory that offers a greater sense of meaning … and/or less supportive of the theory that is the true mainstay of the scientific worldview, but seems to offer little in the way of existential comfort," they conclude.

So are we emotionally predisposed to stay scientifically ignorant? Not necessarily, Tracy and her colleagues argue. In one of their experiments, featuring 269 psychology students, half of the participants read a passage by cosmologist and science writer Carl Sagan.

In it, he argued that "humans can attain meaning and purpose by seeking to understand the natural origins of life." Even if we are "merely matter," he wrote, "we can still find purpose, but it must be one that we work out for ourselves."

Reading that passage produced the opposite result of the earlier studies. Among those who were exposed to Sagan's notions, thoughts of mortality produced a negative reaction to intelligent design theory and a positive one toward evolution.

It seems the study participants were still looking for meaning in response to an existential threat. But after being told by a trusted source that scientific study can satisfy this longing, they found Darwin's concepts surprisingly appealing.

So, the researchers conclude, resistance to evolutionary theory can be traced to its "apparent lack of an existentially compelling solution to life's origins." But their Sagan study suggests this barrier to acceptance isn't entirely impenetrable.

As Viktor Frankl noted a half century ago, man is strongly inclined to search for meaning. As they ponder how to present their work to the public, scientists are well advised to keep this hunger in mind.

http://www.miller-mccune.com/culture-society/death-anxiety-shapes-views-on-evolution-29580/

**Homeopathy Not All It's Quacked Up to Be**

**Professional skeptic James Randi's offer to pay a million dollars to the maker of any homeopathic remedy that actually works points out the logical fallacies in this branch of 'medicine.'**
By Peter M. Nardi


*Vintage homeopathy: In the old green bottles is Hepar sulph made from calcium sulfide and in the yellow, Rhus toxicodendron, which is derived from poison ivy. Magician and skeptic James Randi has offered a million dollars to anyone who can prove even one remedy works. (Wikipedia.org)*

In February, magician James Randi offered $1 million in a challenge to the manufacturers of homeopathic products to prove their claims. He also asked major drugstore retailers to discontinue carrying these "fake medicines."
Randi, the recipient of a prestigious MacArthur "genius" grant, is the founder/chair of the James Randi Educational Foundation, which promotes critical thinking by investigating paranormal and supernatural claims. For many years, another million dollars has also been available "to anyone who can show, under proper observing conditions, evidence of any paranormal, supernatural, or occult power or event."
Yet, the money remains in an escrow account, earning interest, unclaimed by hundreds of applicants. Now it's time for the homeopathic community to get at Randi's money. And it doesn't take a psychic to see that this money will also likely earn interest in an escrow account for years to come.
According to the Homeopathic Pharmacopoeia of the United States, homeopathy is "the art and the science of healing the sick by using substances capable of causing the same symptoms, syndromes and conditions when administered to healthy people." It is based on the concept *similia similibus curentur*, a Latin expression for "let likes be cured by likes." Developed by German physician Samuel Hahnemann in his 1810 publication *Organon of Rational Therapeutics* (now referred to as *Organon of Medicine*), homeopathy has held a controversial relationship in the medical profession. The homeopathic medical school, Hahnemann Medical College in Philadelphia, stopped focusing on homeopathy in 1920, and ceased offering even elective courses in homeopathy in the 1940s.


SKEPTIC

Yet, these products continue to be sold, resulting in wide-ranging reactions about their efficacy. Other than anecdotal documents, scientific testing has not established that "like cures like." In fact, it's not based on any law of nature or even logic. Follow along with this: a typical remedy involves diluting the relevant ingredients in ever-increasing amounts of distilled water (often mixed with ethyl alcohol) and shaking — or what homeopaths call "succussion" — to the point that barely any molecules of the original substance are left in the preparation. This process results in the "potentization" of the original ingredients and liberates the essence and energy of the substances into the preparation.

In other words, and scientifically contradictory, homeopathic remedies are made powerful by serial dilutions and shakings, even though only trace amounts remain of the original ingredients or none at all. Analogies colorfully describe the equivalent dilution: a pinch of salt in the Atlantic Ocean or, as Hahnemann himself said, a bottle of poison in Lake Geneva.

Take as an example *Arsenicum album*, a very popular homeopathic ingredient derived from arsenic. Too much can kill you but diluted to the point that it's virtually undetectable is supposedly helpful in curing the very symptoms that arsenic causes: headaches, confusion, diarrhea, drowsiness and convulsions (but presumably not death). And while we're at it, toss in anxiety, asthma, food poisoning, flu, psoriasis, flaky scalp, dry eczema, nasal discharge, sore throat and pink eye. The critical thinker should always wonder about any one product that claims to do so much, let alone with a preparation that is chemically barely more than water.

Needless to say, this stretches the skeptical imagination and begs for some scientific research. Or even a personal demonstration: Randi, in his own one-person experiment, swallowed an entire bottle of homeopathic sleeping pills with nary a nodding head.

But let's hear from real scientists. Edzard Ernst, the first professor of complementary medicine in England and former homeopath, scientifically reviews and studies alternative practices. With much controversy, his 2009 *American Journal of Medicine* article with Michael Baum claimed that "Homeopathy is among the worst examples of faith-based medicine that gathers shrill support of celebrities and other powerful lobbies in place of a genuine and humble wish to explore the limits of our knowledge using the scientific method." The authors concluded after reviewing numerous studies that "so far homeopathy has failed to demonstrate efficacy in randomized controlled trials and systematic reviews of well designed studies."

Really though, what's the harm if at worst it's just another proof of the power of placebo? Surely you wouldn't mind if your cold went away six or seven days after taking the homeopathic preparation!

What are the ethical, moral and public health issues when pushing a homeopathic remedy to prevent malaria that is 99.99 percent water with hardly a trace of quinine? And what about the "natural" preparation that promises to cure HIV/AIDS by "oxygenating the cells" and bringing your T-cells back to normal? Or, as a website exclaims: "Approximately 15,000 European Doctors, Naturopaths, and Homeopaths have supplied this amazing remedy to more than 10 million people during the past 70 years to heal over 50 different diseases."

Being skeptical and thoroughly investigating remedies that defy physics and chemistry can help you avoid taking homeopathic substances that may be safe but not effective. More importantly, these treatments could prevent you from trying ones that actually work. Figuring out what works best with established scientific methodologies is the million-dollar question worth pursuing.

http://www.miller-mccune.com/culture-society/homeopathy-not-all-its-quacked-up-to-be-29638/

**Violence and Aggression Linked to Mating in Men's Minds**

**A psychology study from Hong Kong suggests that, among men, the impulses to make love and war are deeply intertwined.**

By Tom Jacob

*Are Betty Grable's legs what the soldiers were truly fighting for during WWII? New research suggests that men's impulses toward mating and war are intrinsically linked. (Wikipedia.org)*

Guys: What do you feel when you look at a photo of an attractive woman? Excited? Intrigued?
How about warlike?
Such a response may seem strange or even offensive. But newly published psychology study suggests it is far from uncommon — and it may help explain the deep psychological roots of warfare.
With yet another war in full swing, we once again face the fundamental question of why groups of humans settle their differences through organized violence. A wide range of motivations have been offered over the years: In a 2002 book, Chris Hedges compellingly argued that war is both an addiction and a way of engaging in the sort of heroic struggle that gives our lives meaning.
Evolutionary psychologists, on the other hand, see war as an extension of mating-related male aggression. They argue men compete for status and resources in an attempt to attract women and produce offspring, thereby passing on their genes to another generation. This competition takes many forms, including violence and aggression against other males — an impulse frowned upon by modern society but one that can be channeled into acceptability when one joins the military.
It's an interesting and well-thought-out theory, but there's not a lot of direct evidence to back it up. That's what makes "The Face That Launched a Thousand Ships," a paper just published in the journal *Personality and Social Psychology Bulletin,* so intriguing.
A team of Hong Kong-based researchers led by psychologist Lei Chang of Chinese University conducted four experiments that suggest a link between the motivation to mate and a man's interest in, or support for, war.

The first featured 111 students (60 men) at a college in China. Each was shown 20 full-body color photographs of members of the opposite sex. Half viewed images of people who had been rated attractive; the other half saw pictures of people classified as unattractive.

Afterward, "participants responded to 39 questions about having wars or trade conflicts with three foreign countries that have had hostile relationships with China in recent history," the researchers write. Twenty-one of the questions "tapped the willingness to go to war with the hostile country," they noted, while 18 addressed "peaceful solutions to trade conflicts."

The results duplicated those of a pilot study: Male participants answering the war-related questions "showed more militant attitudes" if they had viewed the photos of attractive women. This effect was absent in answers to the trade-related questions, nor was it found among women for either set of questions.

In another experiment, 23 young heterosexual males viewed one of two sets of 16 photos. One featured images of Chinese national flags; the other focused on female legs. They then performed a computer test to see how quickly they could respond to common, two-character Chinese words. Half of the words related to war, while the others related to farms.

If they were motivated by nationalism or patriotism, the young men would have presumably responded to the war words more rapidly after having viewed the flag. But in fact, the researchers write, they "responded faster to war words when primed by female legs."

In contrast, the rate at which participants processed farm-related words did not vary depending upon which photos were seen. This result was repeated in a follow-up experiment using a slightly different design.

Why would men with mating on their minds be more receptive to the idea of war? Chang and his colleagues suggest there is a "mating-warring association" deep in the male brain, due to the fact successful warriors have traditionally enjoyed greater access to women.

This instinctual force propels men "to engage in organized lethal aggression by co-opting other human adaptations, including our unique cognitive and social mind," they write. To put it more simply, our rational brains lose the internal battle to our instinctual selves.

If peacocks impress potential mates with colorful feathers, the researchers write, perhaps warriors attract women with their ribbons, badges and fancy dress uniforms. And men's "swords and missiles" may be our answer to a stag's horns: weapons that showcase one's virility.

The researchers concede war is a collective enterprise that cannot be explained entirely by individual motivates. And it's worth noting this theory doesn't explain why women join the military (admittedly in relatively small numbers). Furthermore, while there's no reason to believe their results are culturally driven, it would surely be interesting to try to duplicate them in the U.S. or Europe.

Such caveats aside, their work provides further evidence that the impulse to fight may go deeper than the desire to defend one's nation, religion or tribe. If their thesis is correct, the 1960s slogan "Make love, not war" may have to be revised. Love — at least the sexual variety — may have more in common with war than anyone imagined.

http://www.miller-mccune.com/culture-society/war-mating-linked-in-men%E2%80%99s-minds-29507/

**Is It Ever OK to Spank My Child?**

**Academics come to semantic blows over challenging the baby boom orthodoxy that physical punishment for children is always a bad idea.**
By Richard Korman

*To spank or not to spank, that is the academic question. Some researchers are challenging the baby boom orthodoxy that physical punishment is always a bad idea. (Fertnig / istockphoto.com)*

When psychology professor Marjorie Lindner Gunnoe announced some of her research findings about spanking a little over a year ago, The Center for Effective Discipline, an anti-spanking group, attacked both the research and how the media portrayed it.
In her study, Gunnoe used survey data on youth from ages 12 to 18 about whether they had been spanked, and from the responses, she determined that spanking of children from ages 2 to 6 doesn't put the children at risk for depression, antisocial behavior, violence or sexual activity.
The center's website said that "parents who believe in spanking and some of the media jumped on the opportunity to say that 'spare the rod, spoil the child' is confirmed." It said that the study was unpublished and that its conclusions remain outside mainstream academia.
No academic journal has published the study, but exactly how far outside the mainstream Gunnoe stands may say more about the mainstream than Gunnoe.
If you accept Gunnoe's nuanced view of spanking — that a few calmly delivered swats to the behind of a 2- to 10-year-old, done without rage or face-slapping or belts or switches, won't damage the child — you can't justify support for categorical warnings against any physical punishment by parents.
If you accept the center's view that any spanking is bad given the proof that much spanking is associated with aggression and other harmful effects in children, then Gunnoe is an apologist who muddles the anti-spanking, anti-child abuse message.
But if you talk to and email Gunnoe and her critics, as I did, you might decide that she is a dissident from a humanitarian doctrinal orthodoxy that won't open to even the slightest deviance from its canon.
Later this month, Gunnoe will present in a Montreal symposium her newest spanking research, but she doesn't expect the anti-spanking academic establishment to be any more welcoming or open-minded about her work.

"This is the most politicized area in child psychology, and you really have people working from good motivations. But the strong, strong, strong conviction that they are so right from some of us has affected our objectivity."

One thing no one disagrees about is the idea that some child abuse begins or masquerades as diligent parenting.

The basic anti-spanking position holds that parents in general can't judge when they cross the line between reasonable physical punishment and abuse.

Most often, the following pattern emerges: A child quickly stops hitting friends or throwing rocks soon after a spanking but will likely return to the prohibited behavior; the parent, having watched the spanking initially succeed, applies the punishment again, more severely, then again, escalating toward abuse.

For example, Tennessee police last month charged 33-year-old David Cain of Memphis with child abuse after a grand jury indictment that said he used a belt to "spank" his 7-year-old daughter. She ended up in a local hospital with bruises and swelling on her buttocks, arms and legs.

Elizabeth T. Gershoff, a respected researcher and associate professor at the University of Texas, is a capable opponent of physical punishment. She recommends in a 2008 report that parents avoid it, schools stop using it and governments ban it. Social workers and caregivers should be educated about how physical discipline harms children, she writes.

Pediatricians endorse this anti-spanking approach, more or less. The American Academy of Pediatrics reaffirmed in 2004 an existing policy encouraging parents to use other behavioral controls than spanking. That message resonates with many baby boomers. Some of them, like their parents, conceive of progressive parenting as spanking-free. Partly due to the influence of pediatricians and scholars such as Benjamin Spock and T. Berry Brazelton, timeouts and other forms of discipline replaced hitting.

Despite its decline, spanking is entwined with the culturally complex issues of respect for authority and the proper rearing of children.

Not every parent sees Dr. Spock as gospel. Devout Christians also may take literally the biblical wisdom, "spare the rod, spoil the child." And the U.S. has been and remains a place where some stressed and volatile dads may threaten to "take off their belt," and overworked moms admonish wailing grade-schoolers that they will "give you something to cry about."

Still legal in 20 U.S. states, school paddlings are performed by the tens of thousands each year, although the number is down significantly in the past two decades. Additionally, the federal government is unlikely to ban spanking anytime soon. U.S. Rep. Carolyn Maloney (D-New York) introduced a bill last session to cut off federal funds to states and school districts that allow paddling. It died in committee.

What may matter more is how far we will go to insert statutes and government between parents and children to clarify and enforce the line between legal physical discipline and child abuse.

Gunnoe isn't the only exponent of what has been described as the provisional-spanking school of thought. Another key colleague in the limited spanking camp, Robert E. Larzelere, associate professor at Oklahoma State University, also questions the prevailing never-spank wisdom of the child development and psychology communities. Gunnoe considers Larzelere a superior methodologist. Neither is warmly considered by spanking's opponents.

"I have not had the pleasure of meeting either Gunnoe or Larzelere personally, so I cannot comment on either," says Deborah Sendek, executive director of the anti-spanking Center for Effective Discipline, in a thoughtful email message. "I do believe that they are professionals who believe in what they advocate. I do not think either one of them would ever condone abuse or maltreatment of any child."

But, Sendek says, Gunnoe and Larzelere are misguided in their conclusions.

"They are talking about spanking under very controlled environments — not in the heat of the moment or as a lashing out. I understand their philosophy but respectfully beg to differ. If a parent is going to take the time to step back (cool down) from the immediate anger, frustration, disappointment, then there are other more proactive strategies that can be taken.

"Do I become frustrated, angry, upset with my co-workers, my spouse, my pets, my neighbors, etc.? Most definitely, but I do not strike out and hit them — even if it is to teach a lesson.

"Why should that be different for my child?"

A professor of psychology at Calvin College, a small Christian liberal arts school in Grand Rapids, Mich., Gunnoe is alternately outspoken and self-effacing, especially in deferring to Larzelere's methodological

sophistication and to other accomplished researchers in the field. For herself, Gunnoe, who is 45, has a doctorate, several published studies, has made numerous media appearances, and she has three kids — "only one of which has ever been spanked. I'm not here to say spank, spank, spank."
She also is a dedicated Christian, which exposes her to a special type of criticism.
"And anyone who knows anything about Michigan knows that Grand Rapids is a hotbed of rightist Christian zealots," wrote blogger "Detroit Mark" on the Daily Kos. "A Christian claiming to be a scientist who endorses beating children? Not important to the story?"
"I teach at a religiously affiliated school and Bob's a person of faith also," Gunnoe says of herself and Larzelere. "Nothing equivalent to what I'm saying is in the Bible. I happen to be a person of faith who likes to do good research. Easy to say we're raving fundamentalists and dismiss work. I think Bob and I are a real threat to [the absolute anti-spanking] position."
Much spanking research stands on a foundation of shifting sand. An early, descriptive phase of research conducted in laboratory settings in the late 1950s was succeeded by another phase in the late 1980s that looked at the processes that make punishment effective or ineffective. In the words of Ross D. Parke, a faculty member at the University of California, Riverside, punishment is a packaged variable that requires "unwrapping" to "isolate the components that account for its effectiveness while not destroying the interrelated process under study."
Challenges abound, beginning with the very definition of spanking itself and the limits of isolating causes and effects in the home environment, all the way to the importance of frequency and severity. Much of the recent research has been done in the form of retrospective interviews with parents, kids, or both, but there is still plenty of controversy about what to include and what's good or bad about that.
Two reviews of spanking studies, one by Larzelere (2000) and the other by Gershoff (2002), found that spanking gets immediate results, works better before adolescence and has some bad effects the more frequently it is carried out.
As Gunnoe explains it, some researchers conceive of physical discipline differently. Some "draw a sharp distinction between 'customary spanking' and 'abuse.'"
Larzelere, for example, in his meta-analysis of 38 studies limited his review to studies of non-abusive corporal punishment and eliminated any studies dominated by the severity of the punishment. His study considered how spanking children under the age of 13 affects the children when they are older but not yet adults.
Gershoff, by comparison, in her meta-analysis of 88 studies said she excluded studies where punishment was deliberately intended to cause injury, but she did include other types of corporal punishment. She included punishments that included hitting with an object, and one of her studies included frequent punching and hitting with a stick or belt. Gershoff's meta-analysis was aimed at determining how spanking affects later childhood and adult life to see if it is associated with aggression, delinquency, antisocial behavior and abusive behavior toward others.
There were 18 studies that both researchers included, but Larzelere excluded 34 studies considered by Gershoff because of the severity of the punishment or the breadth of the measure of punishment. Gershoff excluded 20 studies considered by Larzelere.
Gunnoe's journey to social science contrarian began in 1997, when the *Archives of Pediatric and Adolescent Medicine* published her first spanking paper in an issue that included a paper by a well-known professor of sociology and spanking opponent, Murray A. Straus.
She wrote, "For most children, claims that spanking teaches aggression seem unfounded," while he wrote, "When parents use corporal punishment to reduce [antisocial behavior], the long-term effect tends to be the opposite."
Gunnoe is looking forward to the coming biennial meeting of the Society for Research in Child Development, where her most recent findings will be presented in a symposium.
Framed as a response to what she sees as the anti-spanking doctrine's influence in changing laws, clinical practices and social-worker training, Gunnoe's writes in her most recent paper that all the changes have been prompted "by the largely untested supposition that never-spanked youth are better adjusted than spanked youth."
Using data from the Portraits of American Life Study, which collects information from several thousand individuals, Gunnoe looked at 183 interviews with adolescents who answered questions online or on a paper

survey. When comparing never-spanked youth and youth last-spanked from age 2 to 6, the spanked youth were more optimistic about their future. For youth whose physical discipline stopped between the ages of 7 and 11, the spanked youth fared better in three out of four measures.

Gunnoe doesn't think spanking directly *caused* the 2- to 6-year-olds in her sample to be more optimistic when they answered questions at ages 12 to 18 for the study. "To the degree that I am comfortable speculating causation, I expect that willingness to spank — if necessary — is part of a very different parenting package than an a priori commitment to never spank."

Willingess to spank, she explains, communicates that parents are in charge and certain standards will be enforced; the commitment never to spank communicates a false sense of immunity from imposed physical control that even adults abdicate when they routinely violate the rights of others.

Gunnoe's conditional support of limited spanking as a last resort is hardly a hearty endorsement of physical punishment.

But the anti-spanking establishment comes at the research from one direction only, Gunnoe complains, mostly based on social-learning theory.

"I'm trying to get folks to understand the nuances and complexity of the issue and the gaps in the research," Gunnoe told me. "Many high-IQ kids from well-adjusted homes can be raised without spanking. As a general rule, social scientists should encourage parents to give non-physical methods a sustained try before turning to [physical discipline]."

If her anti-spanking rivals were not promoting a distorted account of the research, Gunnoe says, she would be promoting an anti-spanking message herself. But for some kids, she adds, "spanking can be a helpful tool in eliciting necessary levels of child compliance, and we should not outlaw it because a minority of parents go too far."

http://www.miller-mccune.com/culture/is-it-ever-ok-to-spank-my-child-29529/

**Childhood Memories Provoke Charitable Behavior**

**New Harvard University research suggests childhood memories stimulate selflessness.**
By Tom Jacobs

*Remembering the time you scored a goal in that soccer game when you were a kid? That memory might make you more charitable, new research suggests. (istockphoto.com)*

Remember your first bicycle? How about your first pet? If such inquiries conjure up images from your formative years, be grateful: Briefly reliving moments from childhood may make you a better person.
According to a Harvard Business School Working Paper, triggering childhood memories stimulates people to behave more helpfully and charitably. Researchers Francesca Gino and Sreedhari Desai report these early memories activate feelings of moral purity linked in our minds with the innocence of youth.
Surprisingly, the results of their experiments suggest it doesn't matter if a childhood memory is happy or sad. Either way, evoking that early stage of life and the sense of innate goodness it suggests appear to be an effective catalyst for pro-social behavior.
The researchers describe four experiments that provide evidence for their thesis. The first featured 113 undergraduates, half of whom spent five to 10 minutes writing an essay about a specific childhood memory and the emotions it evoked. The others wrote about a recent trip to the supermarket.
Afterward, all rated their current emotional state and feelings of moral purity, responding to such statements as "I feel innocent."
They were then told the experiment was over, but offered "the option of helping the experimenter with an extra task, described as pilot testing for another project." This involved answering a brief questionnaire about sports and health habits.
Seventy-five percent of participants who had described a scene from their childhood expressed willingness to help out the experimenter by completing the extra task, compared to 54.5 of those who had mentally traveled down the produce aisle.
The second experiment, featuring 103 undergrads, was similar to the first, except that in conclusion, participants were asked whether they wanted to donate money to help the survivors of the Haitian earthquake (which had taken place the week before). Once again, those who recalled childhood memories were more likely to help, with 61.5 giving money compared to 41.2 percent of the control group.
In another test, the participants — 194 adults, some of whom were parents — were randomly assigned to either write about a good childhood memory, a bad childhood memory or that trip to the grocery store.

Afterward, they read a purportedly true story about a student who was going through a rough time after being injured in an auto accident. They expressed their feelings about the man and reported their willingness to help him out by taking notes at a class he couldn't attend.

Those who had recalled childhood memories expressed more empathy for the man and were more willing to assist him. Interestingly, there was no significant difference between those who wrote about good times and bad times.

Gino and Desai found no connection between these pro-social attitudes and any feelings of nostalgia they brought up. Rather, they write, "people's mental representation of childhood is linked to the construct 'moral purity,'" and when that notion is activated in their minds by childhood memories, they are more likely to behave in ways that reflect those moral strictures.

So should we all keep a photo of our first dog Skip — the one Dad ran over with the station wagon — on our desks, as a cue to act less selfishly? Perhaps so. Gino and Desai note approvingly that some major employers, including Google, "organize their space such that employees are surrounded by toys and colorful furniture." No wonder they're not evil.

But the researchers also uncovered a more complicated aspect of this phenomenon. In another experiment, conducted along similar lines, participants read a story about ethically questionable behavior. (A job applicant seizes an opportunity to obtain private information that will increase the likelihood he'll be hired.) They were then asked to judge the ethics of the person involved and indicate how harshly he should be punished.

Compared to the control group, those who had written about a childhood memory judged his behavior as more unethical and indicated they would punish him more severely. Those feelings of moral purity apparently inspired them to expect — if not demand — the same purity in others.

So evoking childhood memories doesn't produce the sort of nuanced ethical thinking that is arguably appropriate for dealing with real-world situations. But it could be an effective strategy for soliciting charitable donations.

Charles Dickens knew this intuitively: Gino and Desai note that after the miserly Scrooge revisits his childhood in *A Christmas Carol*, he expresses regret for not giving a boy a coin the night before. Even for the humbug-inclined, it seems, memories of a tender age activate tender feelings.

http://www.miller-mccune.com/culture-society/childhood-memories-provoke-charitable-behavior-29402/

**Fighting Fatigue with Diet**

Though fatigue is poorly understood, food researchers know that a better diet can keep us energized throughout the day. Learn about the foods that help keep you feeling at your peak.
By Erik Strand, published on October 01, 2003 - last reviewed on February 25, 2011

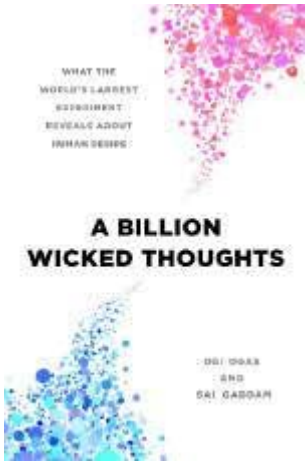
Everyone from time to time experiences fatigue; for some it is an almost daily struggle. It can be a serious drag on your mood.
Broadly speaking, fatigue is simply mental or physical exhaustion. In many ways it is a normal phenomenon, a process that slows the body down at the end of the day and prepares us for sleep, or protects overworked muscles from possible injury. Too often however, fatigue is a negative force in our lives: at best an inconvenience, at worst completely debilitating. Though fatigue is poorly understood, some simple dietary changes can help us keep fatigue from getting us down.
**Drink plenty of water**. We've all been told a thousand times, but a lot of us still don't get enough. Mild dehydration is a common and often overlooked cause of fatigue. Dehydration can reduce blood flow to organs, slowing down your brain—and you along with it. Drink about eight glasses of water a day, and don't wait until you're thirsty.

**Eat breakfast**. The brain is fuel-hungry, using up to 30 percent of calories. A good breakfast refills our energy stores, keeping lethargy at bay during the morning hours. This is especially true for children, who have a higher metabolism and smaller energy reserves. Include carbohydrates at breakfast—a whole grain muffin with peanut butter, a piece of fruit and a glass of skim milk.
**Eat protein and carbs in combination, especially at lunch**. It's not your imagination: that drowsy, dopey feeling you get around 4pm is part of your brain's natural daily rhythms. Dr. Judith Wurtman, a pioneering food researcher at MIT, recommends eating carbohydrates and protein in tandem at lunchtime to fight the afternoon doldrums. Protein contains the amino acid tryptophan, precursor of serotonin, a neurotransmitter that promotes a calm, relaxed feeling, which helps to fight emotional fatigue. Eaten with protein, carbohydrates may boost the brain's intake of tryptophan. Protein-rich foods also contain tyrosine, a precursor to neurotransmitters dopamine and norepinephrine, promoters of alertness, attention, and motivation.
"There's one group of people who are especially susceptible to afternoon fatigue," says Wurtman. "They're called 'women.'" Women often choose skimpy salads for lunch, leaving them at a loss for the nutrients they need. Opt instead for lean protein and unrefined carbohydrates to elevate energy and mood.
**Use caffeine judiciously**. Caffeinated beverages fight fatigue. Caffeine not only makes you feel more energized, it also increases alertness, reaction speed and ability to think clearly for up to three hours. Harris Lieberman, Ph.D., research psychologist for the U.S. Army, reports that even if you're already rested, a single can of cola can improve vigilance—the ability to pay attention to a boring task. But five or six cups of coffee a day can make you irritable and jittery, actually decreasing performance on some tasks; caffeine late in the day can cause insomnia. If caffeine's your thing, try one cup in the morning and a Diet Coke with lunch.

**Get enough calories, but avoid big meals**. While overeating is a serious problem for many folks (and can itself lead to fatigue), if you're an intensely active person or you're on a stringent diet, you may not be getting enough calories. Needs vary: take care to consume enough calories for your gender, body type and activity level. High-intensity exercisers need to get enough protein.
Don't, however, take all your calories in one or two daily feasts. Instead, eat five or six smaller meals. A full stomach draws blood to the belly and away from the brain, leaving you listless and dull. Smaller meals also help to keep insulin levels constant, avoiding fluctuations of energy and mood.
**Eat iron-rich foods**. Iron enables blood to carry oxygen to the organs of the body. Deprived of adequate oxygen, the brain cannot function optimally, leading to lack of mental acuity and feelings of fatigue. Iron intake is not in general a problem for men, but many women have mild iron deficiency. If you suspect you're not getting enough iron, boost your intake with foods like lean red meat, liver, spinach, and apricots.

http://www.psychologytoday.com/articles/200310/fighting-fatigue-diet

**The World's Largest Experiment in Human Behavior**




An unprecedented new landscape of data documents our sexual interests
Published on April 11, 2011
***How men like slender women endowed with gigantic penises, and women like reading about rugged men having unlubed sex with other men.***
*Homo sapiens*' sexual predilections have always been tough to nail down. Most people don't make merry love in shopping malls and public squares. We are loathe to share our intimate desires with neighbors or scientists. Our brains recoil in disgust or ignite in anger when confronted with sexual ideas different from our own. Alfred Kinsey was the first and only scientist to systematically document the sexual interests of a large sample of Homo sapiens--and rarely has a scientist encountered such hostility and outrage. More than enough social outrage to prevent any subsequent researcher from extending his survey.
As a result, it hasn't been possible to "***see what's on the end of everyone's fork***," to steal an expression from William Burroughs. What do men and women *truly* like? Scientists just haven't been able to get accurate data.

Until now.
Here is the record of one man's sexual predilections:
**college cheerleaders**
**cheerleaders in Hawaii**
**pics of bikinis and girls**
**the sin of masturbation**
**pretty girls in bikinis**
**girls suntanning in bikinis**
**college cheerleader pics in bikinis**
**nooooooo**
**christian advice on lust**

And one woman's:
**harry draco fan fiction**
**www.adultfanfiction.net**
**lyrics which backstreet boy's gay**
**draco harry slash**
**adultfanfiction harry draco blackmail hermione bdsm**
**gary roberts buffy in hell**
**recipes deliciousindia.co.m**
**disney male nudity rated g**

**can you get an std if you use a vibrator**

A Search History
These are fragments of an unprecedented new landscape of data documenting humankind's private interests. Specifically, these are two abbreviated search histories taken from America Online search data. For the first time in human history, each one of us now has the ability to instantly request ANY kind of erotica imaginable by making a wish to the genie of a million squicks: the internet.
As the internet has matured and evolved, it has become an ever-growing cross-cultural repository of all of our fantasies and a reflection of our aggregate psyche. By examining the content, frequency, and distribution of these fantasies we can obtain a clear picture of what men and women really like.
In our research, we have done exactly that. **We analyzed a billion web searches, a million Web sites, a million erotic stories, a half-million erotic videos, millions of personal ads, millions of online dating responses, millions of paid subscriptions to adult sites, tens of thousands of comments on erotic sites, tens of thousands of digitized romance novels, and much more.**
We now know, for example, that men seek out penises almost as often as they seek out vaginas. We know that women virtually never pay for online porn. We know that men search for overweight women three times as often as they search for underweight women. We know that women around the world enjoy romantic and erotic stories about two men. We know that virtually all of clinical psychology's ideas about the prevalence of various fetishes (*paraphilias* in the literature) are completely and embarrassingly *wrong*.
In other words, we can finally see what's on the end of everyone's fork. And uncovering *what* we really like is the first, essential step in explaining *why*.

http://www.psychologytoday.com/blog/billion-wicked-thoughts/201104/the-worlds-largest-experiment-in-human-behavior

**New Genetic Study Helps Solve Darwin's Mystery About Ancient Evolution of Flowering Plants**

*Amborella trichopoda, a flowering plant. Amborella trichopoda is a basal angiosperm and the earliest surviving branch of the angiosperm tree of life. This plant was included in the Ancestral Angiosperm Genome Project. (Credit: Sangtae Kim)*

ScienceDaily (Apr. 11, 2011) — The evolution and diversification of the more than 300,000 living species of flowering plants may have been "jump started" much earlier than previously calculated, a new study indicates. According to Claude dePamphilis, a professor of biology at Penn State University and the lead author of the study, which includes scientists at six universities, two major upheavals in the plant genome occurred hundreds of millions of years ago -- nearly 200 million years earlier than the events that other research groups had described. The research also indicates that these upheavals produced thousands of new genes that may have helped drive the evolutionary explosion that led to the rich diversity of present-day flowering plants. The study, which provides a wealth of new genetic data and a more precise evolutionary time scale, is expected to change the way biologists view the family trees of plants in general and flowering plants in particular.

The research findings are posted on the early online website of the journal *Nature* on 10 April 2011, and later will be published in the journal.

"We began with some intense genomic detective work -- combing through nine previously sequenced plant genomes, plus millions of new gene sequences that the Ancestral Angiosperm Genome Project (http://ancangio.uga.edu/) had gathered from the earliest surviving lineages of flowering plants," dePamphilis said. "We knew that, at some point in ancient history, one or more important genetic metamorphoses had occurred in the ancestor of flowering plants, and we also knew that these metamorphoses could explain the enormous success of so many species living on the Earth today. Most importantly, we suspected that these important changes had been driven by a common mechanism instead of by many independent events."

DePamphilis explained that, after examining volumes of molecular evidence, his team discovered and calculated the dates for two instances of a special kind of DNA mutation -- called a polyploidy event -- that revolutionized the flowering-plant lineage.

"A polyploidy event is basically the acquisition, through mutation, of a 'double dose' of genetic material," explained Yuannian Jiao, a graduate student at Penn State and the first author of the study. "In vertebrates, although genome duplication is known to occur, it generally is lethal. Plants, on the other hand, often survive and can sometimes benefit from duplicated genomes." Jiao explained that, over the generations, most duplicated genes from polyploidy events simply are lost. However, other genes adopt new functions or, in some instances, subdivide the workload with the genetic segments that were duplicated, thereby cultivating more efficiency and better specialization of tasks for the genome as a whole.

Jiao also explained that, although ancient events of polyploidy have been well documented in plant-genome-sequencing projects, biologists had dated the earliest polyploidy event in flowering plants at around 125 to 150 million years ago. "There were hints that even earlier events had occurred, but no good evidence," Jiao said. "That's what makes our team's findings so exciting. We identified at least two major events -- one occurring in the ancestor of all seed plants about 320 million years ago, and another occurring in the flowering-plant lineage specifically, about 192 to 210 million years ago. That's up to 200 million years earlier than such events were assumed to have taken place."

DePamphilis added that such polyploidy events probably set in motion a kind of genomic renaissance, and that present-day varieties now are reaping the rewards. "Thanks to events such as these, where vast stretches of DNA have been duplicated and added to the genome, flowering plants have been able to evolve new and better functions. They have seized on the opportunity to become so diverse, so exquisite, and so prevalent," dePamphilis said. He explained that his team was able to trace the history of some of the major genes that define how flowering plants work. "Some of these new genes led to true innovations and have become vital parts of the genetic toolkit for the regulation of flower development," he said. "In other words, without the genes that these polyploidy events helped to create, flowering plants as we know them today probably would not exist."

DePamphilis also said that, thanks to the two polyploidy events that his research team identified, flowering plants may have enjoyed a distinct evolutionary advantage that allowed them to survive harsh climate changes and even mass extinctions. One such extinction that was accompanied by more-recent polyploidy events in several flowering-plant groups was the Cretaceous-Tertiary extinction event (the K-T event) -- a mass extinction of animals and plants that occurred approximately 65.5 million years ago that may have been triggered by a massive asteroid impact.

"Ever since Charles Darwin so famously called the rapid diversification of flowering plants in the fossil record an 'abominable mystery,' generations of scientists have worked to solve this puzzle," dePamphilis said. "We used to say that most of the hundreds of thousands of successful species of flowering plants show genetic traces of ancient polyploidy events. The further we push back the date of when these events happened, the more confidently we can claim that, not most, but all flowering plants are the result of large-scale duplications of the genome. It's possible that the important polyploidy events we've identified were the equivalent of two 'big bangs' for flowering plants."

In addition to dePamphilis and Jiao, other researchers who contributed to the study include Norman J. Wickett, Lena Landherr, Paula E. Ralph, Lynn P. Tomsho, Yi Hu, Stephan C. Schuster, and Hong Ma from Penn State; Saravanaraj Ayyampalayam and Jim Leebens-Mack from the University of Georgia; André S. Chanderbali, Pamela S. Soltis, and Douglas E. Soltis from the University of Florida; Haiying Liang from Clemson University; Sandra W. Clifton from Washington University; and Scott E. Schlarbaum from the University of Tennessee.

The work was funded, primarily, by the National Science Foundation Plant Genome Research Program (the Ancestral Angiosperm Genome Project), and, in part, by the Penn State Department of Biology, the Huck Institutes of the Life Sciences at Penn State, and Fudan University in China.

**Story Source:**

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Penn State**.

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**Journal Reference**:

1. Yuannian Jiao, Norman J. Wickett, Saravanaraj Ayyampalayam, André S. Chanderbali, Lena Landherr, Paula E. Ralph, Lynn P. Tomsho, Yi Hu, Haiying Liang, Pamela S. Soltis, Douglas E. Soltis, Sandra W. Clifton, Scott E. Schlarbaum, Stephan C. Schuster, Hong Ma, Jim Leebens-Mack, Claude W. dePamphilis. **Ancestral polyploidy in seed plants and angiosperms**. *Nature*, 2011; DOI: 10.1038/nature09916

http://www.sciencedaily.com/releases/2011/04/110410181309.htm

**Squid and Octopuses Experience Massive Acoustic Trauma from Noise Pollution in the Oceans**

*Noise pollution in the oceans has been shown to cause physical and behavioral changes in marine life, especially in dolphins and whales, which rely on sound for daily activities. However, low frequency sound produced by large scale, offshore activities is also suspected to have the capacity to cause harm to other marine life as well. (Credit: © Mykel / Fotolia)*

ScienceDaily (Apr. 11, 2011) — Noise pollution in the oceans has been shown to cause physical and behavioral changes in marine life, especially in dolphins and whales, which rely on sound for daily activities. However, low frequency sound produced by large scale, offshore activities is also suspected to have the capacity to cause harm to other marine life as well.

Giant squid, for example, were found along the shores of Asturias, Spain in 2001 and 2003 following the use of airguns by offshore vessels and examinations eliminated all known causes of lesions in these species, suggesting that the squid deaths could be related to excessive sound exposure.

Michel André, Technical University of Catalonia in Barcelona, and colleagues examined the effects of low frequency sound exposure -- similar to what the giant squid would have experienced in Asturias -- in four cephalopod species. As reported in an article published in *Frontiers in Ecology and the Environment*, a journal of the Ecological Society of America, all of the exposed squid, octopus and cuttlefish exhibited massive acoustic trauma in the form of severe lesions in their auditory structures.

The researchers exposed 87 individual cephalopods -- specifically, *Loligo vulgaris, Sepia officinalis, Octopus vulgaris* and *Illex coindeti* -- to short sweeps of relatively low intensity, low frequency sound between 50 and 400 Hertz (Hz) and examined their statocysts. Statocysts are fluid-filled, balloon-like structures that help these invertebrates maintain balance and position -- similar to the vestibular system of mammals. The scientists' results confirmed that statocysts indeed play a role in perceiving low frequency sound in cephalopods.

André and colleagues also found that, immediately following exposure to low frequency sound, the cephalopods showed hair cell damage within the statocysts. Over time, nerve fibers became swollen and, eventually, large holes appeared -- these lesions became gradually more pronounced in individuals that were examined several hours after exposure. In other words, damage to the cephalopods' auditory systems emerged immediately following exposure to short, low intensity sweeps of low frequency sound. All of the individuals exposed to the sound showed evidence of acoustic trauma, compared with unexposed individuals that did not show any damage.

"If the relatively low intensity, short exposure used in our study can cause such severe acoustic trauma, then the impact of continuous, high intensity noise pollution in the oceans could be considerable," said André. "For example, we can predict that, since the statocyst is responsible for balance and spatial orientation, noise-induced damage to this structure would likely affect the cephalopod's ability to hunt, evade predators and even reproduce; in other words, this would not be compatible with life."

The effect of noise pollution on marine life varies according to the proximity of the animal to the activity and the intensity and frequency of the sound. However, with the increase in offshore drilling, cargo ship

transportation, excavation and other large-scale, offshore activities, it is becoming more likely that these activities will overlap with migratory routes and areas frequented by marine life.
"We know that noise pollution in the oceans has a significant impact on dolphins and whales because of the vital use of acoustic information of these species," said André, "but this is the first study indicating a severe impact on invertebrates, an extended group of marine species that are not known to rely on sound for living. It left us with several questions: Is noise pollution capable of impacting the entire web of ocean life? What other effects is noise having on marine life, beyond damage to auditory reception systems? And just how widespread and invasive is sound pollution in the marine environment?"

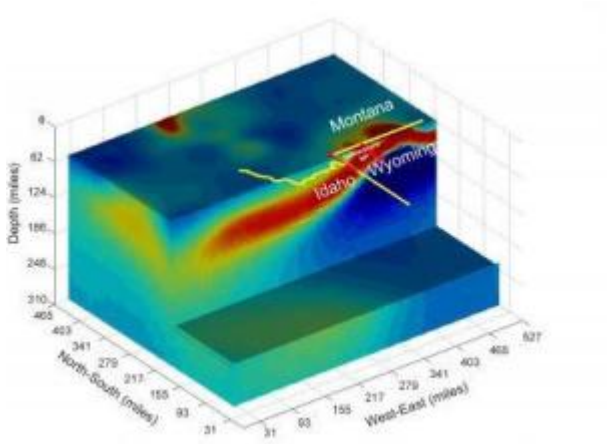
**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Ecological Society of America**, via EurekAlert!, a service of AAAS.

**Journal Reference**:

1. Michel André, Marta Solé, Marc Lenoir, Mercè Durfort, Carme Quero, Alex Mas, Antoni Lombarte, Mike van der Schaar, Manel López-Bejar, Maria Morell, Serge Zaugg, Ludwig Houégnigan. **Low-frequency sounds induce acoustic trauma in cephalopods**. *Frontiers in Ecology and the Environment*, 2011; : 110408135918022 DOI: 10.1890/100124

http://www.sciencedaily.com/releases/2011/04/110411111032.htm

**Electric Yellowstone: Conductivity Image Hints Supervolcano Plume Is Bigger Than Thought**




*This image, based on variations in electrical conductivity of underground rock, shows the volcanic plume of partly molten rock that feeds the Yellowstone supervolcano. Yellow and red indicate higher conductivity, green and blue indicate lower conductivity. Made by University of Utah geophysicists and computer scientists, this is the first large-scale "geoelectric" image of the Yellowstone hotspot. (Credit: University of Utah.)*

ScienceDaily (Apr. 10, 2011) — University of Utah geophysicists made the first large-scale picture of the electrical conductivity of the gigantic underground plume of hot and partly molten rock that feeds the Yellowstone supervolcano. The image suggests the plume is even bigger than it appears in earlier images made with earthquake waves.

"It's like comparing ultrasound and MRI in the human body; they are different imaging technologies," says geophysics Professor Michael Zhdanov, principal author of the new study and an expert on measuring magnetic and electrical fields on Earth's surface to find oil, gas, minerals and geologic structures underground.

"It's a totally new and different way of imaging and looking at the volcanic roots of Yellowstone," says study co-author Robert B. Smith, professor emeritus and research professor of geophysics and a coordinating scientist of the Yellowstone Volcano Observatory.

The new University of Utah study has been accepted for publication in *Geophysical Research Letters*, which plans to publish it within the next few weeks.

In a December 2009 study, Smith used seismic waves from earthquakes to make the most detailed seismic images yet of the "hotspot" plumbing that feeds the Yellowstone volcano. Seismic waves move faster through cold rock and slower through hot rock. Measurements of seismic-wave speeds were used to make a three-dimensional picture, quite like X-rays are combined to make a medical CT scan.

The 2009 images showed the plume of hot and molten rock dips downward from Yellowstone at an angle of 60 degrees and extends 150 miles west-northwest to a point at least 410 miles under the Montana-Idaho border -- as far as seismic imaging could "see."

In the new study, images of the Yellowstone plume's electrical conductivity -- generated by molten silicate rocks and hot briny water mixed in partly molten rock -- shows the conductive part of the plume dipping more gently, at an angle of perhaps 40 degrees to the west, and extending perhaps 400 miles from east to west. The geoelectric image can "see" only 200 miles deep.

**Two Views of the Yellowstone Volcanic Plume**

Smith says the geoelectric and seismic images of the Yellowstone plume look somewhat different because "we are imaging slightly different things." Seismic images highlight materials such as molten or partly molten rock that slow seismic waves, while the geoelectric image is sensitive to briny fluids that conduct electricity.

"It [the plume] is very conductive compared with the rock around it," Zhdanov says. "It's close to seawater in conductivity."

The lesser tilt of the geoelectric plume image raises the possibility that the seismically imaged plume, shaped somewhat like a tilted tornado, may be enveloped by a broader, underground sheath of partly molten rock and liquids, Zhdanov and Smith say.
"It's a bigger size" in the geoelectric picture, says Smith. "We can infer there are more fluids" than shown by seismic images.
Despite differences, he says, "this body that conducts electricity is in about the same location with similar geometry as the seismically imaged Yellowstone plume."
Zhdanov says that last year, other researchers presented preliminary findings at a meeting comparing electrical and seismic features under the Yellowstone area, but only to shallow depths and over a smaller area.
The study was conducted by Zhdanov, Smith, two members of Zhdanov's lab -- research geophysicist Alexander Gribenko and geophysics Ph.D. student Marie Green -- and computer scientist Martin Cuma of the University of Utah's Center for High Performance Computing. Funding came from the National Science Foundation (NSF) and the Consortium for Electromagnetic Modeling and Inversion, which Zhdanov heads.

**The Yellowstone Hotspot at a Glance**

The new study says nothing about the chances of another cataclysmic caldera (giant crater) eruption at Yellowstone, which has produced three such catastrophes in the past 2 million years.
Almost 17 million years ago, the plume of hot and partly molten rock known as the Yellowstone hotspot first erupted near what is now the Oregon-Idaho-Nevada border. As North America drifted slowly southwest over the hotspot, there were more than 140 gargantuan caldera eruptions -- the largest kind of eruption known on Earth -- along a northeast-trending path that is now Idaho's Snake River Plain.
The hotspot finally reached Yellowstone about 2 million years ago, yielding three huge caldera eruptions about 2 million, 1.3 million and 642,000 years ago. Two of the eruptions blanketed half of North America with volcanic ash, producing 2,500 times and 1,000 times more ash, respectively, than the 1980 eruption of Mount St. Helens in Washington state. Smaller eruptions occurred at Yellowstone in between the big blasts and as recently as 70,000 years ago.
Seismic and ground-deformation studies previously showed the top of the rising volcanic plume flattens out like a 300-mile-wide pancake 50 miles beneath Yellowstone. There, giant blobs of hot and partly molten rock break off the top of the plume and slowly rise to feed the magma chamber -- a spongy, banana-shaped body of molten and partly molten rock located about 4 miles to 10 miles beneath the ground at Yellowstone.

**Computing a Geoelectrical Image of Yellowstone's Hotspot Plume**

Zhdanov and colleagues used data collected by EarthScope, an NSF-funded effort to collect seismic, magnetotelluric and geodetic (ground deformation) data to study the structure and evolution of North America. Using the data to image the Yellowstone plume was a computing challenge because so much data was involved.
Inversion is a formal mathematical method used to "extract information about the deep geological structures of Earth from the magnetic and electrical fields recorded on the ground surface," Zhdanov says. Inversion also is used to convert measurements of seismic waves at the surface into underground images.
Magnetotelluric measurements record very low frequencies of electromagnetic radiation -- about 0.0001 to 0.0664 Hertz -- far below the frequencies of radio or TV signals or even electric power lines. This low-frequency, long-wavelength electromagnetic field penetrates a couple hundred miles into Earth. By comparison, TV and radio waves penetrate only a fraction of an inch.
The EarthScope data were collected by 115 stations in Wyoming, Montana and Idaho -- the three states straddled by Yellowstone National Park. The stations, which include electric and magnetic field sensors, are operated by Oregon State University for the Incorporated Research Institutions for Seismology, a consortium of universities.
In a supercomputer, a simulation predicts expected electric and magnetic measurements at the surface based on known underground structures. That allows the real surface measurements to be "inverted" to make an image of underground structure.
Zhdanov says it took about 18 hours of supercomputer time to do all the calculations needed to produce the geoelectric plume picture. The supercomputer was the Ember cluster at the University of Utah's Center for High Performance Computing, says Cuma, the computer scientist.

Ember has 260 nodes, each with 12 CPU (central processing unit) cores, compared with two to four cores commonly found on personal computer, Cuma says. Of the 260 nodes, 64 were used for the Yellowstone study, which he adds is "roughly equivalent to 200 common PCs."
To create the geoelectric image of Yellowstone's plume required 2 million pixels, or picture elements.

**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Utah**.

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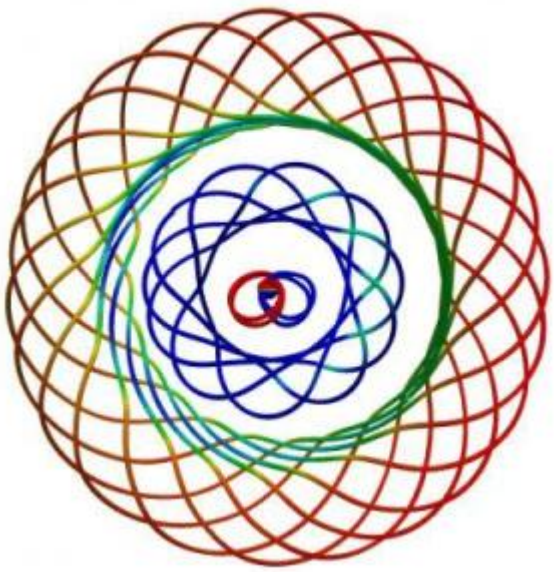
**Journal Reference**:

1. Zhdanov, M. S., R. B. Smith, A. Gribenko, M. Cuma, and M. Green. **Three-Dimensional Inversion of Large-Scale EarthScope Magnetotelluric Data Based On The Integral Equation Method: Geoelectrical Imaging Of The Yellowstone Conductive Mantle Plume**. *Geophys. Res. Lett.*, 2011 DOI: 10.1029/2011GL046953

http://www.sciencedaily.com/releases/2011/04/110411083533.htm

**Physicists Discover New Way to Visualize Warped Space and Time**



*Two doughnut-shaped vortexes ejected by a pulsating black hole. Also shown at the center are two red and two blue vortex lines attached to the hole, which will be ejected as a third doughnut-shaped vortex in the next pulsation. (Credit: The Caltech/Cornell SXS Collaboration)*

ScienceDaily (Apr. 11, 2011) — When black holes slam into each other, the surrounding space and time surge and undulate like a heaving sea during a storm. This warping of space and time is so complicated that physicists haven't been able to understand the details of what goes on -- until now.

"We've found ways to visualize warped space-time like never before," says Kip Thorne, Feynman Professor of Theoretical Physics, Emeritus, at the California Institute of Technology (Caltech).

By combining theory with computer simulations, Thorne and his colleagues at Caltech, Cornell University, and the National Institute for Theoretical Physics in South Africa have developed conceptual tools they've dubbed tendex lines and vortex lines.

Using these tools, they have discovered that black-hole collisions can produce vortex lines that form a doughnut-shaped pattern, flying away from the merged black hole like smoke rings. The researchers also found that these bundles of vortex lines -- called vortexes -- can spiral out of the black hole like water from a rotating sprinkler.

The researchers explain tendex and vortex lines -- and their implications for black holes -- in a paper that's published online on April 11 in the journal *Physical Review Letters*.

Tendex and vortex lines describe the gravitational forces caused by warped space-time. They are analogous to the electric and magnetic field lines that describe electric and magnetic forces.

Tendex lines describe the stretching force that warped space-time exerts on everything it encounters. "Tendex lines sticking out of the moon raise the tides on the Earth's oceans," says David Nichols, the Caltech graduate student who coined the term "tendex." The stretching force of these lines would rip apart an astronaut who falls into a black hole.

Vortex lines, on the other hand, describe the twisting of space. If an astronaut's body is aligned with a vortex line, she gets wrung like a wet towel.

When many tendex lines are bunched together, they create a region of strong stretching called a tendex. Similarly, a bundle of vortex lines creates a whirling region of space called a vortex. "Anything that falls into a vortex gets spun around and around," says Dr. Robert Owen of Cornell University, the lead author of the paper.

Tendex and vortex lines provide a powerful new way to understand black holes, gravity, and the nature of the universe. "Using these tools, we can now make much better sense of the tremendous amount of data that's

produced in our computer simulations," says Dr. Mark Scheel, a senior researcher at Caltech and leader of the team's simulation work.

Using computer simulations, the researchers have discovered that two spinning black holes crashing into each other produce several vortexes and several tendexes. If the collision is head-on, the merged hole ejects vortexes as doughnut-shaped regions of whirling space, and it ejects tendexes as doughnut-shaped regions of stretching. But if the black holes spiral in toward each other before merging, their vortexes and tendexes spiral out of the merged hole. In either case -- doughnut or spiral -- the outward-moving vortexes and tendexes become gravitational waves -- the kinds of waves that the Caltech-led Laser Interferometer Gravitational-Wave Observatory (LIGO) seeks to detect.

"With these tendexes and vortexes, we may be able to much more easily predict the waveforms of the gravitational waves that LIGO is searching for," says Yanbei Chen, associate professor of physics at Caltech and the leader of the team's theoretical efforts.

Additionally, tendexes and vortexes have allowed the researchers to solve the mystery behind the gravitational kick of a merged black hole at the center of a galaxy. In 2007, a team at the University of Texas in Brownsville, led by Professor Manuela Campanelli, used computer simulations to discover that colliding black holes can produce a directed burst of gravitational waves that causes the merged black hole to recoil -- like a rifle firing a bullet. The recoil is so strong that it can throw the merged hole out of its galaxy. But nobody understood how this directed burst of gravitational waves is produced.

Now, equipped with their new tools, Thorne's team has found the answer. On one side of the black hole, the gravitational waves from the spiraling vortexes add together with the waves from the spiraling tendexes. On the other side, the vortex and tendex waves cancel each other out. The result is a burst of waves in one direction, causing the merged hole to recoil.

"Though we've developed these tools for black-hole collisions, they can be applied wherever space-time is warped," says Dr. Geoffrey Lovelace, a member of the team from Cornell. "For instance, I expect that people will apply vortex and tendex lines to cosmology, to black holes ripping stars apart, and to the singularities that live inside black holes. They'll become standard tools throughout general relativity."

The team is already preparing multiple follow-up papers with new results. "I've never before coauthored a paper where essentially everything is new," says Thorne, who has authored hundreds of articles. "But that's the case here."

This research was supported by the National Science Foundation, the Sherman Fairchild Foundation, the Brinson Foundation, NASA, and the David and Barbara Groce Fund.

**Story Source:**

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **California Institute of Technology**. The original article was written by Marcus Woo.

**Journal Reference**:

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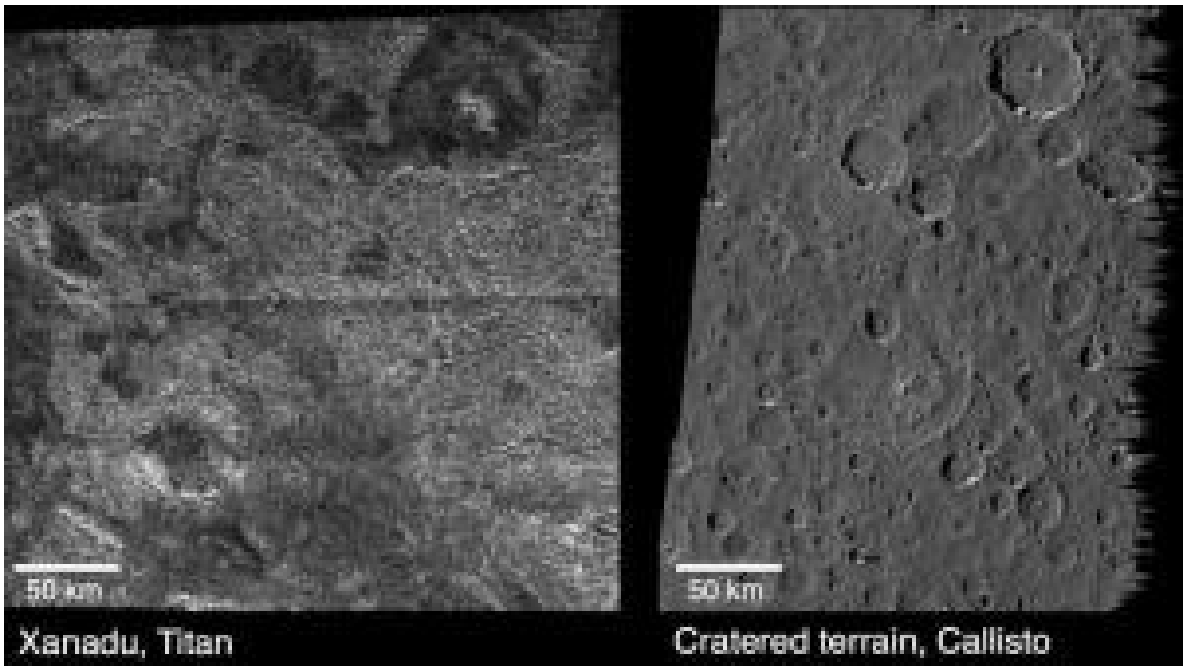
http://www.sciencedaily.com/releases/2011/04/110411092750.htm

**Saturn's Moon Titan Shaped by Weather, Not Ice Volcanoes?**




*Titan and Callisto: These images compare surface features observed by NASA's Cassini spacecraft at the Xanadu region on Saturn's moon Titan (left), and features observed by NASA's Galileo spacecraft on Jupiter's cratered moon Callisto (right). (Credit: NASA/JPL-Caltech)*

ScienceDaily (Apr. 11, 2011) — Have the surface and belly of Saturn's smog-shrouded moon, Titan, recently simmered like a chilly, bubbling cauldron with ice volcanoes, or has this distant moon gone cold? In a newly published analysis, a pair of NASA scientists analyzing data collected by the Cassini spacecraft suggests Titan may be much less geologically active than some scientists have thought.

In the paper, published in the April 2011 edition of the journal Icarus, scientists conclude Titan's interior may be cool and dormant and incapable of causing active ice volcanoes.

"It would be fantastic to find strong evidence that clearly shows Titan has an internal heat source that causes ice volcanoes and lava flows to form," said Jeff Moore, lead author of the paper and a planetary scientist at NASA's Ames Research Center, Moffett Field, Calif. "But we find that the evidence presented to date is unconvincing, and recent studies of Titan's interior conducted by geophysicists and gravity experts also weaken the possibility of volcanoes there."

Scientists agree that Titan shows evidence of having lakes of liquid methane and ethane, and valleys carved by these exotic liquids, as well as impact craters. However, a debate continues to brew about how to interpret the Cassini data on Titan. Some scientists theorize ice volcanoes exist and suggest energy from an internal heat source may have caused ice to rise and release methane vapors as it reached Titan's surface.

But in the new paper, the authors conclude that the only features on Titan's surface that have been unambiguously identified were created by external forces -- such as objects hitting the surface and creating craters; wind and rain pummeling its surface; and the formation of rivers and lakes.

"Titan is a fascinating world," said Robert Pappalardo, a research scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif., and former project scientist for NASA's Cassini mission. "Its uniqueness comes from its atmosphere and organic lakes, but in this study, we find no strong evidence for icy volcanism on Titan."

In December 2010, a group of Cassini scientists presented new topographic data on an area of Titan called Sotra Facula, which they think makes the best case yet for a possible volcanic mountain that once erupted ice on Titan. Although Moore and Pappalardo do not explicitly consider this recent topographic analysis in their paper, they do not find the recent analysis of Sotra Facula to be convincing so far. It remains to be seen whether ongoing analyses of Sotra Facula can change minds.

Titan, Saturn's largest moon, is the only known moon to have a dense atmosphere, composed primarily of nitrogen, with two to three percent methane. One goal of the Cassini mission is to find an explanation for what, if anything, might be maintaining this atmosphere.
Titan's dense atmosphere makes its surface very difficult to study with visible-light cameras, but infrared instruments and radar signals can peer through the haze and provide information about both the composition and shape of the surface.
"Titan is most akin to Jupiter's moon Callisto, if Callisto had weather," Moore added. "Every feature we have seen on Titan can be explained by wind, rain and meteorite impacts, rather than from internal heating."
Callisto is almost the exact same size as Titan. It has a cratered appearance, and because of its cool interior, its surface features are not affected by internal forces. Moore and Pappalardo conclude that Titan also might have a cool interior, with only external processes like wind, rain and impacts shaping its surface.
The Cassini spacecraft, currently orbiting Saturn, continues to make fly-bys of Titan. Scientists will continue to explore Titan's mysteries, including investigations of the changes in the landscapes.
The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL, a division of the California Institute of Technology in Pasadena, manages the mission for NASA's Science Mission Directorate, Washington. The Cassini orbiter and several of its instruments were designed, developed and assembled at JPL.
For more information about the Cassini-Huygens mission, visit http://www.nasa.gov/cassini and http://saturn.jpl.nasa.gov.
Fore more information about possible ice volcanoes on Titan, visit http://www.jpl.nasa.gov/news/news.cfm?release=2010-416 and http://www.jpl.nasa.gov/news/news.cfm?release=2008-237.
For more information about Alan Howard's Landform Evolution Computer Simulation Modeling at the University of Virginia, visit http://erode.evsc.virginia.edu/marsfluv.htm.

**Story Source:**
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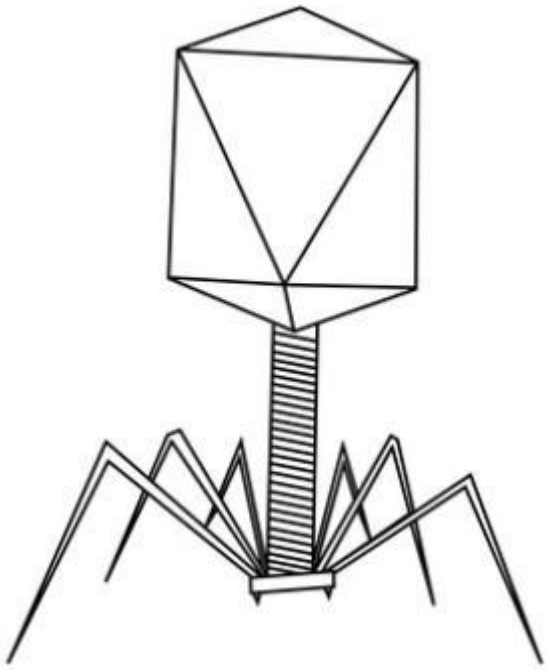
http://www.sciencedaily.com/releases/2011/04/110408102443.htm

**Accelerated Lab Evolution of Biomolecules Could Yield New Generation of Medicines**



*Artist's rendering of a bacteriophage. (Credit: © ohjedermatze / Fotolia)*

ScienceDaily (Apr. 11, 2011) — Scientists at Harvard University have harnessed the prowess of fast-replicating bacterial viruses, also known as phages, to accelerate the evolution of biomolecules in the laboratory. The work, reported in the journal *Nature,* could ultimately allow the tailoring of custom pharmaceuticals and research tools from lab-grown proteins, nucleic acids, and other such compounds.

The researchers, led by Professor David R. Liu, say their approach -- dubbed phage-assisted continuous evolution, or PACE -- is roughly 100 times faster than conventional laboratory evolution, and far less labor-intensive for scientists.

"Most modern drugs are based on small organic molecules, but biological macromolecules may be better suited as pharmaceuticals in some cases," says Liu, a professor of chemistry and chemical biology at Harvard and an investigator with the Howard Hughes Medical Institute. "Our work provides a new solution to one of the key challenges in the use of macromolecules as research tools or human therapeutics: how to rapidly generate proteins or nucleic acids with desired properties."

Liu and Harvard co-authors Kevin M. Esvelt and Jacob C. Carlson achieved up to 60 rounds of protein evolution every 24 hours by linking laboratory evolution to the life cycle of a virus that infects bacteria. This phage's life cycle of just 10 minutes is among the fastest known. Because this generation time is so brief, the phage makes a perfect vehicle for accelerated protein evolution. The PACE system uses E. coli host cells to produce the resulting proteins, to serve as factories for phage production, and to perform the key selection step that allows phage-carrying genes encoding desired molecules to flourish.

In three separate protein evolution experiments, PACE was able to generate an enzyme with a new target activity within a week, achieving up to 200 rounds of protein evolution during that time. Conventional laboratory evolution methods, Liu says, would require years to complete this many rounds of evolution.

Evolution of biomolecules is also a natural process, of course, but during biological evolution generation times tend to be very long and researchers have no control over the outcomes. Laboratory evolution (also called directed evolution) has been practiced for decades to generate biomolecules with tailor-made

properties, but typically proceeds at a rate of about one round of evolution every few days and requires frequent sample manipulation by scientists or technicians during that time.
In addition to not requiring human intervention during the evolutionary process, Liu's new approach uses readily available components and is designed to be resistant to "cheater" molecules that bypass the desired selection process. Researchers can control PACE's selection stringency as well as its mutation rate.
"Laboratory evolution has generated many biomolecules with desired properties, but a single round of mutation, gene expression, screening or selection, and replication typically requires days or longer with frequent human intervention," Liu, Esvelt, and Carlson write in Nature. "Since evolutionary success is dependent on the total number of rounds performed, a means of performing laboratory evolution continuously and rapidly could dramatically enhance its effectiveness."
Among other achievements reported in Nature, Liu and colleagues used PACE to recast an RNA polymerase normally activated by a T7 promoter to recognize a T3 promoter instead. They also evolved polymerases that initiate RNA transcripts with the genetic bases adenine (A) or cytosine (C) instead of the usual guanine (G). In all cases, the PACE-generated enzymes on their new targets matched or exceeded the activity of wild-type enzymes.
This work was supported by the National Institutes of Health, the Howard Hughes Medical Institute, the Hertz Foundation, the National Science Foundation, and the Harvard Chemical Biology Graduate Program.

**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Harvard University**, via EurekAlert!, a service of AAAS.

**Journal Reference**:

1. Kevin M. Esvelt, Jacob C. Carlson, David R. Liu. **A system for the continuous directed evolution of biomolecules**. *Nature*, 2011; DOI: 10.1038/nature09929

http://www.sciencedaily.com/releases/2011/04/110410181305.htm

**Scientists Develop 'Universal' Virus-Free Method to Turn Blood Cells Into 'Beating' Heart Cells**

*"Beating" cardiomyocyte. (Credit: Paul Burridge)*

ScienceDaily (Apr. 11, 2011) — Johns Hopkins scientists have developed a simplified, cheaper, all-purpose method they say can be used by scientists around the globe to more safely turn blood cells into heart cells. The method is virus-free and produces heart cells that beat with nearly 100 percent efficiency, they claim.

"We took the recipe for this process from a complex minestrone to a simple miso soup," says Elias Zambidis, M.D., Ph.D., assistant professor of oncology and pediatrics at the Johns Hopkins Institute for Cell Engineering and the Kimmel Cancer Center.

Zambidis says, "many scientists previously thought that a nonviral method of inducing blood cells to turn into highly functioning cardiac cells was not within reach, but "we've found a way to do it very efficiently and we want other scientists to test the method in their own labs." However, he cautions that the cells are not yet ready for human testing.

To get stem cells taken from one source (such as blood) and develop them into a cell of another type (such as heart), scientists generally use viruses to deliver a package of genes into cells to, first, get them to turn into stem cells. However, viruses can mutate genes and initiate cancers in newly transformed cells. To insert the genes without using a virus, Zambidis' team turned to plasmids, rings of DNA that replicate briefly inside cells and eventually degrade.

Adding to the complexity of coaxing stem cells into other cell types is the expensive and varied recipe of growth factors, nutrients and conditions that bathe stem cells during their transformation. The recipe of this "broth" differs from lab to lab and cell line to cell line.

Reporting in the April 8 issue of *Public Library of Science ONE (PLoS ONE)*, Zambidis' team described what he called a "painstaking, two-year process" to simplify the recipe and environmental conditions that house cells undergoing transformation into heart cells. They found that their recipe worked consistently for at least 11 different stem cell lines tested and worked equally well for the more controversial embryonic stem cells, as well as stem cell lines generated from adult blood stem cells, their main focus.

The process began with Johns Hopkins postdoctoral scientist Paul Burridge, Ph.D., who studied some 30 papers on techniques to create cardiac cells. He drew charts of 48 different variables used to create heart cells, including buffers, enzymes, growth factors, timing, and the size of compartments in cell culture plates. After testing hundreds of combinations of these variables, Burridge narrowed the choices down to between four to nine essential ingredients at each of three stages of cardiac development.

Beyond simplification, an added benefit is reduced cost. Burridge used a cheaper growth media that is one-tenth the price of standard media for these cells at $250 per bottle lasting about one week.

Zambidis says that he wants other scientists to test the method on their stem cell lines, but also notes that the growth "soup" is still a work in progress. "We have recently optimized the conditions for complete removal of the fetal bovine serum from one brief step of the procedure -- it's made from an animal product and could introduce unwanted viruses," he says.

In their experiments with the new growth medium, the Hopkins team began with cord blood stem cells and a plasmid to transfer seven genes into the stem cells. They delivered an electric pulse to the cells, making tiny holes in the surface through which plasmids can slip inside. Once inside, the plasmids trigger the cells to

revert to a more primitive cell state that can be coaxed into various cell types. At this stage, the cells are called induced pluripotent stem cells (iPSC).
Burridge then bathed the newly formed iPSCs in the now simplified recipe of growth media, which they named "universal cardiac differentiation system." The growth media recipe is specific to creating cardiac cells from any iPSC line.
Finally, they incubated the cells in containers that removed oxygen down to a quarter of ordinary atmospheric levels. "The idea is to recreate conditions experienced by an embryo when these primitive cells are developing into different cell types," says Burridge. They also added a chemical called PVA, which works like glue to make cells stick together.
Nine days later, the nonviral iPSCs turned into functional, beating cardiac cells, each the size of a needlepoint. Burridge manually counted how often iPSCs formed into cardiac cells in petri dishes by peering into a microscope and identifying each beating cluster of cells. In each of 11 cell lines tested, each plate of cells had an average of 94.5 percent beating heart cells. "Most scientists get 10 percent efficiency for IPSC lines if they're lucky," says Zambidis.
Zambidis and Burridge also worked with Johns Hopkins University bioengineering experts to apply a miniversion of an electrocardiograph to the cells, which tests how cardiac cells use calcium and transmit a voltage. The resulting rhythm showed characteristic pulses seen in a normal human heart.
Virus-free, iPSC-derived cardiac cells could be used in laboratories to test drugs that treat arrhythmia and other conditions. Eventually, bioengineers could develop grafts of the cells that are implanted into patients who suffered heart attacks.
Zambidis' team has recently developed similar techniques for turning these blood-derived iPSC lines into retinal, neural and vascular cells.
The research was funded by the Maryland Stem Cell Research Fund and the National Institutes of Health.
Research participants include Susan Thompson, Michal Millrod, Seth Weinberg, Xuan Yuan, Ann Peters, Vasiliki Mahairaki, Vassilis E. Koliatsos, and Leslie Tung at Johns Hopkins.

**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Johns Hopkins Medical Institutions**, via EurekAlert!, a service of AAAS.

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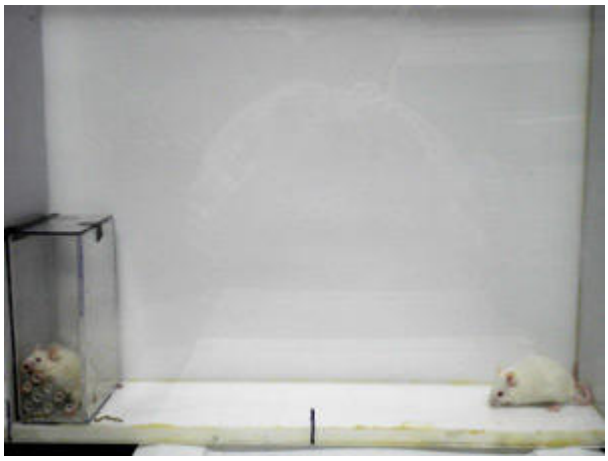
http://www.sciencedaily.com/releases/2011/04/110408210728.htm

**Bullying Alters Brain Chemistry, Leads to Anxiety, Mouse Study Finds**



*Bullies and the brain. Mice that have been repeatedly bullied by dominant males show an unusual reluctance to approach new, even nonthreatening mice. Above a bullied mouse (right) keeps as much distance as it can from its corralled counterpart. (Credit: Image courtesy of Rockefeller University)*

ScienceDaily (Apr. 10, 2011) — Being low mouse on the totem pole is tough on murine self-esteem. It turns out it has measurable effects on brain chemistry, too, according to recent experiments at Rockefeller University. Researchers found that mice that were bullied persistently by dominant males grew unusually nervous around new company, and that the change in behavior was accompanied by heightened sensitivity to vasopressin, a hormone involved in a variety of social behaviors. The findings suggest how bullying could contribute to long-term social anxiety at the molecular level.

"We found that chronic social stress affects neuroendocrine systems that are paramount for adaptive mammalian social behaviors such as courtship, pair-bonding and parental behaviors," says Yoav Litvin, M. S. Stoffel Postdoctoral Fellow in Mind, Brain and Behavior. "Changes in components of these systems have been implicated in human disorders, such as social phobias, depression, schizophrenia and autism."

Litvin and colleagues in Donald Pfaff's Laboratory of Neurobiology and Behavior set up a rough-and-tumble school yard scenario in which a young mouse is placed in a cage with a series of larger older mice -- a different one in each of 10 days. The mice, being territorial, fight it out in a contest that the new arrival invariably loses. Following the 10-minute battle, the mice were separated in the same cage by a partition that keeps them physically apart but allows them to see, smell and hear one another, a stressful experience for the loser.

Given a day to rest, the test mice are then put in the company of nonthreatening mice of comparable size and age. The biggest change in behavior was that the traumatized mice were more reluctant to socialize with their fellow mice, preferring to keep their distance compared to their unbullied counterparts. The mice that had lost their battles were also more likely to "freeze" in place for longer periods of time and to frequently display "risk assessment" behaviors toward their new cage-mates, behaviors that have been shown to be valid indices of fear and anxiety in humans. The researchers also gave a group of mice a drug that blocked vasopressin receptors, which partly curbed some of the anxious behavior in the bullied mice.

The researchers then examined the brains of the mice, particularly sections in the middle of the forebrain known to be associated with emotion and social behavior. They found that mRNA expression for vasopressin receptors -- specifically V1bRs -- had increased in the bullied mice, making them more sensitive to the hormone, which is found in high levels in rats with innate high anxiety. In humans, the hormone is associated with aggression, stress and anxiety disorders. The surge of vasopressin receptors was especially notable in the amygdala, Litvin and colleagues reported this month in *Physiology & Behavior*.

How long these effects last remains an open question. Other studies have found, for instance, that chronic stress can impair some cognitive functions in rodents and people, but that their brains can bounce back, given time to recuperate.

Still, many studies in rodents, primates and people have shown that early psychological trauma can have ill effects on health throughout life. Litvin says his study suggests that victims of bullying may have difficulty forming new relationships, and it identifies the possible role for a specific vasopressin receptor.
"The identification of brain neuroendocrine systems that are affected by stress opens the door for possible pharmacological interventions," Litvin says. "Additionally, studies have shown that the formation and maintenance of positive social relationships may heal some of the damage of bullying. These dynamic neuroendocrine systems may be involved."

**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Rockefeller University**.

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http://www.sciencedaily.com/releases/2011/04/110407202536.htm

**Ancient Fossils Hold Clues for Predicting Future Climate Change**

*View of the Canadian Museum of Nature paleontology research camp located in Strathcona Fiord. (Credit: Martin Lipman)*

ScienceDaily (Apr. 10, 2011) — By studying fossilized mollusks from some 3.5 million years ago, UCLA geoscientists and colleagues have been able to construct an ancient climate record that holds clues about the long-term effects of Earth's current levels of atmospheric carbon dioxide, a key contributor to global climate change.

Two novel geochemical techniques used to determine the temperature at which the mollusk shells were formed suggest that summertime Arctic temperatures during the early Pliocene epoch (3.5 million to 4 million years ago) may have been a staggering 18 to 28 degrees Fahrenheit warmer than today. And these ancient fossils, harvested from deep within the Arctic Circle, may have once lived in an environment in which the polar ice cap melted completely during the summer months.

"Our data from the early Pliocene, when carbon dioxide levels remained close to modern levels for thousands of years, may indicate how warm the planet will eventually become if carbon dioxide levels are stabilized at the current value of 400 parts per million," said Aradhna Tripati, a UCLA assistant professor in the department of Earth and space sciences and the department of atmospheric and oceanic sciences.

The results of this study lend support to assertions made by climate modelers that summertime sea ice may be eliminated in the next 50 to 100 years, which would have far-reaching consequences for Earth's climate, she said.

The research, federally funded by the National Science Foundation, is scheduled to be published in the April 15 print issue of *Earth and Planetary Science Letters*.

"The Intergovernmental Panel on Climate Change identifies the early Pliocene as the best geological analog for climate change in the 21st century and beyond," said Tripati, who is also a researcher with UCLA's Institute of the Environment and Sustainability and Institute of Geophysics and Planetary Physics. "The climate-modeling community hopes to use the early Pliocene as a benchmark for testing models used for forecasting future climate change."

The poles are exhibiting the most warming of any place on the planet, and the effect is most severe in the Arctic, Tripati said. The poles are the first regions on Earth to respond to any global climate change; in some sense, the Arctic serves as the proverbial canary in the coal mine, the first warning sign of fast-approaching danger.

Ice sheets and sea ice in polar regions reflect incoming solar radiation to cool Earth -- a phenomenon that makes the poles incredibly sensitive to variations in climate, she said. An increase in Arctic temperatures

would not only cause the ice sheets to melt but would also result in the exposed land and ocean absorbing significantly more incoming solar energy and further heating the planet.
Without a permanent ice cap in the Arctic, global temperatures in the early Pliocene were 2 to 5 degrees Fahrenheit higher than the current global average. This suggests that the carbon dioxide threshold for maintaining year-round Arctic ice may be well below modern levels, Tripati said.

**What fossilized shells can tell us about climate**

The research was conducted on mollusk fossils collected from Beaver Pond, located in the Strathcona Fiord on Ellesmere Island, at northernmost point of Canada, which is well within the Arctic Circle. Named for the numerous branches discovered with beaver teeth marks that have lasted for millions of years, Beaver Pond has proven to be a treasure trove of fossilized plant and animal specimens that remain remarkably well-preserved within a peat layer encased in ice, Tripati said.
Climate scientists typically determine ancient temperatures by analyzing the composition of core samples drilled miles into the ice sheets of Greenland or Antarctica.
"Ice cores are a remarkable archive of past climate change because they can give us direct insights into how the poles have responded to variations in past greenhouse gas levels," Tripati said. "However, ice core data is available for only the past 800,000 years, during which carbon dioxide levels were never above 280 to 300 parts per million. To understand environmental change for earlier time periods in Earth's history when carbon dioxide levels were near 400 parts per million, we have to rely on other archives."
By measuring the isotopic content of oxygen in a combination of fossilized mollusk and plant samples, it is possible to determine the temperature at which the specimens originally formed, Tripati said. While this method enables climate reconstructions dating back millions of years without the need for ice core samples, it is uncommon to find a site that contains both plant and shell specimens from the same time and place.
Additionally, Tripati and her co-authors have pioneered a new method for measuring past temperature using only the calcium carbonate found in fossilized shells. Determining how much of the rarest isotopes of carbon and oxygen are present in the mollusk sample yields results consistent with the original method, which required an associated plant specimen.
Conclusions drawn from the two techniques used in this study also agree with three entirely different approaches used in a recently published study by several of the co-authors to determine the average temperatures at the same site. Given the consistency among many distinct processes, this new method can be considered a reliable technique for use on samples from a variety of time periods and locations, Tripati said
Samples were collected from Beaver Pond by co-author Natalia Rybczynski, a paleobiologist at the Canadian Museum of Nature and adjunct research professor at Carleton University.
Adam Csank, a graduate student in the department of geosciences at the University of Arizona, is the first author of the study. Other co-authors include William Patterson, professor of geological sciences at the University of Saskatchewan; Robert Eagle, a postdoctoral scholar at the California Institute of Technology; Ashley Ballantyne, a postdoctoral scholar at the University of Colorado-Boulder; and John Eiler, professor of geological and planetary sciences at the California Institute of Technology.

**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Los Angeles**.

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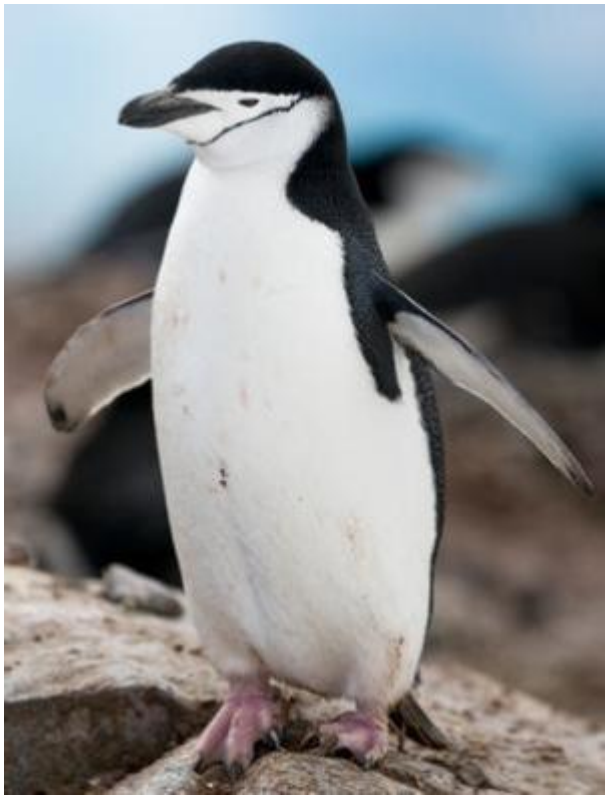
**Journal Reference**:

1. Adam Z. Csank, Aradhna K. Tripati, William P. Patterson, Robert A. Eagle, Natalia Rybczynski, Ashley P. Ballantyne, John M. Eiler. **Estimates of Arctic land surface temperatures during the early Pliocene from two novel proxies**. *Earth and Planetary Science Letters*, 2011; 304 (3-4): 291 DOI: 10.1016/j.epsl.2011.02.030

http://www.sciencedaily.com/releases/2011/04/110408101751.htm

**Penguins That Shun Ice Still Lose Big from a Warming Climate**



*Chinstrap penguin. Although chinstrap penguins avoid feeding in icy habitats, sea ice provides the necessary environment for krill to reproduce. Increasing temperatures and reductions in sea ice have made conditions unfavorable to sustain ample populations of this food source. (Credit: © Rich Lindie / Fotolia)*

ScienceDaily (Apr. 11, 2011) — Fluctuations in penguin populations in the Antarctic are linked more strongly to the availability of their primary food source than to changes in their habitats, according to a new study published online on April 11 in the *Proceedings of the National Academy of Sciences*. Funded in part by the Lenfest Ocean Program, this research indicates that species often considered likely "winners" of changing conditions, such as large-scale ice melting, may actually end up as the most vulnerable to the impacts of climate change.

The two penguin species of focus in the study rely on small shrimp-like creatures known as krill for their survival. A previous assessment in *Nature* of krill in the Southern Ocean suggests that their abundance has declined as much as 80 percent since the 1970s.

"For penguins and other species, krill is the linchpin in the food web. Regardless of their environmental preferences, we see a connection between climate change and penguin populations through the loss of habitat for their main food source," said Dr. Wayne Trivelpiece, lead author and seabird researcher of the National Oceanic and Atmospheric Administration's Antarctic Ecosystem Research Division. "As warming continues, the loss of krill will have a profound effect throughout the Antarctic ecosystem."

A 30-year field study of Adélie (ice-loving) and chinstrap (ice-avoiding) penguins shows that populations of both species in the West Antarctic Peninsula and Scotia Sea have declined by respective averages of 2.9 and 4.3 percent per year for at least the last 10 years. Some colonies have decreased by more than 50 percent. Lack of an abundant supply of krill has been particularly hard on fledgling penguins that must learn where to locate and how to catch the prey on their own, having never been at sea before. Data from the study suggest that fewer young penguins are surviving this transition to independence today than in previous years when these crustaceans were much more abundant.

Although chinstrap penguins avoid feeding in icy habitats, sea ice provides the necessary environment for krill to reproduce. Increasing temperatures and reductions in sea ice have made conditions unfavorable to sustain ample populations of this food source. The authors suggest that fishing for krill and increased competition among other predators also have made them less available to penguins.
"Penguins are excellent indicators of changes to the biological and environmental health of the broader ecosystem because they are easily accessible while breeding on land, yet they depend entirely on food resources from the sea. In addition, unlike many other krill-eating top predators in the Antarctic, such as whales and fur seals, they were not hunted by humans," said Dr. Trivelpiece. "When we see steep declines in populations, as we have been documenting with both chinstrap and Adélie penguins, we know there's a much larger ecological problem."
Adélie penguins, which feed in icy habitats, are also declining due to food shortages and shrinking habitat. They differ from chinstrap penguins, however, in that they have breeding populations outside of the western Antarctic, which makes them less vulnerable to the rapid warming in the Antarctic Peninsula region by comparison.

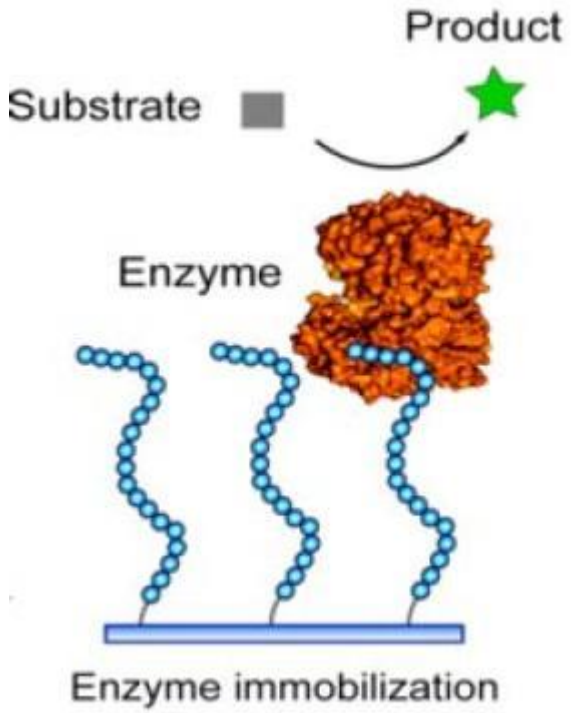
**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Pew Environment Group**, via EurekAlert!, a service of AAAS.

**Journal Reference**:

1. Wayne Z. Trivelpiece, Jefferson T. Hinke, Aileen K. Miller, Christian S. Reiss, Susan G. Trivelpiece and George M. Watters. **Variability in krill biomass links harvesting and climate warming to penguin population changes in Antarctica**. *Proceedings of the National Academy of Sciences*, April 11, 2011 DOI: 10.1073/pnas.1016560108

http://www.sciencedaily.com/releases/2011/04/110411152535.htm

**Positioning Enzymes With Ease**




*Peptide chains composed of 20 amino acids (blue) hold an enzyme in its proper orientation on a glass slide, permitting high-efficiency catalysis. (Credit: Image courtesy of Arizona State University)*

ScienceDaily (Apr. 9, 2011) — Virtually all processes in the human body rely on a unique class of proteins known as enzymes. To study them, scientists want to attach these molecules to surfaces and hold them fast, but this can often be a tricky undertaking.

Now Jinglin Fu and his colleagues at the Biodesign Institute at Arizona State University have developed a superior method for immobilizing enzymes on surfaces, deftly controlling their orientation, improving their efficiency and rendering them more stable. The group's results appear in the April 11 advanced online issue of *PLoS ONE.*

Enzymes are essential for the normal functioning of cells, and are involved in tasks including cell regulation, metabolism and signal transduction. They are also necessary for muscle contraction and the transport of ions and other materials throughout the cytoskeleton.

Enzymes like amylases and proteases are central players in the digestive systems of many animals, breaking down starches and other large molecules into smaller parts that can be absorbed by the intestines. Herbivorous animals make use of the enzyme cellulose, to break down plant fiber. "No wonder enzyme function has been a topic of longstanding concern for biochemistry and medicine," says Fu.

Like other proteins, enzymes are composed of linear chains of amino acids. They can range from tens to thousands of amino acids in length. The job of the enzyme is to increase the rate of the desired reaction, without increasing the rate of undesired reactions. Here, a molecule known as the substrate interacts with a given enzyme to produce a product. Without enzymes, many reactions essential to living things could not proceed.

Such catalytic activity has also been adapted and broadly applied in the biomedical arena (especially for various diagnostic testing), as well for industrial applications ranging from photography to the brewing of beer.

Enzymes are also critical for the study of disease. Given their central role in maintaining homeostasis, any single enzyme aberration, including mutation, overproduction, underproduction or deletion can have dire consequences for health. Phenylketonuria, for example, is a disease linked with a single amino acid mutation in the enzyme phenylalanine hydroxylase. If untreated, the condition can lead to mental retardation. Malfunctioning of DNA repair enzymes is associated with a number of forms of cancer.

To properly study enzymes, particularly their catalytic activity, it is necessary to fix them in place on a surface. While researchers have used several techniques for enzyme immobilization, existing methods suffer from several shortcomings. Enzymes need to be properly oriented on the surface with respect to the molecule they are catalyzing in order to work properly. The non-specific binding of proteins can contaminate the reaction and lower or block its efficient progress. Finally, proteins are prone to becoming unfolded and deactivated over time -- a process known as denaturation.

In the current study, Fu first generated a high-density array of peptides on a glass slide, each peptide composed of 20 randomly assembled amino acids. A specific enzyme, β galactosidase, was then screened against this array. This method identified two peptides that covalently bound to the enzyme with high affinity, and these were used for the subsequent experiments.

When compared with low-affinity binding peptides and with preexisting surface immobilization techniques, the group found that the high affinity peptides not only were more effective at holding the enzyme in its proper orientation on the slide, they also produced higher specific activity in the enzyme. The enzyme was also less subject to denaturation, compared with controls.

In a further refinement of the technique, the group created mutations of the high affinity peptides, by deleting a single amino acid along the peptide's length and replacing it with a different amino acid. This procedure was repeated with all 20 amino acids in the peptide chain, with the resulting mutations once more screened against the β galactosidase enzyme. The technique, known as single-point variant screening, improved both the binding affinity and specific activity of the bound enzyme.

"This development gives us a new tool, both for enhancing the function of surface bound enzymes, which are of ever-increasing importance to industry, and also for studying the interactions between multiple enzymes in a metabolic pathway," said Neal Woodburry, a co-author of the *PLoS ONE* study.

**Story Source:**

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Arizona State University**. The original article was written by Richard Harth.

http://www.sciencedaily.com/releases/2011/04/110411092752.htm

**Vision Loss in Eye Disease Slowed Using Novel Encapsulated Cell Therapy**

*Image showing geographic atrophy (GA). (Credit: UC San Diego School of Medicine)*

ScienceDaily (Apr. 11, 2011) — A phase 2 clinical trial for the treatment of a severe form of age-related macular degeneration called geographic atrophy (GA) has become the first study to show the benefit of a therapy to slow the progression of vision loss for this disease. The results highlight the benefit of the use of a neurotrophic factor to treat GA and provide hope to nearly one million Americans suffering from GA.

The multi-center research team, including Kang Zhang, MD, PhD, of the University of California, San Diego, Shiley Eye Center, the lead author of the paper and one of the leading investigators in the study, found that long-term delivery of ciliary neurotrophic factor (CNTF) served to re-nourish the retina and stop or slow the loss of visual acuity caused by the disorder. The results were recently published online in the *Proceedings of National Academy of Sciences* (*PNAS*).

According to Zhang -- professor of ophthalmology and human genetics at the UCSD School of Medicine and director of UCSD's Institute of Genomic Medicine -- there is currently no effective treatment for dry AMD or GA, though there is a very big need. "This could open the door to long-term treatment of dry AMD, using a simple surgical procedure."

Age-related macular degeneration, or AMD, is a leading cause of vision loss in Americans age 60 and older. It is a disease that causes cells in the macula -- the part of the eye that allows us to see in fine detail -- to die. There are two forms of the disorder, wet and dry AMD. GA is considered the end stage of dry AMD, where central vision is lost.

According to the National Eye Institute, wet AMD occurs when abnormal blood vessels behind the retina start to grow under the macula. These new blood vessels tend to be very fragile and often leak blood and fluid. The blood and fluid raise the macula from its normal place at the back of the eye, resulting in rapid loss of central version. There is currently a very effective therapy for wet AMD. Dry AMD occurs when the light-sensitive cells in the macula slowly break down, gradually blurring central vision in the affected eye.

In the trial, high-dose CNTF was delivered to 27 GA patients using encapsulated cell therapy (ECT). Another 24 patients received either a sham surgery (12) or a low-dose of CNTF (12). CNTF affects survival and

differentiation of cells in the nervous system, including retinal cells. CNTF has been shown to retard the loss of photoreceptor cells in many animal models of retinal degeneration.
The ECT utilized a capsule that contains genetically engineered cells to continuously produce CNTF over a 12-month period. The CNTF-secreting capsule was implanted in the back of the study subject's eye. The implant allows the CNTF molecules to diffuse into the eye tissue, while keeping out antibodies and immune cells that would attack and destroy the CNTF-producing cells.
There was a statistically significant difference in the change of the total macular volume in the eyes of study participants at the 12-month point, versus baseline in the high-dose group, according to Zhang. "In addition, all but one of the patients in the high dose group, or 96.3 percent, maintained stabilized vision, compared to only 75% of the patients in the sham-treatment group."
The patients treated with a high dose of CNTF also showed an increase in retinal thickness as early as four months after implant, an increase that correlated to the stabilization of vision.
Additional contributors to the study included Jill J. Hopkins, Retina-Vitreous Associates Medical Group, Los Angeles; Jeffrey S. Heier, Ophthalmic Consultants of Boston; David G. Birch, Retina Foundation of the Southwest, Dallas; Lawrence S. Halperin, Retina Group of Florida, Ft. Lauderdale; Thomas A. Albini, Bascom Palmer Eye Institute, University of Miami Miller School of Medicine; David M. Brown, Retina Consultants of Houston, Houston; Glenn J. Jaffe, Duke University Eye Center; Weng Tao, Neurotech USA, Lincoln, RI; and George A. Williams, Beaumont Eye Institute, Royale Oak, MI.
Zhang's research is supported by the National Eye Institute, National Institutes of Health; the Macula Vision Research Foundation; Burroughs Wellcome Fund; Research to Prevent Blindness, Lew Wasserman Merit Award and Senior Investigator Award; and the Chinese National 985 Project to Sichuan University and West China Hospital.

**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - San Diego**, via EurekAlert!, a service of AAAS.

**Journal Reference**:

1. K. Zhang, J. J. Hopkins, J. S. Heier, D. G. Birch, L. S. Halperin, T. A. Albini, D. M. Brown, G. J. Jaffe, W. Tao, G. A. Williams. **Ciliary neurotrophic factor delivered by encapsulated cell intraocular implants for treatment of geographic atrophy in age-related macular degeneration**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1018987108

http://www.sciencedaily.com/releases/2011/04/110407092040.htm

**Health Halo Effect: Don't Judge a Food by Its Organic Label**

*Potato chips. Subjects were asked to compare what they thought were conventionally and organically produced chocolate sandwich cookies, plain yogurt, and potato chips. The subjects reported preferring almost all of the taste characteristics of the organically-labeled foods, even though they were actually identical to their conventionally-labeled counterparts. (Credit: © Elenathewise / Fotolia)*

ScienceDaily (Apr. 11, 2011) — Jenny Wan-chen Lee, a graduate student in Cornell University's Dyson School of Applied Economics and Management, has been fascinated with a phenomenon known as "the halo effect" for some time. Psychologists have long recognized that how we perceive a particular trait of a person can be influenced by how we perceive other traits of the same individual. In other words, the fact that a person has a positive attribute can radiate a "halo," resulting in the perception that other characteristics associated with that person are also positive. An example of this would be judging an attractive person as intelligent, just because he or she is good-looking.

A growing literature suggests that the halo effect may also apply to foods, and ultimately influence what and how much we eat. For instance, research has shown that people tend to consume more calories at fast-food restaurants claiming to serve "healthier" foods, compared to the amount they eat at a typical burger-and-fry joint. The reasoning is that when people perceive a food to be more nutritious, they tend to let their guard down when it comes to being careful about counting calories -- ultimately leading them to overeat or feel entitled to indulge. This health halo effect also seems to apply to certain foods considered by many to be especially healthy, such as organic products. Specifically, some people mistakenly assume that these foods are more nutritious just because they carry an "organic" label -an area of longstanding active debate among food and nutrition scientists.

As part of her master's research, Lee asked whether the "health halo" surrounding organic foods would lead people to automatically perceive them as tastier or lower in calories. She tested this question by conducting a double-blind, controlled trial in which she asked 144 subjects at the local mall to compare what they thought were conventionally and organically produced chocolate sandwich cookies, plain yogurt, and potato chips. All of the products, however, were actually of the organic variety -- they were just labeled as being "regular" or "organic." Participants were then asked to rate each food for 10 different attributes (e.g., overall taste, perception of fat content) using a scale from 1 to 9. She also asked them to estimate the number of calories in each food item and how much they would be willing to pay.

As part of the scientific program of the American Society for Nutrition annual meeting, results from this study will be presented on April 10 at the Experimental Biology 2011 meeting.

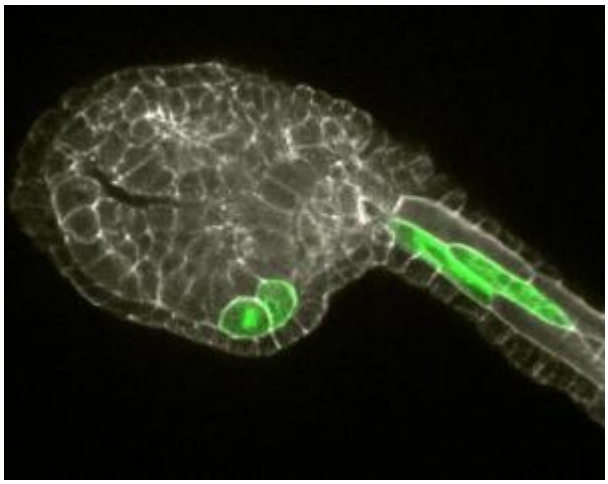
Confirming Lee's health halo hypothesis, the subjects reported preferring almost all of the taste characteristics of the organically-labeled foods, even though they were actually identical to their conventionally-labeled counterparts. The foods labeled "organic" were also perceived to be significantly lower in calories and evoked a higher price tag. In addition, foods with the "organic" label were perceived as being lower in fat and higher

in fiber. Overall, organically-labeled chips and cookies were considered to be more nutritious than their "non-organic" counterparts.
So, not only is there a health halo emanating from organic foods, but it's strong and consistent- at least for cookies, chips, and yogurt. Although Lee is the first to acknowledge that her study was limited in the variety of foods tested, she is confident that this effect is real and has important implications as to what, and how much, people eat, especially those who preferentially seek out foods carrying an "organic" seal. Additional studies will be needed before we know whether these perceived taste and nutrition attributes result in greater consumption of organic versus conventional foods.
Until that time, remember not to judge a book (or a cookie) by its cover (or its organic label).
Jenny Wan-chen Lee (Cornell University), Mitsuru Shimizu (Cornell University), and Brian Wansink (Cornell University) were coauthors on this paper.

**Story Source:**
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Federation of American Societies for Experimental Biology**, via EurekAlert!, a service of AAAS.

http://www.sciencedaily.com/releases/2011/04/110410130831.htm

**What Sea Squirts Can Teach Us About the Heart**



*Ciona allows scientists to study in detail how cells interact to build complex organs. In this microscopic image, two of the cells that will form the heart were stained with a green fluorescent marker and can be seen in the lower portion of the tadpole-like Ciona embryo. (Credit: Katerina Ragkousi)*

ScienceDaily (Apr. 8, 2011) — Each year in the U.S., approximately 40,000 babies are born with a heart defect. Without the proper diagnosis and treatment, many of these babies would die before their first birthday, according to Dr. Scott Klewer, a cardiologist at the UA's College of Medicine.

"We still don't know much about the causes of many of these defects. Some have been linked to certain genes but the picture is still sketchy," he says. "At this point, we can't predict how children will respond to current methods, but if we had genetic indicators we could use them to personalize treatments."

Dr. Ricardo Samson, who heads the pediatric cardiology section at the College of Medicine, adds that "some heart defects can be difficult to diagnose because they don't present the typical signs such as a heart murmur or blueness of the skin."

"Fortunately, prenatal ultrasound allows obstetricians to identify many babies with specific forms of severe heart defects before they are born," he says. "But because of the way the heart develops in a fetus, some severe defects go undetected and don't cause problems until the baby has gone home from the nursery."

Samson and Klewer both are members of the UA's Steele Children's Research Center and the UA's Sarver Heart Center's heart development research group, which is internationally recognized for its discoveries expanding the understanding of molecular elements that cause congenital heart defects.

**In studying heart-specifying genes, less is more**

Studying the genetic underpinnings of heart defects is complicated by the fact that humans, like all other vertebrates, have multiple and slightly different copies of each gene. This redundancy makes it difficult if not impossible to tease apart the functions associated with a particular gene, because disrupting its function in model organisms such as mice to figure out its role does not always result in an obvious effect.

In their quest to better understand and help clinicians develop better diagnostics and treatments for congenital heart defects, scientists at the UA's department of molecular and cell biology have turned to a creature most people -- with the possible exception of scuba divers -- would not consider a familiar sight: a sea squirt in the genus Ciona.

Lacking a head, appendages and eyes, sea squirts resemble strange-looking, leathery sacks more than animals. Up to 6 inches long, with two conspicuous openings, Ciona spends its life attached to submerged rocks or piers, pumping sea water through its body and straining out food particles, much like clams do. Its simple body structure, however, belies the sea squirts' biological kinship, which places them closer to the vertebrate lineage than any other invertebrate. Most importantly, Ciona's genetic blueprint is almost the same as that of vertebrates.

"We want to understand the basic processes by which embryonic cells make the decision to become heart cells," says Brad Davidson, an assistant professor in the UA's department of molecular and cellular biology

and a member of the Sarver Heart Center. "Early steps of heart formation are very similar in Ciona, mice and humans."
Except -- and for a scientist studying heart development, this is huge -- each of Ciona's genes is represented only once because the genome has not been duplicated as in vertebrates. Therefore, Ciona has only one copy of the major genes involved in heart development.
One of the genes vital for heart development is GATA, a so-called transcription factor or master gene that controls other heart-specific genes and plays a key role in heart development. Human babies with GATA mutations have congenital heart defects. If the gene's function is disrupted, both the heart and the gut are deformed.
"But it's not clear where the problem is," Davidson says. "Is it because the heart doesn't form properly or because the gut doesn't form properly? Ciona allows us to break it apart."
**IMAGE:** This is Katerina Ragkousi, the first author of the research report, with principal investigator Brad Davidson.
Click here for more information.
**A heart needs a gut**
"We tend to think of cells building an organ as an isolated process but that is never true in an embryo," he says. "Anything that is being built has to be made alongside all the other organs, and there are a lot of complications in terms of the instructions."
Katerina Ragkousi, a postdoctoral fellow in Davidson's lab, just published the results of a study shedding light on this process in the journal *Developmental Biology*. The editors deemed her work important enough to feature it on the cover of the magazine.
"We know that in vertebrates, GATA has to be activated not only in the future heart cells, but in the neighboring gut cells, too," Ragkousi says. "In this study, we show that this is the same in Ciona, justifying even more the value of this model organism in studying heart development."
"Vertebrates have three GATA factors that are both in the developing gut and in the heart, so it has been really difficult to tease apart what's going on with these factors in each tissue."
When Ragkousi and her team experimentally disrupted GATA in heart precursor cells, the cells lost their identity.
"They don't express the right genes and stay in a state of limbo instead of moving on with their development," Davidson said.
"When we disturb GATA function independently in the developing gut, we see that heart cell identity is not perturbed, at least not at this stage," Ragkousi says. "However, we find that GATA in the gut plays an indirect role in heart formation in that it is necessary for heart precursors to be properly positioned in the developing embryo."
In addition to its genetic similarity to vertebrates, Ciona comes with several other benefits. It is easy to keep in the lab, and, unlike vertebrate embryos, a Ciona embryo consists of a mere few hundred cells. The embryos develop in only 24 hours and are translucent, allowing scientists to literally watch as the heart forms from only four cells.
"It is this simplicity that we are hoping to be able to exploit," Davidson says. "That we can not only see vaguely and in general how the cells build a heart, but very specifically how each cell is acting as they come together to make the heart."
In their natural habitat, Ciona embryos drift along with the ocean currents until they hatch as tiny, tadpole-like larvae.
"They need to develop rapidly because until they hatch, they're floating around as food," Davidson says. "Sometimes it can take days for them to settle. They can stay alive for five or six days. In the right kind of current, they can go pretty far."
Once the larvae come to rest on the seafloor, a rock or a pier, they undergo one of the most dramatic metamorphoses found in the natural world. Giving their body a total makeover, they morph from a free-swimming larva with a brain, primitive eyes and a tail into the sponge-like sack that spends remainder of its life attached to the very place it settled down.
"With Ciona, we can introduce genes into the early embryo and as it develops, we can study where the genes are expressed," Ragkousi says. "We also can locate the cells relative to each other. We are looking at the

cellular interactions that happen during the early stages heart formation. It has been almost impossible to address this at such a high resolution and study the behavior of individual cells in more complex organisms."

**Bench-to-bedside medicine, or from the water tank to the hospital**

"Basic research with model organisms like Ciona allows us to identify the genes involved in heart development and recognize who the players are," says Klewer. "We can then look at these factors in patients to determine the best approach for treatment that would benefit that particular patient. It also gives us an opportunity to refine our approaches based on the genetic background. I am hopeful that we can soon integrate that knowledge in our clinical practice."

Researchers studying heart development put high hopes in Ciona not only to improve diagnostic tests through a better understanding of the genetic mechanisms underlying heart development, but also to develop better therapeutics for failing hearts.

"Many people are going to have a heart attack at some point in their lives," says Davidson. "And since the heart can't regenerate damaged tissue, what do you do to manage that? There is a big push to see if we can reprogram cells to build heart tissue. Progress is being made, but there are a lot of stumbling blocks to figuring out how to do that right. One of the keys is to make sure the cells that doctors put into a damaged heart behave like heart cells and not like cancer cells and don't do the wrong things."

Klewer adds: "In the future, clinicians will have more options for successfully performing surgery on a fetus. But they can't do that unless they know there is a problem. This approach holds the promise of correcting a heart problem early, and allow for more normal heart growth and function during development, which might save an affected child from a lot of complicated procedures that otherwise would be needed after birth."

**Story Source:**

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Arizona**, via EurekAlert!, a service of AAAS.

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**Journal Reference**:

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http://www.sciencedaily.com/releases/2011/04/110411092756.htm

**Ozone Reduces Fungal Spoilage of Fruits and Vegetables**

*Dr. Ian Singleton in the ozone lab. (Credit: Newcastle University)*

ScienceDaily (Apr. 10, 2011) — Storing fruits and vegetables in ozone-enriched environments reduces spoilage explains a scientist at the Society for General Microbiology's Spring Conference in Harrogate. Dr Ian Singleton explains how ozone treatment could be a safe, effective replacement for pesticides as it leaves no residue on foods.

It is estimated that up to 30% of fresh produce can be lost due to microbial spoilage. Dr Singleton from Newcastle University explains that low levels of gaseous ozone are able to prevent fungal spoilage in a wide range of stored fresh produce, including strawberries, tomatoes, grapes and plums. His work has shown that enriching the storage environment with ozone causes a substantial decline in fungal spore production as well as a reduction in visible lesions on fruits that are already infected. Fruit stored at low levels of ozone for up to 8 days prevented almost 95% of disease from developing, depending on the fruit and levels of fungal infection.

Fungal contamination is the most common cause of spoilage of stored fruit, salads and vegetables and the risk of microbial contamination increases with longer storage periods. From the 1950s onwards, heat treatment was replaced with cheap and effective synthetic fungicides, often used in combination with pre-pack sanitation treatment containing chlorine or bromine.

Dr Singleton explains why alternative methods to reduce fungal spoilage are needed. "There are public concerns over pesticide residues on fresh produce. Ozone is a viable alternative to pesticides as it is safe to use and effective against a wide spectrum of micro-organisms. Importantly, it leaves no detectable residues in contrast to traditional methods of preserving fresh produce."

Interestingly, Dr Singleton's team found that exposing tomatoes to ozone before infecting them with fungus also reduced spoilage. "This suggests that ozone treatment exerts a 'memory' or 'vaccination' effect that protects fruit from damage. It is unclear how this phenomenon works, but is certainly worthy of further, detailed investigation," suggested Dr Singleton.

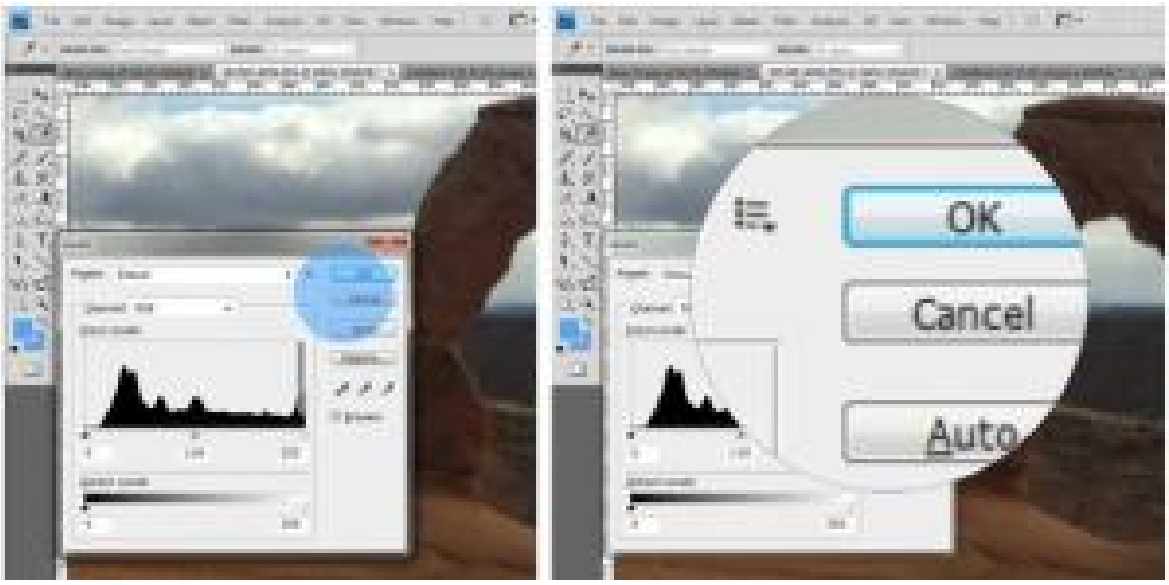
Careful work is also needed to optimize levels of ozone and length of exposure for each variety of produce. "Different fruits have been shown to have different tolerances for ozone. We need to look carefully at how we control the atmospheric concentration of the gas in stores and transit containers, since levels of ozone that are too high can damage produce, causing financial losses"

**Story Source:**

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Society for General Microbiology**, via EurekAlert!, a service of AAAS.

http://www.sciencedaily.com/releases/2011/04/110410194709.htm

**Free Software Makes Computer Mouse Easier for People With Disabilities**




*The Pointing Magnifier. (Credit: University of Washington)*

ScienceDaily (Apr. 11, 2011) — The hand moves the computer mouse, but the cursor doesn't comply. The cursor doesn't go where told. The hand tries again. The cursor shoots past the intended target. The hand tries a third time -- and the cursor loops farther from the target than where it started. And the user is frustrated.

So it often goes for computer users whose motor disabilities prevent them from easily using a mouse.

As the population ages, more people are having trouble with motor control, but a University of Washington team has invented two mouse cursors that make clicking targets a whole lot easier. And neither requires additional computer hardware -- just some free, downloadable software. The researchers hope that in exchange for the software, users offer feedback.

The Pointing Magnifier combines an area cursor with visual and motor magnification, reducing need for fine, precise pointing. The UW's AIM Research Group, which invented the Pointing Magnifier, learned that users can much more easily acquire targets, even small ones, 23 percent faster with the Pointing Magnifier.

The magnifier runs on Windows-based computer systems. It replaces the conventional cursor with a larger, circular cursor that can be made even larger for users who have less motor control. To acquire a target, the user places the large cursor somewhere over the target, and clicks. The Pointing Magnifier then magnifies everything under that circular area until it fills the screen, making even tiny targets large. The user then clicks with a point cursor inside that magnified area, acquiring the target. Although the Pointing Magnifier requires two clicks, it's much easier to use than a conventional mouse, which can require many clicks to connect with a target.

Screen magnifiers for people with visual impairments have been around a long time, but such magnifiers affect only the size of screen pixels, not the motor space in which users act, thus offering no benefit to users with motor impairments. The Pointing Magnifier enlarges both visual and motor space.

Software for the Pointing Magnifier includes a control panel that allows the user to adjust color, transparency level, magnification factor, and area cursor size. User preferences are saved when the application is closed. Keyboard shortcuts quickly enable or disable the Pointing Magnifier. The UW team is also making shortcuts customizable.

"It's less expensive to create computer solutions for people who have disabilities if you focus on software rather than specialized hardware, and software is usually easier to procure than hardware," said Jacob O. Wobbrock, an assistant professor in the Information School who leads the AIM Group.

His group's paper on enhanced area cursors, including the Pointing Magnifier, was presented at the 2010 User Interface Software and Technology symposium in New York. A follow-on paper will be presented at a similar conference in May.

Another AIM technology, the Angle Mouse, similarly helps people with disabilities. Like the Pointing Magnifier, it may be downloaded, and two videos, one for general audiences and another for academic ones, are available as well.

When the Angle Mouse cursor initially blasts towards a target, the spread of movement angles, even for people with motor impairments, tends to be narrow, so the Angle Mouse keeps the cursor moving fast. However, when the cursor nears its target and the user tries to land, the angles formed by movements diverge sharply, so the Angle Mouse slows the cursor, enlarges motor space and makes the target easier to get into. The more trouble a user has, the larger the target will be made in motor space. (The target's visual appearance will not change.)

Wobbrock compares the Angle Mouse to a race car. "On a straightaway, when the path is open, the car whips along, but in a tight corner, the car slows and makes a series of precise corrections, ensuring its accuracy."

A study of the Angle Mouse included 16 people, half of whom had motor impairments. The Angle Mouse improved motor-impaired pointing performance by 10 percent over the regular Windows™ default mouse and 11 percent over sticky icons -- an earlier innovation in which targets slow the cursor when it is inside them.

"Pointing is an essential part of using a computer, but it can be quite difficult and time consuming if dexterity is a problem," Wobbrock said. "Even shaving one second off each time a person points may save hours over the course of a year."

Wobbrock suggests that users try both the Pointing Magnifier and the Angle Mouse before deciding which they prefer.

"Our cursors make ubiquitous mice, touchpads, and trackballs more effective for people with motor impairments without requiring new, custom hardware," Wobbrock said. "We're achieving accessibility by improving devices that computer users already have. Making computers friendlier for everyone is the whole point of our work."

The Pointing Magnifier work was funded by the National Science Foundation and the Natural Sciences and Engineering Research Council of Canada.

Co-authors of the research paper that included the Pointing Magnifier are Leah Findlater, Alex Jansen, Kristen Shinohara, Morgan Dixon, Peter Kamb, Joshua Rakita and Wobbrock.

The Angle Mouse work was supported by Microsoft Research, Intel Research and the National Science Foundation.

Co-authors of the Angle Mouse paper are Wobbrock, James Fogarty, Shih-Yen (Sean) Liu, Shunichi Kimuro, and Susumi Harada.

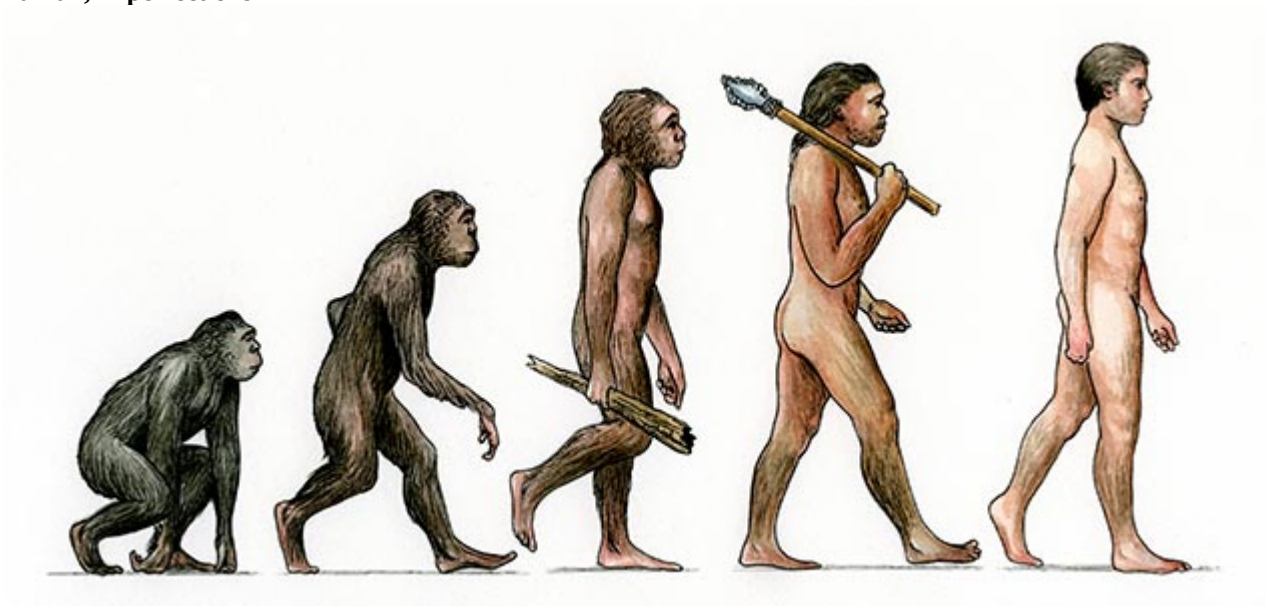
**Story Source:**

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Washington**. The original article was written by Catherine O'Donnell.

http://www.sciencedaily.com/releases/2011/04/110408163911.htm

**The Top Ten Daily Consequences of Having Evolved**

**From hiccups to wisdom teeth, the evolution of *homo sapiens* has left behind some glaring, yet innately human, imperfections**



- By Rob Dunn
- Smithsonian.com, November 19, 2010

Natural selection acts by winnowing the individuals of each generation, sometimes clumsily, as old parts and genes are co-opted for new roles. As a result, all species inhabit bodies imperfect for the lives they live. Our own bodies are worse off than most simply because of the many differences between the wilderness in which we evolved and the modern world in which we live. We feel the consequences every day. Here are ten.

**1. Our cells are weird chimeras**

Perhaps a billion years ago, a single-celled organism arose that would ultimately give rise to all of the plants and animals on Earth, including us. This ancestor was the result of a merging: one cell swallowed, imperfectly, another cell. The predator provided the outsides, the nucleus and most of the rest of the chimera. The prey became the mitochondrion, the cellular organ that produces energy. Most of the time, this ancient symbiosis proceeds amicably. But every so often, our mitochondria and their surrounding cells fight. The result is diseases, such as mitochondrial myopathies (a range of muscle diseases) or Leigh's disease (which affects the central nervous system).

**2. Hiccups**

The first air-breathing fish and amphibians extracted oxygen using gills when in the water and primitive lungs when on land—and to do so, they had to be able to close the glottis, or entryway to the lungs, when underwater. Importantly, the entryway (or glottis) to the lungs could be closed. When underwater, the animals pushed water past their gills while simultaneously pushing the glottis down. We descendants of these animals were left with vestiges of their history, including the hiccup. In hiccupping, we use ancient muscles to quickly close the glottis while sucking in (albeit air, not water). Hiccups no longer serve a function, but they persist without causing us harm—aside from frustration and occasional embarrassment. One of the reasons it is so difficult to stop hiccupping is that the entire process is controlled by a part of our brain that evolved long before consciousness, and so try as you might, you cannot think hiccups away.

**3. Backaches**
The backs of vertebrates evolved as a kind of horizontal pole under which guts were slung. It was arched in the way a bridge might be arched, to support weight. Then, for reasons anthropologists debate long into the night, our hominid ancestors stood upright, which was the bodily equivalent of tipping a bridge on end. Standing on hind legs offered advantages—seeing long distances, for one, or freeing the hands to do other things—but it also turned our backs from an arched bridge to an S shape. The letter S, for all its beauty, is not meant to support weight and so our backs fail, consistently and painfully.

**4. Unsupported intestines**
Once we stood upright, our intestines hung down instead of being cradled by our stomach muscles. In this new position, our innards were not as well supported as they had been in our quadrupedal ancestors. The guts sat atop a hodgepodge of internal parts, including, in men, the cavities in the body wall through which the scrotum and its nerves descend during the first year of life. Every so often, our intestines find their way through these holes—in the way that noodles sneak out of a sieve—forming an inguinal hernia.

**5. Choking**
In most animals, the trachea (the passage for air) and the esophagus (the passage for food) are oriented such that the esophagus is below the trachea. In a cat's throat, for example, the two tubes run roughly horizontal and parallel to each other before heading on to the stomach and lung, respectively. In this configuration, gravity tends to push food down toward the lower esophagus. Not so in humans. Modifications of the trachea to allow speech pushed the trachea and esophagus further down the throat to make way. Simultaneously, our upright posture put the trachea and esophagus in a near-vertical orientation. Together these changes leave falling food or water about a 50-50 chance of falling in the "wrong tube." As a consequence, in those moments in which the epiglottis does not have time to cover the trachea, we choke. We might be said to choke on our success. Monkeys suffer the same fate only rarely, but then again they can't sing or dance. Then again, neither can I.

**6. We're awfully cold in winter**
Fur is a warm hug on a cold day, useful and nearly ubiquitous among mammals. But we and a few other species, such as naked mole rats, lost it when we lived in tropical environments. Debate remains as to why this happened, but the most plausible explanation is that when modern humans began to live in larger groups, our hair filled with more and more ticks and lice. Individuals with less hair were perhaps less likely to get parasite-borne diseases. Being hairless in Africa was not so bad, but once we moved into Arctic lands, it had real drawbacks. Evolution has no foresight, no sense of where its work will go.

**7. Goosebumps don't really help**
When our ancestors were covered in fur, muscles in their skin called "arrector pili" contracted when they were upset or cold, making their fur stand on end. When an angry or frightened dog barks at you, these are the muscles that raise its bristling hair. The same muscles puff up the feathers of birds and the fur of mammals on cold days to help keep them warm. Although we no longer have fur, we still have fur muscles just beneath our skin. They flex each time we are scared by a bristling dog or chilled by a wind, and in doing so give us goose bumps that make our thin hair stand uselessly on end.

**8. Our brains squeeze our teeth**
A genetic mutation in our recent ancestors caused their descendants to have roomy skulls that accommodated larger brains. This may seem like pure success—brilliance, or its antecedent anyway. But the gene that made way for a larger brain did so by diverting bone away from our jaws, which caused them to become thinner and smaller. With smaller jaws, we could not eat tough food as easily as our thicker-jawed ancestors, but we could think our way out of that problem with the use of fire and stone tools. Yet because our teeth are roughly the same size as they have long been, our shrinking jaws don't leave enough room for them in our mouths. Our wisdom teeth need to be pulled because our brains are too big.

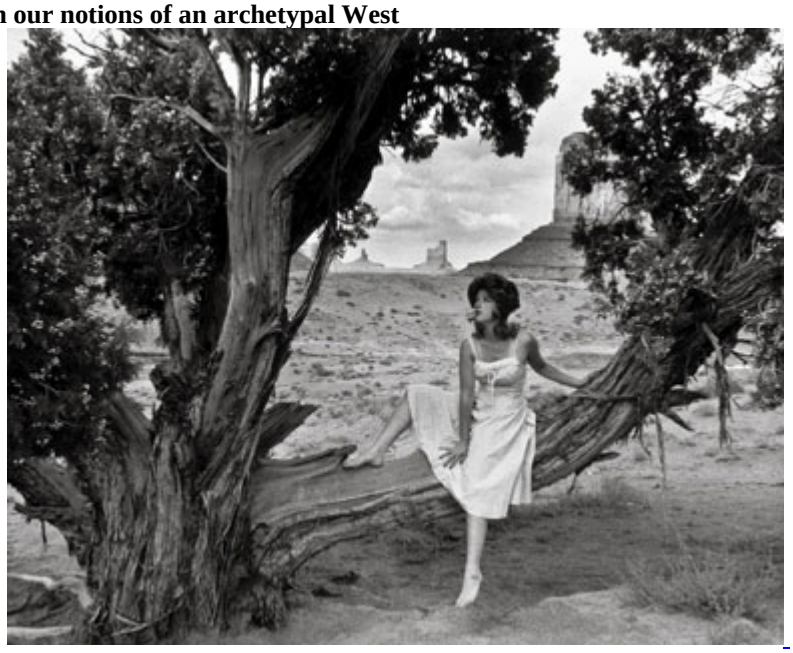
**9. Obesity**
Many of the ways in which our bodies fail have to do with very recent changes, changes in how we use our bodies and structure our societies. Hunger evolved as a trigger to drive us to search out food. Our taste buds evolved to encourage us to choose foods that benefited our bodies (such as sugar, salt and fat) and avoid those that might be poisonous. In much of the modern world, we have more food than we require, but our hunger and cravings continue. They are a bodily GPS unit that insists on taking us where we no longer need to go. Our taste buds ask for more sugar, salt and fat, and we obey.

**10 to 100. The list goes on.**
I have not even mentioned male nipples. I have said nothing of the blind spot in our eyes. Nor of the muscles some of use to wiggle our ears. We are full of the accumulated baggage of our idiosyncratic histories. The body is built on an old form, out of parts that once did very different things. So take a moment to pause and sit on your coccyx, the bone that was once a tail. Roll your ankles, each of which once connected a hind leg to a paw. Revel not in who you are but who you were. It is, after all, amazing what evolution has made out of bits and pieces. Nor are we in any way alone or unique. Each plant, animal and fungus carries its own consequences of life's improvisational genius. So, long live the chimeras. In the meantime, if you will excuse me, I am going to rest my back.

Find this article at:
http://www.smithsonianmag.com/science-nature/The-Top-Ten-Daily-Consequences-of-Having-Evolved.html

**Cindy Sherman: Monument Valley Girl**

**The artist's self portrait plays with our notions of an archetypal West**



Sherman has said she "didn't want to compete with the landscape," but she cleared space for a new Western woman.

- By Victoria Olsen
- *Smithsonian* magazine, March 2009

The enduring image of the American West is one of endless plains and unpopulated vistas. In a 1904 photograph by Edward Curtis, the monumental cliffs of Canyon de Chelly in northern Arizona dwarf the Navajo horsemen riding by.

Then there's the photograph on this page, made in 1979: a lone woman sits on a tree branch in a desolate precinct of Monument Valley, near the border of Arizona and Utah. She—not the landscape—is the subject. Who is she? Why does she look as fresh as a cactus flower? And what is this photograph doing in the same exhibition as the Curtis picture from 1904?

The exhibition, "Into the Sunset: Photography's Image of the American West," goes on display March 29 at the Museum of Modern Art in New York City (through June 8). Almost any survey of photography and the American West would include work from the expeditions Curtis made between 1900 and 1930 to document the lives of Native Americans. This picture, by Cindy Sherman, is a bit of a surprise. Sherman, born in 1954, is best known for dressing up in character and photographing herself. (That is her posing as what she calls a "Monument Valley girl.") What do Sherman's self-portraits have to do with the mythologies of the West?

This image is one of a series of what she calls "film stills," made between 1977 and 1980. In each she photographed herself in black and white dressed as a generic character inspired by movies of the 1940s, '50s and '60s. The scenes were narratives "without involving other people, just suggesting them outside the frame," she wrote in the preface to her book *The Complete Untitled Film Stills*. She avoided putting titles on the images to preserve their ambiguity. (This one is *Untitled Film Still #43*.) She wanted viewers to be able to invent their own stories to suit the scene, perhaps even insert themselves in it. The women in these photographs, she wrote, "are on their way to wherever the action is (or to their doom)...or have just come from a confrontation (or a tryst)."

Sherman made this photograph while on a vacation with her parents. She loaded a camera, a tripod and a suitcase full of wigs, makeup and costumes into a station wagon, and whenever she saw an interesting location she asked her parents to stop while she set up a scene to shoot. She says she was interested in playing with stereotypes and visual clichés.

Sherman has said she "didn't want to compete with the landscape" in the pictures she made in Arizona, but this one shows her ability to do so. Her centrality in the foreground helps, but so does her pose, with a bare leg on the tree limb echoing the shape of the cliff behind her. The picture subtly suggests a relationship between women and nature that is missing from the generic Western landscape.

Although director John Ford's most famous westerns, including *Stagecoach* and *The Searchers*, were filmed in Monument Valley, Sherman's photograph resists any reference to cowboys or Indians. Instead, it offers an alternative mythology, with a woman displacing Curtis' horsemen or Clint Eastwood's "man with no name." (Her other Arizona film stills feature other kinds of women, as if to suggest that the possibilities of the frontier include self-invention.)

"Our image of the West was always constructed," says Eva Respini, assistant curator of photography at MoMA, who organized "Into the Sunset." "Curtis' Canyon de Chelly is a fabrication, just like Sherman's." And just as Sherman uses costume to transform herself, Curtis sometimes had his Native American subjects change into traditional dress. "She may look here like a wistful, lonesome country girl," says Respini of Sherman, "but she's really playing a Western type."

Sherman stopped taking her film stills photographs around 1980. "I knew it was over when I started repeating myself," she wrote. She has spent the decades since exploring role-playing through color self-portraits.

Americans may have run out of frontier, but we haven't given up our preoccupation with it. Joan Didion wrote in *Where I Was From* that California, where her family lived for generations, remains a "wearying enigma...we worry it, correct and revise it, try and fail to define our relationship to it and its relationship to the rest of the country." The same holds true for the wider West. But each revision has the potential to show us something new. Cindy Sherman redefined the valley, and the girl.

**Victoria Olsen** is the author of *From Life: Julia Margaret Cameron and Victorian Photography*.

Find this article at:
http://www.smithsonianmag.com/people-places/Indelible-Images-Monument-Valley-Girl.html

**How to Build a Giant Dinosaur**

**Sauropods were humongous creatures, but how they got so large is a mystery that paleontologists are still trying to unravel**

- By Brian Switek
- Smithsonian.com, April 29, 2011

They were the most gigantic animals ever to walk the earth. Sauropod dinosaurs—"thin at one end; much, much thicker in the middle; and then thin again at the far end," as comedian John Cleese described them—were titans that thrived for more than 130 million years. The largest known species, such as *Argentinosaurus* and *Futalognkosaurus* from prehistoric South America, stretched more than 100 feet long and weighed in excess of 70 tons. Bones found in the 1870s (and since somehow lost) hint that an enigmatic species dubbed *Amphicoelias* may have been even bigger still.

No land mammal has ever come close to the size of these gargantuan dinosaurs. The prehistoric hornless rhino *Paraceratherium*—the largest land mammal ever—was a mere 40 feet long and weighed a paltry 17 tons, and today's African bush elephants, at 5 tons, would look dainty next to the largest sauropod dinosaurs. (Blue whales, at 100 feet and 200 tons, are a bit more massive than sauropods, but it's easier, physiologically, to be large in an aquatic environment.)

What was it about these dinosaurs that allowed them to become the biggest terrestrial animals of all time? Paleontologists have been puzzling over the question for more than a century. Even relatively modest-sized giants such as *Apatosaurus* and *Diplodocus*, early naturalists believed, were so huge that they must have been confined to rivers and lakes deep enough to support the dinosaurs' bulk. On land, the argument went, these dinosaurs would collapse under their own weight. By the 1970s, skeletal evidence and preserved footprints in trackways confirmed that sauropods were land-dwellers. But it has only been recently that paleontologists have been able to start unlocking the secrets of how these seemingly improbable animals developed over their lifetimes and how they evolved in the first place.

Understanding the natural history of sauropods has been crucial to figuring out how they got so big. Though some of the earliest members of the sauropod lineage—such as the 230 million-year-old *Panphagia* from Argentina—were less than five feet long, even they possessed a unique combination of traits that eventually allowed the group to attain huge sizes.

The way sauropods reproduced may have been a key to their ability to grow to such prodigious sizes. Mother sauropods laid about 10 eggs at a time in small nests; scores of fossilized egg clutches have been found, as have thousands of eggs from sites all over the world. (Some even preserved embryos inside, allowing

paleontologists to definitively identify sauropod eggs by their shape.) That means these dinosaurs grew outside of their mother's bodies. According to Christine Janis of Brown University and Matthew Carrano of Smithsonian's National Museum of Natural History, laying eggs opened up evolutionary possibilities for these dinosaurs.

For large mammals, carrying a fetus is a major investment. Developing African bush elephants gestate inside their mothers for a staggering 22 months, for example, and the larger mammal species get, the longer their offspring have to develop before birth. A lot can go wrong during a long gestation, including miscarriage, and nourishing such a large embryo for so long is a huge energy drain on an expectant mother (to say nothing of nursing the baby and providing care after birth). As mammals get larger, the risks and costs of carrying offspring increase, and so there might be some kind of size threshold that land mammals can't cross.

Mother sauropods, on the other hand, did not have to carry their developing babies for nearly two years, and they could lay numerous eggs at relatively short intervals. Some species may have provided parental care after hatching: rare trackways show that some herds likely included sauropods of different ages. But fans of the animated movie *The Land Before Time* may be disappointed to know that others probably didn't care for their young. Paleontologists have also found bone beds that contain only young sauropods of species such as *Alamosaurus*, indicating that these dinosaurs were on their own after leaving the nest.

Regardless of whether juvenile sauropods hung out in big herds or in smaller groups of dinosaurs their own age, though, the young dinosaurs were probably picky eaters. They had to be if they were to grow to adult size. *Diplodocus* is one of the most iconic sauropod dinosaurs, and adults of this Jurassic herbivore had broad, squared-off muzzles indicative of an indiscriminate diet. In addition to energy-rich ginkgo trees and conifers called monkey puzzles, they could have also survived on lower-quality food like cycads and the tough parts of conifers. The skull of a juvenile, described by John Whitlock, Jeffrey Wilson and Matthew Lamanna last year, hints that young *Diplodocus* had different tastes.

Paleontologists have recognized that the differences in menu choice between grazing and browsing herbivores can generally be seen in skull shape. While grazers have broad muzzles to scarf up a wide variety of food, selective browsers have narrower and rounded snouts that make it possible for them to pick specific plants or plant parts. (Some fanciful reconstructions gave *Diplodocus* and other sauropods elephant-like trunks with which to pluck food, but this idea has been thoroughly debunked.) Since the juvenile *Diplodocus* skull had a more rounded shape, Whitlock and colleagues proposed that it selected the juiciest browse – juvenile *Diplodocus* may have focused on foods like horsetails, ferns and high-energy evergreens, instead of sucking down whatever was available, as adults did.

From an energy perspective, it made sense for young sauropods to be choosy. Small dinosaurs required the most bang for their buck in terms of food; they were specialized to pick high-energy plants to fuel their rapid growth. Adults, which were already large and merely had to maintain—rather than grow—large bodies, could afford to hork down large amounts of lower-quality fuel. While they consumed more food in absolute terms, adult sauropods could eat lower-quality foods, whereas smaller sauropods required high-quality food. (This is a common pattern seen among animals even today: a tiny shrew has to eat nutritious insects almost constantly, but African elephants can subsist on a diet of lower-quality grass and other plant food.) The dietary difference may have allowed young and mature *Diplodocus* to live in the same area through a phenomenon ecologists call "niche partitioning." The specialization of the juveniles and the more generalist diet of the adults kept them out of constant competition for food, meaning that the young and old *Diplodocus* fed almost as if they were two different species.

In order to consume all that food, though, sauropods had to reach it. Long necks were a critical, early adaptation that allowed sauropods to attain large body sizes, according to a recent review by Martin Sander and 15 other scientists. Think of an *Apatosaurus* standing at the edge of a prehistoric forest. The dinosaur's long neck would allow it to reach a wide swath of vegetation—high and low, left and right—without moving its body at all. From early on in sauropod evolution, long necks made these dinosaurs efficient feeders able to reach resources that were inaccessible to other herbivores, and even with tiny heads, big sauropods would have easily been able to vacuum up huge quantities of food.

Just how these dinosaurs converted all this green food into energy and tissue is a trickier matter. Sauropods did not have robust batteries of molars to chew their food. Many had only a few pencil- or spoon-shaped teeth to pluck food before swallowing it whole. Given sauropods' poor table manners, scientists used to think that the dinosaurs might have swallowed stones to grind up food still in the stomach the way some birds do.

Paleontologists Oliver Wings and Martin Sander have argued that this probably wasn't the case—so-called "stomach stones" found with some sauropod fossils do not show a pattern of wear consistent with what would be expected if they were being used this way. Instead, the dinosaurs extracted as much nutrition as possible from their food by retaining it for long periods in their digestive systems.

A few details of sauropod digestion were experimentally modeled by Jürgen Hummel and colleagues in 2008. The scientists placed modern-day samples of the most abundant sauropod chow from the Mesozoic—ferns, horsetails, ginkgoes and conifers—in simple artificial stomachs. They inoculated the fake guts with microbes taken from the part of sheeps' digestive systems where plant food is initially broken down. As the plants fermented, the scientists tracked how much nutrition they released.

Contrary to what had been assumed, many of these plants degraded relatively easily in the crude stomach environments. Horsetails and monkey puzzles were especially nutritious. Actual dinosaur stomachs might have been even better equipped at breaking down these plants, and there was certainly enough available energy in the plants of the time for sauropods to grow large. Sauropods probably did not require extraordinary gut architecture to survive.

Another major feature allowed these titans to balloon in size. It is a trait they share with birds. Birds are the direct descendants of small theropod dinosaurs related to species like *Velociraptor* and *Anchiornis*, but they are not very closely related to sauropod dinosaurs; they last shared a common ancestor more than 230 million years ago. Even so, both the theropod and sauropod lineages shared a peculiar trait that was extremely important in their evolution—a network of internal air sacs connected to the lungs.

The soft air sacs haven't been seen directly in the fossil record, but the structures left telltale pockets where they invaded bones. Naturalists recognized the indentations more than a century ago, but modern paleontologists are only just beginning to understand their significance. As in birds, the lungs of sauropods were probably connected to a series of air sacs, and attached to these organs was a network of smaller pockets—called diverticula—that infiltrated the bones in the neck, chest and abdomen of the dinosaurs. From a structural point of view, this network of air-filled structures lowered the density of the sauropod skeleton, and allowed these dinosaurs to have a relatively lightweight construction for their size. Rather than having extra-strength bones, as had once been suggested, sauropod skeletons were made lighter by a trait they share with birds, and the network of air sacs probably had other benefits, too.

In birds, air sacs are part of a flow-through breathing arrangement that is far more efficient at extracting oxygen than is the respiratory system of mammals. We don't yet know if sauropods breathed the same way birds did—the degree to which their skeletons were modified by air sacs varied across species—but it is likely that the air sacs of the giant dinosaurs were better equipped at delivering oxygen to their bodies than the alternative seen in giant mammals. Birds have a high metabolic rate that requires a great deal of oxygen for sustained flying; similarly, the size and active lives of sauropods would have required a great deal of oxygen, and the air sac system would have provided them with essential breathing benefits.

Not all sauropod dinosaurs were giants. Some species—such as *Magyarosaurus* from the strata of Romania—were small descendants of much larger species. They shrunk in size because of their isolation on islands, though the exact reason why such island dwarfs evolve is debated by scientists. Still, sauropods weighing more than 40 tons evolved independently in at least four lineages during the long tenure of this dinosaur group, all thanks to a suite of characteristics that made large body size possible.

Paleontologists are still investigating the evolutionary pressures that made such large forms advantageous. Their size gave them some protection from predators, presumably, and their long necks let them reach food that smaller creatures looked at hungrily but couldn't reach. What other advantages giant size might have provided remain unclear. Nevertheless, sauropods were astounding creatures that could only have existed thanks to a peculiar confluence of events. They were fantastic forms unlike anything that came before or has evolved since.

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**A Triumph in the War Against Cancer**

**Oncologist Brian Druker developed a new treatment for a deadly cancer, leading to a breakthrough that has transformed medicine**

- By Terence Monmaney
- Photographs by Robbie McClaran
- *Smithsonian* magazine, May 2011

There's a photograph of LaDonna Lopossa that helps tell the story. She's all smiles, lying on the grass in a vaguely Betty Grable manner atop her own cemetery plot. The portrait was her husband's idea—in their decades together it seems George, a.k.a. Mr. No Serious, never saw a gag he didn't like—but it was LaDonna who came up with the cheesecake pose.
"OK," George had said, "now take off your shirt."
"George!"
Click.
On the one hand it's a silly snapshot of a 60-year-old woman in a cardigan and sensible sandals in Winlock, Washington, one sunny day in May 2000. On the other hand it's a glimpse of a possible future in which science has solved a fearsome problem. For this is how LaDonna and George faced her lethal cancer, not just whistling past the graveyard but clowning around in the middle of it.
Three months before, LaDonna was lying in a hospital bed in Olympia about to draw the curtain. There was a lot to let go of: four grown children, several grandkids, friends at church, a good marriage. (Never mind that as she lay there George was loudly telling the nurses he was going to hit the bars to find another wife, which she understood as his oddball effort to ease her mind.) She was ready to leave everyone and all those things and more because of the pain.
Her spleen, normally tucked beneath the lowest left rib and no bigger than a peach, was so engorged with white blood cells it was the size of a cantaloupe. She could hardly walk. Her skin was ghostly, her blood dangerously short of red cells. To breathe was a chore. Regular vomiting. Stabbing aches deep in her bones, where the marrow was frantically cranking out white cells, or leukocytes. Recurring fevers. And cold, strangely, unnervingly *cold*: she was freezing under the hospital blankets.
She was too old and too sick to undergo a bone marrow transplant, a grueling, highly risky treatment for her blood cancer, chronic myeloid leukemia (CML). She had already tried the other standard CML treatment, regular doses of the powerful compound interferon. But it so intensified her nausea, fevers and bone pain she abandoned the medication, come what may. With nothing left in their leukemia-fighting arsenal, the doctors were down to Dilaudid, a derivative of morphine, the narcotic painkiller. It was calming, it was comforting and for a patient in her condition it was, of course, the end.
George had given away most of her belongings and had reserved a U-Haul truck to cart his stuff to Southern California, where he would move in with one of their sons. The music for her funeral was chosen, including "Because I Have Been Given Much," to be sung by the grandkids. When the hospital recommended moving LaDonna to a hospice, George took her home instead and followed her doctor's advice to summon the

children; Terry, Darren and Stephen flew up from the Los Angeles area, and Kelly drove over from her place in Winlock. One by one they went into the bedroom, sat at LaDonna's bedside and said goodbye.
CML is one of the four main types of adult leukemia, but it is not common, striking 5,000 people in the United States each year. As a rule, it is fatal, with most patients dying within five years of being diagnosed. The first phase, a stealthy explosion of otherwise normal white blood cells, can last months or years; patients are often alerted to the condition by a routine blood test. If the disease goes unchecked, the white cells become increasingly abnormal, issuing helter-skelter from particular stem cells in bone marrow called myeloid cells; such leukocytes burst capillaries, overwhelm organs and suffocate tissues by crowding out oxygen-carrying red blood cells. The disease's course is exceptionally predictable, physicians say, but its clockwork nature has also provided scientists with an opportunity: prying into the molecular gears and springs that propel CML, they understand it better than any other cancer.
Once, in early December 1999, George was driving to see LaDonna at the hospital in Olympia and stopped at a Safeway to buy a newspaper. Mr. No Serious is an avid reader, had even briefly run a bookstore with LaDonna, and he devoured the paper in her hospital room. As it happened, an experimental leukemia treatment was then making headlines. "Leukemia Pill Holds Promise," the Associated Press reported, saying CML patients "had normal blood counts within a month of beginning treatment." The study was then underway at the Oregon Health & Science University (OHSU) in Portland.
George hurried out of the hospital room to find LaDonna's oncologist.
A steep, winding, tree-lined road leads to the main campus, which is perched near the summit of 574-foot-high Marquam Hill and on foggy days appears to float above the city like a castle in a fairy tale. Another route up to OHSU is the Portland aerial tram: two Swiss-made gondola cars of gleaming steel soar on cables high over Interstate 5, whizzing people back and forth between the west bank of the Willamette River and a hospital platform perched closer to the edge of a cliff than disembarking heart patients might wish it to be.
Brian Druker arrived at OHSU in 1993, years before the tram would be built and the hall-of-fame mural in the adjacent passageway would include a picture of him. Tall, as lanky and lightfooted as a greyhound, soft-spoken, Druker was 38 and had just spent nine years at the Dana-Farber Cancer Institute, part of Harvard Medical School, in Boston. "I saw cancer as being a tractable problem," he recalled of the research path he chose after finishing medical school at the University of California, San Diego. "People were beginning to get some hints and some clues and it just seemed to me that in my lifetime it was likely to yield to science and discovery."
At Dana-Farber, Druker landed in a laboratory studying how a normal human cell gives rise to runaway growth—malignancy. Among other things, the lab focused on enzymes, proteins that change other molecules by breaking them down (gut enzymes, for example, help digest food) or linking them up (hair follicle enzymes construct silky keratin fibers). Enzymes also figure in chain reactions, with one enzyme activating another and so on, until some complex cellular feat is accomplished; thus a cell can control a process such as growth or division by initiating a single reaction, like tipping the first domino. Under the lab's chief, Thomas Roberts, Druker mastered numerous techniques for tracking and measuring enzymes in tissue samples, eventually turning to one implicated in CML.
Working out the details of why this particular enzyme is the key to CML had involved hundreds of scientists around the world—research that would lead to several Nobel Prizes—but here's basically where Druker started:
First, all CML patients have the renegade enzyme in their white blood cells.
Second, the enzyme itself is the product of a freakish gene, called BCR-ABL, formed during a single myeloid stem cell's division and thereafter transmitted to billions of descendants: the tips of two chromosomes, those spindly structures that store DNA, actually swap places, causing separated genes called BCR and ABL to fuse (see illustration). The new mutant BCR-ABL gene sits on a peculiar chromosome discovered in 1960 by scientists at the University of Pennsylvania. This "Philadelphia chromosome," visible through a microscope, is CML's hallmark.
Third, the BCR-ABL enzyme is the evil twin of a normal enzyme that helps control the production of white blood cells. But like a switch stuck in the "on" position, the mutant spurs the wild proliferation that is leukemia.

You didn't have to be a Harvard doctor to see that a single enzyme that causes a fatal leukemia was, as researchers say, an attractive target for intervention. And, indeed, scientists were then setting out to find or invent compounds that could block the BCR-ABL enzyme.

Druker and his Boston co-workers, using specially designed antibodies, developed a new way to measure the enzyme's activity—a tool that would prove invaluable to evaluating potential CML treatments. A necktie-wearing physician among jean-clad PhDs, Druker was racing competitors at other research centers to find a drug that suppresses cancer by disabling a critical enzyme and spares healthy tissues in the bargain. By tradition, cancer treatments carpet-bombed the body with powerful drugs, killing healthy and cancer cells alike—"cytotoxic chemotherapy," doctors call it. The alternative, targeted therapy, would fight cancer better with less collateral damage, or at least that was the notion that often kept Druker in the lab until 11 p.m.

Then things began to fall apart. "My marriage had broken down. I wasn't what you would call a devoted husband. I was a devoted researcher and scientist and physician. And that took a toll." (Druker and his wife split after two years of marriage and were later divorced.)

Still, with a score of published studies and a nifty enzyme-measuring technique to show for his efforts, Druker thought he was ready to move up the Harvard ladder from instructor to assistant professor. "I sat down with the head of medical oncology at Dana-Farber," Druker recalled. "He looked over my résumé and said, 'I just don't think this work is going to go anywhere here.'" Translation: "I was told I had no future at Dana-Farber."

"It was awful," he recalled. "I was depressed. But it forced me to really say, Do I believe in myself? Am I going to make it, make a difference?"

Asked to describe Druker's approach, one scientist said it boiled down to "perseverance and stubbornness in not letting go of an idea."

"I think intrinsically he's a shy person," said another. "But on this"—cancer therapy—"he's like a crusader."

"He takes everything that is complicated, shoves it in his mind and outputs the simplest possible interpretation and intervention."

"When you ask a question, there's silence in the room, almost uncomfortable silence, and you're, like, did he even hear me? He thinks things through before giving an answer."

"He lets the science do the talking."

Druker grew up the youngest of four children in St. Paul, Minnesota, and attended public schools, excelling at math and science. His father was a chemist at 3M whose work on printing processes was patented. His mother was a homemaker who got involved in school-board politics and ran unsuccessfully for the state legislature.

After graduating with a chemistry degree from UC San Diego, he stayed on, and in 1978, his first year in medical school, he wrote a 16-page paper hinting at a future he would help create. Written in longhand with blue ink on lined notebook paper and titled "Cancer Chemotherapy," it concluded that, someday, when the action of cancer drugs is "understood in biochemical terms the field of cancer chemotherapy should make advancements far beyond the progress already made."

After the Dana-Farber Cancer Institute gave him the bum's rush, Druker marshaled new resolve. "When I moved here to Oregon, my goal was to identify a drug company that had a drug for CML and get that into the clinic," he said.

He'd previously met Nick Lydon, a biochemist at the Swiss pharmaceutical firm Ciba-Geigy (which would merge with Sandoz in 1996 to form Novartis). Lydon had collaborated with Roberts, Druker's former lab chief. "I called my friend Nick at Ciba-Geigy and he said, 'We have what you're looking for.'" It was called STI571. Company chemists had synthesized it and other compounds while searching for a new anti-inflammatory drug, but they had learned it could also block the activity of enzymes in a test tube. Still, they hadn't quite decided what to do with the compound.

In August 1993, Druker received his first batch of liquid STI571 and another candidate compound from Switzerland. Using the enzyme-measuring tool he'd helped develop, he confirmed that STI571 strongly inhibited the BCR-ABL enzyme, which belongs to a class of enzymes known as tyrosine kinases; the other compound did so only weakly. He also poured minute amounts of STI571 into a tray of thimble-size containers that held fluid and live white blood cells derived from a CML patient. Druker had hoped the cells' growth would slow or stop. Even better, the cells died. Moreover, a large amount of STI571 given to healthy cells in a dish did no harm. "Brian's contribution was critical," Lydon recalled, in convincing the company to "move in that direction."

But, of course, the road to dashed hopes is paved with experimental drugs that looked terrific in a test tube but failed in human beings. Skeptics pointed out that hundreds of different types of tyrosine kinase enzymes are at work in the body, and, they added, wouldn't a drug that blocked one also block many others and wreak physiological havoc? "There were many naysayers who argued that it would be impossible to develop specific protein kinase inhibitors" for treating cancer, Tony Hunter, a biochemist at the Salk Institute in La Jolla, California, wrote in the *Journal of Clinical Investigation*.

Scientific ideas don't take root like dandelion seeds wafted onto fertile ground. They need advocates, people who want to *win*. Druker plugged away, doing more experiments, such as inducing a form of CML in laboratory mice and subjecting them to STI571. It all but eliminated the animals' disease. "I was putting in probably 60 to 80 hours a week," recalled Druker, who in his scant free time competed in bicycle races, a sport that demands a high tolerance for pain and a sense of when to break out of the pack. "My life in those days was I'd work [in the lab], work out, eat and sleep." What was driving him, he said, were CML patients who were dying.

By 1997, having published numerous studies with co-workers in Portland and Switzerland, Druker believed the compound was ready to be tried in human beings. Novartis disagreed. For one thing, when dogs had been given the drug in intravenous form, it tended to cause blood clots at the end of the catheter. Novartis chemists spent months reformulating the liquid drug as a pill. But when the researchers gave large doses to dogs, the animals showed signs of liver damage. Some company officials, Druker recalled, advised dropping the project altogether.

But the canine liver damage didn't faze him; chemotherapy, after all, is destructive. "We knew how to give people toxic cancer drugs," he said.

The next thing Druker did may not have been illegal, but it certainly wasn't kosher. He bypassed Novartis and went straight to the Food and Drug Administration to see if he'd accumulated enough data to start a human trial. "I called up the toxicologist at the FDA and said, 'Here's the problem.' And he said, 'My goodness, you have a ton of data, we would probably accept this application.'" Druker then told Novartis what he'd done. "I got myself in some hot water because I'd gone behind their back."

Finally, in June 1998, with FDA permission to proceed, Druker administered STI571 to a human being, a 68-year-old Oregon man with CML. "It was almost anticlimactic," Druker recalled, "in that we'd been ready in November 1996 and here it was over a year and a half later."

He had recruited two eminent oncologists to help run the clinical trial, Moshe Talpaz at the M.D. Anderson Cancer Center in Houston and Charles Sawyers at UCLA. All the CML patients enrolled in the three cities had undergone interferon therapy and either had failed to improve or had relapsed. None was eligible for a bone marrow transplant.

Gradually increasing the STI571 dosage, the physicians observed by around six months that astronomical white blood counts of nearly 100,000 cells per cubic millimeter were falling to less than 10,000, well within normal. Analysis of one of the first patients' white blood cells found no signs of the Philadelphia chromosome, suggesting the leukemia had been stopped at the source. More impressive, whatever trace of the BCR-ABL gene remained had ceased copying itself. "That's when we knew we had something the likes of which had never been seen before in cancer therapy," Druker said.

As word spread on the Internet, other CML patients wanted in. Druker pressed Novartis to produce more of the drug. But Novartis wasn't ready. The drug was difficult to make, Daniel Vasella, then the Novartis chief executive officer and now chairman of the board, would recall in his book about the drug, *Magic Cancer Bullet*. "Nor was [the drug] a high priority, given the small number of CML patients," he added. Plus, proving that it was both safe and effective would require a substantial investment. "A severe side effect could develop in one out of 1,000 patients and that would be the end of the trial," he wrote.

In September 1999, Druker got an e-mail from a 33-year-old CML patient in Montreal, Suzan McNamara. She'd been on interferon, which had suppressed her disease for nearly a year, but now it was roaring back, and she wanted to join an STI571 trial. "I was sick to the point where I could barely leave my house," she recalled to me.

Druker phoned her the next day and said it would be months before she could enroll in a study—Novartis had not committed to producing more STI571. But, he added, the company might move more quickly if it heard directly from patients.

McNamara and a friend used an Internet site to create a petition requesting that the drug be made more widely available; thousands of CML patients endorsed it. She sent it to Vasella with a letter saying, "We have viewed with growing concern our belief...that the supply of the drug has not been sufficient to expand the trials as fast as the evidence to date would warrant."
"The letter could not be ignored," Vasella has said. The company increased STI571 production.
The honor of announcing the early clinical results fell to Druker. In New Orleans on December 3, 1999, he told an auditorium full of hematologists that all 31 patients in the study responded favorably to STI571, with the white blood cell counts of 30 falling to normal within a month. The pill's side effects—upset stomachs, muscle cramps—were what oncologists term "mild to moderate." Druker says he doesn't remember the standing ovation.
The findings were "a molecular oncologist's dream come true," wrote Harold Varmus, who now heads the National Cancer Institute and was awarded a Nobel Prize for research that laid some of the groundwork for STI571's success. The drug, he recalls in his 2009 book, *The Art and Politics of Science*, was "the best evidence to date that the most fundamental aspects of cancer research had dramatic benefits for patients with cancer."
CNN, the *New York Times*, "Good Morning America" and the Associated Press covered the breakthrough cancer pill.
After LaDonna Lopossa and her children said their goodbyes in February 2000, she eked out a few more days and made it to an appointment at OHSU. LaDonna's oncologist and George had managed to get her into the second phase of the STI571 trial, which would enroll some 500 new patients at a dozen medical centers worldwide. She shuffled into the clinic on George's arm. "What have we gotten ourselves into?" one of the nurses said, meaning LaDonna's death, which appeared imminent, would count as a black mark against the drug. Her white blood count exceeded 200,000, more than 20 times normal. "There were no two ways about it," Druker said. "You looked at her and she was in trouble."
They examined her and gave her an STI571 pill. She threw it up.
The next morning, George and LaDonna awoke in her sister's apartment in Portland and George made LaDonna a banana milkshake. Later that day, the STI571 pill stayed down. And the next, and so on.
"Within three weeks her spleen was back to practically normal," Druker said. "She was feeling great. White count had come down. A Lazarus-like effect. It was truly miraculous."
It was in May of that same year that LaDonna and George visited the cemetery in Winlock to place flowers on her mother's gravesite, which is next to the plot LaDonna had bought for herself. "I'm supposed to be in that grave," she said to George.
"Well," he said, "since you're not, why don't we take a picture?"
By the late winter of 2001, Druker and his collaborators had pooled much of their STI571 data: in roughly 95 percent of patients, white blood cell levels had returned to normal, and in 60 percent the Philadelphia chromosome was not detected. The company submitted the results with its new-drug application to the FDA, which it approved in two and a half months—to this day the fastest drug review in the agency's history.
Ten years ago this month, the U.S. government announced that the drug, which Novartis named Gleevec in the North American market (Glivec in Europe), would be available to CML patients. It was a defining moment. The previous century of cancer treatments—intermittently successful, based on trial-and-error testing, almost always agonizing—would be known to experts as "before Gleevec." From then on was "after Gleevec," the era of targeted therapy. At a Washington, D.C. press conference on May 10, the Secretary of Health and Human Services, Tommy Thompson, called the drug a "breakthrough" and "the wave of the future." The then director of the National Cancer Institute, Richard Klausner, described it as "a picture of the future of cancer treatment."
Today, Suzan McNamara would agree that future is good. When she first traveled to Portland in 2000 to take part in the Gleevec study, she recalled, "I went there with half my hair, and anorexic, and couldn't even walk up a flight of stairs. And I came back in one and a half months 20 pounds heavier and full of life." Her next steps were to attend McGill University, study leukemia therapies and earn a PhD in experimental medicine. Now 44, she lives in Montreal and works in Ottawa for Health Canada, a federal agency. Still on Gleevec, she runs several miles a few times a week. "I'd go more if I wasn't so lazy," she said. In January 2010 she wed her longtime boyfriend, Derek Tahamont, in Hawaii. "He stood by me through the whole illness and

everything," she said. "We decided to hop on a plane and get married on a beach, just the two of us. It was perfect."

Gleevec has encouraged people to think cancer is not always a deadly invader that must be annihilated but a chronic ailment that can be managed, like diabetes. In follow-up studies led by Druker, some 90 percent of newly diagnosed CML patients who began taking Gleevec had survived five years. "I tell patients how optimistic I am about their future," Druker said. "We're projecting for Gleevec that average survival will be 30 years. Someone who's diagnosed at 60 can live to 90, and die of something else."

Back when LaDonna Lopossa was 60, she recalled, Druker said he would keep her alive until she was 70. Then she reached that milestone. "I meant when I turned 70," he joked to her then.

LaDonna, now 71, and George, 68, live in Battle Ground, Washington, a rural town 24 miles north of OHSU, where LaDonna remains under Druker's care. The Lopossas live in a bungalow in a state-subsidized senior-citizen housing complex across the street from a family that keeps hens in the yard and lets George grow herbs. A framed magazine ad for Gleevec featuring LaDonna hangs on a living room wall. Two portraits of Christ grace a dining room wall. George, who is quick to say he's not religious—"nobody knows what Jesus looked like," he quipped of LaDonna's iconography—has his own den, where he watches "Family Guy."

LaDonna volunteers at the North County Community Food Bank down the street at the Mormon church she belongs to and, by telephone, she counsels people newly diagnosed with CML for the Leukemia and Lymphoma Society. One of her biggest challenges these days, she said, is convincing patients to keep taking Gleevec; they haven't endured the symptoms of fulminating CML and some find the drug's side effects annoying.

Gleevec held LaDonna's CML at bay for seven years, at which time her disease became resistant to the drug. Fortunately, medical scientists and drug companies had developed two new CML drugs, each disabling the BCR-ABL enzyme in a different fashion and compensating for a type of Gleevec resistance. Sprycel didn't help LaDonna, but Tasigna did—for about two years. Now she's on her fourth targeted CML drug, bosutinib, which is still experimental. "Her leukemia is the best controlled it's ever been since I have taken care of her in the past 11 years," Druker said.

Seated at the small round conference table in his small corner office high on Marquam Hill, Druker said he was still studying CML, hoping to understand how to eliminate every last mutant stem cell, and he was also trying to apply "the Gleevec paradigm" to other leukemias. A bright yellow bicycle-racing jersey worn and autographed by the Tour de France champ and cancer survivor Lance Armstrong hung framed on the wall. It was a clear day and the great vanilla ice-cream scoop of Mount St. Helens was visible out the window facing north and the storybook white triangle of Mount Hood could be seen through the window facing east. The guy who didn't have the right stuff to be a Harvard assistant professor is today the director of OHSU's Knight Cancer Institute, named after Phil Knight, the founder of Nike and a Portland native, and his wife, Penny, who in 2008 pledged $100 million to the facility. "Brian Druker is nothing short of a genius and a visionary," Phil Knight said at the time.

The honors have poured in, including the field's top U.S. prize, the Lasker-DeBakey Clinical Medical Research Award, which Druker shared in 2009 with Lydon and Sawyers. Of his many appearances in the news media none would change his life more than a story about him in *People*, "The Miracle Worker," published in February 2001. The magazine had sent a reporter named Alexandra Hardy to interview the dragon-slaying physician at the hospital in the clouds. The two were married in 2002 and are parents to Holden, Julia and Claire. Said Druker: "I have the ability now to focus on family as a priority. I couldn't have done that 10 or 15 years ago."

To some observers, the Gleevec fable soon lost its luster. "'Wonder Drug' for Leukemia Suffers Setback," the *Wall Street Journal* reported in 2002 once some patients became resistant to the drug or could not tolerate it. Also, it seemed researchers were slow to produce other drugs targeted to tame other cancers, calling the strategy's promise into question. A *Time* reporter blogged in 2006 that Gleevec was a "Cinderella drug"—a glass slipper that fit a singular candidate. Sawyers said he got tired of researchers saying Gleevec was a one-off, a lucky shot.

The drug's cost has been controversial since Day 1. A year's supply in the United States now runs about $50,000, or around $140 per daily pill. That is twice the original cost, which Vasella had defended as "high" but also "fair," because the drug gives patients a good quality of life and the company's revenue underwrites research on other drugs. (Asked about the reasons for the price increase, a Novartis spokeswoman declined to

comment.) In any event, a drug that Novartis balked at developing because the market was too small is now a blockbuster. In 2010, Gleevec generated $4.3 billion in worldwide sales—the company's second-highest-grossing drug. To be sure, Novartis has provided free or discounted medication to low-income patients. In 2010, the company assisted some 5,000 U.S. patients by donating to them $130 million worth of Gleevec and Tasigna, also a Novartis drug.

But patients, doctors and others have long complained about Gleevec's price. In her 2004 book, *The Truth About the Drug Companies*, Marcia Angell, former editor of the *New England Journal of Medicine*, suggested Novartis was "gouging" patients on Gleevec. Recently, physicians have reported that patients stopped taking Gleevec because they could not afford it, despite the company's assistance program.

Druker, who said his lab has received Novartis research funding but neither he nor OHSU has ever earned Gleevec royalties, deplores the cost. "It should be an affordable price, which would be in the $6,000 to $8,000 a year range," he told me. "The company would still have plenty of profits." He went on, "Many cancer drugs are now priced well out of the realm of affordability. As a health care industry, we're going to have to tackle and deal with that."

There will be plenty to deal with: it appears Gleevec was not merely a lucky shot. Just the fact that scientists quickly designed new drugs to cope with Gleevec resistance shows they increasingly know what they're doing, said Sawyers, now at Memorial Sloan-Kettering Cancer Center. He led a group that was the first to explain resistance and was involved in Sprycel's development. "Why am I so optimistic?" he said. "We know the enemy and we know how to vanquish it."

Indeed, several enzyme-targeted cancer therapies won FDA approval in Gleevec's wake, including drugs against particular forms of lung cancer and pancreatic cancer. And researchers say they're heartened by treatments well along in clinical trials. Some melanoma patients whose disease is caused by a known genetic mutation appear to benefit greatly from an experimental drug called PLX4032. Sawyers is studying a form of prostate cancer spurred by a mutant hormone receptor, and he said clinical tests of a drug (called MDV3100) targeted against it are "exciting." One pharmaceutical-industry analysis estimates that drug companies are currently developing and testing nearly 300 targeted molecular cancer therapies à la Gleevec.

Arul Chinnaiyan, a research pathologist specializing in cancer at the University of Michigan Medical School, in Ann Arbor, is frank about Gleevec's influence. "We're trying to franchise its success," he said of his attempts to apply the targeted-therapy approach to solid tumors, which are more complex than CML. Each type of solid tumor may be driven by multiple errant enzymes and receptors—protein structures that transmit chemical messages—and the variety of mutations might vary person to person. Chinnaiyan himself has discovered two different mutant gene fusions analogous to BCR-ABL that appear to drive many prostate cancers. "The thought is if we know these are the molecular lesions, we'll be able to match the drug or combination of drugs appropriately," Chinnaiyan said.

I got a sense of what he calls "personalized oncology" one day in a brew pub in Ann Arbor. Across the scarred wooden table eating a bacon cheeseburger and sipping ale was Jerry Mayfield, 62, a former Louisiana state trooper. Diagnosed with CML in 1999, Mayfield was told at the time by his hematologist that he had two to three years to live. Mayfield asked if there were experimental drugs to consider. The doctor said no. Mayfield checked the Internet, learned about STI571 and, having taught himself computer programming while manning the night desk at police headquarters in Monroe, created a Web site, newcmldrug.com, to inform other patients. If he'd listened to his hometown doctor, Mayfield said, "without question I would not be here today."

He still runs his Web site, and these days lives in Bloomington, Illinois. He was in Ann Arbor to see Talpaz, who had collaborated on the initial Gleevec clinical trials in Houston but had moved to the University of Michigan. He has taken care of Mayfield for more than a decade, administering targeted therapies in succession as Mayfield became resistant or could no longer tolerate them: Gleevec, Sprycel, Tasigna, bosutinib and now ponatinib, yet another experimental kinase-blocking CML drug racing through clinical trials.

Mayfield is "a poster boy for CML therapy," Talpaz told me. "He's doing extremely well."

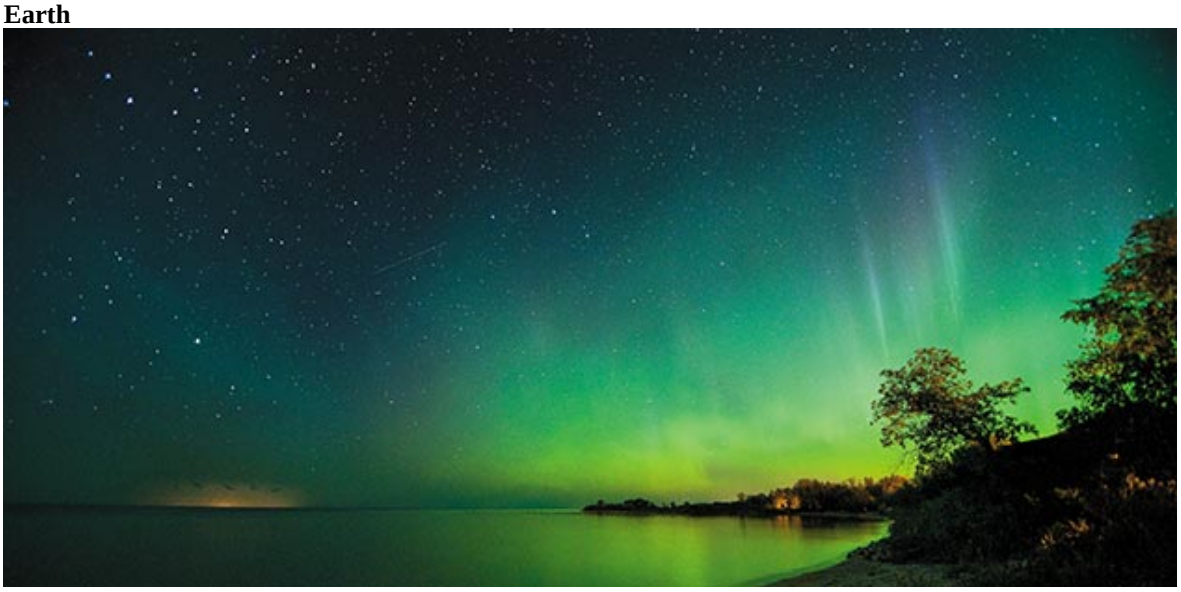
Over the pub's blaring music Mayfield said of his BCR-ABL gene, "I had the G250E mutation—*have* the G250E mutation—which is why I became resistant to Gleevec."

His remark sounded like something out of a time machine programmed to years or decades from now, when people will nonchalantly talk about their deadly genetic mutations and the drugs that stymie them. It's an

image Druker often conjures. “In the not-too-distant future,” he wrote when accepting the Lasker-DeBakey Award, “clinicians will be able to thoroughly analyze individuals’ tumors for molecular defects and match each person with specific, effective therapies that will yield a durable response with minimal toxicity.”
Mayfield has never been treated by Druker but has consulted him. “I was sitting in my local oncologist’s office one day ten years ago, and my cellphone rang,” Mayfield said. “It was Dr. Druker. I’d sent him an e-mail. I was stunned. I told my oncologist, ‘It’s rude to answer this call but this is my hero.’ He’s such a kind and gentle and dedicated man, not the least bit arrogant. He has saved so many lives. Everybody in the country should know his name. He’s the kind of idol we should have, instead of sports stars.”
Mayfield’s Web site has an “appreciation album” dedicated to Druker, filled with tributes from CML patients. Snapshot after snapshot shows people smiling in bright sunlight—hiking, planting trees, drinking champagne—people who felt moved to say they owed him, well, *everything*. They submitted dozens of poems and limericks, such as this one by a patient named Jane Graham:
*There once was a doctor named Brian*
*On whose research we all were relyin’*
*He knew we were ill,*
*So he made us a pill,*
*And now we’re not plannin’ on dyin.’*
Druker met with LaDonna Lopossa in the examining room where he sees study patients every Thursday. George, who says LaDonna has an “unsinkable-Molly Brown quality,” had driven her down from Battle Ground for her checkup. She sat in a chair while Druker, wearing a loose-fitting dark blue suit, leaned against the edge of an examining table. “I wouldn’t be here without you,” LaDonna said (possibly for my benefit).
“Well, you’re here,” Druker said. “You’re doing well.”
“I’m, like, dancing-in-the-streets well.”
“Great. Any problems?”
“No. I just have a rash.”
“When did that start?”
“About ten weeks ago.”
He asked about the rash, and later I would leave the room so he could examine her.
“You still working at the food bank?” he asked.
“I’m doing one day a week.”
“How’s that going?”
“Terrific.”
“How’s your energy?”
“My energy is low. But my brain is active.”
“You’re just doing spectacularly, leukemia-wise.”
“I know it. I can feel it.”
“What else? Questions for me?”
“I’m going on a trip tomorrow.”
“To?”
“San Diego and Knott’s Berry Farm with all my grandkids.” She updated their progress, and Druker recited their ages, as if to check that he had the facts right. When he addresses scientists at professional conferences, he often shows photographs of LaDonna and her grandchildren. Contrary to all expectations, he says, she is getting to watch her great-grandchildren grow up.
“I have such a wonderful life,” LaDonna said, tearing up. “And I didn’t want it. I told my doctors, ‘Don’t do any more to me.’ ”
Dabbing her eyes with a tissue, she mentioned her first visit to the clinic, in 2000, when she’d barely made it through the door. “That was a long time ago,” she said to no one in particular.
Then, to Druker, she said, “But it’s gone fast, hasn’t it?”
“Hasn’t it?” he said.
**Terence Monmaney** first wrote for *Smithsonian* in 1985. He is the executive editor. Portland-based **Robbie McClaran** photographed his adopted hometown for the November 2010 issue.
Find this article at:
http://www.smithsonianmag.com/science-nature/A-Victory-in-the-War-Against-Cancer.html

**Something New Under the Sun**

**Scientists are probing deep beneath the surface of our nearest star to calculate its profound effect on Earth**



- By Robert Irion
- *Smithsonian* magazine, April 2011

On an uncharacteristically tropical morning in the San Francisco Bay Area, the ground shimmers with waves of heat, and it's impossible to look to the sky without squinting. But the real heat is inside the Lockheed Martin Solar and Astrophysics Laboratory in Palo Alto. There, in a dark room stacked with computer processors, a high-definition view of the Sun fills nine conjoined TV screens to create a seven-foot-wide, theater-quality solar extravaganza.

Solar physicist Karel Schrijver types commands to start the show: an accelerated movie of a sequence of explosions that wracked the Sun on August 1, 2010. "This is one of the most stunning days I've ever seen on the Sun," Schrijver says. He's been looking at our nearest star for two decades.

"At the beginning this tiny little region decides it's not happy," he says, sounding like an astronomical psychiatrist coping with solar neuroses. He points to a flare, a modest spasm of whitish light. "Then, this nearby region begins to get unhappy, and it flares. Then a huge filament erupts and cuts through the [magnetic] field like a knife. We see this arc of glowing material, and it grows with time. A little filament under the arc says, 'I don't like that one bit,' and it becomes unstable and goes off."

Who knew the Sun has so much personality?

Within hours—sped up to minutes in the digitized replay—much of its magnetic field "gets upset," Schrijver says, and rearranges itself, unleashing flares and vast belches of magnetized gas. The chain reaction is more vivid than any Hollywood depiction. "When we show these movies to our colleagues for the first time," says Schrijver, "the professional expression is generally, 'Whoa!'"

The torrent of images comes from the most advanced satellite ever to study the Sun: NASA's Solar Dynamics Observatory, or SDO. Launched in February 2010, SDO stares at the star from a point 22,300 miles above Earth. The satellite's orbit keeps it at a steady position in view of two radio antennas in New Mexico. Every second, 24 hours a day, SDO beams 18 megabytes of data to the ground. The high-resolution pictures, as well as maps of the Sun's tortured magnetic fields, show the genesis of sunspots and the origins of their outbursts. This solar movie should provide new insights into space weather—the impacts felt on Earth when the Sun's ejections head our way. Sometimes the weather is mild. The August 1, 2010, eruptions set off colorful displays of aurora borealis over the United States two days later when a fast-moving storm of charged gas

disturbed Earth's magnetic field. But when the Sun truly gets angry, the northern lights can signal potentially disabling threats.

The most intense solar storm ever recorded struck in the summer of 1859. British astronomer Richard Carrington observed a giant network of sunspots on September 1, followed by the most intense flare ever reported. Within 18 hours, Earth was under magnetic siege. Dazzling northern lights glowed as far south as the Caribbean Sea and Mexico, and sparking wires shut down telegraph networks—the Internet of the day—across Europe and North America.

A magnetic storm in 1921 knocked out the signaling system for New York City's rail lines. A solar storm in March 1989 crippled the power grid in Quebec, depriving millions of customers of electricity for nine hours. And in 2003, a series of storms caused blackouts in Sweden, destroyed a $640 million Japanese science satellite and forced airlines to divert flights away from the North Pole at a cost of $10,000 to $100,000 each.

Our modern, globally connected electronic society is now so reliant on far-flung transformers and swarms of satellites that a major blast from the Sun could bring much of it down. According to a 2008 report from the National Research Council, a solar storm the size of the 1859 or 1921 events could zap satellites, disable communication networks and GPS systems and fry power grids at a cost of $1 trillion or more.

"The space around us isn't as benign, friendly and accommodating to our technology as we had assumed," Schrijver says.

By documenting the origins of these storms in unprecedented detail, SDO gives researchers their best chance yet to understand the Sun's destructive capabilities. The goal is to forecast space weather—to read the Sun's moods far enough in advance that we can take precautions against them. Success will rely upon gazing through the Sun's surface to see magnetic outbursts as they develop, in much the same way that meteorologists use cloud-penetrating radar to see signs of a tornado before it roars to the ground.

But for now, the Sun's activity is so complex that its convulsions baffle the field's top minds. When asked to explain the physics that drives the Sun's violence, SDO scientist Philip Scherrer of Stanford University minces no words: "We fundamentally don't know."

Our parent star is just eight minutes away, as the light flies. The Sun gets more telescope time than any other object in space, and the research is a global enterprise. The most successful satellite prior to SDO, a joint NASA-European Space Agency mission called the Solar and Heliospheric Observatory (SOHO), still sends back images of the Sun 15 years after its launch. A smaller explorer now in space, called Hinode, is a Japan-NASA collaboration that studies how the Sun's magnetic fields store and release energy. And NASA's Solar Terrestrial Relations Observatory (STEREO) mission consists of two nearly identical satellites traveling in Earth's orbit, one in front of our planet and one behind. The satellites allow scientists to create 3-D images of solar ejections. Now on opposite sides of the Sun, this past February they took the first photo of the Sun's entire surface. On the ground, telescopes in the Canary Islands, California and elsewhere examine the Sun with techniques that eliminate the blurring effects of Earth's atmosphere.

The Sun is a spinning ball of gas large enough to contain 1.3 million Earths. Its core is a furnace of nuclear fusion, converting 655 million tons of hydrogen into helium every second at a temperature of 28 million degrees Fahrenheit. This fusion creates energy that ultimately reaches us as sunlight. But the core and inner layers of the Sun are so dense that it may take a million years for a photon of the energy to fight just two-thirds of the way out. There it reaches what solar physicists call the "convective zone." Above that is a thin layer we perceive as the Sun's surface. Solar gases continue far into space beyond this visible edge in a blazing hot atmosphere called the corona. A tenuous solar wind blows through the entire solar system.

Things get especially interesting in the convective zone. Giant gyres of charged gas rise and fall, as in a pot of boiling water, only more turbulent. The Sun rotates at different speeds—about once every 24 days at its equator and more slowly, about every 30 days, at its poles. This difference in velocity shears the gas and tangles its electrical currents, fueling the Sun's magnetic fields. The overall magnetic field has a direction, just as Earth's north and south poles attract our compasses. However, the Sun's field is full of curves and kinks, and every 11 years, it flips: the north pole becomes the south, then back to north again 11 years later. It's a dynamic cycle that scientists don't fully grasp, and it's at the heart of most efforts to understand how the Sun behaves.

During those flips, the Sun's deep magnetic field gets really gnarled. It rises up and pokes through the visible surface to create sunspots. These dark patches of gas are cooler than the rest of the Sun's surface because the knotted magnetic fields act as barriers, preventing some of the Sun's energy from escaping into space. The

fields in sunspots have the potential to erupt. Above sunspots, the Sun's magnetic field loops and swirls through the corona. These writhings ignite the explosions on Lockheed's video screens in Palo Alto.
Schrijver and his boss, Alan Title, have worked together for 16 years, long enough to complete each other's sentences. Their group's latest creation, the Atmospheric Imaging Assembly—a set of four telescopes that take pictures of million-degree gases in the corona—is one of three instruments deployed on SDO. NASA compares it to an IMAX camera for the Sun.
"This bubble of gas blowing off is 30 times Earth's diameter, moving at a million miles an hour," Title says, pointing on the screen to an expanding red vortex caught by SDO soon after the satellite's launch. And, he notes almost casually, this was a fairly minor eruption.
Magnetic fields keep the Sun's gases in line as they arch into space, Title says, much as a bar magnet puts iron filings into neat patterns. The more tangled the fields become, the less stable they are. Solar outbursts happen when the magnetic fields snap into a new pattern—an event that physicists call "reconnection."
A typical solar outburst expelled toward Earth, called a coronal mass ejection, might contain ten billion tons of charged gas racing across space. "You have to imagine a set of forces sufficient to launch all of the water in the Mississippi River to a velocity 3,000 times faster than a jet plane flies, in 15 to 30 seconds," he says, pausing a moment to let that sink in. "There is no counterpart to this on Earth. We have trouble explaining these processes."
Previous solar missions took fuzzy snapshots of large coronal mass ejections. Other telescopes zoomed in for fine details but could focus on only a tiny portion of the Sun. SDO's high resolution of an entire hemisphere of the Sun and its rapid-fire recordings reveal how the surface and atmosphere change minute to minute.
Some features are so unexpected that the scientists haven't yet named them, such as a corkscrew-like pattern of gas that Schrij-ver traces on the screen with his finger. He thinks it's a spiraling magnetic field seen along its edge, lacing through gas as it ascends into space. "It's like [the gas] is being lifted in slings," he says.
Before the mission was a year old, the scientists had analyzed hundreds of events, covering many thousands of hours. (The August 1 eruptions, they found, were linked by magnetic "fault zones" spanning hundreds of thousands of miles.) The team is working under pressure, from NASA and elsewhere, for better forecasts of space weather.
"Good Lord, this is complicated," says Schrijver, playing a movie of the Sun's mood on another day. "There is no quiet day on the Sun."
A few miles away, on the campus of Stanford, solar physicist Philip Scherrer is wrestling with the same question that animates the Lockheed Martin group: Will we be able to predict when the Sun will cataclysmically hurl charged gas toward Earth? "We'd like to give a good estimate whether a given active region will produce flares or mass ejections, or if it will just go away," he says.
Scherrer, who uses a satellite downlink for television reception, explains the impact of space weather by recalling an event in 1997. "One Saturday, we woke up and all we saw was fuzz," he says. A coronal mass ejection had swept past Earth the night before. The magnetic cloud apparently took out the Telstar 401 satellite used by UPN and other networks.
"I took that personally, because it was 'Star Trek' [I was unable to watch]," Scherrer says with a wry smile. "If it had happened on the morning of the Super Bowl, everyone would have known about it."
Scherrer's team and Lockheed Martin engineers developed SDO's Helioseismic and Magnetic Imager, an instrument that probes into the Sun's churning interior and monitors the direction and strength of the magnetic field, creating black-and-white maps called magnetograms. When sunspots come along, the maps show magnetic turmoil at the bases of arching structures in the Sun's atmosphere.
The instrument also measures vibrations on the Sun's surface. On Earth, seismologists measure surface vibrations to reveal earthquake faults and geologic structures far underground. On the Sun, vibrations come not from sunquakes but from pulsations caused by gases heaving up and down on the surface at speeds of some 700 miles per hour. As each blob of gas crashes down, it propels sound waves into the Sun, and they jiggle the entire star. Scherrer's device gauges those vibrations across the Sun's face.
The key, says Scherrer, a leading expert in helioseismology, as this science is known, is that the sound waves move faster through hotter gas, such as turbulent knots far below the surface that often presage sunspots. The sound waves also accelerate when they move through gases flowing in the same direction. Although these measurements create mathematical nightmares, computers can create pictures of what's happening under the Sun's surface.

In this way, Scherrer's team can detect sunspots on the far side of the Sun days before they rotate into view and before they are in position to spew harmful particles and gas toward Earth. The scientists also hope to spot active regions bubbling up from within the Sun a day or more before they are visible as sunspots.
These techniques provide previews of coming attractions. The challenge, Scherrer says, is finding the right signs of magnetic entanglement that—like the radar images of a newly forming tornado—give reliable warnings. Some researchers have keyed in on the shapes of magnetic fields, noting that a particular S-shaped curvature often heralds an outburst. Others look at whether magnetic strength across the center of a sunspot changes quickly—an indication that it might be ready to snap.
Scherrer calls up some pictures on his screen, apologizing that they don't rival the Lockheed movies. The helioseismic images remind me of the knobby surface of an orange, with nodules of gas surging upward across the Sun's entire sphere. The magnetic graphics cast the Sun in mottled gray tones, but when Scherrer zooms in, black and white flecks grow into irregular patches. These are the ribbons of magnetic force, poking into or out of the Sun's constantly moving surface.
When magnetic field lines reconnect high in the Sun's atmosphere, Scherrer says, "it's very much like a short circuit when you touch two wires with a current. The energy flowing in the current turns into heat or light." The sudden sparks shoot down along the magnetic field and slam into the Sun's surface, setting off a powerful flare.
The strongest of the Sun's arching magnetic fields can trap billions of tons of gas beneath them, setting the stage for coronal mass ejections. When a magnetic reconnection suddenly releases all that tension, the gas lifts off into space with the solar wind. "It's like cutting the string on a helium balloon," Scherrer says.
By studying many such events, Scherrer thinks he and his colleagues can devise a system that ranks the odds of the Sun aiming an eruption at Earth—a scale that might run from "all clear" to "take precautions." Such guidelines would not be predictions, he admits, and he acknowledges, too, that solar forecasting may never rival earthly weather reports. Solar predicting requires the team to compare recent activity on the Sun with computer models. But the models are so involved that by the time the computer spits out an answer, the Sun may already have popped off or stayed quiet.
One of the biggest solar surprises in the past 50 years wasn't something the Sun did but something it didn't do: it didn't produce many sunspots for most of 2008 and 2009. "We'd go 60, 70, 80, 90 days without a single sunspot," says NASA science editor Tony Phillips, who independently publishes SpaceWeather.com. "In the lifetime of solar physicists, no one had seen this. It surprised the entire community."
No one knows what caused the eerie quiet. The deep magnetic field apparently did not twist up in its usual way, perhaps because electrical currents inside the Sun grew weaker. Some scientists speculated that the Sun was powering down, at least temporarily. A panel of solar physicists studied these changes and projected that the Sun's activity might reach just half of its recent levels in its next 11-year sunspot cycle. This could have minor implications for climate change. For the past century, human activity far outweighed the Sun's modulations in affecting Earth's climate. If the pattern of reduced solar activity continues through another of the Sun's cycles and beyond, the subtle decrease in energy from the Sun could slightly offset global warming.
The Sun is projected to reach the peak of its current sunspot cycle in late 2013 or early 2014. But there's no reason to think a more sedate Sun will stay that way. "The biggest particle event and geomagnetic storm in recorded history"—the 1859 event observed by Carrington—"occurred during a solar cycle of about the same size as the one we're projecting in the next couple of years," says Phillips. Moreover, a recent study by Suli Ma and colleagues at the Harvard-Smithsonian Center for Astrophysics showed that one-third of the solar storms striking Earth arise without solar flares or other warning signs. These sneak attacks suggest that the Sun can be hazardous even when it appears quiet.
There's no way to shield the Earth from the Sun's eruptions; powerful storms will always disrupt our planet's magnetic field. But advance warning can limit their impact. Precautions include reducing power loads to prevent surges on electrical lines, putting satellites into an electronic safe mode, and—in NASA's case—telling astronauts to take shelter within the most fortified parts of their spacecraft.
Even with those measures, an event as severe as the solar storms of 1859 or 1921 would wreak havoc, says solar and space physicist Daniel Baker of the University of Colorado, lead author of the 2008 National Research Council report. People grow more dependent on communications technology by the year, Baker says, making us ever more vulnerable to electromagnetic chaos. "Those [severe] events probably occur every decade," he says. "It's just a question of time before one of them hits us."

Baker and his colleagues have urged NASA and the National Oceanic and Atmospheric Administration, which runs the Space Weather Prediction Center in Boulder, Colorado, to develop a system of space-weather warning satellites. Today the only instrument that can determine the direction of the magnetic field inside an approaching coronal mass ejection—a critical factor for determining how violently it will interact with Earth—is on a 13-year-old satellite that has no near-term replacement.

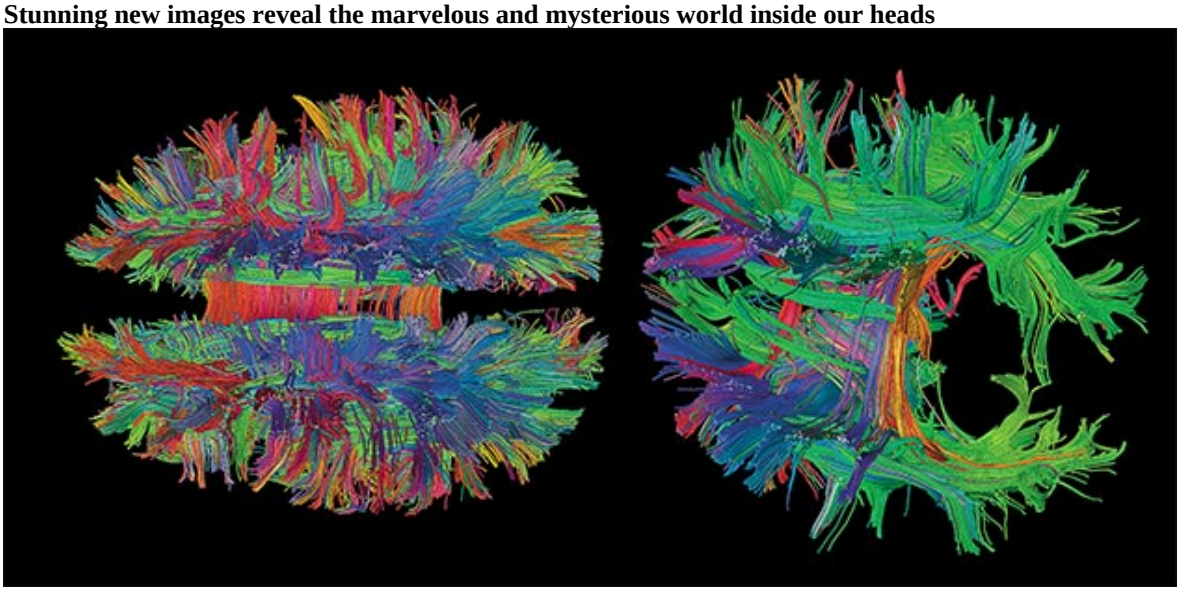
"The Sun is a highly variable star," Baker warns. "We live in its outer atmosphere, and the cyber-electric cocoon that surrounds Earth is subject to its whims. We'd better come to terms with that."

**Robert Irion** directs the science writing program at the University of California at Santa Cruz.

Find this article at:
http://www.smithsonianmag.com/science-nature/Something-New-Under-the-Sun.html

**Beauty of the Brain**

**Stunning new images reveal the marvelous and mysterious world inside our heads**



- By Laura Helmuth
- *Smithsonian* magazine, March 2011

Is the human brain, with all its problem-solving prowess and creative ability, powerful enough to understand itself? Nothing in the known universe (with the exception of the universe itself) is more complex; the brain contains about 100 billion nerve cells, or neurons, each of which can communicate with thousands of other brain cells.

Because we primates are primarily visual creatures, perhaps the best way for us to make sense of the brain is to *see* it clearly. That has been the goal for 125 years, since the Spanish scientist Santiago Ramón y Cajal began using a stain that marked individual neurons. He peered through a microscope at the stained cells and the branchlike projections with which they connected to other neurons. "Here everything was simple, clear and unconfused," he wrote of his observations, the beginning of modern neuroscience.

Scientists have since devised methods for determining the specific tasks in which different brain regions specialize—for example, some neurons, devoted to processing sight, detect only horizontal lines, while others sense danger or produce speech. Researchers have created maps delineating how brain regions not adjacent to one another are connected by long tracts of cellular projections called axons. The newest microscope techniques reveal neurons changing shape in response to experience—potentially recording a memory. The ability to see the brain in a fresh light has given rise to a wealth of insights in the past few decades.

Now scientists' forays into this universe are being put to a different use—as art objects. Carl Schoonover, a neuroscientist in training at Columbia University, has collected intriguing images of the brain for a new book, *Portraits of the Mind* (Abrams). "They are real data, not artists' renditions," he says. "This is what neuroscientists are looking at in their microscopes, MRI machines or electrophysiology systems. Neuroscience exists because of these techniques."

By borrowing a gene from fluorescent jellyfish and inserting it into the DNA of worms or mice in the lab, scientists have made neurons glow. Cajal's staining technique worked only on post-mortem tissue, and it marked neurons randomly, but the new dyes have enabled scientists to "study neurons in *living* animals and tissues," Joshua Sanes of Harvard University notes in an essay in the book.

One of the newest methods relies on a gene that makes algae sensitive to light. Shining a light on neurons containing the gene can change their behavior. "The advances allow us to manipulate the activities of

individual cells and cell types using beams of light," writes Terrence Sejnowski of the Salk Institute for Biological Studies.

The brain remains mysterious, but the patterns in these images—rich whorls of neural connections, unexpected symmetries and layers of structure—encourage scientists to believe they will yet decipher it. For his part, Schoonover hopes to "make readers think it's worth trying to figure out what the images are and why they are so beautiful."

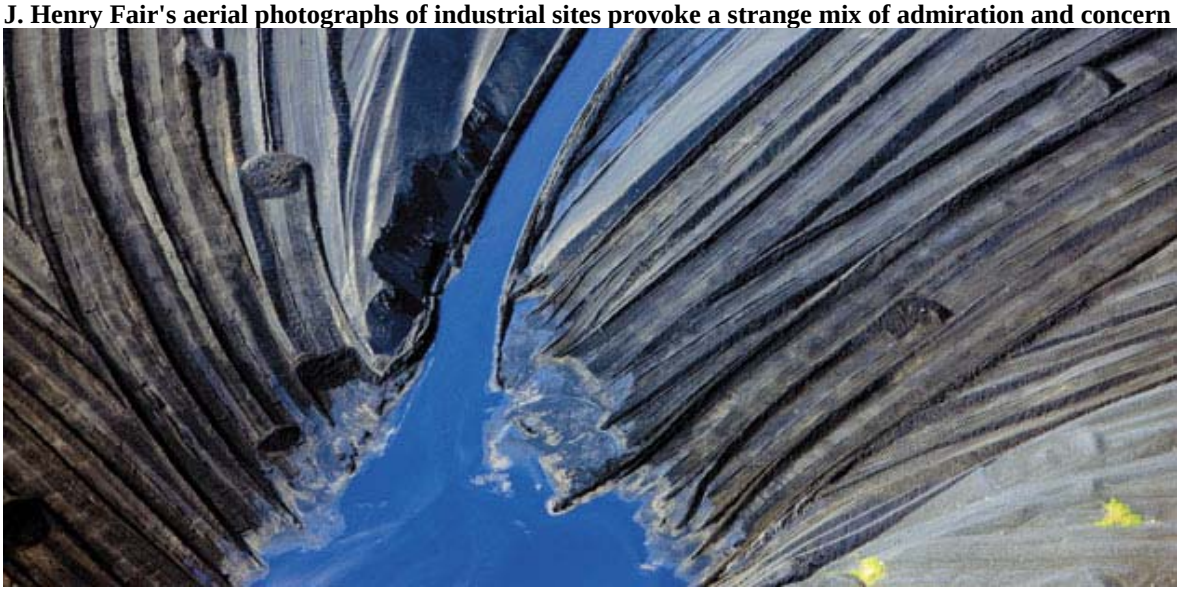
**Laura Helmuth** is a senior editor for *Smithsonian*.

Photographs are from *Portrait of the Mind: Visualizing the Brain from Antiquity to the 21st Century* by Carl Schoonover, published by Abrams.

Find this article at:
http://www.smithsonianmag.com/science-nature/Beauty-of-the-Brain.html

**Devastation From Above**

**J. Henry Fair's aerial photographs of industrial sites provoke a strange mix of admiration and concern**



- By Megan Gambino
- Photographs by J. Henry Fair
- *Smithsonian* magazine, January 2011

J. Henry Fair was stumped. He couldn't figure out how to photograph whatever might be hiding behind the walls and fences of industrial plants. Then, on a cross-country flight about 15 years ago, he looked out the window and saw a series of cooling towers poking through a low-lying fog. "Just get a plane!" he recalls thinking.

Today Fair, 51, is known in ecological as well as art circles for his strangely beautiful photographs of environmental degradation, most of them made out the open windows of small airplanes at about 1,000 feet. Fair has flown over oil refineries in Texas, paper mills in Ontario, ravaged West Virginia mountaintops, the oil-slicked Gulf of Mexico and a string of factories along the lower Mississippi River known as "Cancer Alley." He is currently photographing coal ash disposal sites, many considered highly hazardous by the Environmental Protection Agency.

Dozens of his photographs appear in *The Day After Tomorrow*, due out next month. They don't instantly make someone an environmentalist, says Lily Downing Burke, director of Manhattan's Gerald Peters Gallery, which exhibits Fair's work. "You have to think about them for a while. Then, when you find out what [the subject] is, it makes you take a step back and really question what we're doing out there."

Fair, who lives in New York State, consults scientists to better understand the images in his viewfinder: vast cranberry red ponds of hazardous bauxite waste spewed by aluminum smelters; kelly green pits filled with byproducts, some radioactive, from the manufacture of fertilizer. But pollution never looked so good. "To make an image that stops people it has to be something that tickles that beauty perception and makes people appreciate the aesthetics," says Fair, who specialized in portraiture before taking to the skies.

His goal is not to indict—he doesn't identify the polluters by name—but to raise public awareness about the costs of our choices. Such advocacy groups as Greenpeace and Rainforest Alliance have used Fair's work to advance their causes.

"He is a real asset to the national environmental movement," says Allen Hershkowitz, a senior scientist at the Natural Resources Defense Council who contributed an essay to Fair's book. A Fair photograph, he adds, "takes the viewer, in an artistic context, to an intellectual place that he or she didn't expect to go. My aluminum foil comes from *that*? My electricity comes from *that*? My toilet paper comes from *that*?"

Critics say Fair's bird's-eye images tell only part of the story. Patrick Michaels, a senior environmental studies fellow at the Cato Institute in Washington, D.C., says many people may tolerate, say, drilling natural gas wells in a forest—Fair has photographed these in the Catskill Mountains—if it reduces U.S. dependence on foreign oil.

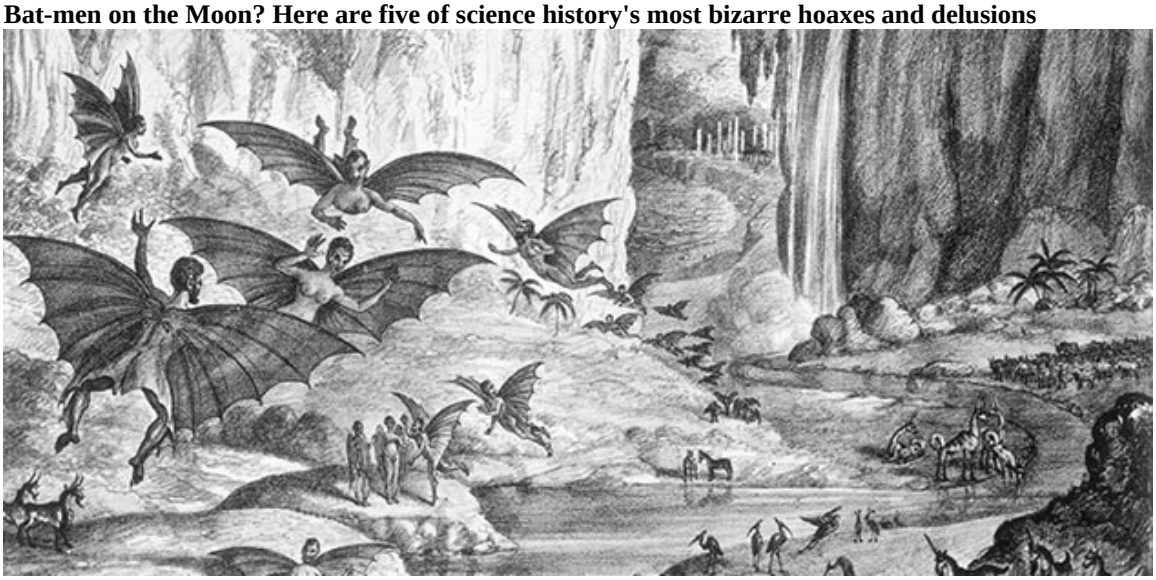
Fair picked up his first camera, a Kodak Retina, at age 14, and learned darkroom techniques as a teenager working in a camera store in Charleston, South Carolina. His first subjects were people he would see on the streets and rusty machinery that he felt captured society in decay. At Fordham University in New York City, Fair ran the school's photo labs while earning a degree in media studies; he graduated in 1983. He worked construction jobs until he could support himself with commercial photography, which included album covers for cellist Yo-Yo Ma and mezzo-soprano Cecilia Bartoli. But as Fair's eco-consciousness rose in the 1990s, his gaze turned back to machinery, industry and pollution.

Years of documenting "industrial scars" has had a personal effect. Fair says he uses as little electricity as possible and often burns candles to light his house. He tweets advice on living the environmentally aware life. (Example: bring your own bathrobe to the doctor's office.)Though he owns a hybrid car, he often hitchhikes to a train station miles away. "People first think I'm crazy," Fair says, "then they think about it a little bit." Which is precisely the point.

**Megan Gambino** wrote about the aerial photos of David Maisel in January 2008.

Find this article at:
http://www.smithsonianmag.com/science-nature/Devastation-From-Above.html

**Cosmic Errors**
**Bat-men on the Moon? Here are five of science history's most bizarre hoaxes and delusions**



- By Erik Washam
- *Smithsonian* magazine, December 2010

**Bat-Men On The Moon!**

One August morning in 1835, readers of the New York Sun were astonished to learn that the Moon was inhabited. Three-quarters of the newspaper's front page was devoted to the story, the first in a series entitled "Great Astronomical Discoveries Lately Made by Sir John Herschel, L.L.D, F.R.S, &c At The Cape of Good Hope." Herschel, a well-known British astronomer, was able "by means of a telescope of vast dimensions and an entirely new principle," the paper reported, to view objects on the Moon as though they were "at the distance of a hundred yards." Each new story in the six-part series reported discoveries more fantastic than the last.

Herschel's telescope revealed lunar forests, lakes and seas, "monstrous amethysts" almost a hundred feet high, red hills and enormous chasms. Populating this surreal landscape were animals resembling bison, goats, pelicans, sheep—even unicorns. Beavers without tails walked on two legs and built fires in their huts. A ball-shaped amphibian moved around by rolling. There were moose, horned bears and miniature zebras. But the biggest surprise of all was reserved for the fourth article in the series. Herschel and his team of astronomers had spotted humanoids: bipedal bat-winged creatures four feet tall with faces that were "a slight improvement" on the orangutan's. Dubbed Vespertilio-homo (or, informally, the bat-man), these creatures were observed to be "innocent," but they occasionally conducted themselves in a manner that the author thought might not be fit for publication.

The *Sun* also described massive temples, though the newspaper cautioned that it was unclear whether the bat-men had built them or the structures were the remnants of a once-great civilization. Certain sculptural details—a globe surrounded by flames—led the *Sun*'s writer to wonder whether they referred to some calamity that had befallen the bat-men or were a warning about the future.

Reaction to the series—an effort to boost circulation, which it did—ranged from amazed belief to incredulity. Herschel himself was annoyed. In a letter to his aunt Caroline Herschel, also an astronomer, he wrote, "I have been pestered from all quarters with that ridiculous hoax about the Moon—in English French Italian & German!!" The author of the piece was most likely Richard Adams Locke, a Sun reporter. The newspaper never admitted it concocted the story. It's tempting to think that we're immune to such outlandish hoaxes today, and perhaps we are. But a passage from the series reminds us that we're not as different from our

forebears of almost 200 years ago as we might think. When Herschel made his supposed optic breakthrough, the Sun reported, a colleague leapt into the air and exclaimed: "Thou art the man!"

**Planet Vulcan Found!**

Vulcan is best known today as the fictional birthplace of the stoic Mr. Spock on "Star Trek," but for more than half a century it was considered a real planet that orbited between Mercury and the Sun. More than one respectable astronomer claimed to have observed it.

Astronomers had noticed several discrepancies in Mercury's orbit. In 1860, French mathematician Urbain Le Verrier speculated that an undetected planet exerting a gravitational pull on Mercury could account for the odd orbit. He named it Vulcan.

An astronomer named Edmond Lescarbault said he had spotted the planet the previous year. Other astronomers pored over reports of previous sightings of objects crossing in front of the Sun. Occasional sightings of planet-like objects were announced, each prompting astronomers to recalculate Vulcan's orbit. After the solar eclipse of 1878, which gave astronomers a rare opportunity to see objects normally obscured by the Sun's glare, two astronomers reported they had seen Vulcan or other objects inside Mercury's orbit.

Le Verrier was awarded the Légion d'honneur for predicting the location of a real planet: Neptune. He died in 1877 still believing he had also discovered Vulcan. It took until 1915 and improved photography and the acceptance of Einstein's general theory of relativity, which explained Mercury's orbital discrepancies, for the idea to be laid to rest. The observations of the phantom planet were either wishful thinking or sunspots.

**Martians Build Canals!**

Percival Lowell peered through a telescope on an Arizona hilltop and saw the ruddy surface of Mars crisscrossed with canals. Hundreds of miles long, they extended in single and double lines from the polar ice caps. Bringing water to the thirsty inhabitants of an aging planet that was drying up, the canals were seen as a spectacular feat of engineering, a desperate effort by the Martians to save their world.

Lowell was an influential astronomer, and the canals, which he mapped with elaborate precision, were a topic of scientific debate during the early 20th century. We know now that the canals didn't exist, but how did this misperception begin?

In 1877, Giovanni Schiaparelli, an Italian astronomer, reported seeing canali on the surface of Mars. When his report was translated into English, canali, which in Italian means channels, was rendered as canals, which are by definition man-made.

Lowell's imagination was ignited by Schiaparelli's findings. In 1894, Lowell built an observatory in Flagstaff, Arizona, and focused on Mars. Other astronomers had noticed that some areas of the planet's surface seemed to change with the seasons—blue-green in the summer and reddish-ocher in the winter. These changes seemed to correspond with the growing and shrinking of the polar ice caps. Lowell believed that the melting caps in summer filled the canals with water that fed large areas of vegetation. He filled notebook after notebook with observations and sketches and created globes showing the vast network of waterways built by Martians.

The intricacy of Lowell's canal system is all the more mystifying because it doesn't seem to correspond to any actual features on the planet—yet he apparently saw the same canals in exactly the same places time after time. Even in Lowell's day, most other astronomers failed to see what he saw, and his theory fell into disrepute among most of the scientific community (though the public continued to embrace the notion). To this day, no one knows whether Lowell's maps were the result of fatigue, optical illusions or, perhaps, the pattern of blood vessels in his eye.

Like any romantic idea, belief in Martian canals proved hard to abandon. The possibility of life on the planet closest to ours has fascinated us for centuries and continues to do so. Lowell's canals inspired science fiction writers including H.G. Wells and Ray Bradbury. It took the Mariner missions to Mars of the 1960s and 1970s to prove that there are no canals on the Red Planet.

**The Earth Is Hollow!**

**(and we might live on the inside)**

Imagine the earth as a hollow ball with an opening at each pole. On its inner surface are continents and oceans, just like on the outer surface. That's the Earth envisioned by Capt. John Cleves Symmes, an American veteran of the War of 1812. He toured the country in the 1820s, lecturing on the hollow Earth and urging Congress to fund an expedition to the polar openings. His hope was that Earth's inner surface would be explored and that trade would be established with its inhabitants.

The hollow Earth theory wasn't entirely new—the idea of open spaces inside Earth had been suggested by ancient thinkers including Aristotle, Plato and Seneca. Caves and volcanoes gave the concept plausibility, and legends and folktales abound with hidden civilizations deep below the crust.

In 1691, to explain variations in Earth's magnetic poles, royal astronomer Sir Edmond Halley, better known for recognizing the schedule of a brilliant comet, proposed a hollow Earth consisting of four concentric spheres. The interior must be lit and inhabited, he said; the idea of the Creator failing to populate the land and provide its populace with life-giving light seemed inconceivable. Halley proposed a luminous substance that filled the cavity, and he attributed the aurora borealis to its escape through the crust at the poles.

To make a weird idea even weirder, Cyrus Teed, a 19th-century physician, alchemist and experimenter with electricity, concluded that the world was not only hollow but also that human beings were living on its inner surface. He got the idea in 1869, when an angelic vision announced (after Teed had been shocked into unconsciousness by one of his experiments) that Teed was the messiah. According to the angel, the Sun and other celestial bodies rose and set within the hollow Earth due to an atmosphere that bent light in extreme arcs. The entire cosmos, he claimed, was contained inside the sphere, which was 8,000 miles in diameter. Teed changed his name to Koresh (the Hebrew form of "Cyrus"), founded his own cult (Koreshanity) and eventually built a compound for his followers, who numbered 250, in southwestern Florida. The compound is now preserved by the state of Florida as the Koreshan State Historic Site and draws tens of thousands of visitors every year.

**Venus Attacks!**

In 1950, Immanuel Velikovsky published *Worlds in Collision*, a book that claimed cataclysmic historical events were caused by an errant comet. A psychoanalyst by training, Velikovsky cited the Old Testament book of Joshua, which relates how God stopped the Sun from moving in the sky. Moses' parting of the Red Sea, Velikovsky claimed, could be explained by the comet's gravitational pull. He theorized that in 1500 B.C., Jupiter spewed out a mass of planetary material that took the form of a comet before becoming the planet Venus.

Velikovsky was one in a long line of catastrophists, adherents of the theory that sudden, often planet-wide cataclysms account for things like mass extinctions or the formation of geological features. His book is remarkable not so much for its theories—which are unexceptional by catastrophist standards—but for its popularity and longevity. A *New York Times* best seller for 11 weeks, it can be found on the science shelves of bookstores to this day and enjoys glowing reviews on some Web sites.

*Worlds in Collision* was met with derision from scientists. Among other problems, the composition of Venus and Jupiter are quite different, and the energy required for ejecting so much material would have vaporized the nascent planet. At a 1974 debate sponsored by the American Association for the Advancement of Science, Carl Sagan, the popular astronomer, was among the panelists opposing Velikovsky. But the attacks may have strengthened Velikovsky's standing; he struck some people as an underdog fighting the scientific establishment.

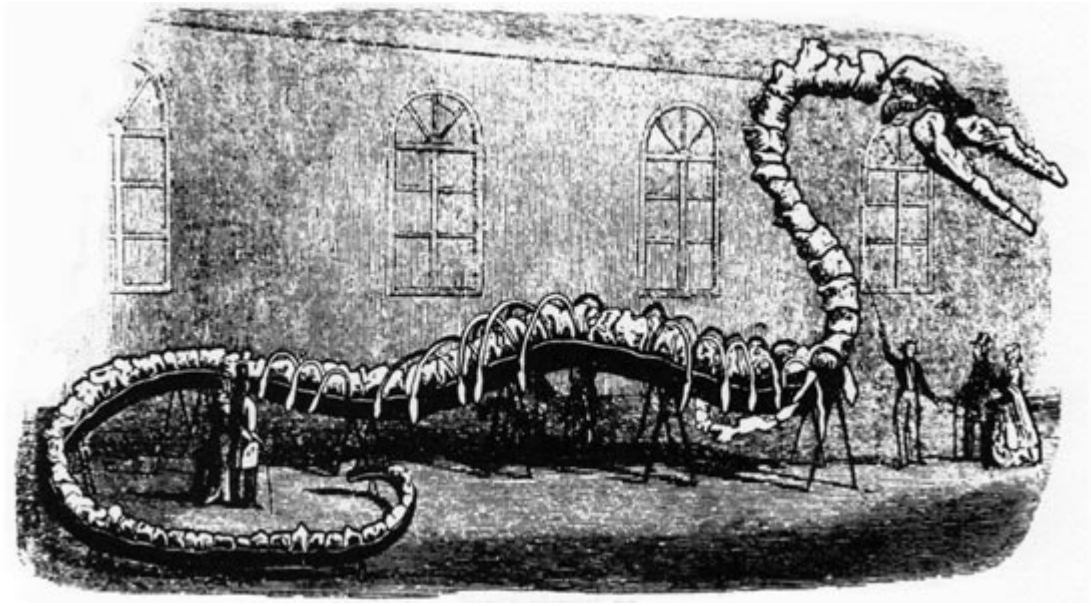
Velikovsky's ideas seemed radical a half century ago—most astronomers assumed that planetary change occurred at a slow, constant rate. His remaining adherents point to the asteroid impact that killed most of the dinosaurs 65 million years ago as evidence he was ahead of his time.

**Erik Washam** is the associate art director for *Smithsonian*.

Find this article at:
http://www.smithsonianmag.com/science-nature/Cosmic-Errors.html

**How Did Whales Evolve?**

**Originally mistaken for dinosaur fossils, whale bones uncovered in recent years have told us much about the behemoth sea creatures**



- By Brian Switek
- Smithsonian.com, December 01, 2010

What springs to mind when you think of a whale? Blubber, blowholes and flukes are among the hallmarks of the roughly 80 species of cetaceans (whales, dolphins and porpoises) alive today. But, because they are mammals, we know that they must have evolved from land-dwelling ancestors.

About 375 million years ago, the first tetrapods—vertebrates with arms and legs—pushed themselves out of the swamps and began to live on land. This major evolutionary transition set the stage for all subsequent groups of land-dwelling vertebrates, including a diverse lineage called synapsids, which originated about 306 million years ago. Though these creatures, such as *Dimetrodon*, looked like reptiles, they were actually the archaic precursors of mammals.

By the time the first mammals evolved 200 million years ago, however, dinosaurs were the dominant vertebrates. Mammals diversified in the shadow of the great archosaurs, and they remained fairly small and secretive until the non-avian dinosaurs were wiped out by a mass extinction 65 million years ago. This global catastrophe cleared the way for a major radiation of mammals. It was only about 10 million years after this extinction—and more than 250 million years since the earliest tetrapods crawled out onto land—that the first whales evolved. These earliest cetaceans were not like the whales we know today, and only recently have paleontologists been able to recognize them.

For more than a century, our knowledge of the whale fossil record was so sparse that no one could be certain what the ancestors of whales looked like. Now the tide has turned. In the space of just three decades, a flood of new fossils has filled in the gaps in our knowledge to turn the origin of whales into one of the best-documented examples of large-scale evolutionary change in the fossil record. These ancestral creatures were stranger than anyone ever expected. There was no straight-line march of terrestrial mammals leading up to fully aquatic whales, but an evolutionary riot of amphibious cetaceans that walked and swam along rivers, estuaries and the coasts of prehistoric Asia. As strange as modern whales are, their fossil predecessors were even stranger.

Pioneers who cleared land in Alabama and Arkansas frequently found enormous round bones. Some settlers used them as fireplace hearths; others propped up fences with the bones or used them as cornerstones; slaves used the bones as pillows. The bones were so numerous that in some fields they were destroyed because they interfered with cultivating the land.

In 1832, a hill collapsed on the Arkansas property of Judge H. Bry and exposed a long sequence of 28 of the circular bones. He thought they might be of scientific interest and sent a package to the American Philosophical Society in Philadelphia. No one quite knew what to make of them. Some of the sediment attached to the bone contained small shells that showed that the large creature had once lived in an ancient sea, but little more could be said with any certainty.

Bry's donation was soon matched, and even exceeded, by that of Judge John Creagh from Alabama. He had found vertebrae and other fragments while blasting on his property and also sent off a few samples to the Philadelphia society. Richard Harlan reviewed the fossils, which were unlike any he had seen before. He asked for more bones, and Creagh soon sent parts of the skull, jaws, limbs, ribs, and backbone of the enigmatic creature. Given that both Creagh and Bry said they had seen intact vertebral columns in excess of 100 feet in length, the living creature must have been one of the largest vertebrates to have ever lived. But what kind of animal was it?

Harlan thought the bones were most similar to those of extinct marine reptiles such as the long-necked plesiosaurs and streamlined ichthyosaurs. He tentatively assigned it the name Basilosaurus. He wasn't certain, though. The jaw contained teeth that differed in size and shape, a characteristic of mammals but not most reptiles. Why did the largest fossil reptile that ever lived have mammal-like teeth?

Harlan traveled to London in 1839 to present *Basilosaurus* to some of the leading paleontologists and anatomists of the day. Richard Owen, a rising star in the academic community, carefully scrutinized every bone, and he even received permission to slice into the teeth to study their microscopic structure. His attention to such tiny details ultimately settled the identification of the sea monster. *Basilosaurus* did share some traits with marine reptiles, but this was only a superficial case of convergence—of animals in the same habitat evolving similar traits—because both types of creature had lived in the sea. The overall constellation of traits, including double-rooted teeth, unquestionably identified *Basilosaurus* as a mammal.

A few years later, a scientist handling a different specimen with his colleagues pulled out a bone from the skull, dropped it, and it shattered on the floor. When the unnerved scientists gathered the fragments, they noticed that the bone now revealed the inner ear. There was only one other kind of creature with an inner ear that matched: a whale.

Not long after the true identity of *Basilosaurus* was resolved, Charles Darwin's theory of evolution by means of natural selection raised questions about how whales evolved. The fossil record was so sparse that no definite determination could be made, but in a thought experiment included in *On the Origin of Species*, Darwin speculated about how natural selection might create a whale-like creature over time:

In North America the black bear was seen by [the explorer Samuel] Hearne swimming for hours with widely open mouth, thus catching, like a whale, insects in the water. Even in so extreme a case as this, if the supply of insects were constant, and if better adapted competitors did not already exist in the country, I can see no difficulty in a race of bears being rendered, by natural selection, more and more aquatic in their structure and habits, with larger and larger mouths, till a creature was produced as monstrous as a whale.

Darwin was widely ridiculed for this passage. Critics took it to mean he was proposing that bears were direct ancestors of whales. Darwin had done no such thing, but the jeering caused him to modify the passage in subsequent editions of the book. But while preparing the sixth edition, he decided to include a small note about *Basilosaurus*. Writing to his staunch advocate T.H. Huxley in 1871, Darwin asked whether the ancient whale might represent a transitional form. Huxley replied that there could be little doubt that *Basilosaurus* provided clues as to the ancestry of whales.

Huxley thought that *Basilosaurus* at least represented the type of animal that linked whales to their terrestrial ancestors. If this was true, then it seemed probable that whales had evolved from some sort of terrestrial carnivorous mammal. Another extinct whale called *Squalodon*, a fossil dolphin with a wicked smile full of triangular teeth, similarly hinted that whales had evolved from meat-eating ancestors. Like *Basilosaurus*, though, *Squalodon* was fully aquatic and provided few clues as to the specific stock from which whales arose. Together these fossil whales hung in a kind of scientific limbo, waiting for some future discovery to connect them with their land-dwelling ancestors.

In the meantime, scientists speculated about what the ancestors of whales might have been like. The anatomist William Henry Flower pointed out that seals and sea lions use their limbs to propel themselves through the water while whales lost their hind limbs and swam by oscillations of their tail. He could not imagine that early cetaceans used their limbs to swim and then switched to tail-only propulsion at some later point. The semi-aquatic otters and beavers, he claimed, were better alternative models for the earliest terrestrial ancestors of whales. If the early ancestors of whales had large, broad tails, that could explain why they evolved such a unique mode of swimming.

Contrary to Huxley's carnivore hypothesis, Flower thought that ungulates, or hoofed mammals, shared some intriguing skeletal similarities with whales. The skull of *Basilosaurus* had more in common with ancient "pig-like Ungulates" than seals, thus giving the common name for the porpoise, "sea-hog," a ring of truth. If ancient omnivorous ungulates could eventually be found, Flower reasoned, it would be likely that at least some would be good candidates for early whale ancestors. He envisioned a hypothetical cetacean ancestor easing itself into the shallows:

We may conclude by picturing to ourselves some primitive generalized, marsh-haunting animals with scanty covering of hair like the modern hippopotamus, but with broad, swimming tails and short limbs, omnivorous in their mode of feeding, probably combining water plants with mussels, worms, and freshwater crustaceans, gradually becoming more and more adapted to fill the void place ready for them on the aquatic side of the borderland on which they dwelt, and so by degree being modified into dolphin-like creatures inhabiting lakes and rivers, and ultimately finding their way into the ocean.

The fossil remains of such a creature remained elusive. By the turn of the 20th century the oldest fossil whales were still represented by *Basilosaurus* and similar forms like *Dorudon* and *Protocetus*, all of which were fully aquatic—there were no fossils to bridge the gap from land to sea. As E.D. Cope admitted in an 1890 review of whales: "The order Cetacea is one of those of whose origin we have no definite knowledge." This state of affairs continued for decades.

While analyzing the relationships of ancient meat-eating mammals in 1966, however, the evolutionary biologist Leigh Van Valen was struck by the similarities between an extinct group of land-dwelling carnivores called mesonychids and the earliest known whales. Often called "wolves with hooves," mesonychids were medium- to large-sized predators with long, toothy snouts and toes tipped with hooves rather than sharp claws. They were major predators in the Northern Hemisphere from shortly after the demise of the dinosaurs until about 30 million years ago, and the shape of their teeth resembled those of whales like *Protocetus*.

Van Valen hypothesized that some mesonychids may have been marsh dwellers, "mollusk eaters that caught an occasional fish, the broadened phalanges [finger and toe bones] aiding them on damp surfaces." A population of mesonychids in a marshy habitat might have been enticed into the water by seafood. Once they had begun swimming for their supper, succeeding generations would become more and more aquatically adapted until something "as monstrous as a whale" evolved.

A startling discovery made in the arid sands of Pakistan announced by University of Michigan paleontologists Philip Gingerich and Donald Russell in 1981 finally delivered the transitional form scientists had been hoping for. In freshwater sediments dating to about 53 million years ago, the researchers recovered the fossils of an animal they called *Pakicetus inachus*. Little more than the back of the animal's skull had been recovered, but it possessed a feature that unmistakably connected it to cetaceans.

Cetaceans, like many other mammals, have ear bones enclosed in a dome of bone on the underside of their skulls called the auditory bulla. Where whales differ is that the margin of the dome closest to the midline of the skull, called the involucrum, is extremely thick, dense, and highly mineralized. This condition is called pachyosteosclerosis, and whales are the only mammals known to have such a heavily thickened involucrum. The skull of *Pakicetus* exhibited just this condition.

Even better, two jaw fragments showed that the teeth of *Pakicetus* were very similar to those of mesonychids. It appeared that Van Valen had been right, and *Pakicetus* was just the sort of marsh-dwelling creature he had envisioned. The fact that it was found in freshwater deposits and did not have specializations of the inner ear for underwater hearing showed that it was still very early in the aquatic transition, and Gingerich and Russell thought of *Pakicetus* as "an amphibious intermediate stage in the transition of whales from land to sea," though they added the caveat that "Postcranial remains [bones other than the skull] will provide the best test of this hypothesis." The scientists had every reason to be cautious, but the fact that a transitional whale had

been found was so stupendous that full-body reconstructions of *Pakicetus* appeared in books, magazines and on television. It was presented as a stumpy-legged, seal-like creature, an animal caught between worlds. Throughout the 1990s, the skeletons of more or less aquatically adapted ancient whales, or archaeocetes, were discovered at a dizzying pace. With this new context, however, the stubby, seal-like form for *Pakicetus* depicted in so many places began to make less and less sense. Then, in 2001, J.G.M. Thewissen and colleagues described the long-sought skeleton (as opposed to just the skull) of *Pakicetusattocki*. It was a wolf-like animal, not the slick, seal-like animal that had originally been envisioned. Together with other recently discovered genera like *Himalayacetus*, *Ambulocetus*, *Remingtonocetus*, *Kutchicetus*, *Rodhocetus* and *Maiacetus*, it fits snugly within a collection of archaeocetes that exquisitely document an evolutionary radiation of early whales. Though not a series of direct ancestors and descendants, each genus represents a particular stage of whale evolution. Together they illustrate how the entire transition took place.

The earliest known archaeocetes were creatures like the 53-million-year-old *Pakicetus* and the slightly older *Himalayacetus*. They looked as if they would have been more at home on land than in the water, and they probably got around lakes and rivers by doing the doggie paddle. A million years later lived *Ambulocetus*, an early whale with a crocodile-like skull and large webbed feet. The long-snouted and otter-like remingtonocetids appeared next, including small forms like the 46-million-year-old *Kutchicetus*. These early whales lived throughout near-shore environments, from saltwater marshes to the shallow sea.

Living at about the same time as the remingtonocetids was another group of even more aquatically adapted whales, the protocetids. These forms, like *Rodhocetus*, were nearly entirely aquatic, and some later protocetids, like *Protocetus* and *Georgiacetus*, were almost certainly living their entire lives in the sea. This shift allowed the fully aquatic whales to expand their ranges to the shores of other continents and diversify, and the sleeker basilosaurids like *Dorudon*, *Basilosaurus* and *Zygorhiza* populated the warm seas of the late Eocene. These forms eventually died out, but not before giving rise to the early representatives of the two groups of whales alive today, the toothed whales and the baleen whales. The early representatives of these groups appeared about 33 million years ago and ultimately gave rise to forms as diverse as the Yangtze River dolphin and the gigantic blue whale.

Studies coming out of the field of molecular biology conflicted with the conclusion of the paleontologists that whales had evolved from mesonychids, however. When the genes and amino acid sequences of living whales were compared with those of other mammals, the results often showed that whales were most closely related to artiodactyls—even-toed ungulates like antelope, pigs, and deer. Even more surprising was that comparisons of these proteins used to determine evolutionary relationships often placed whales *within* the Artiodactyla as the closest living relatives to hippos.

This conflict between the paleontological and molecular hypotheses seemed intractable. Mesonychids could not be studied by molecular biologists because they were extinct, and no skeletal features had been found to conclusively link the archaeocetes to ancient artiodactyls. Which were more reliable, teeth or genes? But the conflict was not without hope of resolution. Many of the skeletons of the earliest archaeocetes were extremely fragmentary, and they were often missing the bones of the ankle and foot. One particular ankle bone, the astragalus, had the potential to settle the debate. In artiodactyls this bone has an immediately recognizable "double pulley" shape, a characteristic mesonychids did not share. If the astragalus of an early archaeocete could be found it would provide an important test for both hypotheses.

In 2001, archaeocetes possessing this bone were finally described, and the results were unmistakable. Archaeocetes had a "double-pulley" astragalus, confirming that cetaceans had evolved from artiodactyls. Mesonychids were not the ancestors of whales, and hippos are now known to be the closest living relatives to whales.

Recently scientists determined which group of prehistoric artiodactyls gave rise to whales. In 2007, Thewissen and other collaborators announced that *Indohyus*, a small deer-like mammal belonging to a group of extinct artiodactyls called raoellids, was the closest known relative to whales. While preparing the underside of the skull of *Indohyus*, a student in Thewissen's lab broke off the section covering the inner ear. It was thick and highly mineralized, just like the bone in whale ears. Study of the rest of the skeleton also revealed that *Indohyus* had bones marked by a similar kind of thickening, an adaptation shared by mammals that spend a lot of time in the water. When the fossil data was combined with genetic data by Jonathan Geisler and Jennifer Theodor in 2009, a new whale family tree came to light. Raoellids like *Indohyus* were the closest

relatives to whales, with hippos being the next closest relatives to both groups combined. At last, whales could be firmly rooted in the mammal evolutionary tree.



Find this article at:
http://www.smithsonianmag.com/science-nature/How-Did-Whales-Evolve.html

**Save the Poor by Selling Them Stuff — Cheap**

**The bottom-of-the-pyramid marketing movement tries to profit the developing world and make a profit at the same time.**

By Vince Beiser

*A foot-powered irrigation pump and solar lamps are examples of items being sold to poverty-stricken regions. (Proximity Designs and D.light)*

The first slide comes up on the white-walled lecture room's double display screens. In capital letters, it declares: "EMPATHY."

The 40-odd Stanford students gathered in a semicircle of plastic chairs on the cement floor blink at the screen, awaiting explanation. Almost all of them are pursuing graduate degrees in some form of engineering or business — disciplines known more for unemotional logic and bare-knuckle competitiveness than getting in touch with someone else's feelings.

Erica Estrada, a recent Stanford mechanical engineering grad with long, loose black hair, clicks to the next slide. "You need to experience what you think the end users of your product experience," she says. "Immerse. Observe. Engage," read the screens. Estrada brings up a photo of herself with a Burmese farmer in a rice field in Myanmar. It was taken a few years ago, when she was a student in this same class. Her team's project had been to invent a product to help the rural poor in the isolated Asian nation. The next few pictures show her and her fellow students politely watching the Burmese farmers at work. But soon, one of the Americans has taken off his shoes and is hauling giant watering cans through ankle-deep mud alongside the villagers. "That's what I'm talking about," Estrada says.

The class, dubbed "Entrepreneurial Design for Extreme Affordability," is premised on a counterintuitive idea: You can enrich the poor by selling them stuff. It brings together teams of graduate students from business, design, engineering and other disciplines to research a specific problem in developing-world communities, design a product to address it, and then, with the help of local and international organizations, sell that product as cheaply as possible to as many people as possible. The course has yielded some impressive results. Students have designed low-cost solar-powered lanterns, extra-efficient irrigation pumps and other useful products now being used by tens of thousands of people from India to East Africa.

"We are not treating the poor as recipients of charity, but as customers," says Jim Patell, a professor at the Stanford Graduate School of Business who founded the program. "That means you need to figure out what they really want. That means treating them as equals. Charities don't have to do that."

For decades, the main model of Third World aid has been the obvious: Give stuff to poor people — be it hydroelectric dams, surplus food or medical equipment. But Western countries have poured some $1.5 trillion into such efforts over the last 60 years, and more than 1 billion people worldwide still live on less than a dollar a day.

The Extreme Affordability program is an experiment with a dramatically different approach to fighting poverty, one that in recent years has generated tremendous buzz among academics, development workers, entrepreneurs and corporate executives. It's called "bottom of the pyramid" marketing. The idea is to harness capitalism to solve the problems of the world's poorest — those at the bottom of the global economic pyramid. If you design a useful product for a market rather than for charity's sake, the theory goes, the target population is more likely to actually want it and use it. If businesses can turn a profit making that product, it not only creates jobs but will keep getting made even if Western donors lose interest. And there should be colossal profits to be made: The world's poor don't have much money individually, but there are billions of them.

Get rich by helping the poor. It's a powerfully alluring idea. A surge of books, symposia, blogs and corporate annual reports champion it. Major organizations, including the World Bank and the United Nations Development Program, have set up programs that support it. Venture capital funds are giving millions to startup firms trying to implement it. MIT, Penn State, Cornell and other top universities in the U.S. and other countries are teaching MBA students about it. "It's picking up, big time," says Luiz Ros, manager of a $250 million Inter-American Development Bank fund dedicated to supporting bottom-of-the-pyramid ventures. But despite all the hoopla, a couple of key questions have yet to be fully answered: Can companies really make money from the destitute? And if they can, is that always a good thing?

The notion of targeting products to the poor to help everyone get richer isn't entirely new. Henry Ford famously raised the salaries of his assembly line workers so that they could buy his cars. More recently, microfinance — tiny loans to would-be entrepreneurs in poor communities, as pioneered by Muhammad Yunus' Grameen Bank — has sparked a worldwide industry that now serves some 25 million people.

The phrase "bottom of the pyramid" was coined in 2002 in a groundbreaking paper by Stuart Hart, a professor at Cornell University's Samuel Curtis Johnson Graduate School of Management, and the late C.K. Prahalad, a prominent management specialist at the University of Michigan. "At the time," Prahalad later wrote, "the proposition that the private sector had a critical role to play in alleviating global poverty was generally met with skepticism. The idea that they could have the greatest impact through creating profitable businesses serving the 5 billion people who represented the 'invisible, unserved market' was even more radical." Nonetheless, the theory attracted considerable attention, even more so after Prahalad expanded it in 2004 into a best-selling book, *The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits*.

"What is needed is a better approach to help the poor, an approach that involves partnering with them to innovate and achieve sustainable win-win scenarios where the poor are actively engaged and, at the same time, the companies providing products and services to them are profitable," Prahalad wrote in the book's first chapter. "Market development at the bottom of the pyramid will also create millions of new entrepreneurs at the grass root level — from women working as distributors and entrepreneurs to village level micro enterprises." He detailed several successful examples, such as companies selling single-serve packets of shampoo and tea and others that have developed low-cost but high-quality soap, banking services and even eye operations aimed at the poor in developing countries.

Prahalad's book caught fire. Global luminaries from Bill Gates to Madeline Albright gave it admiring reviews. In the book's 2010 reissue, top executives of globe-spanning corporations, including GlaxoSmithKline, Philips Electronics and Unilever, added glowing comments on how Prahalad has influenced them.

"Ten years ago, no one in multinational corporations was thinking about poverty as a business opportunity," says Hart, who recently published his own follow-up, *Next Generation Business Strategies for the Base of the Pyramid*. "Today, there are hundreds upon hundreds of businesses focused on the bottom of the pyramid."

Patell, who launched the Stanford program in 2003, is a solidly built man with a softening midsection, a dimpled chin, flat blue eyes and a no-nonsense, blunt-spoken manner verging on gruffness. He's always been a hands-on kind of guy. He worked in his father's tool-and-die shop in upstate New York as a teenager, then trained as an engineer at MIT and Carnegie Mellon. He designed Navy destroyers for a defense contractor

before joining the faculty of Stanford's Graduate School of Business. Teaching stints in Zimbabwe and South Africa got him interested in the problems of doing business in the Third World.

But he brushes aside questions suggesting that he might have an altruistic motive in running this course. Building warships or baby incubators — it's all just engineering, he says. "I'm not going to say designing products for poor farmers in Burma is good, but doing it for writers who want a nice bag is less good," he scoffs, gesturing at my undeniably handsome leather satchel as we talk on a classroom couch. "That's not my job."

Nonetheless, it's clear he's deeply, personally invested in the course. He and his wife host some of its events at their home. He pays for the students' travel on his own credit card, taking it upon himself to get reimbursement out of Stanford. And he has helped several of his students launch companies after they graduate.

The course attracts a wide range of students. Timnit Gebru, for instance, fled civil war in her native Ethiopia with her parents when she was 15. "I liked the sound of this course because you actually build an actual product to help people," says Gebru, who is studying electrical engineering.

"Yeah, it's not hypothetical; it's the real thing," chimes in Will Harte, an earnest 23-year-old from Portland, Maine, who is studying for a degree in Earth systems.

During the two-quarter course, the 40 students are divided into teams and partnered with nonprofits working in Cambodia, Myanmar and Indonesia and on Arizona's White Mountain Apache reservation. Some of the students spend their spring break in those places, essentially doing in-depth market research. They immerse themselves in the culture, talking to locals about their needs and documenting in notes, photos and video how they meet those needs — how they irrigate their fields and heat their homes, where they get their materials.

"Engineers are usually told to make a specific product," says Patell's co-instructor David Beach, a gray-bearded, excitable professor of mechanical engineering. "What we try to do is figure out who needs something and what is it that they need in much more general terms: better light, more efficient ways to get water to their croplands. We abstract the problem back to a level like that and then go out and explore what solutions there might be with the help of people who live and work there."

The team uses those findings to come up with an idea for a product or service. The students then design and prototype it back in the workshops and whiteboard-and-Post-It-crammed brainstorming spaces of Stanford's design school. At course's end, the teams deliver the result — along with a business plan for marketing the product they have designed — to their partner organizations.

Many of the products never go further than prototype. But more than a few have been successfully adopted by in-country organizations or pushed forward by companies, for-profit and nonprofit, launched by the students themselves. Estrada's team, for instance, came up with a solar-powered LED-based lantern to replace the dangerous, inefficient kerosene lanterns they found Burmese shopkeepers using. She turned the idea into a commercial venture, co-founding a company called D.light, which has since sold more than 250,000 of the lights in some 40 countries. The company recently hauled in $5.5 million in investment to help it toward a goal of lighting the homes of 100 million people by 2020. Other students have set up organizations to market other products from the course, including paper asthma inhalers, a premature infant incubator that costs just $25 and a $20 prosthetic knee.

"We've done 60 projects so far," Patell says. "Fifteen, easy, have been good. That's a better hit rate than most Silicon Valley startups."

Why make the poor pay for such items, rather than giving them away? "If you don't buy it, you don't value it," says Stuart Coulson, a Silicon Valley investor who volunteers as a lecturer with the Extreme Affordability course. There are, he points out, all kinds of examples of donated humanitarian goods being misused — mosquito nets turned into wedding veils, energy-efficient cook stoves converted into planters. "If someone buys something, it's much more likely it will be used and kept in good order. And then they have the right to demand that it works and works better than the competition, so there's an incentive to keep improving the product. It's sustainable, because the manufacturers are making money. You're not depending on some donor's largesse."

To hold on to their business, entrepreneurs also need to provide maintenance and spare parts, something nongovernmental organizations often fail to do. And businesses are naturally driven to expand, a pressure that doesn't often apply in the nonprofit world. With a for-profit model, Coulson says, "you build this organic thing that just spreads on its own."

But all of that reasoning holds true only if one major condition is met: The business must actually be profitable. For several reasons, profit is where the bottom-of-the-pyramid principle runs into trouble in practice.

First, it's hard to make a quality product that's cheap enough for poor people in the developing world to buy. D.light's lanterns, for instance, cost from $10 to $45 – a major outlay for someone living on $2 a day. "It's not yet at a price where most of the people we're targeting can afford it," Estrada admits.

Distribution is also a massive challenge. "Companies here can just assume that FedEx or a trucking company will carry their products to wherever they need to go," Coulson says. But in the developing world, there's no guarantee that there will be trucks to move your goods — or even roads for the trucks to drive on. Coulson once visited a village in Indonesia that wanted to install a micro-hydropower station to generate electricity from a nearby river. "It was an eight-hour jeep ride from the nearest town and then another mile from the asphalt, and then you had to cross a rope bridge over the river to get to the village," he says. The generator had to be designed in pieces small enough to be carried by hand over the bridge.

Market research, a key component of any business plan for the Western world, is another hurdle. Bottom-of-the-pyramid consumers often lack the education to answer written surveys, and the marketplace has few comparable products from which to extrapolate potential sales. "Solar technology is a brand-new concept for most of our customers," says Dorcas Cheng-Tozun, a D.light spokesperson. "Some have never even seen electric light before. Our marketing efforts have to incorporate an extra level of information that helps our customers understand what the product is, how it is used and how it can benefit them."

As a result, so far, there are precious few major success stories for bottom-of-the-pyramid products. "Only a handful of enterprises in low-income markets are commercially viable and operate at scale," note the authors of a 2009 study by the Monitor Group, a Cambridge, Mass., corporate consulting outfit. With all that in mind, Aneel Karnani, a professor at the University of Michigan's Steven M. Ross School of Business, concluded in a 2010 paper that "there is no fortune at the bottom of the pyramid. Marketing socially useful products to the poor offers only limited business opportunities."

Hart draws a different conclusion: Businesses have been doing it wrong. Most corporations that have tried selling to the bottom of the pyramid have done so simply by making cheaper versions of their existing products, he says. "That doesn't work well," he says. "What we're discovering is we need to move from a mentality of finding the fortune at the bottom of the pyramid to *creating* the fortune *with* the bottom of the pyramid."

To create products the developing world will buy, Hart says, companies must more or less do what Patell does: send their people into urban shantytowns and rural villages so they can connect with locals and figure out what they really want and how it can be made and sold to them — with the help of local entrepreneurs. He has even developed a research protocol to guide companies through this process.

There are at least a few clear-cut cases of corporations doing very well with, while also doing good for, the bottom of the pyramid. The astonishing proliferation of cell phones throughout the developing world is the standout example. Eight million new users sign up for mobile service in India alone every *month*; more than 60 percent of the population already has one. China's biggest mobile carrier boasts more than half a billion subscribers.

That growth is generating big profits for established mobile providers and spawning new ones, while also creating countless jobs for local vendors that sell prepaid calling cards and electric chargers for phones. There are other benefits: Farmers, fishermen and small entrepreneurs use their phones to keep abreast of local weather and market conditions, and mobile phones hold out great promise for better delivery of financial, educational and government services to the poor.

The story of the mobile industry seems to prove the bottom-of-the-pyramid theory. But, as the scientific adage goes, the plural of anecdote is not evidence. It's possible that other products might sell in the developing world but do more harm than good for the people who live there.

Prahalad took pains to praise the consumer savvy and entrepreneurial acumen of the poor. "The process must start with respect for bottom-of-the-pyramid consumers as individuals," Prahalad wrote. "The process of co-creation assumes that consumers are equally important joint problem solvers."

But research indicates that poor people are just as likely as anyone else to throw money away on useless and even harmful junk, whether it's lottery tickets or cigarettes. The poor may be even more prone to do so, Karnani points out, given their lower levels of education and access to information. There are also fewer

restrictions on marketing vices like booze and smokes in the Third World. "DOM Benedictine, a French liqueur that contains 40 percent alcohol, touts its health-giving and medicinal properties to poor people in Malaysia. United Kingdom-based Diageo likewise assures Malaysian consumers that Guinness Stout promotes virility," Karnani writes. That may help explain why a 2007 MIT study found that people living on $2 a day or less in several developing countries spent 5 percent or more of their incomes on alcohol and cigarettes.

Corporate executives' primary allegiance is to shareholders, not customers. Cigarettes, soft drinks and junk food — products that are already widely sold to the poor — may add something to the local economy by enriching local suppliers and vendors, but their overall impact on the community is surely a net negative. "Simply selling to the poor does not necessarily improve their welfare or reduce poverty," writes Nancy Landrum, an associate professor of business at the University of Arkansas at Little Rock, in a paper critiquing Prahalad's work. "In fact, one can question whether multinational corporations are serving a need or creating a need where none previously existed."

Even seemingly benign products can have disastrous impacts in the context of extreme poverty. Swiss Food giant Nestle successfully promoted its baby milk powder products for years to women in Third World countries — even though many poor mothers lacked the sanitary conditions, refrigerators and clean water necessary to use formula safely. The World Health Organization estimated in 1981 that the accompanying shift to bottle-feeding in the developing world may have boosted infant mortality rates by as much as tenfold in some areas. Nestle finally curbed its formula marketing campaign in 1984 after enduring a seven-year international boycott.

There's also the possibility that introducing a new product into an economy will displace a locally made one, costing jobs rather than creating them. One of the Stanford program's projects, in fact, did exactly that. Students came up with a metal band that greatly strengthens *mitads*, the clay disks Ethiopian villagers cook bread on, tripling the disks' life spans. The Stanford-designed bands save villagers money — but cut directly into the livelihood of *mitad* makers.

"There are winners and losers," Patell says. "We try to have our students understand that there may be difficult consequences that they need to think through, and talk to those that will be affected." In that case, he says, *mitad* makers were licensed to sell the bands along with their clay disks.

Hart acknowledges these pitfalls, but on balance, he says, bottom-of-the-pyramid strategies deserve a chance. "It's absurd to say there's no opportunity in a market where two-thirds of humanity is underserved," Hart says. "Or to say it's up to governments or aid agencies to cure poverty. We've been doing that for 50 years, and it hasn't worked. There is a role for NGOs and governments, but we need more arrows in the quiver. I think this new model has enormous potential."

The evening after Estrada's lecture, the Extreme Affordability class gets into gear with a crowded buffet dinner in the classroom. The first few weeks were preparation. Now, the students will actually meet representatives from the partner organizations and choose which projects they'll spend the next several months working on. Students, teachers and visitors jostle together on stools and folding chairs, paper plates loaded with chicken cacciatore and tortellini. Patell briskly introduces one speaker after another.

First up is Jim Taylor, a balding, 60-ish man wearing a blazer over a striped shirt; he is director of Proximity Designs, a Myanmar-based organization that helps poor farmers. "We sell all our products — we don't give anything away," he tells the room. "We give people the right to say no. That makes it a much more reciprocal, dignified relationship."

The Extreme Affordability classes' greatest successes so far have come from partnering with Proximity Designs. Flashing one slide after another up on the screens, Taylor explains how earlier classes developed foot-operated irrigation pumps that Proximity has gone on to sell to tens of thousands of local farmers. With the productivity boost they get from the pump, he says, the farmers typically see their incomes double or even triple. "We have countless stories of lives that have been changed," Taylor says.

He is followed by a half dozen other do-gooders. Not all the projects are exactly sexy. One group wants a gadget to efficiently plant fertilizer pellets. Another needs help coping with excess human excrement; might there be a business model to profitably remove and treat it — even convert it into fertilizer?

No one seems surprised when the last speaker to take the floor is from ITT, the giant U.S. corporation best known as a defense contractor. Engineering manager Humberto Meza explains that ITT is also the world's biggest manufacturer of pumps. Irrigation pumps, boat pumps, septic pumps — pretty much anything that

moves fluids. Meza is volunteering to be a resource to the students; they can visit ITT's facility in San Diego for mentoring and ideas, he tells them.
The presentations over, the lights come on and the room wells up with energy and excitement. The students swarm around the presenters, asking questions, swapping ideas. Patell beams at the scene like a parent at a high school play in which all the parts were performed by his kids. "This is what I live for," he says.
ITT's Meza is also pleased. He's not embarrassed to say that ITT is hoping to find ways to produce their pumps cheaply enough to sell in the developing world. "The management team, including myself, wants to do something to help those in need," he says. "And it could be good business. Even if you only make $1 on every pump, if you sell 10 million of them, that's a lot of money."

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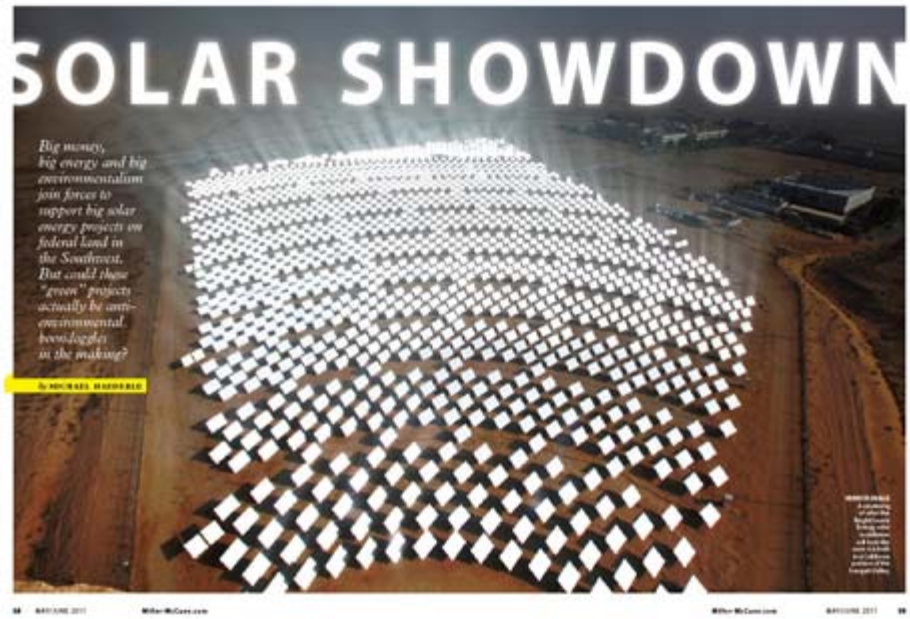
**Are New Solar Power Projects Anti-Environmental?**

**Big money, big energy and big environmentalism join forces to support big solar energy projects on federal land in the Southwest. But could these "green" projects actually be anti-environmental boondoggles in the making?**

By Michael Haederle




*Could huge solar projects on public land in the Southwest actually be anti-environmental boondoggles in the making?*

Last December, I flew to Phoenix, rented a car and drove two hours west on Interstate 10 to Blythe, Calif., a sun-baked town of 13,000 on the lower Colorado River surrounded by orange groves and irrigated farmland. In the winter, this area attracts tens of thousands of snowbirds, many of whom park their recreational trailers along dirt roads in the desert and tool around in all-terrain vehicles. I hadn't come to see them, though. I wanted to learn about another new arrival, an international consortium called Solar Millennium LLC, which is building a 7,000-acre solar power generating station just outside town.

Pulling off the highway near the city's airport, I find little more evidence of the project than a wooden sign half-hidden in the brush and some surveyors' stakes. It doesn't look like much now, but when the plant is fully built out in 2014, long curved mirrors called parabolic troughs will focus sunlight on oil-filled tubes that transfer heat to steam generators. The four linked plants — the largest solar complex in the world, by some estimates — are expected to generate 1,000 megawatts of electricity, enough to power 300,000 single-family homes.

Tourists and truckers crisscrossing the California desert are usually in a hurry to get somewhere else — Los Angeles, San Diego, Phoenix or Las Vegas. For hours on end, they gaze out on endless waves of withered, yellow-green creosote brush lapping up against sere mountain slopes, broken up here and there by low-lying dry lakebeds called playas. It is one of the last large tracts of unspoiled wilderness in the Lower 48, but to many people its very vastness and emptiness makes it a natural place to build new solar power projects like the one at Blythe.

Sure enough, farther west along I-10, I pass the planned sites of two more fast-track solar projects, Palen (a Solar Millennium parabolic-trough project encompassing 3,800 acres) and Genesis (parabolic troughs on 4,640 acres), along with a natural gas-fired power plant and a couple of state prisons.

In fact, dozens of large-scale solar installations could be built on federally managed lands in six Southwest states over the next few years. They represent a key piece of the Obama administration's plan to create

thousands of green jobs and meet a congressional mandate of adding 10,000 megawatts of renewable energy to the nation's portfolio by 2015.

Proponents, including national environmental organizations like the Sierra Club, The Wilderness Society and the Natural Resources Defense Council, see this as a critical and long-overdue step toward ending our reliance on fossil fuels. Last October, when Interior Secretary Ken Salazar announced approval of the first two new solar plants on public lands in more than two decades, Johanna Wald, the NRDC's senior attorney, hailed the move as "a major milestone in renewable energy on public lands and a down payment on America's transition to a clean energy economy."

Katherine Gensler, senior manager for government affairs for the Solar Energy Industries Association, a trade group that represents both big solar developers and manufacturers of smaller photovoltaic systems, says federal incentives aimed at jump-starting large-scale solar development made 2010 a banner year for new U.S. installations. And the tax package crafted last December by the lame-duck Congress included a provision to extend generous cash grants in lieu of tax credits for renewable energy through 2011.

But an assortment of scientists, local land conservationists, Native Americans and solitude-loving desert rats maintain that the huge solar installations approved for the Southwest — the Blythe project is nearly half the size of Manhattan — will be inefficient. They won't produce electricity at night, and, as with conventional power sources, some of the energy they generate will dissipate as it flows over hundreds of miles of transmission lines.

Industrial-scale solar energy will come at a steep environmental price, critics contend: Groundwater will be depleted to cool machinery operating at high temperatures. Construction will sometimes require scraping native vegetation down to bare soil, despoiling fragile, carbon-sequestering ecosystems. And, the critics say, these huge solar projects will be obsolete almost as soon as they are built because photovoltaic panels, which can be deployed in small arrays on residential rooftops, are rapidly becoming more efficient and affordable.

"There are folks who truly believe this is going to be a revolutionary change in our society toward renewables," says Jim André, a respected desert botanist who warns that public land managers are presiding over an unfolding environmental disaster. "The facts are that it's the biggest wholesale impact that we've seen in North America to our natural heritage."

So far, though, most objections to the giant solar projects planned for the Southwest have been washed away by a tsunami of money from Wall Street, lured to invest by billions of dollars in federal grants, tax credits and loan guarantees and a fast-track regulatory approval process.

But as marginalized as they have been, the critiques of this multibillion-dollar solar land rush raise some troubling questions: Could the big new solar installations be draining money from more worthy alternative energy investments? Could they actually worsen the environmental catastrophe they are trying to avert?

Nearing the boundary of Joshua Tree National Park, I turn into the Chuckwalla Valley, where I find Donna and Larry Charpied leaning against a pickup, relaxing with a couple of beers after a hard day's work. They moved here from Santa Barbara nearly 30 years ago to breed and grow jojoba, a hardy native plant that produces valuable oil used in cosmetics. They know they're a tad evangelical about its near-miraculous properties, cheerfully calling themselves "jojoba's witnesses."

They live in a 10-acre clearing on the valley floor surrounded by Bureau of Land Management property. Orange trees, date palms, figs and Paraguayan mesquite shade their trailer and workshop, and on a clear day they can see mountains on the U.S.-Mexico border, 100 miles to the southeast. "We moved out here and we thought, 'We're so protected — it's BLM land,'" Donna says.

The Charpieds were dismayed last year when they found survey crews working in the desert just 600 feet from their property line. It turned out First Solar Development Inc. was planning to build the bucolically named Desert Sunlight Solar Farm, an array of thin-film photovoltaic panels spread across 7,040 acres that is expected to generate 550 megawatts. The developers will have to remove native vegetation to install the panels, Donna says, and that will stir up silt laced with naturally occurring arsenic that is bound to become airborne when the wind kicks up.

On a slope several miles away, I can discern massive tailings from the Eagle Mountain mine, where iron ore was produced to build Victory ships in California shipyards during World War II. In the late 1980s, the Charpieds learned of a plan to turn the old mine into a landfill that would have brought in 20,000 tons of solid waste per day on rail cars. With a how-to book and a typewriter, they filed a series of successful legal

challenges. Later, national environmental organizations hired lawyers who helped turn the tide against the project.

Now those one-time allies have signed off on large-scale solar development like the Desert Sunlight project. "They are such traitors I can hardly believe it," Donna says. "I think they have taken a page out of the developers' book."

Darkness falls as I continue west along the southern boundary of Joshua Tree and descend into the incandescent sprawl of Indio, Palm Springs and the Coachella Valley. I suddenly feel pessimistic at the thought of how much energy is being used to beat back the night. Americans buy about 4,100 terawatt-hours of electricity a year (a terawatt equals 1 trillion watts). They draw on 1,100 gigawatts of power-generating capacity, about 50 percent of which comes from coal-fired plants. Nuclear and natural gas-fired plants each pick up about 20 percent of the load; hydroelectric sources come in around 6 percent, while renewables, like wind and solar, amount to about 4 percent.

How could solar technology ever hope to supplant the coal-powered electrical generation network that spews massive amounts of climate-altering carbon dioxide into the atmosphere?

The next morning finds me in Lucerne Valley, where the forested foothills of the San Bernardino Mountains fall into the western Mojave Desert. At a crossroads café, I meet up with Jim Harvey, a 45-year-old Chicago native and freelance Web designer who moved out here 10 years ago.

In 2007, Harvey founded the Alliance for Responsible Energy Policy after learning that the Los Angeles Department of Water and Power wanted to build a power transmission line nearby — a plan that was later abandoned. Now he's fighting Chevron Energy Solutions' Lucerne Valley Solar Project, a field of thin-film photovoltaic panels on 516 acres that has gotten an enthusiastic thumbs-up from environmental groups. Harvey, who has an impressive command of technical data, worries that toxic cadmium telluride used in the thin-film panels will escape into the environment, and he isn't soothed by Chevron's assurances that it will spray polymer-based binders on the disturbed soil to keep it from blowing around.

But his objections run deeper. He believes Chevron wanted to locate the project here because it didn't think rural residents would have the will or the resources to fight it. He also thinks solar developers are pushing to build as many projects as they can before widespread rooftop solar gains momentum and wins out. "We really are in a battle here — a battle of ideas," Harvey says.

He points to the popularity of California programs that offer homeowners loans to install photovoltaic panels and improve their homes' energy efficiency. "People were standing in line for these loans," he says. Governments and electrical utilities know these programs work, but they don't really want to see them succeed, Harvey says. "There's a huge lobby," he says. "That's what this all boils down to."

**Rooftop Solar Power to the People?**: Some environmental advocates say the federal government is ignoring the real future of solar energy: photovoltaic cells on almost every roof. But even supporters acknowledge rooftop solar isn't the complete answer to the energy question, yet.

Big environmental organizations have been co-opted by grants from solar developers intended to buy their acquiescence, Harvey charges. “They were giving these environmental groups money to hire them as consultants to promote their projects,” he says.

As proof, Harvey cites a document posted on his organization’s website. It is a February 2008 proposal from the Sacramento-based Center for Energy Efficiency and Renewable Technologies, which Harvey describes as “a very questionable alliance” of environmental organizations, energy corporations and utility companies. “CEERT’s established partnerships with leading environmental groups like NRDC and Sierra Club allow environmental concerns to be closely considered in all solar development and transmission infrastructure plans,” the proposal reads. “However, energy siting issues are largely a new area for many of the organizational staff working on this project. For these organizations to advocate their positions effectively they will need to build new capacity. CEERT plans to provide subgrants to Sierra Club and NRDC which will allow them to hire new staff specifically assigned to work on Big Solar.”

CEERT’s current board of directors includes members hailing from the NRDC, the Environmental Defense Fund and Defenders of Wildlife, along with representatives of solar, wind and fuel cell companies, the Union of Concerned Scientists and the American Lung Association. Founded in 1990, the group describes itself on its website as “a partnership of major environmental groups and private-sector clean energy companies” that “fight for policies that promote global warming solutions and increased reliance on clean, renewable energy sources for California and the West.”

Harvey and I drive out to the future Chevron site — quiet for now. Dotted with 15-foot Joshua trees, the area provides habitat for bobcats, mountain lions, desert bighorn sheep, coyote, mule deer, San Joaquin kit fox and Gambel’s quail. “This is very typical Mojave Desert,” he says, “and it doesn’t have to be any more beautiful than this.”

The seeds for large-scale solar development on public land were sown when Congress passed the Energy Policy Act of 2005, mandating 10,000 megawatts of new, non-hydroelectric renewable power capacity by 2015. Not much solar capacity was added during the Bush presidency, however, as would-be solar developers had difficulty attracting investors for their projects. Still, by one estimate, there were a million acres of solar lease applications pending at the BLM as the Bush era wound down. The industry revived when President Barack Obama took office and Interior Secretary Ken Salazar announced he wanted to reach the 10,000-megawatt goal by the end of the administration’s first term in 2012.

The new utility-scale solar energy effort is flush with cash thanks to provisions of the $787 billion American Recovery and Reinvestment Act. These include cash grants of up to 30 percent of construction costs in lieu of investment tax credits and hefty loan guarantees of $1 billion or more in some cases. Obama has touted these measures as necessary if we are to create a new green economy.

Ray Brady leads the energy policy team at the Bureau of Land Management, the Interior Department branch that administers more than 250 million acres of federal land in 11 Western states and Alaska. Under the 1976 Federal Land Policy and Management Act, the BLM manages public lands for multiple uses, including mining, grazing, oil and gas extraction, hunting, off-road recreation, wildlife and landscape conservation — and, now, renewable energy development. Brady says most of the new solar projects are likely to be located on BLM land in the Southwest for an obvious reason: It’s where the sun shines.

The BLM approved nine solar projects in California and Nevada in 2010 and continues to review other applications — more than 120 in all — but only a handful may actually be built, Brady tells me. Much of the criticism leveled at the bureau’s permitting process has revolved around its approval of environmentally sensitive tracts for solar development, but Brady says the solar sites were identified from existing local resource management plans.

The initial grant program required construction to start by Dec. 31, 2010, which explains the push to get major projects off the drawing board quickly. “A lot of companies were competing to try to get their projects jump-started so they could qualify for tax credits this year,” Brady says.

Practically speaking, some observers say, it became an improvised process with too few staffers to handle the flood of applications and a regulatory framework ill-suited to the new technology.

Hoping to be more methodical moving forward, the BLM recently drafted a massive programmatic environmental impact statement meant to identify the best sites for solar development in a huge region that includes the Four Corners states, Nevada and California. Public hearings on the document got under way in February. Twenty-four high-potential solar-study areas representing about 670,000 acres have been identified for site-specific environmental reviews, Brady says. A realistic guess is that 24,000 megawatts of solar generation capacity could be built out over a 20-year period on BLM lands, he says, translating into a total of 240,000 acres that might be repurposed for utility scale solar. That would still amount to 30 or more projects the size of the Blythe plant, covering a total of about 375 square miles.

The BLM approves a large solar project as a "right of way authorization" — a concept originally applied to oil and gas leases. Under that provision, the bureau can collect an annual rent payment called an acreage fee, as well as a "megawatt capacity fee" geared toward the amount of electricity that could potentially be generated. For the nine solar projects approved in 2010, total acreage fees would amount to $5.5 million a year, with an additional $23.9 million in annual megawatt capacity fees, Brady says.

The BLM will also require developers to post a bond to ensure that solar panels, mirrors and support structures are removed once a project is decommissioned. "One of the companies estimated that the amount of construction and metal work was as much metal for steel as was used to build the Golden Gate Bridge," Brady notes.

Despite these planning efforts, the BLM and the individual solar developers have been hit with at least a half dozen lawsuits alleging that the approval process failed to comply with federal environmental and cultural-protection regulations.

The first legal challenge was brought by the Quechan Tribe of the Fort Yuma Indian Reservation to block a 6,100-acre, 709-megawatt solar project in the Imperial Valley, east of San Diego. A federal judge issued a temporary injunction based on claims that the Interior Department had not addressed the tribe's concerns about hundreds of culturally sensitive sites.

Next, La Cuna de Aztlan Sacred Sites Protection Circle, a Blythe-based organization led by Alfredo Figueroa, a garrulous 76-year-old retired miner, community activist and gadfly, sued the federal agencies over six desert solar plants that it claimed were approved without due consultation with Native Americans. Figueroa, whose mother belonged to the local Chemehuevi tribe, believes he can prove that the area around Blythe is Aztlán, the legendary homeland of the Aztecs before they made their way south to the Valley of Mexico.

The Blythe plant and others planned for this sacred landscape will be devastating for Native Americans, Figueroa says. "They're trying to destroy all remnants of our culture and tradition," he says. The BLM says that the Solar Millennium project, which is being built in partnership with Chevron Energy Solutions, will not disturb any of the undisputedly ancient Native-American geoglyphs in the Blythe area.

In other litigation, a group called California Unions for Reliable Energy sued over the proposed Genesis plant on the grounds that it would illegally deplete groundwater. And local environmental groups in East San Diego County filed a lawsuit against the BLM and Interior Department over the Imperial Valley project. The Sierra Club also took action, petitioning the California Supreme Court to block the Calico project, proposed for a site just east of Barstow.

Driving over the Clark Mountains from Barstow on I-15, I drop into the Ivanpah Valley, a long, dry basin of salt, sand and cactus ringed by rugged peaks along the California-Nevada border. The interstate runs straight as a ruler across the salt flats to Primm (formerly Stateline), Nev., a garish collection of hotel-casinos replete with a replica mining town, castle turrets and an outlet mall — Yosemite Sam-meets-Robin-Hood-at-Williams-Sonoma.

**Species in Danger**

*A partial list of rare or endangered flora and fauna at the Ivanpah Valley solar plant site:*

*FLORA*

**Clark Mountain agave** (*Agave utahensis var. nevadensis*) A small agave found in only a few mountain ranges in the eastern Mojave, southern Nevada and the Utah-Arizona border region.

**Small-flowered androstephium** (*Androstephium breviflorum*) Listed on the rare-plant index maintained by the California Native Plant Society and the California Department of Fish and Game.

**Mojave milkweed** (*Asclepias nyctaginifolia*) Nearly 80 percent of this plant's known California range is on the Ivanpah project site.

**Desert pincushion** (*Coryphantha chlorantha*) Endangered in California, although more common elsewhere.

**Parish club-cholla** (*Grusonia parishii*) These low-growing cactii are not widespread in California.

**Viviparous foxtail cactus** (*Coryphantha vivipara var. rosea*) Listed as endangered or protected by several states.

**Utah vine milkweed** (*Cynanchum utahense*) An uncommon perennial vine native to the Mojave Desert.

*FAUNA*
**Desert tortoise** (*Gopherus agassizii*) These creatures, which can live to be 100 years old but are susceptible to contagious disease, are declining in numbers throughout the Mojave Desert, where they are regarded as threatened.

**Gila monster** (*Heloderma suspectum cinctum*) The Ivanpah Valley region is in the only place in California in which these venomous lizards are found. They are protected in Nevada and Arizona.

**Golden eagle** (*Aquila chrysaetos*) This legally protected species is vulnerable to habitat depletion throughout its range.

**Burrowing owl** (*Athene cunicularia*) Listed as a species of special concern throughout most of the western U.S. due to habitat loss.

**Say's phoebe** (*Sayornis saya*) Numbers for this migratory bird are declining due to habitat loss.

**San Bernardino kangaroo rat** (*Dipodomys merriami parvus*) This Southern California subspecies was once common in dry washes of San Bernardino and Riverside counties, but since 1998 has been listed as endangered by the U.S. Fish and Wildlife Service.
In October, BrightSource Energy broke ground on a 3,400-acre project here. When it is finished next year, 170,000 movable mirrors will focus sunlight on solar boilers atop three 300-foot towers, creating steam to generate 370 megawatts of electricity, enough to power 140,000 homes.
Jim André, sporting a goatee and mop of unruly brown hair, pulls up to meet me in a weathered white Toyota pickup with a camper shell in back. For 17 years he has directed the Sweeney Granite Mountains Desert Research Center, a 9,000-acre enclave operated by the University of California, Riverside, in the middle of the Mojave National Preserve, 75 miles from the nearest town.
André describes the area in Southern California, Arizona and Nevada where he has done field research as one of the most species-diverse deserts in the world. The Ivanpah site alone is home to a dozen rare plant species, he says. Twenty desert species can live for more than 1,000 years, and some of the creosote brush colonies, which reproduce through cloning, may be 10,000 years old, dating back to the time when these plants first arrived during the Pleistocene.
André pulls the truck through a gate in a casino parking lot onto a dirt road that follows a utility right-of-way. Four sets of 150-foot steel electrical transmission towers march side by side toward Los Angeles, paralleled by a buried natural gas pipeline. André scans the low-lying plants and shrubs with a practiced eye as we roll along, occasionally stopping for a second look, before pulling over next to an electrical tower.
We get out and scramble a couple hundred feet up a limestone outcropping sprinkled with colorful little barrel cacti to survey the entire Ivanpah Valley. It might not look like much, but to André, this is a valuable and uncommonly diverse ecosystem, home to desert bighorn sheep, the Mojave fringe-toed lizard and the endangered desert tortoise. "This is just a tragedy," he says quietly, pointing to a large scar in the landscape a

few miles away, where bulldozers are clearing thickets of creosote brush and bursage for one of the BrightSource thermal towers.

Construction will inevitably disturb the top layer of soil, called a cryptobiotic crust, which contains dozens of species of moss, lichen, algae and fungi in each square centimeter and is critical to the desert's health, André says. "Once you remove that crust," he says, "it can take many hundreds of years to grow back."

As arid as it is, this landscape absorbs as much carbon from the atmosphere as an African savannah, he tells me. "As an ecologist, I know how important these systems are to us as a society," he says. "You're destroying a system that you depend on to stem global climate change."

Laura Cunningham, a wildlife biologist who, like André, belongs to a coalition called Solar Done Right, says opponents of huge public lands projects like the one at Ivanpah aren't against solar energy — even at the utility scale — per se. "We're saying put it on disturbed land," she says. For example, there are 30,000 acres of selenium-contaminated farmland in the San Joaquin basin. "Maybe we should slow down a little bit and put the Ivanpah solar tower there," Cunningham says.

The BLM's Brady acknowledges the impact from the sheer scale of large solar projects like the one at Ivanpah, but he maintains these issues have been addressed in the environmental review process. For example, developers might have to mitigate the impact on a site by shrinking the construction footprint or buying additional land to protect from development and offset habitat loss, he says. To avoid harming the endangered desert tortoise, BLM requires developers to set aside for protection as much as five acres of desert for every acre of native habitat lost.

Still, Brady concedes, "It is a long-term alteration of landscape. It basically is converting it from a more natural desert environment to a more of an industrialized site. Some of the solar companies are trying to develop some best-management practices to try to reduce that amount of disturbance, but it's still a very intensive use."

The BLM's approval of the Ivanpah Project triggered yet another lawsuit, this one from the Western Watersheds Project over the federal government's alleged failure to comply with environmental laws in the California Desert Conservation Area. Nevertheless, BrightSource Energy, formed in 2006 and based in the Bay Area, is proud of the environmental mitigation it has done for the project, which broke ground last October. It hired 100 biologists to study tortoise habitat and relocate the creatures to new burrows a mile from the construction zone, according to Kristin Hunter, a company spokeswoman.

The plant's air-cooled solar thermal design will not require much water or extensive grading, and the mirrors will be mounted on poles planted directly in the ground, rather than on concrete pads (so less native vegetation is disturbed). The choice of site was hardly accidental; the existing electric transmission corridor and gas pipeline had already disrupted the area — better to build here than disturb virgin land.

"Environmental stewardship is core to BrightSource's approach, and we've kept the environmental protection in mind throughout our technology development and our project siting," Hunter says. "Not all utility-scale solar companies are created equal."

If BrightSource and other solar developers usually portray themselves as siding with the angels, the same is true of the environmental organizations that have given these development plans their imprimatur, while at the same time arguing for design changes and improvements in the BLM approval process.

Johanna Wald, a San Francisco-based lawyer who's worked for the Natural Resources Defense Council for nearly 40 years, has spent most of her career holding BLM's feet to the fire over its public lands management. She well understands the misgivings many have about utility-scale solar plants. "I have to say that as a longtime public lands advocate, I wish we didn't need any of these plants either, but the fact of the matter is NRDC believes that we do," she says. "We need programs at multiple scales, and we need them all, if we are to going to develop and implement an effective response to climate change." As it is, the environmental group gave its blessing to just three of the projects BLM approved in 2010.

Wald believes the Bureau of Land Management was ill prepared for the avalanche of solar plant applications it received. The NRDC and such sister environmental organizations as the Sierra Club, The Wilderness Society, Defenders of Wildlife and the Center for Biological Diversity met repeatedly with the bureau and fast-track solar developers throughout the approval process, Wald says. "We were trying to improve the process as well as the projects," she says. "So relatively early on, we did bring to the bureau some issues that we think they needed to pay attention to, and in some cases they actually did."

Wald spent much of her career saying no to conventional energy projects on public lands. “I was always saying, ‘Don’t do this, don’t drill for oil over here. Do renewable energy instead — it’s cheaper and it means more jobs,’” she says. Now that renewable energy is becoming a reality, she says, she realized it was time to put her money where her mouth was.

Wald sounds disheartened but not surprised when I tell her that local conservationists feel betrayed by her organization and its sister groups. “The fact is, we use energy, and there’s no free lunch when it comes to energy,” she says. But Wald bristles at Jim Harvey’s accusations that the NRDC has been bought off by big solar advocates, saying her organization maintains a “rigorous” conflict-of-interest policy that precludes accepting money from solar developers.

“As I have previously told Mr. Harvey and his associates at [Alliance for Responsible Energy Policy] orally and in writing on many occasions, neither I nor anyone at NRDC were ever consulted about this proposal,” she says. “NRDC received no money at all from CEERT, including no sub-grants, for the renewables work we have been engaged in.”

V. John White, the executive director of the Center for Energy Efficiency and Renewable Technologies, agreed. “It was really an initial set of ideas that we were working on,” White says. “It was inadvertently put up on our website and seized upon.” Ultimately, the environmental groups involved found their own funding to build in-house solar energy expertise, he says.

CEERT, which receives its funding from foundations as well as the energy industry, provides a forum where the different parties with an interest in renewable energy can collaborate on making renewable energy projects less destructive, White says. “We still think the companies and the [nongovernmental organizations] should keep talking to each other and realize that on individual projects there are going to be differences,” he says.

Given the urgency of the climate change problem and this country’s ravenous energy hunger, it seems obvious that the U.S. will need industrial-scale solar power if it is to make significant progress in cutting its reliance on fossil fuels. But so far, the process of deciding where and how to build these projects has been flawed, and the perception, at least, is that objections have too often gone unheard in the rush to do a deal and lock in federal funding.

Judgments on the best way to proceed seem in part to reflect professional orientation — whether one is an economist or a biologist, for example — and in part whether environmental threats are being assessed from a local or a global perspective.

The government, solar developers and the major environmental organizations think it makes sense to rely on a tried-and-true centralized generation method to rapidly scale up the new solar technology to the point where it will make a real impact. This path has, to a certain extent, led them to avert their eyes from the habitat destruction that will almost certainly ensue. Saving the planet, they believe, is such an important goal that some collateral environmental damage simply must be tolerated.

Local conservationists opposed to industrial-scale solar might be chasing a utopian fantasy — ubiquitous rooftop solar — and seriously underestimating the risk of failing to increase solar capacity quickly enough. At the same time, they haven’t lost sight of what stands to be lost in environmental and financial terms as the desert is transformed from wilderness to industrial wasteland. Perhaps environmental damage is more than “collateral” if it results from hasty multibillion-dollar investments in outmoded technology that can’t compete in the green energy marketplace.

Everyone involved in the controversy claims a commitment to the environment, even if much of the time the participants seem to be talking past one another, blinkered by confrontational us-versus-them thinking and even outright conspiracy theories. The rash of recently filed lawsuits arising from the flawed BLM process are bound to drag on for months or years, but they are more likely to slow the pace of solar development than to derail it completely.

Within a decade we’ll know whether the direst predictions about large-scale solar energy have come true — and whether it is actually making a dent in our nation’s carbon emissions. Meanwhile, for better or for worse, the ship of solar development has already set sail, charting an uncertain course into the future.

http://www.miller-mccune.com/science-environment/are-new-solar-power-projects-anti-environmental-29888/?utm_source=Newsletter157&utm_medium=email&utm_content=0419&utm_campaign=newsletters

**Petroleum Engineering Shows U.S. Students' Hidden Prowess**

**American students' behavior defies the prevailing stereotype when looking at how they flock to the hot field of petroleum engineering.**

By Beryl Lieff Benderly

*The prevailing narrative that asserts the nation has a shortage of scientists and engineers is being undermined by the startling uptick in graduates with bachelor's degrees getting well-paying jobs in the hot field of petroleum engineering. (AlexRaths / istockphoto.com)*

What Americans pay for gasoline gets lots of attention, but the price at the pump is only one oil industry indicator that has been rising lately. The starting salaries of bachelor's degree-holding petroleum engineers are also at historic highs. This other price spike has gotten almost no coverage even though labor market experts believe it seriously undermines the prevailing narrative about America's technical workforce.

That narrative asserts that the nation has a shortage of scientists and engineers caused by inadequate school systems that can't produce enough excellent math, engineering and science students. Exhibit A for this argument is the generally low percentage of American students and the high percentage of foreign students in many of the nation's engineering programs.

The evidence, as *Miller-McCune* magazine pointed out last year in a July cover story, indicates the opposite. The U.S. produces a large supply of able math and science students. What keeps their numbers low in many engineering programs is not a lack of ability but a lack of desirable career opportunities after they graduate.

But opportunity is bubbling in the oil patch. Rising crude oil prices inspired both more exploration and more use of new and expensive extraction technologies, for example from tar sands. This coincides with retirement of the large generation of petroleum engineers who built the Trans-Alaskan Pipeline and expanded exploration in the 1970s. Since 2002, the Bureau of Labor Statistics has gone from forecasting declining demand for petroleum engineers to a 2010 prediction of 18 percent greater demand over the coming decade.

In recent years, the upward spurt in new petroleum engineers' starting salaries reflects these trends. From an "already high $43,674 in 1997," average bachelor's degree starting salaries leapt to $86,220 in 2010, write Hal Salzman of Rutgers University and Leonard Lynn of Case Western Reserve University in a paper presented to the Association for Public Policy Analysis and Management.

In response, the number of Americans graduating with bachelor's degrees in petroleum engineering more than doubled since 2003, even as the number of Americans earning petroleum engineering master's degrees lagged. Because "most industry demand is at the Bachelor's level," Salzman and Lynn believe that today's

new graduates are mirroring the choices made by the computer graduates of the 1990s dot-com boom, who flocked to industry's enticing opportunities rather than to graduate school.
As demand and pay have risen, so have both the number and percentage of Americans in petroleum engineering programs. "At the Bachelor's level, the number and percent of total graduates who are on student visas dropped to the lowest proportion of total graduates in the last 15 years," write Salzman and Lynn.
The notion that the U.S. can't produce enough "students with the qualifications to become engineers in response to demonstrated demand [is] ill-founded," they conclude. Not only are the science and math skills of America's best students increasing, they state, but those students' ability to spot and respond to real career opportunities remains as sharp as ever.

http://www.miller-mccune.com/science/petroleum-engineering-shows-u-s-students-hidden-prowess-30484/

**ARCHIVE Says Home Is Where the Health Is**
**Peter Williams, an architect turned advocate, touts an unacknowledged connection between design and well-being.**
By Jordan Lite

*Peter Williams is pushing for home design to be the key to curbing disease through his nonprofit, Architecture for Health in Vulnerable Environments. Here is one of ARCHIVE's designs. (ARCHIVE Institute)*

Growing up in Kingston, Jamaica, Peter Williams took for granted the holes in the wood floors of his house — and the rats that crawled through them. But when his father contracted a bacterial infection that left him paralyzed, Williams, a budding architect, began to recognize the connection between shoddy housing and ill health.

"The disease was directly attributed to the fact that the house was poorly constructed," says Williams, 35. "I saw firsthand how housing was both responsible for his illness and also incapable of meeting his care needs, given that he was quite immobile."

If the link between housing and health seems obvious (think cholera spread in refugee camps, or lead poisoning in homes containing lead paint), it's one that Williams says is woefully neglected. To a large extent, public health programs focus on disease outcomes, and urban planners talk of units built, but their missions rarely intersect. Big health donors such as governments and foundations prioritize vaccines, drugs and medical services; architects are drawn to large infrastructure projects like hospitals and health centers. Those narrow focuses, Williams believes, minimize the overcrowding, dirty water and disease-carrying insects that cause so much illness in both developing and industrialized countries.

Williams is pushing for home design to be a key strategy in curbing disease through his nonprofit, Architecture for Health in Vulnerable Environments (also called the ARCHIVE Institute). The group is building five prototype homes intended to reduce tuberculosis transmission in Saint-Marc, Haiti, the destination of many refugees from the January 2010 earthquake. Later this year, ARCHIVE will build houses in Cameroon's North Province engineered to reduce their inhabitants' exposure to malaria-carrying mosquitoes. The goal is twofold: to demonstrate an association between design features and good health, and to prove that healthy homes are affordable on a mass scale.

"Without addressing root causes of poor health, such as unsuitable living conditions and lack of suitable sanitation, economic and human resources will continue to be spent by prioritizing treatments for people who get ill rather than on prevention," Williams says. "This approach is inherently unsustainable."

Williams' mission is inextricably tied to growing up in the prefab sprawl of Kingston's working-class Duhaney Park neighborhood — and to the disconnect he later felt as a lead designer working on "dream projects" for giant architecture firms in New York and Singapore. Although his father's illness was a singular event in his personal life, Williams became aware of the connection between housing and well-being only gradually.

The Williams family's home was a single-story, stand-alone unit, one of about 1,000 he says were built in the late 1960s to house teachers and nurses. By Williams' childhood, that area of Kingston had fallen into disrepair: Squatter settlements had sprung up around the periphery, and residences harbored mold and broken windowpanes. The units were often dark and overcrowded.

Unlike homes built in communities that have money, where construction has start and end dates, shelter in poor areas is often built incrementally, one wall at a time. During walks with his father, 8-year-old Peter was taken by endless scenes of men mixing concrete on the side of the road. "I want to do that, Dad," Williams told his father on one of those walks. But Williams' dad had grander ambitions. "What you really want to be," he said, "is an architect."

"You didn't have to go far to see very, very poor housing conditions," Williams says. "One thing that reinforced my belief and conviction on this issue was that I knew we weren't the poorest in the country; people were surviving on much less. Public health — something not very visible — is very often sidelined."

Williams worked his way through an undergraduate degree at City College in New York before going on to graduate school at Columbia and Oxford. During his time as a job captain at the firm Gensler, he was granted a sabbatical to study the relationship between housing and HIV in South Africa, courtesy of an award from Columbia. The experience lingered when he went to RDC Architects in Singapore, where he was lead designer on the development of a residential community of 80,000 people in the Al Khor region of Qatar, on the master plan for the expansion of King Fahd University in Saudi Arabia, and on upscale residences in Mumbai.

Since its founding five years ago, ARCHIVE has conducted workshops to teach residents of overcrowded housing stock in London techniques to reduce the spread of germs inside the home, such as trying to lower humidity through ventilation and limiting the number of people living in a unit. This year, using the winning designs from a contest it sponsored, the nonprofit will test whether building homes that emphasize light, ventilation, sanitation and uncrowded conditions can be constructed in the developing world at prices comparable to shelter without those features. The nonprofit also will evaluate whether the designs are doing what they're supposed to (for example, fostering air flow) and monitor the health of the homes' inhabitants. The organization's operating budget is a slim $200,000, raised through government, commercial and anonymous donations; its 20 staffers in New York and London, including Williams, are volunteers.

"We're trying to connect the dots for designers," Williams says. "The future of health care, particularly among the poorest, is not institutional care. We're working one community at a time by addressing immediate, micro-level conditions and how we can use targeted improvement on the house as a key strategy for improving health."

Worldwide, nearly 830 million people live in slums, a population expected to rise to 2 billion by 2030, according to U.N. Habitat, a part of the United Nations dedicated to studying settlement patterns. The U.N.'s Millennium Development Goals include improving the lives of 100 million slum-dwellers by 2020.

The characteristics of slums — lack of clean water and toilet/sanitation facilities, shoddy construction and severe overcrowding — are linked to a slew of infectious diseases, according to the World Health Organization. Cholera is spread through contaminated water and food. Overcrowding quickens cholera's transmission, as it does for flu and whooping cough. Malaria, dengue and yellow fever are transmitted by mosquitoes that reproduce in standing water and infiltrate homes unprotected by screens. Respiratory diseases, including TB, can be made worse by mold and poor ventilation, according to the nonprofit Partners in Health.

Despite the clear connection between slums and disease, in international aid circles, housing and health are usually treated as separate endeavors, Williams says. The Obama administration requested nearly $9.4 billion in foreign assistance for health last year, but specific infectious diseases commanded most of the pot. Water and sanitation, which are essential to healthy housing but not surrogates for shelter itself, occupied $239.5 million of the administration's foreign assistance health request. There is no distinct funding stream for shelter from the State Department or the U.S. Agency for International Development — by, it seems, design.

"Housing doesn't fall under the health portfolio by any means," says Ryan Cherlin, a USAID spokesman. "While there are undoubtedly correlations between poor housing and ill health, our health programs focus on specific diseases and health services. Allocating global health funds for housing purposes would violate current legislation."

With the exception of a homeless program in the Pacific Northwest, shelter isn't included in the Bill and Melinda Gates Foundation's programming either, despite the philanthropy's huge investment in vaccines, reproductive and global health. Nor is it part of programming at the Wellcome Trust, another large funder of studies into the origins and treatment of diseases in developing countries.

The disconnect is curious, says Paul Pholeros, director of the Australian nonprofit Healthabitat, which has been touting the link between housing and disease for 26 years. Historically, he says, housing codes tend to be based on health outcomes. Hospitalizations for infections plummeted by 40 percent over a decade among Aboriginal households that were upgraded to Healthabitat's healthy housing principles, according to a report published last year by the New South Wales Health Department, which noted that "the results exceeded expectations with regard to health benefits."

Research published last year in *Social Science & Medicine* estimated that waterborne illness fell from 32 to 14 percent between 2001 and 2008 after a slum in Ahmedabad, India, was upgraded. Replacing dirt with concrete floors in Mexico resulted in a 78 percent decrease in parasitic infections and a 49 percent reduction in diarrheal diseases among those homes' inhabitants, according to a 2007 report by the World Bank. And in the U.S., homeless people with AIDS who received housing assistance were less likely to be hospitalized or use the emergency room over 18 months than patients who didn't get that help, a 2009 study in the *Journal of the American Medical Association* reported.

Others argue that it may cost less to boost health by spending money on vaccines and health care than on housing, partly because the health-promoting qualities of specific design elements are still being quantified. "This is a complex subject with no simple answers," says Roger England, chairman of Health Systems Workshop, a nonprofit that reviews health care finance and delivery, in an e-mail. "Housing can have health-improving qualities, but we do not know how much 'better housing' results in 'better health.' To even begin to look at this we need to take housing apart — what are its components and which of them make the most difference?"

At University College London's Healthy Infra-structure Research Center, where Williams is a visiting scholar in civil, environmental and geomatic engineering, scientists are indeed taking housing apart through research. With more than $1.5 million in grant funding, UCL recently launched the center on the premise that infectious disease is connected to architecture. A structure can house pathogens (for example, the bacteria *legionella* multiplying in ventilation systems), and conversely, it can be designed to kill or otherwise get rid of them (via disinfection systems). Infrastructure can help disease spread; the transmission of SARS in Hong Kong was partly blamed on the failure of drainage systems in buildings there, says the center's director, Ka-Man Lai. Finally, design can control infection indirectly by, say, placing a tap in a location most likely to make people pause to wash their hands.

The center's scientists are now studying these and other connections between design and disease in commercial, outdoor and residential structures, including the prototype homes ARCHIVE will build in Haiti. The homes will collectively house 20 people with HIV/AIDS, who are vulnerable to infections such as tuberculosis. Each house will have a concrete foundation and will be designed to maximize ventilation and access to sanitation and clean water.

While designs for the Cameroon homes will be selected through another contest, certain architectural features are known or thought to affect mosquitoes' ability to get inside homes and breed, Williams says, including: elevating homes (certain mosquitoes fly close to the ground), using insect-repellent paint, screening windows and installing ceilings to prevent mosquitoes from flying through porous roofs and into living spaces.

In addition to tracking the ventilation patterns inside the Haiti prototype houses, ARCHIVE will measure indoor particles, such as those from smoke that can compromise breathing. It will track tuberculosis and other bacteria and the fluctuation in relative humidity, a factor in TB transmission. The group also will monitor carbon dioxide levels, a marker for overcrowding. A Haitian organization will monitor the residents' health. Simultaneously, Williams hopes to show that the homes can be built for prices comparable to typical Haitian construction. Though construction prices in Haiti are fluctuating in the wake of the earthquake, Williams says,

he expects the houses to cost around $30,000 each. (Costs would fall should the designs be replicated, he says.) In Cameroon, he expects the prototype homes to cost about $5,000 apiece.

Not everyone is convinced that the prototypes ARCHIVE is building will be specifically health-promoting or make a big impact on their own. “A lot of it is dependent on the overall planning of the area as well as what the neighborhood looks like,” says Sandhya Janardhan, program coordinator for the volunteer group Architecture for Humanity. “More often than not, the issue is not just spaces but the education of the population, that they aren’t aware of how disease gets transmitted, that they don’t engage in hygienic practices when it comes to cooking, cleaning up surroundings or just living a healthy lifestyle.”

Williams has a different view. “One falls into this trap of making sharp distinctions between these things. We believe it’s all of those things combined to provide sustainable improvement,” he says. “The current challenge of individuals living in poor housing conditions exists — that is a fact. It’s not as though education can somehow address that — people need to live somewhere.” Late last year, Habitat published a report highlighting the need to incorporate health priorities in the construction of new housing. Hard-surface floors and roofs, screened windows and adequate space, it said, “should become routine.”

In 2009, then-acting U.S. Surgeon General Steven Galson issued a “call to action” for more research into the health outcomes from specific housing designs, noting that many of the leading causes of preventable deaths and disease, such as falls, fires, burns, drowning, asthma and lead poisoning, occur in the home. The Department of Housing and Urban Development issued a complementary report, asserting that a more holistic approach to construction that addressed causes of ill health — mold, pests, poor structural safety and lead paint, for example — would be the most cost-effective way to address health risks such as asthma, allergies, poisoning and accidents. “A comprehensive, coordinated approach to healthy homes,” Galson wrote, “will result in the greatest public health impact.”

For his part, Williams is content to be methodical in showing that such an approach can make practical sense. “Success,” he says, “is literally one household at a time.”

http://www.miller-mccune.com/health/archive-says-home-is-where-the-health-is-29857/

**Rooftop Solar Power to the People?**

**Some environmental advocates say the federal government is ignoring the real future of solar energy: photovoltaic cells on almost every roof. But even supporters acknowledge rooftop solar isn't the complete answer to the energy question — yet.**

By Michael Haederle

*Environmentalists point to the example of Germany, which has outstripped the U.S., rapidly adding solar resources to its energy portfolio through rooftop solar installations. (64MM/Flickr.com)*

While chasing the mirage of a game-changing renewable energy source in the form of industrial-scale solar plants capable of powering hundreds of thousands of homes, the federal government has turned its back on a better, cheaper form of energy from the sun: distributed solar power generation, sometimes known as rooftop solar.

At least, that's the way desert environmental advocates see it. A coalition of scientists and local land conservationists calling itself Solar Done Right envisions roofing homes, commercial buildings and parking lots throughout the Southwest with a vast network of photovoltaic panels, each connected to the rest through the power grid.

Should large-scale solar power facilities be needed, they say, they ought to be built close to the cities where the electricity is consumed, either on degraded farmland or abandoned industrial sites known as brownfields. This approach, they say, will spare fragile desert landscapes while rapidly scaling up the nation's solar capacity and usurping the role traditionally played by utility companies in allocating resources and setting electrical rates.

"Distributed solar isn't on their radar, because it isn't under their control," says Bill Powers, a San Diego electrical engineer and Solar Done Right member who has also testified as an expert for the Natural Resources Defense Council in their efforts to block new coal-fired electricity plants. "The big-and-remote paradigm has always been the utilities' paradigm."

Powers argues that the huge, complex projects breaking ground in the California desert are technologically obsolete. "We *should* be pouring money into green technology and green jobs," Powers says, "but we shouldn't be preferentially supporting a technology that crested in 1990."

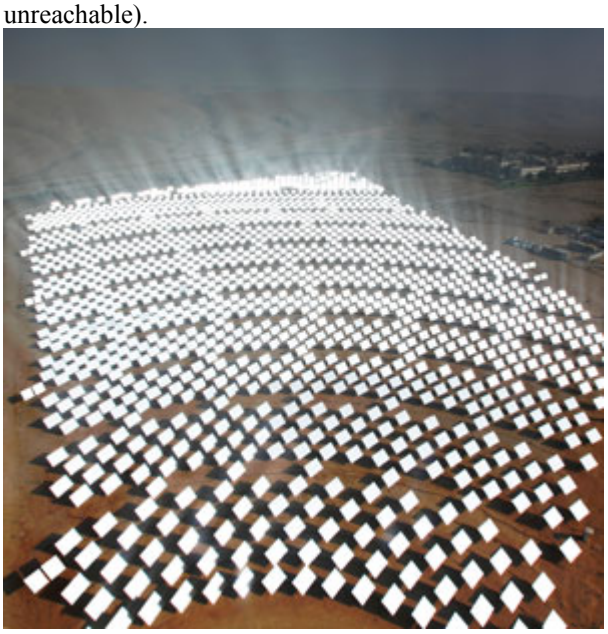
Powers and other Solar Done Right members point to the example of Germany, which, in recent years, has outstripped the U.S., rapidly adding solar resources to its energy portfolio through rooftop solar installations.

Germany built its solar program with a pricing mechanism called feed-in tariffs, in which money collected from ratepayers is used to buy surplus power from owners of rooftop photovoltaic arrays at a guaranteed price per kilowatt-hour. The cash incentive is enough to offset the substantial up-front costs of setting up a photovoltaic system, says Sheila Bowers, a Santa Monica, Calif., attorney and member of Solar Done Right. Germans have been installing 30 times the U.S. total of solar capacity per year, creating 40,000 new jobs in the process — even though Germany lies well north of much of the U.S.

"They have created a new economy," Bowers says. If anything, the German feed-in tariff program has worked almost too well: The government announced in January it would cut the solar subsidy by up to 15 percent starting this summer to ease the expected $17.5 billion annual cost of paying people all too eager to install solar arrays on their homes.

Here in the U.S., meanwhile, the Energy Department's support for next-generation photovoltaic research amounted to $21.7 million in grants that were doled out in 2007 to two dozen colleges and universities, a figure that pales by comparison with the billions of dollars in grants and loan guarantees the government is handing out for new industrial-scale projects.

The city of Los Angeles, 150 miles to the west of the desert basins where big solar projects are planned, has focused its sights on rooftop solar. Mayor Antonio Villaraigosa has set an ambitious goal of getting 40 percent of its electricity from renewable sources by 2020 (a figure that many of his aides, by the way, think is unreachable).



At the behest of the Los Angeles Business Council, J.R. DeShazo, director of UCLA's Luskin Center for Innovation, has studied whether feed-in tariffs will work as advertised. DeShazo and his collaborators first wanted to establish that L.A. has the raw solar resources it needs. They calculated that rooftops and parking lots throughout the sprawling Los Angeles basin could potentially generate 19 gigawatts of electricity with photovoltaic technology. The city alone has about 5.5 gigawatts of solar capacity, he says.

DeShazo modeled the phase-in of 600 megawatts of rooftop-generated electricity over 10 years. Despite substantial installation costs, "given falling solar costs and rising avoided costs for utilities, it looks as if right around year 12 to 13, large-scale in-basin solar — rooftops and parking lots — will become cheaper than the natural gas alternative that you have to supply peak power," he says. "If that's true, then the feed-in tariff would be cost effective for ratepayers over its lifetime."

I ask DeShazo about the relative advantages and disadvantages of the two solar generation schemes. "The two major advantages to large-scale utility solar are it's cheaper by somewhere between 3 and 6 cents a kilowatt-hour compared to large-scale urban rooftop settings," De Shazo says. Also, he says, wind and solar energy will always be limited by variable weather conditions, making power-supply management difficult. It's easier to manage fluctuating supplies with industrial solar than with thousands of distributed units in a city, he says.

But a disadvantage of big solar is that it happens in the desert, far from the labor market, so the "green jobs" benefits are vastly diminished, DeShazo says. "The second disadvantage is you have to transmit that power, so you run into exactly the same kind of transmission issues and environmental issues as with gas or coal," he says.

Finally, distributed solar has an edge in the speed with which it will respond to financial incentives, he says. The private sector will begin to install solar panels in response to a feed-in tariff much more quickly than developers of large solar projects can negotiate power-purchase agreements with utilities and win regulatory approval from the government.

For now, electric utilities rely on coal-fired plants both because coal is cheap and the plants can be ramped up reliably to meet increasing demand. Researchers are hard at work devising new ways to store the electricity generated by intermittent sources like wind and solar. "When we get to good storage, the whole game is going to change radically," DeShazo says. "That's going to be a hard day for the utilities."

But even if new electrical storage capacity is added and the electrical grid is improved so excess electricity from thousands of rooftop solar arrays can be sent to distant locales in need of power, DeShazo says, he doesn't expect solar — industrial-scale or rooftop — to grow quickly enough to play a dominant role in L.A.'s power mix in his lifetime. "When I look out over the foreseeable future — 10 or 20 years — we'll be lucky if we get solar to 10 to 15 percent of our load here in L.A.," he says.

Cai Steger, an energy policy analyst for the NRDC's Center for Market Innovation in New York, agrees, saying his team has run a national model for the growth of distributed solar generation for a 20-year period that makes generous assumptions about how quickly it could be implemented. "What that got you to was somewhere around 80 gigawatts of photovoltaic capacity by 2030," Steger says. "That's basically about 4 percent of total electrical generation."

In addition, Steger says, many aging coal-fired plants will be coming offline in the next 10 to 15 years, and something will have to replace them. The numbers just don't support the belief that distributed solar power could fill that huge void, Steger says, and given the pressing need to respond to climate change, eschewing industrial-scale solar power projects is "just not a risk we can take."

Still, there is a future for photovoltaics. Arno Harris, founder and CEO of San Francisco-based Recurrent Energy, says his company has carved out a niche building small-to-midsize photovoltaic projects that sidestep many of the regulatory hurdles that confront the huge industrial power stations. Recurrent's projects have included a 5 megawatt photovoltaic array mounted atop San Francisco's Sunset Reservoir, Harris says. Meanwhile, the company has contracts to develop 400 megawatts of new capacity.

In his 10 years in the business, Harris has seen the average efficiency of photovoltaic cells improve from about 12 percent to 15 or 16 percent. The current generation of PV technologies might reach up to 20 percent efficiency, he says.

It costs between $4 and $6 per watt to install a home photovoltaic system, but the midsize projects Recurrent is building represent a threshold where costs are falling below $3 per watt. If PV efficiency continues to improve and that installation cost drops below $2 per watt, Harris says, photovoltaics will become competitive with fossil fuel. When that happens, he says, solar will quickly be embraced by the world's largest electricity market.

"Those kind of economics in a big market can have a big effect and drive a lot of capacity," Harris says. "I think the U.S. is at a pretty big turning point."

http://www.miller-mccune.com/science-environment/rooftop-solar-power-to-the-people-29885/

**What Defines a Meme?**
**Our world is a place where information can behave like human genes and ideas can replicate, mutate and evolve**

By James Gleick

Photographs by Stuart Bradford

*Smithsonian* magazine, May 2011

What lies at the heart of every living thing is not a fire, not warm breath, not a 'spark of life.' It is information, words, instructions," Richard Dawkins declared in 1986. Already one of the world's foremost evolutionary biologists, he had caught the spirit of a new age. The cells of an organism are nodes in a richly interwoven communications network, transmitting and receiving, coding and decoding. Evolution itself embodies an ongoing exchange of information between organism and environment. "If you want to understand life," Dawkins wrote, "don't think about vibrant, throbbing gels and oozes, think about information technology."

We have become surrounded by information technology; our furniture includes iPods and plasma displays, and our skills include texting and Googling. But our capacity to understand the role of information has been sorely taxed. "TMI," we say. Stand back, however, and the past does come back into focus.

The rise of information theory aided and abetted a new view of life. The genetic code—no longer a mere metaphor—was being deciphered. Scientists spoke grandly of the *biosphere*: an entity composed of all the earth's life-forms, teeming with information, replicating and evolving. And biologists, having absorbed the methods and vocabulary of communications science, went further to make their own contributions to the understanding of information itself.

Jacques Monod, the Parisian biologist who shared a Nobel Prize in 1965 for working out the role of messenger RNA in the transfer of genetic information, proposed an analogy: just as the biosphere stands above the world of nonliving matter, so an "abstract kingdom" rises above the biosphere. The denizens of this kingdom? Ideas.

"Ideas have retained some of the properties of organisms," he wrote. "Like them, they tend to perpetuate their structure and to breed; they too can fuse, recombine, segregate their content; indeed they too can evolve, and in this evolution selection must surely play an important role."

Ideas have "spreading power," he noted—"infectivity, as it were"—and some more than others. An example of an infectious idea might be a religious ideology that gains sway over a large group of people. The American neurophysiologist Roger Sperry had put forward a similar notion several years earlier, arguing that ideas are "just as real" as the neurons they inhabit. Ideas have power, he said:

*Ideas cause ideas and help evolve new ideas. They interact with each other and with other mental forces in the same brain, in neighboring brains, and thanks to global communication, in far distant, foreign brains. And they also interact with the external surroundings to produce in toto a burstwise advance in evolution that is far beyond anything to hit the evolutionary scene yet.*

Monod added, "I shall not hazard a theory of the selection of ideas." There was no need. Others were willing. Dawkins made his own jump from the evolution of genes to the evolution of ideas. For him the starring role belongs to the replicator, and it scarcely matters whether replicators were made of nucleic acid. His rule is "All life evolves by the differential survival of replicating entities." Wherever there is life, there must be replicators. Perhaps on other worlds replicators could arise in a silicon-based chemistry—or in no chemistry at all.

What would it mean for a replicator to exist without chemistry? "I think that a new kind of replicator has recently emerged on this very planet," Dawkins proclaimed near the end of his first book, *The Selfish Gene*, in 1976. "It is staring us in the face. It is still in its infancy, still drifting clumsily about in its primeval soup, but already it is achieving evolutionary change at a rate that leaves the old gene panting far behind." That "soup" is human culture; the vector of transmission is language, and the spawning ground is the brain.

For this bodiless replicator itself, Dawkins proposed a name. He called it the meme, and it became his most memorable invention, far more influential than his selfish genes or his later proselytizing against religiosity. "Memes propagate themselves in the meme pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation," he wrote. They compete with one another for limited resources: brain time or bandwidth. They compete most of all for *attention*. For example:

*Ideas.* Whether an idea arises uniquely or reappears many times, it may thrive in the meme pool or it may dwindle and vanish. The belief in God is an example Dawkins offers—an ancient idea, replicating itself not just in words but in music and art. The belief that Earth orbits the Sun is no less a meme, competing with others for survival. (Truth may be a helpful quality for a meme, but it is only one among many.)

*Tunes.* This tune has spread for centuries across several continents.

*Catchphrases.* One text snippet, "What hath God wrought?" appeared early and spread rapidly in more than one medium. Another, "Read my lips," charted a peculiar path through late 20th-century America. "Survival of the fittest" is a meme that, like other memes, mutates wildly ("survival of the fattest"; "survival of the sickest"; "survival of the fakest"; "survival of the twittest").

*Images.* In Isaac Newton's lifetime, no more than a few thousand people had any idea what he looked like, even though he was one of England's most famous men. Yet now millions of people have quite a clear idea—based on replicas of copies of rather poorly painted portraits. Even more pervasive and indelible are the smile of *Mona Lisa*, *The Scream* of Edvard Munch and the silhouettes of various fictional extraterrestrials. These are memes, living a life of their own, independent of any physical reality. "This may not be what George Washington looked like then," a tour guide was overheard saying of the Gilbert Stuart portrait at the Metropolitan Museum of Art, "but this is what he looks like now." Exactly.

Memes emerge in brains and travel outward, establishing beachheads on paper and celluloid and silicon and anywhere else information can go. They are not to be thought of as elementary particles but as organisms. The number three is not a meme; nor is the color blue, nor any simple thought, any more than a single nucleotide can be a gene. Memes are complex units, distinct and memorable—units with staying power.

Also, an object is not a meme. The hula hoop is not a meme; it is made of plastic, not of bits. When this species of toy spread worldwide in a mad epidemic in 1958, it was the product, the physical manifestation, of a meme, or memes: the craving for hula hoops; the swaying, swinging, twirling skill set of hula-hooping. The hula hoop itself is a meme vehicle. So, for that matter, is each human hula hooper—a strikingly effective meme vehicle, in the sense neatly explained by the philosopher Daniel Dennett: "A wagon with spoked wheels carries not only grain or freight from place to place; it carries the brilliant idea of a wagon with spoked wheels from mind to mind." Hula hoopers did that for the hula hoop's memes—and in 1958 they found a new transmission vector, broadcast television, sending its messages immeasurably faster and farther than any

wagon. The moving image of the hula hooper seduced new minds by hundreds, and then by thousands, and then by millions. The meme is not the dancer but the dance.

For most of our biological history memes existed fleetingly; their main mode of transmission was the one called "word of mouth." Lately, however, they have managed to adhere in solid substance: clay tablets, cave walls, paper sheets. They achieve longevity through our pens and printing presses, magnetic tapes and optical disks. They spread via broadcast towers and digital networks. Memes may be stories, recipes, skills, legends or fashions. We copy them, one person at a time. Alternatively, in Dawkins' meme-centered perspective, they copy themselves.

"I believe that, given the right conditions, replicators automatically band together to create systems, or machines, that carry them around and work to favor their continued replication," he wrote. This was not to suggest that memes are conscious actors; only that they are entities with interests that can be furthered by natural selection. Their interests are not our interests. "A meme," Dennett says, "is an information-packet with attitude." When we speak of *fighting for a principle* or *dying for an idea*, we may be more literal than we know.

*Tinker, tailor, soldier, sailor....*Rhyme and rhythm help people remember bits of text. Or: rhyme and rhythm help bits of text get remembered. Rhyme and rhythm are qualities that aid a meme's survival, just as strength and speed aid an animal's. Patterned language has an evolutionary advantage. Rhyme, rhythm and reason—for reason, too, is a form of pattern. *I was promised on a time to have reason for my rhyme; from that time unto this season, I received nor rhyme nor reason.*

Like genes, memes have effects on the wide world beyond themselves. In some cases (the meme for making fire; for wearing clothes; for the resurrection of Jesus) the effects can be powerful indeed. As they broadcast their influence on the world, memes thus influence the conditions affecting their own chances of survival. The meme or memes comprising Morse code had strong positive feedback effects. Some memes have evident benefits for their human hosts ("Look before you leap," knowledge of CPR, belief in hand washing before cooking), but memetic success and genetic success are not the same. Memes can replicate with impressive virulence while leaving swaths of collateral damage—patent medicines and psychic surgery, astrology and satanism, racist myths, superstitions and (a special case) computer viruses. In a way, these are the most interesting—the memes that thrive to their hosts' detriment, such as the idea that suicide bombers will find their reward in heaven.

Memes could travel wordlessly even before language was born. Plain mimicry is enough to replicate knowledge—how to chip an arrowhead or start a fire. Among animals, chimpanzees and gorillas are known to acquire behaviors by imitation. Some species of songbirds learn their songs, or at least song variants, after hearing them from neighboring birds (or, more recently, from ornithologists with audio players). Birds develop song repertoires and song dialects—in short, they exhibit a birdsong culture that predates human culture by eons. These special cases notwithstanding, for most of human history memes and language have gone hand in glove. (Clichés are memes.) Language serves as culture's first catalyst. It supersedes mere imitation, spreading knowledge by abstraction and encoding.

Perhaps the analogy with disease was inevitable. Before anyone understood anything of epidemiology, its language was applied to species of information. An emotion can be infectious, a tune catchy, a habit contagious. "From look to look, contagious through the crowd / The panic runs," wrote the poet James Thomson in 1730. Lust, likewise, according to Milton: "Eve, whose eye darted contagious fire." But only in the new millennium, in the time of global electronic transmission, has the identification become second nature. Ours is the age of virality: viral education, viral marketing, viral e-mail and video and networking. Researchers studying the Internet itself as a medium—crowdsourcing, collective attention, social networking and resource allocation—employ not only the language but also the mathematical principles of epidemiology.

One of the first to use the terms "viral text" and "viral sentences" seems to have been a reader of Dawkins named Stephen Walton of New York City, corresponding in 1981 with the cognitive scientist Douglas Hofstadter. Thinking logically—perhaps in the mode of a computer—Walton proposed simple self-replicating sentences along the lines of "Say me!" "Copy me!" and "If you copy me, I'll grant you three wishes!" Hofstadter, then a columnist for Scientific American, found the term "viral text" itself to be even catchier. *Well, now, Walton's own viral text, as you can see here before your eyes, has managed to commandeer the facilities of a very powerful host—an entire magazine and printing press and distribution service. It has leapt*

*aboard and is now—even as you read this viral sentence—propagating itself madly throughout the ideosphere!*

Hofstadter gaily declared himself infected by the *meme* meme.

One source of resistance—or at least unease—was the shoving of us humans toward the wings. It was bad enough to say that a person is merely a gene's way of making more genes. Now humans are to be considered as vehicles for the propagation of memes, too. No one likes to be called a puppet. Dennett summed up the problem this way: "I don't know about you, but I am not initially attracted by the idea of my brain as a sort of dung heap in which the larvae of other people's ideas renew themselves, before sending out copies of themselves in an informational diaspora.... Who's in charge, according to this vision—we or our memes?" He answered his own question by reminding us that, like it or not, we are seldom "in charge" of our own minds. He might have quoted Freud; instead he quoted Mozart (or so he thought): "In the night when I cannot sleep, thoughts crowd into my mind.... Whence and how do they come? I do not know and I have nothing to do with it."

Later Dennett was informed that this well-known quotation was not Mozart's after all. It had taken on a life of its own; it was a fairly successful meme.

For anyone taken with the idea of memes, the landscape was changing faster than Dawkins had imagined possible in 1976, when he wrote, "The computers in which memes live are human brains." By 1989, the time of the second edition of *The Selfish Gene*, having become an adept programmer himself, he had to amend that: "It was obviously predictable that manufactured electronic computers, too, would eventually play host to self-replicating patterns of information." Information was passing from one computer to another "when their owners pass floppy discs around," and he could see another phenomenon on the near horizon: computers connected in networks. "Many of them," he wrote, "are literally wired up together in electronic mail exchange.... It is a perfect milieu for self-replicating programs to flourish." Indeed, the Internet was in its birth throes. Not only did it provide memes with a nutrient-rich culture medium, it also gave wings to the *idea* of memes. *Meme* itself quickly became an Internet buzzword. Awareness of memes fostered their spread.

A notorious example of a meme that could not have emerged in pre-Internet culture was the phrase "jumped the shark." Loopy self-reference characterized every phase of its existence. To jump the shark means to pass a peak of quality or popularity and begin an irreversible decline. The phrase was thought to have been used first in 1985 by a college student named Sean J. Connolly, in reference to an episode of the television series "Happy Days" in which the character Fonzie (Henry Winkler), on water skies, jumps over a shark. The origin of the phrase requires a certain amount of explanation without which it could not have been initially understood. Perhaps for that reason, there is no recorded usage until 1997, when Connolly's roommate, Jon Hein, registered the domain name jumptheshark.com and created a web site devoted to its promotion. The web site soon featured a list of frequently asked questions:

*Q. Did "jump the shark" originate from this web site, or did you create the site to capitalize on the phrase?*
*A. This site went up December 24, 1997, and gave birth to the phrase "jump the shark." As the site continues to grow in popularity, the term has become more commonplace. The site is the chicken, the egg and now a Catch-22.*

It spread to more traditional media in the next year; Maureen Dowd devoted a column to explaining it in the *New York Times* in 2001; in 2002 the same newspaper's "On Language" columnist, William Safire, called it "the popular culture's phrase of the year"; soon after that, people were using the phrase in speech and in print without self-consciousness—no quotation marks or explanation—and eventually, inevitably, various cultural observers asked, "Has 'jump the shark' jumped the shark?" Like any good meme, it spawned mutations. The "jumping the shark" entry in Wikipedia advised in 2009, "See also: jumping the couch; nuking the fridge."

Is this science? In his 1983 column, Hofstadter proposed the obvious memetic label for such a discipline: *memetics*. The study of memes has attracted researchers from fields as far apart as computer science and microbiology. In bioinformatics, chain letters are an object of study. They are memes; they have evolutionary histories. The very purpose of a chain letter is replication; whatever else a chain letter may say, it embodies one message: *Copy me*. One student of chain-letter evolution, Daniel W. VanArsdale, listed many variants, in chain letters and even earlier texts: "Make seven copies of it exactly as it is written" (1902); "Copy this in full and send to nine friends" (1923); "And if any man shall take away from the words of the book of this prophecy, God shall take away his part out of the book of life" (Revelation 22:19). Chain letters flourished with the help of a new 19th-century technology: "carbonic paper," sandwiched between sheets of writing

paper in stacks. Then carbon paper made a symbiotic partnership with another technology, the typewriter. Viral outbreaks of chain letters occurred all through the early 20th century. Two subsequent technologies, when their use became widespread, provided orders-of-magnitude boosts in chain-letter fecundity: photocopying (c. 1950) and e-mail (c. 1995).

Inspired by a chance conversation on a hike in the Hong Kong mountains, information scientists Charles H. Bennett from IBM in New York and Ming Li and Bin Ma from Ontario, Canada, began an analysis of a set of chain letters collected during the photocopier era. They had 33, all variants of a single letter, with mutations in the form of misspellings, omissions and transposed words and phrases. "These letters have passed from host to host, mutating and evolving," they reported in 2003.

*Like a gene, their average length is about 2,000 characters. Like a potent virus, the letter threatens to kill you and induces you to pass it on to your "friends and associates"—some variation of this letter has probably reached millions of people. Like an inheritable trait, it promises benefits for you and the people you pass it on to. Like genomes, chain letters undergo natural selection and sometimes parts even get transferred between coexisting "species."*

Reaching beyond these appealing metaphors, the three researchers set out to use the letters as a "test bed" for algorithms used in evolutionary biology. The algorithms were designed to take the genomes of various modern creatures and work backward, by inference and deduction, to reconstruct their phylogeny—their evolutionary trees. If these mathematical methods worked with genes, the scientists suggested, they should work with chain letters, too. In both cases the researchers were able to verify mutation rates and relatedness measures.

Still, most of the elements of culture change and blur too easily to qualify as stable replicators. They are rarely as neatly fixed as a sequence of DNA. Dawkins himself emphasized that he had never imagined founding anything like a new science of memetics. A peer-reviewed *Journal of Memetics* came to life in 1997—published online, naturally—and then faded away after eight years partly spent in self-conscious debate over status, mission and terminology. Even compared with genes, memes are hard to mathematize or even to define rigorously. So the gene-meme analogy causes uneasiness and the genetics-memetics analogy even more.

Genes at least have a grounding in physical substance. Memes are abstract, intangible and unmeasurable. Genes replicate with near-perfect fidelity, and evolution depends on that: some variation is essential, but mutations need to be rare. Memes are seldom copied exactly; their boundaries are always fuzzy, and they mutate with a wild flexibility that would be fatal in biology. The term "meme" could be applied to a suspicious cornucopia of entities, from small to large. For Dennett, the first four notes of Beethoven's Fifth Symphony (quoted above) were "clearly" a meme, along with Homer's *Odyssey* (or at least the idea of the *Odyssey*), the wheel, anti-Semitism and writing. "Memes have not yet found their Watson and Crick," said Dawkins; "they even lack their Mendel."

Yet here they are. As the arc of information flow bends toward ever greater connectivity, memes evolve faster and spread farther. Their presence is felt if not seen in herd behavior, bank runs, informational cascades and financial bubbles. Diets rise and fall in popularity, their very names becoming catchphrases—the South Beach Diet and the Atkins Diet, the Scarsdale Diet, the Cookie Diet and the Drinking Man's Diet all replicating according to a dynamic about which the science of nutrition has nothing to say. Medical practice, too, experiences "surgical fads" and "iatro-epidemics"—epidemics caused by fashions in treatment—like the iatro-epidemic of children's tonsillectomies that swept the United States and parts of Europe in the mid-20th century. Some false memes spread with disingenuous assistance, like the apparently unkillable notion that Barack Obama was not born in Hawaii. And in cyberspace every new social network becomes a new incubator of memes. Making the rounds of Facebook in the summer and fall of 2010 was a classic in new garb:

*Sometimes I Just Want to Copy Someone Else's Status, Word for Word, and See If They Notice.*

Then it mutated again, and in January 2011 Twitter saw an outbreak of:

*One day I want to copy someone's Tweet word for word and see if they notice.*

By then one of the most popular of all Twitter hashtags (the "hashtag" being a genetic—or, rather, memetic—marker) was simply the word "#Viral."

In the competition for space in our brains and in the culture, the effective combatants are the messages. The new, oblique, looping views of genes and memes have enriched us. They give us paradoxes to write on

Möbius strips. “The human world is made of stories, not people,” writes the novelist David Mitchell. “The people the stories use to tell themselves are not to be blamed.” Margaret Atwood writes: “As with all knowledge, once you knew it, you couldn’t imagine how it was that you hadn’t known it before. Like stage magic, knowledge before you knew it took place before your very eyes, but you were looking elsewhere.” Nearing death, John Updike reflected on

*A life poured into words—apparent waste intended to preserve the thing consumed.*

Fred Dretske, a philosopher of mind and knowledge, wrote in 1981: “In the beginning there was information. The word came later.” He added this explanation: “The transition was achieved by the development of organisms with the capacity for selectively exploiting this information in order to survive and perpetuate their kind.” Now we might add, thanks to Dawkins, that the transition was achieved by the information itself, surviving and perpetuating its kind and selectively exploiting organisms.

Most of the biosphere cannot see the infosphere; it is invisible, a parallel universe humming with ghostly inhabitants. But they are not ghosts to us—not anymore. We humans, alone among the earth’s organic creatures, live in both worlds at once. It is as though, having long coexisted with the unseen, we have begun to develop the needed extrasensory perception. We are aware of the many species of information. We name their types sardonically, as though to reassure ourselves that we understand: urban myths and zombie lies. We keep them alive in air-conditioned server farms. But we cannot own them. When a jingle lingers in our ears, or a fad turns fashion upside down, or a hoax dominates the global chatter for months and vanishes as swiftly as it came, who is master and who is slave?



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Find this article at:
http://www.smithsonianmag.com/arts-culture/What-Defines-a-Meme.html#ixzz1KVKsZ7wn

**Odd McIntyre: The Man Who Taught America About New York**

**For millions of people, their only knowledge about New York City was O.O. McIntyre's daily column about life in the Big Apple**

- By Greg Daugherty
- Smithsonian.com, April 25, 2011

On a steamy July day 100 years ago, a 27-year-old newspaperman stepped off the train from Cincinnati at Pennsylvania Station in Manhattan. He wore a checkered suit, carried a bamboo cane and would have put on his loudest red necktie had his wife not talked him out of it. Years later he'd cringe at his youthful fashion sense but remember his first glimpse of Manhattan with awe. He called it "life's most thrilling moment."

So began one of the great romances of the 20th century. "I came to New York with no special qualifications, no brilliant achievements and certainly nothing to recommend me to metropolitan editors," he said. "Yet New York accepted me, just as it has thousands of others who came from the prairie cottage and the village street, so generously and wholeheartedly that I love it devotedly."

By the early 1920s, O. O. (for Oscar Odd) McIntyre was perhaps the most famous New Yorker alive—at least to people who didn't reside there. His daily column about the city, "New York Day by Day," reportedly ran in more than 500 newspapers throughout the United States. He also wrote a popular monthly column for *Cosmopolitan*, then one of the country's largest general-interest magazines. His annual output totaled some 300,000 words, the bulk of them about New York. In return for all that time at the typewriter, he was reputed to be the most widely read and highly paid writer in the world, earning an estimated $200,000 a year.

McIntyre's most devoted audience was small-town America, where readers saw him as a local boy turned foreign correspondent, reporting from an exotic, faraway place. He referred to his daily column as "the letter," and its tone often resembled a note to the folks back home. "[T]he metropolis has never lost its thrill for me," he once wrote. "Things the ordinary New Yorker accepts casually are my dish—the telescope man on the curb, the Bowery lodging houses and drifters, chorus girls, gunmen," as well as "speakeasies on side streets, fake jewelry auction sales, cafeterias, chop houses, antique shops, $5 hair bobbing parlors—in short all the things we didn't have in our town."

In any given column he might pay tribute to some neighborhood of the Big Town, reminisce about his youth in Gallipolis, Ohio, and sprinkle in personal glimpses of the famous men and women he seemed to bump into everywhere he went:

"Jack Dempsey is one of the most graceful dancers in town…."

"Amelia Earhart's bob is now like Katharine Hepburn's…."

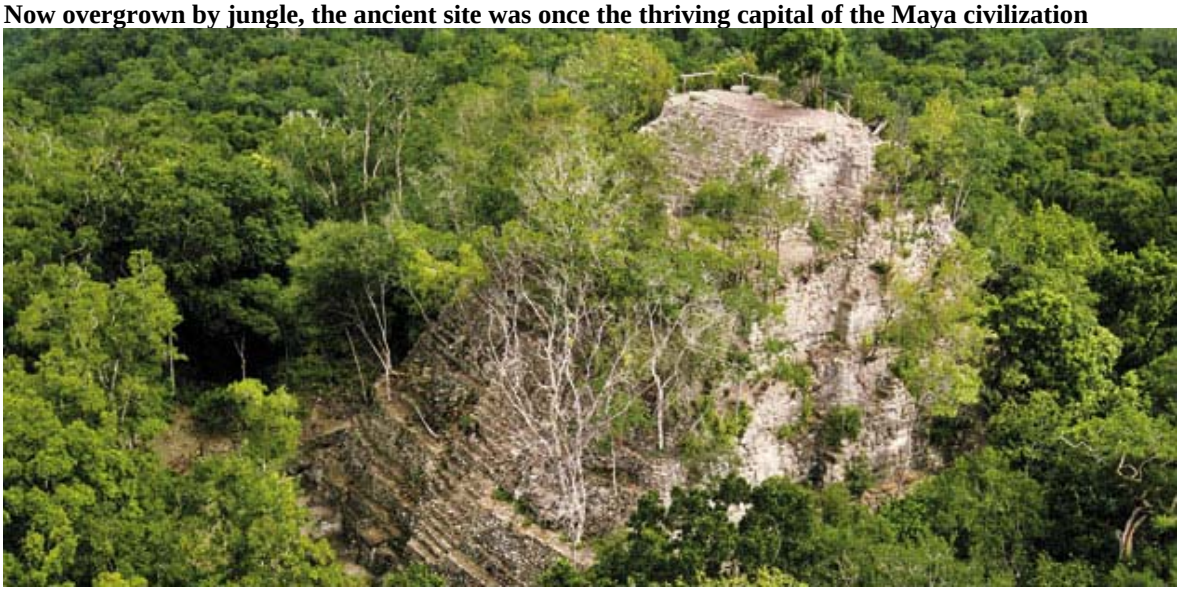
"Ernest Hemingway waxes furious when it is spelled with two m's…."

"Babe Ruth doesn't enjoy dinner without an ice cream finale…."
"Charlie Chaplin cannot talk business to any man behind a desk. His youth was filled with rebuffs over a desktop…."
"Joseph P. Kennedy takes one of his nine children to a matinee every Saturday…."
New York, he told his readers, was "a sort of parade ground for celebrities." Unlike later gossip columnists, McIntyre took pride in the notion that he had "never intentionally written a line I thought would wound the feelings of another." Indeed, you can read hundreds of "New York Day By Day" installments and never come across anything more critical than, "Bob Ripley is putting on weight."
At his peak, McIntyre was receiving 3,000 fan letters a week, including some addressed simply to "O. O., New York." He was parodied by Ring Lardner and celebrated in a suite by Music Man composer Meredith Wilson. When the longtime *New Yorker* editor William Shawn published his sole piece in the magazine (a 1936 sketch about a meteor wiping out everybody in all five New York boroughs), he singled out McIntyre as the only person the rest of the country even noticed was missing.
What few of McIntyre's out-of-town readers might have realized was that his New York often bore about as much resemblance to the real city as a Busby Berkeley musical. "Accuracy was his enemy and glamor was his god," the *New York Times* observed in its obituary of him. "His map of New York came from his own imagination, with Hoboken next to Harlem if it suited his fancy, as it often did."
Even fewer readers could have known that for much of his life, McIntyre suffered from a set of phobias that were remarkable in both number and variety. Those included a fear of being slapped on the back or having someone pick lint off his clothing. He was terrified that he might drop dead in the street. He disliked crowds and often preferred not to leave his Park Avenue apartment at all, except for nightly rides around the city, hunched in the back of his chauffeured blue Rolls-Royce. Further complicating his work as a reporter, he was deathly afraid of the telephone.
In many ways the name "Odd," which he inherited from an uncle, could hardly have been more fitting. Among other things, he wrote mostly in red ink, owned 30 pairs of pajamas for wearing during the day and another 30 for the night, and loved to sprinkle himself with perfume. One interviewer counted 92 bottles on his bureau. Rival gossip columnist Walter Winchell wasn't alone in calling him "the Very Odd McIntyre."
McIntyre and his wife, Maybelle, were childless but owned a succession of dogs, including a Boston terrier named Junior and another named Billy, whose exploits were chronicled in endless detail. "I have often thought my friend O. O. McIntyre gave more space in his column to his little dog than I do to the U. S. Senate," Will Rogers once wrote. "But it just shows Odd knows human nature better than I do. He knows that everybody at heart loves a dog, while I have to try and make converts to the Senate." Billy was the subject of such classic McIntyre fare as "To Billy in Dog Heaven," which supposedly elicited more mail than any other of his columns.
McIntyre died on February 14, 1938, days shy of his 54th birthday, apparently of a heart attack. His biographer and longtime editor, Charles B. Driscoll, speculated that he could have lived a lot longer had he not been afraid of doctors.
His death and the return of his body to Ohio were national news. Before his burial on a hillside overlooking the Ohio River, his remains lay in state at a Gallipolis mansion he and his wife had bought, renovated and furnished for their eventual return. McIntyre had written about the home but never set foot in it during the five years he owned it.
Today, a century after his arrival in New York, Odd McIntyre may be best known as the name of a cocktail—a mix of lemon juice, triple sec, brandy and Lillet. The O. O. McIntyre Park District in Gallia County, Ohio, bears his name, as does a journalism fellowship at the University Missouri. His name also concludes the official poem of the state of Oklahoma, which honors his friend Will Rogers: "Well, so long folks, it's time to retire/I got to keep a date with Odd McIntyre." But that's about it.
McIntyre's return to obscurity would probably not surprise him. "I am not writing for posterity nor do I believe anything I write will live for more than a week or so after publication," he once insisted. "I have found satisfaction in entertaining people a little every day."

Find this article at:
http://www.smithsonianmag.com/history-archaeology/Odd-McIntyre-The-Man-Who-Taught-America-About-New-York.html?c=y&story=fullstory

**El Mirador, the Lost City of the Maya**

**Now overgrown by jungle, the ancient site was once the thriving capital of the Maya civilization**



- By Chip Brown
- Photographs by Christian Ziegler
- *Smithsonian* magazine, May 2011

Had we been traveling overland, it would have taken two or three days to get from the end of the road at Carmelita to El Mirador: long hours of punishing heat and drenching rain, of mud and mosquitoes, and the possibility that the jungle novice in our party (that would be me, not the biologists turned photographers Christian Ziegler and Claudio Contreras) might step on a lethal fer-de-lance or do some witless city thing to provoke a jaguar or arouse the ire of the army ants inhabiting the last great swath of subtropical rain forest in Mesoamerica.

Mercifully, Itzamna, the supreme creator god of the ancient Maya, had favored us with a pilot named Guillermo Lozano, who was now easing his maroon-striped Bell helicopter into the air. It was a Sunday morning in northern Guatemala, late October. Next to him up front was the archaeologist Richard Hansen, the director and principal investigator of the Mirador Basin Project. About a half-hour's flying time due north was the Mirador basin itself—a 2,475-square-mile tract of jungle in northern Guatemala and Campeche, Mexico, filled with hidden ruins that Hansen and others refer to as "the cradle of Maya civilization."

We zipped away from the town of Flores at 140 knots. Off to the east were the spectacular Maya pyramids and ruins of Tikal National Park, which is now linked to Flores by road and draws between 150,000 and 350,000 visitors a year. We crossed a jungle-covered limestone ridge about 600 feet high. Hansen's voice crackled over the intercom.

"This is the southern tip of the Mirador basin," he said. "It's shaped like a heart. It's a self-contained ecosystem surrounded by these ridges. There are five kinds of tropical forest down there. Tikal has only two. "

Visible below were clearings in the forest, the smoke of fires, a scattering of cattle, buildings and the occasional road.

"All this has been deforested in the last five years or so," Hansen said over the roar of the rotor. "Any use of this particular area of forest other than ecotourism would be, to me, the equivalent of using the Grand Canyon for a garbage dump."

After a few minutes there were no more roads or cows or any other signs of human settlement, just a few swampy open patches called *civales* breaking the great green quilt formed by the canopies of the 150-foot-tall ramón (breadnut) and sapodilla trees, whose trunks are slashed by skilled laborers known as *chicleros* for the sap used to make chewing gum. Hansen pointed out some of the sites that he and his colleagues have mapped in the Mirador basin, including the large lost cities of Tintal and Nakbe, which is one of the oldest known Maya settlements, dating from around 1000 to 400 B.C.

"See that there," he said, pointing to a slightly raised and darker line of trees. "That's a causeway. There's a plastered roadbed under there 2 to 6 meters high and 20 to 40 meters wide. A *sacbe* it's called—white road. It runs for about 12 kilometers from Mirador to Nakbe. It's part of the first freeway system in the world."

Suddenly clouds closed in, and Lozano began to climb, anxiously looking for a break in the skies. A tropical storm (named Richard, appropriately enough) was bearing down on northern Guatemala.

"There!" Hansen said. Lozano banked down toward what looked from afar to be a huge stone knoll, half swallowed in vines and trees. The pilots who first flew over the Mirador basin in the 1930s, among them Charles Lindbergh, were startled to see what they thought were volcanoes rising out of the limestone lowlands. In fact, they were pyramids built more than two millennia ago, and what we were circling was the largest of them all, the crown of the La Danta complex. At 230 feet, it is not as tall as the great pyramid at Giza, but, according to Hansen, it is more massive, containing some 99 million cubic feet of rock and fill.

We were hovering now over the heart of the ancient city of El Mirador, once home to an estimated 200,000 people and the capital of a complex society of interconnected cities and settlements that may have supported upwards of a million people. The last thing you would ever guess from a casual aerial overview was that virtually every topographical contour in the primordial forest was created not by geological and environmental forces but by the vanished inhabitants of one of the world's foundational civilizations.

"All this was abandoned nearly 2,000 years ago," Hansen said. "The whole thing developed before Tikal existed. It's like finding Pompeii."

A clearing appeared below us and we fluttered down onto a grassy strip, scattering a delegation of butterflies. It's a dedicated archaeologist whose affection for a place increases even after he's gone into personal debt to keep his research and conservation work going, weathered death threats from irate loggers, had close encounters with fer-de-lances and falling trees, survived a jungle plane crash that nearly killed him, his wife and the oldest of his seven children and incinerated the only copies of his master's thesis. By the same token it's a versatile scientist who can enthrall audiences at Hollywood fund-raisers and bargain in flawless Spanish with muleteers hauling sacks of specially formulated Preclassic Maya mortar.

"To do this you have to be a jack-of-all-trades or an absolute idiot," said Hansen as we sat around that first evening on the long log-and-plank benches of the dining hall, an open-sided barnlike structure with a translucent plastic roof and special gutters that funnel rainwater into a 25,000- gallon cistern. Hansen was wearing a tan cap, a grungy off-white cotton shirt and stained off-white cotton pants—light-colored fabrics make it easier to see which exotic insects might be trying to attach themselves to flesh. (I was immediately regretting my choice of dark gray trousers.)

During the Mirador field-research season, which runs from May to September, there are as many as 350 people in the camp, including scientists from some 52 universities and institutions. The archaeological work could proceed year-round but Hansen spends the off-months raising money (with the goal of maintaining a minimum annual budget ofabout $2.5 million) and preparing publications (now up to 177). He also teaches at Idaho State University in Pocatello, where he is an assistant professor in the department of anthropology and the senior scientist at the university's Institute for Mesoamerican Research.

"If I had five minutes for every hour I've spent chasing dollars, I'd have another 50 publications," he said with a sigh.

There was only a skeletal crew of workmen on hand now, along with guards Hansen had employed to ward off looters, and the camp cook, Dominga Soberanis, a short, powerfully built Maya woman who had fixed us all a supper of fried chicken and black beans on a steel sheet over a wood fire. Fresh tomatoes had come in on the helicopter, and there were pitchers of rice milk and tea brewed from the leaves of the allspice tree that grew in the ramón forest.

That afternoon, after Christian had amused himself at my expense by crying "Snake!" while fumbling in feigned horror with what looked like a fer-de-lance but proved to be a brown stick, Hansen had shown us around the camp. Tent sites, storage magazines, screening tables, a well-equipped research building adjacent

to the dining hall and guest bungalows where we had stashed our gear were linked by a web of root-riddled trails. Hansen was billeted in a bungalow that also served as his office. By some modern shamanism, it had Internet access.

We wandered out to the old helicopter landing strip where campsites had been established for tourists. Some 2,000 to 3,000 visitors a year either make the trek in from Carmelita or fly in by helicopter from Flores. Rangers stationed in the area were feeding an orphaned baby spider monkey creamed corn; dozens of ocellated turkeys—beautiful iridescent birds found only on the Yucatán Peninsula—were pecking at the grass. *Meleagris ocellata* is among the most photogenic of the 184 bird species recorded to date in the basin, which is also a key stopover for many migratory birds that travel the flyways of the eastern United States. The turkeys scrambled for cover under the trees when a pair of brown jays cried out. Their jay-dar had spotted a raptor overhead—possibly an ornate hawk-eagle *(Spizaetus ornatus)*.

"The basin is a contained, enclosed, integrated cultural and natural system, unique in the world," Hansen said. And a veritable ark of biodiversity with some 300 species of trees (many festooned with orchids) and upwards of 200 animal species (many endangered or threatened), from tapirs and crocodiles to five of the six cats indigenous to Guatemala. In the past few years, researchers have found two bird species—the hooded oriole and the Caribbean dove—for the first time in Guatemala, and discovered nine previously unknown moth species. Efforts to preserve the basin's ancient ruins go hand in hand with conserving one of the world's living treasures.

When Hansen came to the Mirador basin as a graduate student in 1979, scientists had been studying the better-known Maya sites in Mesoamerica—such as Palenque and Copán—for more than a century. El Mirador ("the look-out" in Spanish) was still largely unexplored. While some of the basin itself had been surveyed in 1885 by Claudio Urrutia, an engineer who noted the presence of *ruinas grandes*, the existence of El Mirador wasn't officially reported until 1926. And it would be another 36 years before an archaeologist, Harvard University's Ian Graham, would map and explore a portion of the area, partially revealing the extraordinary dimensions of the city.

What was most puzzling was the age of the site. Monumental architecture on the order of what had been found at El Mirador had always been associated with the Classic period of Maya history, from A.D. 250 to about A.D. 900; architecture of the Preclassic era, from 2000 B.C. to A.D. 150, was supposedly less sophisticated (as were, presumably, its political and economic systems). For nearly 40 years the only known Preclassic structure was a nearly nine-yard-high truncated pyramid excavated in the 1920s at Uaxactun, some 12 miles north of Tikal, by a Carnegie expedition. When the late William Coe of the University of Pennsylvania began excavating at Tikal in 1956, he was puzzled by the complexity of the earlier layers. In a 1963 article for the journal *Expedition*, he noted "things were not getting simpler" or more "formative." Writing up his own research in 1967, Graham, who went on to found the Corpus of Maya Hieroglyphic Inscriptions at the Peabody Museum of Archaeology and Ethnology at Harvard, speculated that the poor condition of the ruins he examined at El Mirador might be attributed to an inferior brand of mortar rather than the sheer antiquity of the buildings. Examining pottery that Graham's colleague Joyce Marcus had collected at El Mirador in 1970, Donald Forsyth (now a professor at Brigham Young University) noted that the bulk of the ceramics were in the Chicanel style—monochrome red, black or cream, with thick bodies and the rims turned outward—that clearly dated the surrounding ruins to the Late Preclassic period (300 B.C. to A.D. 150). But could such monumental public architecture really have been built 700 to 1,000 years before the zenith of the Classic period, when, scholars supposed, the Maya had achieved the organizational, artistic and technical expertise to pull off such feats?

The dig Hansen joined was headed by his thesis adviser, Ray Matheny, from Brigham Young University, and Bruce Dahlin of Catholic University. "[Hansen] was a real go-getter," Matheny told me later. "I'm very proud of him." Twenty-six years old at the time, Hansen had grown up in Idaho in a Mormon family, the oldest of three brothers. He got a bug for archaeology at age 6 hunting arrowheads on his father's potato farm in Rupert. He planned to become a lawyer, but his undergraduate degree was delayed after he shattered his right leg in a ski accident. As all he needed for law school were good grades and test scores, he thought the fastest way to get them would be to major in Spanish, which he spoke, and archaeology, which he loved. Degrees in hand, he postponed law school for the chance to join an excavation north of Tel Aviv for two years, an experience that buried the lawyer and begot the archaeologist. It also turned up his wife, Jody, a scientific

illustrator who first impressed him with her dogged work hauling buckets of sand. When they returned from Israel, Matheny invited Hansen to assist with a newly funded project at El Mirador.

So it was that Hansen found himself in March 1979 excavating a room on Structure 34, the Jaguar Paw Temple. The temple, one of the most intensively studied of all the ruins at El Mirador, is part of the Tigre complex in the western side of the city. Hansen had been given to understand it was most likely from the Classic period, but as he cleared the chamber, he came to the original plaster floor littered with pot fragments that had not been disturbed for centuries. "When the Maya walked away, they left everything in place," he said. "We've found flakes of a stone tool right around the tool." The potsherds had the colors and the waxy telltale feel of the Chicanel style, which dated the temple to two centuries before Christ. Hansen stared at them in disbelief.

"I realized at that moment the whole evolutionary model for the economic, cultural and social history of the Maya was wrong. The idea that the Maya slowly became more sophisticated was wrong. And I thought, 'Man, I'm the only person in the world at this moment who knows this.'"

By morning Tropical Storm Richard had eased, but the sky was still overcast and Hansen was surprised to hear the helicopter arriving out of the clouds. "You made it! Welcome!" he cried as three Californians scurried clear of the rotor: Andre Lafleur, an officer for a land trust in Santa Cruz; a travel consultant named Randy Durband; and Joanna Miller, a board member of the Walt Disney Family Museum, established in San Francisco to commemorate her famous grandfather. They joined us at the dining hall for a breakfast of eggs, tortillas, beans and fried Spam. Dominga, the cook, tossed a few stale tortillas into the woods and called "Pancho! Pancho!" Duly summoned, a white-nosed coati appeared, wary and cute, striped tail high. He looked like a lanky raccoon.

Andre, Joanna and Randy had been invited by the Global Heritage Fund, a Palo Alto-based conservation group—and one of several foundations that financially support Hansen's work in the basin, including the Foundation for Cultural and Natural Maya Heritage (PACUNAM) and Hansen's own Foundation for Anthropological Research and Environmental Studies (FARES). The FARES board includes actor Mel Gibson, who has given several million dollars to the cause and who hired Hansen as a consultant for his 2006 Maya chase film *Apocalypto*.

We headed east on a dirt track in two Kawasaki all-terrain vehicles. At more than 14 square miles, greater El Mirador is three times the size of downtown Los Angeles; for many years Hansen would routinely hike 10 to 12 miles a day to check on various sites. The ATVs, donated by a family of prominent Central American brewers, were much appreciated by his now 58-year-old knees. We were bound for La Danta, the pyramid complex we had circled on the flight in.

The trail climbed over what was once possibly a 60-foot-high perimeter wall surrounding a portion of the western part of the city—it was built in the Late Preclassic, Hansen said— and followed one of the elevated causeways to La Danta just over a mile east. We parked and started our ascent.

Hansen has excavated, mapped and explored 51 ancient cities in the Mirador basin. "What you had here was the first state-level society in the Western Hemisphere, a thousand years before anyone suspected," he said. It was not just the monumental architecture of La Danta and structures at sister cities like Nakbe and Tintal that were sophisticated. The achievements of the Preclassic Maya were reflected in the way they made the leap from clans and chiefdoms to complex societies with class hierarchies and a cohesive ideology; in the technical sophistication that enabled them to quarry huge limestone blocks without metal tools and move them to building sites without the wheel; how they collected rainwater off building roofs and stored it in reservoirs and cisterns; how they projected time in their calendars and preserved the records of their civilization in their still-enigmatic histories on stelae in images and glyphs that scholars have yet to decipher (unlike glyphs from the Classic period that have been decoded); how they constructed their homes with posts, stone and stucco; decorated their teeth with jade and brownish-red hematite inlays; imported exotic items such as obsidian, basalt and granite; wrapped the craniums of their infants to modify the shape of their skulls; and adorned themselves with shells from the Caribbean and Pacific Coast—as if civilization were keyed as much to aesthetic refinement as to written language, the specialization of labor or regimens of religious and social control.

To feed their burgeoning population, they terraced fields and carried mud up from swampy marshes to grow maize, beans, squash, cocoa, gourds and other crops. "What brought them here were the swamps," Hansen said. And in his view it was the destruction of the swamps with their nutrient-rich mud that caused the

wholesale collapse of the society sometime between A.D. 100 and 200. What killed the swamps and crippled the farms, he believes, was the runoff of clay into the marshes after the massive deforestation of the surrounding area—deforestation caused by a demand for firewood the Maya needed to make lime plaster. They plastered everything, from major temples like La Danta to their plazas and house floors, which over time got thicker and thicker, an extravagance Hansen attributed to the temptations of "conspicuous consumption."

Hansen believes that El Mirador's inhabitants may have initially gone to the Caribbean coast and then migrated back inland, where they finally ended up in Mexico's Yucatán Peninsula at Calakmul, which emerged as a powerful city-state and rival to Tikal in the sixth and seventh centuries. "Mirador was known in the Preclassic as the Kan Kingdom—Kan meaning 'snake'—and the kings of Calakmul referred to themselves as the Lords of Kan, not as the Lords of Chiik Naab, which is the original name of Calakmul," Hansen said.

We came to the first tier of La Danta pyramid, a high forested platform of cut stone and rock fill that was some 980 feet wide and 2,000 feet long and covered nearly 45 acres.

"We calculate that as many as 15 million man-days of labor were expended on La Danta," Hansen said. "It took 12 men to carry each block—each one weighs about a thousand pounds....We've excavated nine quarries where the stones were cut, some 600 to 700 meters away."

Before long we mounted another platform. It was about 33 feet high also and covered about four acres. The trail led to a set of steps that climbed to a third, 86-foot-high platform that served as the base for a triad of an impressive central pyramid flanked by two smaller pyramids—a formidable sight with its vertiginous staircase bisecting the west face.

"You don't find the triadic pattern before about 300 B.C." Hansen said of the three pyramids. Based upon conversations with present-day Maya spiritual leaders, researchers believe the three-point configuration represents a celestial hearth containing the fire of creation. The Maya thought three stars in the constellation Orion (Alnitak, Saiph and Rigel) were the hearth stones surrounding the fire—a nebula called M42, which is visible just below Orion's belt.

Archaeology at El Mirador is often less about bringing the past to light than keeping it from collapsing: Hansen spent three years just stabilizing the walls of La Danta. He had experimented to find the optimal mortar mix of finely sifted clay, organic compounds, lime, crushed limestone and a form of gritty, decomposed limestone called "sascab." And the archaeologists decided against clearing the trees entirely off the temples as had been done at Tikal because they had learned it was better to leave some shade to minimize the debilitating effects of the sun. Hansen and an engineer from Boeing had designed a vented polycarbonate shed roof that filtered ultraviolet light and protected some of the most delicate stucco carvings on the Jaguar Paw Temple from rain.

We hiked around the base of the upper platform and climbed a cantilevered wooden staircase that zigzagged up the near-vertical east face of La Danta, which plunged more than 230 feet to the jungle floor.

"Wow!" said Joanna.

The summit was the size of a decent home office. There was a surveyor's bench mark embedded in the limestone, a fence to keep you from tumbling off the east precipice and a big leafy tree that from afar stood out like a tasseled toothpick pinned to a club sandwich. After concentrating so long on the ground, verifying that roots weren't snakes, it was a great pleasure to lift my eyes to infinity. It was boggling to think we were standing on the labor of thousands of people from antiquity, and to imagine their vanished metropolis, the business of the city such as it might have been on a day like this; the spiritual and ideological imperatives that lifted these stones; the rituals that might have occurred at this sacred spot—everything from coronations to ceremonies in which priests and kings would draw blood from their genitals to spill onto paper and burn as a sacrifice to the gods.

To the west loomed the forested silhouettes of the Tigre Complex, where high on the pyramid Hansen and his team have found skeletons with obsidian arrow points in their ribs, possibly casualties of an Early Classic period battle that wiped out remnant inhabitants of the abandoned capital. Also visible were the outlines of the Monos and Leon pyramids, which along with Tigre and La Danta and the administrative complex known as the Central Acropolis, made up some of the oldest and largest concentrations of public architecture in all of Maya civilization.

I asked Hansen, if he could have anything, what would it be?

"Fifteen minutes," he answered immediately. "Fifteen minutes here when the city was in its glory. Just to walk around and see what it was like. I'd give anything for that."

In Maya cosmology the underworld is ruled by the Lords of Xibalba (shee-bal-BA). In April 1983, his fifth season at El Mirador, Hansen nearly met them. He boarded Professor Matheny's single-engine Helio Courier H395 with his wife, Jody, and their daughter Micalena; he was carrying the only two copies of his master's thesis, which he'd been working on at the camp, and cash for the camp workers' payroll.

When the plane cleared the trees it was suddenly running with the wind, not into it as a windsock had indicated, and struggling for lift. About two miles from the airstrip, the tail hit a tree, the nose pitched down, the wings sheared off, the propeller chewed through the canopy until it snapped and the plane cartwheeled across the floor of the jungle. The H395 crashed to a stop in a tree five feet off the ground, fuel leaking everywhere. Hansen sat in his seat thinking he was dead."Get out! Get out!" Jody yelled. As they scrambled clear, they heard a tremendous whoosh and were hurled to the ground as a fireball exploded behind them, cresting high above the trees. Everyone on board had survived.

"People say, 'Is your life like Indiana Jones?'" Hansen recalled as he showed us around the crash site. "I say my life isn't as boring. He always jumps out of the airplane before it crashes."

Hansen took us to see what is probably the most beautiful and significant artwork found so far at El Mirador: the Central Acropolis frieze. In 2009, an Idaho State student archaeologist named J. Craig Argyle unearthed two 26-foot carved stucco panels showing the hero twins of Maya cosmology, Hunahpu and his brother Xbalanque. They are the main protagonists in the Popol Vuh, a sacred book of myths, history, traditions and the Maya story of how the world was created. The Popol Vuh recounts the adventures of the supernaturally gifted twins, who resurrected their father Hun-Hunahpu (who had lost his head in a ball game against the evil lords of the underworld). The stucco frieze depicts Hunahpu in a jaguar headdress swimming with the head of his father.

"To find this story in the Preclassic period is beyond belief," Hansen said, pulling back a blue tarp that covered the frieze. "For many years it was thought that the Popol Vuh creation story had been contaminated by the Spanish priests who translated it—that the Indians had been influenced by Christianity. This frieze shows that the Maya account of creation was vibrantly established for thousands of years before the Spanish got here. It's like finding the original copy of the Constitution. I was stunned."

El Mirador today is part of the Mirador-Río Azul National Park, which itself is part of the Maya Biosphere Reserve, an 8,100-square-mile tract of rain forest in northern Guatemala. The reserve, established in 1990, has lost nearly half of its forests in just the past ten years. The protection afforded by the national park, which was set up at the same time, is marginal at best—it covers only a narrow swath of the northern basin along the Mexico border and includes only 3 or 4 of the 51 ancient Maya cities currently mapped. "The boundaries don't respect the hydrological, geological, geographic, botanical or cultural borders of the basin," Hansen said. "The park only saves a small area. We're trying to save the whole system."

Hansen and conservationists from Guatemala and around the world are hoping the government will declare the whole basin a roadless wilderness. Hansen hopes its ancient cities will attract ecotourism and provide livelihoods for local Guatemalans, who might otherwise turn to looting, poaching or the unsustainable promise of logging; despite short-term economic benefits, the industry undermines the long-term integrity of the ecosystem, as it leads to roads, cattle pastures and the destruction of habitat.

"We're trying to give the poor *campesinos* [peasants] more than they have now," Hansen said. "Every country needs wood and wood products. But the issue here is the potential for far greater economic benefits than can be generated [by logging]. There is a model that will work, and is far more lucrative economically, and has far better conservation results than anything in place now. It will need to be done right. If the area is declared a roadless wilderness, then tourists will be obligated to travel to the local communities rather than fly or drive directly to the sites. They will buy local artisan products, sandwiches, soft drinks and beers, and sleep in local microhotels, and hire local guides, cooks, mules, and rent local mountain bikes. The economic pie would get spread among the communities."

He supports those uses of the El Mirador forest that are sustainable, such as the harvesting of renewable plant products: allspice; xate, the Chamaedorea palm leaves used in floral arrangements; bayal, for wicker baskets; and chicle, for chewing gum.

And, of course, he supports archaeology, which has already pumped millions of dollars into the local communities of the Petén, as the region is called. Some of the guards Hansen has hired are former looters.

Most of the workers hired to help excavate the ancient cities participate in literacy classes run by the Mirador Basin Project, which has also provided local schools with computers and computer training, helped install water-purification filters in villages and trained local residents to be guides. The future of the basin ultimately depends on the local people and communities.

My last evening in El Mirador I stopped in the forest not far from the Jaguar Paw Temple, where Hansen had his potsherd epiphany. It was unsettling to think how thoroughly the Preclassic capital of the Maya and hundreds of thousands of people had been silenced by time and rampant nature. The sun was hurrying away, darkness rising. Ocellated turkeys were ascending to the trees for the night, their wings laboring against the plush air. Red-eyed tree frogs were beginning to sing. Curassow birds fussed in the canopies. You could hear the cool interjections of a spectacled owl; cicadas droning; the croak of toucans; lineated woodpeckers running their jackhammers; the grunts of spider monkeys and the fantastic aspirated roar of howler monkeys, which seemed to cross the basso profundo of an African lion with the sound of metal grinding on a lathe. It always amazes me how unsentimental nature is, resoundingly here now, unbound by the past apart from what is secretly conserved in genes. It's left to us to listen for voices that can't be heard, to imagine the dead in that note between the notes, as in those moments when the jungle cacophony dies away and the almost-audible strains of the underworld echo in the stillness and silence of the night, until the clamor of the living starts up again.

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Find this article at:
http://www.smithsonianmag.com/history-archaeology/El-Mirador-the-Lost-City-of-the-Maya.html

**The Great Japan Earthquake of 1923**
**The powerful quake and ensuing tsunami that struck Yokohama and Tokyo traumatized a nation and unleashed historic consequences**

- By Joshua Hammer
- *Smithsonian* magazine, May 2011

The first shock hit at 11:58 a.m., emanating from a seismic fault six miles beneath the floor of Sagami Bay, 30 miles south of Tokyo. A 60- by 60-mile segment of the Philippine oceanic plate ruptured and thrust itself against the Eurasian continental plate, releasing a massive burst of tectonic energy. Down at the docks of Yokohama, Japan's biggest port and its gateway to the West, hundreds of well-wishers were seeing off the *Empress of Australia*, a 615-foot luxury steamship bound for Vancouver. "The smiles vanished," remembered Ellis M. Zacharias, then a young U.S. naval officer, who was standing on the pier when the earthquake hit, "and for an appreciable instant everyone stood transfixed" by "the sound of unearthly thunder." Moments later, a tremendous jolt knocked Zacharias off his feet, and the pier collapsed, spilling cars and people into the water.

The date was September 1, 1923, and the event was the Great Kanto Earthquake, at the time considered the worst natural disaster ever to strike quake-prone Japan. The initial jolt was followed a few minutes later by a 40-foot-high tsunami. A series of towering waves swept away thousands of people. Then came fires, roaring through the wooden houses of Yokohama and Tokyo, the capital, burning everything—and everyone—in their path. The death toll would be about 140,000, including 44,000 who had sought refuge near Tokyo's Sumida River in the first few hours, only to be immolated by a freak pillar of fire known as a "dragon twist." The temblor destroyed two of Japan's largest cities and traumatized the nation; it also whipped up nationalist and racist passions. And the quake may have emboldened right-wing forces at the very moment that the country was poised between military expansion and an embrace of Western democracy, only 18 years before Japan would enter World War II.

The 9.0 earthquake that struck the northeast coast of Honshu this past March is not likely to have such an impact on Japan's history. Nevertheless, there are parallels. Like the 1923 quake, this one unleashed

secondary disasters: a tsunami that washed away dozens of villages; mudslides; fires; and damage to the Fukushima Daiichi reactors that emitted radiation into the atmosphere (and constituted the worst nuclear accident since the Chernobyl disaster in 1986). In both instances, the toll was considerable, with estimated deaths in the 2011 quake approaching 30,000 and damage that could go as high as $310 billion. Fuel, food and water were hard to come by weeks after the earthquake, and the Japanese government acknowledged that it had been ill-prepared for a calamity on this scale. Traditional figures offered words of solace: Crown Prince Hirohito 88 years ago; his son, Emperor Akihito, in 2011.

Before the Great Kanto Earthquake struck, Japan was full of optimism. No center symbolized the country's dynamism more than Yokohama, known as the City of Silk. Founded as Japan's first "Foreign Settlement" in 1859, five years after U.S. Commodore Matthew Perry forced the shogun to open Japan to the West, Yokohama had grown into a cosmopolitan city of half a million. Attracting entrepreneurs, fugitives, traders, spies and drifters from every corner of the world, the port rose "like a mirage in the desert," wrote one Japanese novelist. From the waterfront promenade, known as the Bund, to the Bluff, the hillside neighborhood favored by foreign residents, Yokohama was where East met West, and liberal ideas—including democracy, collective bargaining and women's rights—transfixed those who engaged them. Nobel laureate Junicho Tanizaki, who spent two years in Yokohama writing screenplays, marveled at "a riot of loud Western colors and smells—the odor of cigars, the aroma of chocolate, the fragrance of flowers, the scent of perfume."

The Great Kanto Earthquake obliterated all of that in a single afternoon. According to survivors, the initial quaking lasted for about 14 seconds—long enough to bring down nearly every building on Yokohama's watery, unstable ground. The three-story Grand Hotel, an elegant Victorian villa on the seafront that had played host to Rudyard Kipling, W. Somerset Maugham and William Howard Taft, collapsed, crushing hundreds of guests and employees. Twenty expatriate regulars at the Yokohama United Club, the city's most popular watering hole, died when the concrete building pancaked. Otis Manchester Poole, a 43-year-old American manager of a trading firm, stepped out of his largely still-intact office near the Bund to face an indelible scene. "Over everything had settled a thick white dust," he remembered years later, "and through the yellow fog of dust, still in the air, a copper-coloured sun shone upon this silent havoc in sickly reality." Fanned by high winds, fires from overturned cookstoves and ruptured gas mains spread. Soon, the entire city was ablaze.

Meanwhile, a wall of water surged from the fault zone toward the coast of Honshu. Three hundred people died in Kamakura, the ancient capital, when a 20-foot-high wave washed over the town. "The tidal wave swept out a great section of the village near the beach," wrote Henry W. Kinney, a Tokyo-based editor for *Trans-Pacific* magazine. "I saw a thirty-foot sampan [boat] that had been lifted neatly on top of the roof of a prostrated house. Vast portions of the hills facing the ocean had slid into the sea."

Although the shock waves had weakened by the time they reached through the Kanto region to Tokyo, 17 miles north of Yokohama, many poorer neighborhoods built on unstable ground east of the Sumida River collapsed in seconds. Then, as in Yokohama, fires spread, fueled by flimsy wooden houses and fanned by high winds. The quake destroyed the city's water mains, paralyzing the fire department. According to one police report, fires had broken out in 83 locations by 12:15. Fifteen minutes later, they had spread to 136. People fled toward the Sumida River, drowning by the hundreds when bridges collapsed. Tens of thousands of working-class Japanese found refuge in an empty patch of ground near the river. The flames closed in from all directions, and then, at 4 p.m., a 300-foot-tall "fire tornado" blazed across the area. Of the 44,000 people who had gathered there, only 300 survived. All told, 45 percent of Tokyo burned before the last embers of the inferno died out on September 3.

As the evening of the quake approached, Kinney observed, "Yokohama, the city of almost half a million souls, had become a vast plain of fire, of red, devouring sheets of flame which played and flickered. Here and there a remnant of a building, a few shattered walls, stood up like rocks above the expanse of flame, unrecognizable....It was as if the very earth were now burning. It presented exactly the aspect of a gigantic Christmas pudding over which the spirits were blazing, devouring nothing. For the city was gone."

The tragedy prompted countless acts of heroism. Thomas Ryan, a 22-year-old U.S. naval ensign, freed a woman trapped inside the Grand Hotel in Yokohama, then carried the victim—who had suffered two broken legs—to safety, seconds ahead of a fire that engulfed the ruins. Capt. Samuel Robinson, the Canadian skipper of the *Empress of Australia*, took hundreds of refugees aboard, organized a fire brigade that kept the ship

from being incinerated by advancing flames, then steered the crippled vessel to safety in the outer harbor. Then there was Taki Yonemura, chief engineer of the government wireless station in Iwaki, a small town 152 miles northeast of Tokyo. Hours after the earthquake, Yonemura picked up a faint signal from a naval station near Yokohama, relaying word of the catastrophe. Yonemura tapped out a 19-word bulletin—CONFLAGRATION SUBSEQUENT TO SEVERE EARTHQUAKE AT YOKOHAMA AT NOON TODAY. WHOLE CITY ABLAZE WITH NUMEROUS CASUALTIES. ALL TRAFFIC STOPPED—and dispatched it to an RCA receiving station in Hawaii. For the next three days, Yonemura sent a stream of reports that alerted the world to the unfolding tragedy. The radio man "flashed the news across the sea at the speed of sunlight," reported the *New York Times*, "to tell of tremendous casualties, buildings leveled by fire, towns swept by tidal waves...disorder by rioters, raging fire and wrecked bridges."

Yonemura's bulletins helped to galvanize an international relief effort, led by the United States, that saved thousands from near-certain death or prolonged misery. U.S. naval vessels set sail from China on the evening of September 2, and within a week, dozens of warships packed with relief supplies—rice, canned roast beef, reed mats, gasoline—filled Yokohama Harbor. From Washington, President Calvin Coolidge took the lead in rallying the United States. "An overwhelming disaster has overtaken the people of the friendly nation of Japan," he declared on September 3. "The cities of Tokyo and Yokohama, and surrounding towns and villages, have been largely if not completely destroyed by earthquake, fire and flood, with a resultant appalling loss of life and destitution and distress, requiring measures of urgent relief." The American Red Cross, of which Coolidge was the titular head, initiated a national relief drive, raising $12 million for victims. The wave of good feeling between the two countries would soon dissipate, however, in mutual accusations. Japanese expressed resentment toward Western rescuers; demagogues in the United States charged that the Japanese had been "ungrateful" for the outpouring of help they received.

The earthquake also exposed the darker side of humanity. Within hours of the catastrophe, rumors spread that Korean immigrants were poisoning wells and using the breakdown of authority to plot the overthrow of the Japanese government. (Japan had occupied Korea in 1905, annexed it five years later and ruled the territory with an iron grip.) Roving bands of Japanese prowled the ruins of Yokohama and Tokyo, setting up makeshift roadblocks and massacring Koreans across the earthquake zone. According to some estimates, the death toll was as high as 6,000.

My own view is that by reducing the expatriate European community in Yokohama and putting an end to a period of optimism symbolized by that city, the Kanto earthquake accelerated Japan's drift toward militarism and war. Japan scholar Kenneth Pyle of the University of Washington says that conservative elites were already nervous about democratic forces emerging in society, and "the 1923 earthquake does sort of begin to reverse some of the liberal tendencies that appear right after World War I....After the earthquake, there's a measurable increase in right-wing patriotic groups in Japan that are really the groundwork of what is called Japanese fascism." Peter Duus, an emeritus professor of history at Stanford, states that it was not the earthquake that kindled right-wing activities, "but rather the growth of the metropolis and the emergence of what the right wing regarded as heartless, hedonistic, individualistic and materialist urban culture." The more significant long-term effect of the earthquake, he says, "was that it set in motion the first systematic attempt at reshaping Tokyo as a modern city. It moved Tokyo into the ranks of world metropolises."

University of Melbourne historian J. Charles Schencking sees the rebuilding of Tokyo as a metaphor for something larger. The earthquake, he has written, "fostered a culture of catastrophe defined by political and ideological opportunism, contestation and resilience, as well as a culture of reconstruction in which elites sought to not only rebuild Tokyo, but also reconstruct the Japanese nation and its people."

Though they may dispute its effects, historians agree that the destruction of two great population centers gave voice to those in Japan who believed that the embrace of Western decadence had invited divine retribution. Or, as philosopher and social critic Fukasaku Yasubumi declared at the time: "God cracked down a great hammer" on the Japanese nation.

Regular contributor **Joshua Hammer** is the author of *Yokohama Burning*, about the Great Kanto Earthquake of 1923.

Find this article at:
http://www.smithsonianmag.com/history-archaeology/The-Great-Japan-Earthquake-of-1923.html

**The Women Who Fought in the Civil War**

**Hundreds of women concealed their identities so they could battle alongside their Union and Confederate counterparts**

- By Jess Righthand
- Smithsonian.com, April 08, 2011

Even though women weren't legally allowed to fight in the Civil War, it is estimated that somewhere around 400 women disguised themselves as men and went to war, sometimes without anyone ever discovering their true identities.

Bonnie Tsui is the author of *She Went to the Field: Women Soldiers in the Civil War*, which tells the stories of some of these women. I spoke with the San Francisco-based writer about her research into the seldom-acknowledged participation of women in the Civil War.

**Why weren't women allowed to fight in the Civil War?**

At the time, women weren't perceived as equals by any stretch of the imagination. It was the Victorian era and women were mostly confined to the domestic sphere. Both the Union and Confederate armies actually forbade the enlistment of women. I think it was during the Revolutionary War that they established women as nurses because they needed help on the front when soldiers were injured. But women weren't allowed to serve in combat. Of course, women did disguise themselves and enlist as men. There is evidence that they also did so during the Revolutionary War.

**How did they do it?**

Honestly, the lore is that the physical exams were not rigorous at all. If you had enough teeth in your head and could hold a musket, you were fine. The funny thing is, in this scenario, a lot of women didn't seem any less manly than, for example, the teenage boys who were enlisting. At the time, I believe the Union had an official cutoff age of 18 for soldiers, but that was often flouted and people often lied. They had a lot of young guys and their voices hadn't changed and their faces were smooth. The Confederacy never actually established an age requirement. So [women] bound their breasts if they had to, and just kind of layered on clothes, wore loose clothing, cut their hair short and rubbed dirt on their faces. They also kind of kept to themselves. The evidence that survived often describes them as aloof. Keeping to themselves certainly helped maintain the secret.

**When the women were found out, did it provoke an uproar?**

Even in the cases where these women were found out as soldiers, there does not actually seem to be much uproar. More or less, they were just sent home. The situations in which they were found out were often medical conditions; they were injured, or they got sick from dysentery or chronic diarrhea. Disease killed many more soldiers than bullets did. You're sitting in camps among all these people who are in close quarters.

There wasn't a lot of knowledge then about bacterial infection and particularly in close quarters there wasn't much chance to prevent it.

There is some documentation that shows that some soldiers that were discovered as women were briefly imprisoned. In the letter of one [female disguised as a male] prison guard, it said that there were three [other] women in the prison, one of whom was a major in the Union Army. She had gone to battle with her fellow men and was jailed because she was a woman. It's really interesting hearing about her being a woman, disguised as a man, standing as a prison guard for a woman imprisoned for doing the same thing.

**What was the motivation on the part of the women you studied? Did it seem pretty much the same as the men?**

It absolutely did. I think by all accounts, the women seemed honestly to want to fight in the war for the same reasons as men, so that would range from patriotism, to supporting their respective causes, for adventure, to be able to leave home, and to earn money. Some of the personal writings that survive show that they were also running away from family lives that were really unsatisfying. You can imagine that perhaps they felt trapped at home or weren't able to marry and felt that they were financial burdens to their families. If you profile the substantiated cases of these women, they were young and often poor and from farming families, and that is the exact profile of the typical male volunteer. If you think about that, girls growing up on a farm would have been accustomed to physical labor. Maybe they even would have worn boys' clothing to do farm chores. But then there are also some cases in which women follow their husbands or a brother into battle, and so there are at least a couple of those cases in which female soldiers were on record of enlisting with their relative.

**What duties did the women perform?**

They did everything that men did. They worked as scouts, spies, prison guards, cooks, nurses and they fought in combat. One of the best-documented female soldiers is Sarah Edmonds—her alias was Frank Thompson. She was a Union soldier, and she worked for a long time during the war as a nurse. You often can't really draw a delineation between "civilian workers" and battle, because these people had to be in battle, tending to soldiers. They were often on the field or nearby trying to get to the wounded, so you could argue that it was just as dangerous for them to work as nurses as to be actively shooting and emptying gunfire.

**What is another one of your favorite stories from your research?**

One of my favorite stories of the Civil War era is of Jennie Hodgers, and she fought as Albert Cashier. She enlisted in Illinois and she fought the entire Civil War without being discovered and ended up living out the rest of her life as a man for another fifty years. She even ended up receiving a military pension and living at the sailors' and soldiers' home in Illinois as a veteran. The staff at the home kept her secret for quite sometime, even after they discovered that she was a woman.

Even though it seems pretty outstanding that women were disguising themselves as men and going off to fight, it seems like actually they were accepted amongst their peers. This kind of loyalty to your fellow soldier in battle did in certain cases transcend gender. It's pretty amazing; there was a lot of respect.

Find this article at:
http://www.smithsonianmag.com/history-archaeology/The-Women-Who-Fought-in-the-Civil-War.html

**What is Beneath the Temple Mount?**

**As Israeli archaeologists recover artifacts from the religious site, ancient history inflames modern-day political tensions**

- By Joshua Hammer
- Photographs by Kate Brooks
- *Smithsonian* magazine, April 2011

My stint as an amateur archaeologist began one morning on the southern slope of Mount Scopus, a hill on the northern outskirts of Jerusalem. Inside a large hothouse covered in plastic sheets and marked "Temple Mount Salvage Operation," a woman from Boston named Frankie Snyder—a volunteer turned staffer—led me to three rows of black plastic buckets, each half-filled with stones and pebbles, then pointed out a dozen wood-framed screens mounted on plastic stands. My job, she said, was to dump each bucket onto a screen, rinse off any soil with water from a garden hose, then pluck out anything of potential importance.

It wasn't as easy as it sounded. A chunk of what looked like conglomerate rock turned out to be plaster used to line cisterns during the time of Herod the Great, some 2,000 years ago. When I tossed aside a shard of green glass I thought was from a soft-drink bottle, Snyder snatched it up. "Notice the bubbles," she told me, holding it up to the light. "That indicates it's ancient glass, because during that time, oven temperatures didn't reach as high as they do now."

Gradually, I got the hang of it. I spotted the handle of an ancient piece of pottery, complete with an indentation for thumb support. I retrieved a rough-edged coin minted more than 1,500 years ago and bearing the profile of a Byzantine emperor. I also found a shard of glass from what could only have been a Heineken bottle—a reminder that the Temple Mount has also been the scene of less historic activities.

The odds and ends I was gathering are the fruits of one of Israel's most intriguing archaeological undertakings: a grain-by-grain analysis of debris trucked out of the Temple Mount, the magnificent edifice that has served the faithful as a symbol of God's glory for 3,000 years and remains the crossroads of the three great monotheistic religions.

Jewish tradition holds that it is the site where God gathered the dust to create Adam and where Abraham nearly sacrificed his son Isaac to prove his faith. King Solomon, according to the Bible, built the First Temple of the Jews on this mountaintop circa 1000 B.C., only to have it torn down 400 years later by troops commanded by the Babylonian king Nebuchadnezzar, who sent many Jews into exile. In the first century B.C., Herod expanded and refurbished a Second Temple built by Jews who had returned after their

banishment. It is here that, according to the Gospel of John, Jesus Christ lashed out against the money changers (and was later crucified a few hundred yards away). The Roman general Titus exacted revenge against Jewish rebels, sacking and burning the Temple in A.D. 70.

Among Muslims, the Temple Mount is called Haram al-Sharif (the Noble Sanctuary). They believe it was here that the Prophet Muhammad ascended to the "Divine Presence" on the back of a winged horse—the Miraculous Night Journey, commemorated by one of Islam's architectural triumphs, the Dome of the Rock shrine. A territorial prize occupied or conquered by a long succession of peoples—including Jebusites, Israelites, Babylonians, Greeks, Persians, Romans, Byzantines, early Muslims, Crusaders, Mamluks, Ottomans and the British—the Temple Mount has seen more momentous historical events than perhaps any other 35 acres in the world. Nonetheless, archaeologists have had little opportunity to search for physical evidence to sort legend from reality. For one thing, the site remains a place of active worship. The authority that controls the compound, an Islamic council called the Waqf, has long forbidden archaeological excavations, which it views as desecration. Except for some clandestine surveys of caves, cisterns and tunnels undertaken by European adventurers in the late 19th century—and some minor archaeological work conducted by the British from 1938 to 1942, when the Al-Aqsa Mosque was undergoing renovation—the layers of history beneath the Temple Mount have remained tantalizingly out of reach.

Thus the significance of those plastic buckets of debris I saw on Mount Scopus.

Today the Temple Mount, a walled compound within the Old City of Jerusalem, is the site of two magnificent structures: the Dome of the Rock to the north and the Al-Aqsa Mosque to the south. In the southwest stands the Western Wall—a remnant of the Second Temple and the holiest site in Judaism. Some 300 feet from the Al-Aqsa Mosque, in the southeast corner of the compound, a wide plaza leads to underground vaulted archways that have been known for centuries as Solomon's Stables—probably because the Templars, an order of knights, are said to have kept their horses there when the Crusaders occupied Jerusalem. In 1996, the Waqf converted the area into a prayer hall, adding floor tiles and electric lighting. The Muslim authorities claimed the new site—named the El-Marwani Mosque—was needed to accommodate additional worshipers during Ramadan and on rain days that prevented the faithful from gathering in the open courtyard of the Al-Aqsa Mosque.

Three years later, the Waqf, with the approval of the Israeli government, announced plans to create an emergency exit for the El-Marwani Mosque. But Israeli officials later accused the Waqf of exceeding its self-stated mandate. Instead of a small emergency exit, the Waqf excavated two arches, creating a massive vaulted entranceway. In doing so, bulldozers dug a pit more than 131 feet long and nearly 40 feet deep. Trucks carted away hundreds of tons of soil and debris.

Israeli archaeologists and scholars raised an outcry. Some said the Waqf was deliberately trying to obliterate evidence of Jewish history. Others laid the act to negligence on a monstrous scale.

"That earth was saturated with the history of Jerusalem," says Eyal Meiron, a historian at the Ben-Zvi Institute for the Study of Eretz Israel. "A toothbrush would be too large for brushing that soil, and they did it with bulldozers."

Yusuf Natsheh, the Waqf's chief archaeologist, was not present during the operation. But he told the *Jerusalem Post* that archaeological colleagues had examined the excavated material and had found nothing of significance. The Israelis, he told me, were "exaggerating" the value of the found artifacts. And he bristled at the suggestion the Waqf sought to destroy Jewish history. "Every stone is a Muslim development," he says. "If anything was destroyed, it was Muslim heritage."

Zachi Zweig was a third-year archaeology student at Bar- Ilan University, near Tel Aviv, when he heard news reports about dump trucks transporting Temple Mount soil to the Kidron Valley. With the help of a fellow student he rounded up 15 volunteers to visit the dump site, where they began surveying and collecting samples. A week later, Zweig presented his findings—including pottery fragments and ceramic tiles—to archaeologists attending a conference at the university. Zweig's presentation angered officials at the Israel Antiquities Authority (IAA). "This is nothing but a show disguised as research," Jon Seligman, the IAA's Jerusalem Region Archaeologist, told the *Jerusalem Post*. "It was a criminal deed to take these items without approval or permission." Soon afterward, Israeli police questioned Zweig and released him. By that point though, Zweig says, his cause had attracted the attention of the media and of his favorite lecturer at Bar-Ilan—the archaeologist Gaby Barkay.

Zweig urged Barkay to do something about the artifacts. In 2004, Barkay got permission to search the soil dumped in the Kidron Valley. He and Zweig hired trucks to cart it from there to Emek Tzurim National Park at the foot of Mount Scopus, collected donations to support the project and recruited people to undertake the sifting. The Temple Mount Sifting Project, as it is sometimes called, marks the first time archaeologists have systematically studied material removed from beneath the sacred compound.

Barkay, ten full-time staffers and a corps of part-time volunteers have uncovered a wealth of artifacts, ranging from three scarabs (either Egyptian or inspired by Egyptian design), from the second millennium B.C., to the uniform badge of a member of the Australian Medical Corps, who was billeted with the army of British Gen. Edmund Allenby after defeating the Ottoman Empire in Jerusalem during World War I. A bronze coin dating to the Great Revolt against the Romans (A.D. 66-70) bears the Hebrew phrase, "Freedom of Zion." A silver coin minted during the era when the Crusaders ruled Jerusalem is stamped with the image of the Church of the Holy Sepulchre.

Barkay says some discoveries provide tangible evidence of biblical accounts. Fragments of terra-cotta figurines, from between the eighth and sixth centuries B.C., may support the passage in which King Josiah, who ruled during the seventh century, initiated reforms that included a campaign against idolatry. Other finds challenge long-held beliefs. For example, it is widely accepted that early Christians used the Mount as a garbage dump on the ruins of the Jewish temples. But the abundance of coins, ornamental crucifixes and fragments of columns found from Jerusalem's Byzantine era (A.D. 380–638) suggest that some public buildings were constructed there. Barkay and his colleagues have published their main findings in two academic journals in Hebrew, and they plan to eventually publish a book-length account in English.

But Natsheh, the Waqf's chief archaeologist, dismisses Barkay's finds because they were not found *in situ* in their original archaeological layers in the ground. "It is worth nothing," he says of the sifting project, adding that Barkay has leapt to unwarranted conclusions in order to strengthen the Israeli argument that Jewish ties to the Temple Mount are older and stronger than those of the Palestinians. "This is all to serve his politics and his agenda," Natsheh says.

To be sure, the Mount is a flash point in the Middle East conflict. Israel seized East Jerusalem and the Old City from Jordan in 1967. While Israelis saw this as the reunification of their ancient capital, Palestinians still deem East Jerusalem to be occupied Arab land (a position also held by the United Nations).The Temple Mount is precariously balanced between these opposing views. Although Israel claims political sovereignty over the compound, custodianship remains with the Waqf. As such, Israelis and Palestinians cautiously eye each other for any tilt in the status quo. A September 2000 visit to the Temple Mount by the Israeli politician Ariel Sharon was interpreted by Palestinians as a provocative assertion of Israel's sovereignty, and helped spark the second intifada uprising, which, by some estimates, claimed as many as 6,600 lives, as rioting, armed clashes and terrorist bombings erupted throughout the Palestinian territories and Israel. At its core, the Israeli-Palestinian conflict represents rival claims to the same territory—and both sides rely on history to make the case for whose roots in the land run deepest.

For the Israelis, that history begins 3,000 years ago, when the Temple Mount—believed by many biblical scholars to be the mountain in the region of Moriah mentioned in the Book of Genesis—was an irregularly shaped mound rising some 2,440 feet among the stark Judean Hills. The summit loomed above a small settlement called Jebus, which clung to a ridge surrounded by ravines. The Old Testament describes how an army led by David, the second king of ancient Israel, breached the walls of Jebus around 1000 B.C. David then built a palace nearby and created his capital, Jerusalem. At the site of a threshing floor atop the mountain, where farmers had separated grains from chaff, David constructed a sacrificial altar. According to the Second Book of Kings and the First Book of Chronicles, David's son, Solomon, built the First Temple (later known as the Beit Hamikdash) on that site.

"The Temple Mount was the Parthenon of the Jews," says Barkay, describing how worshipers would have climbed a steep set of stairs to get to it. "You would feel every step of the climb in your limbs and your lungs."

Still, "we know nothing about the First Temple, because there are no traces of its physical remains," says Benjamin Kedar, a history professor at Hebrew University and chairman of the board of directors at the IAA. Scholars, however, have pieced together a tentative portrait of the Beit Hamikdash from descriptions in the Bible and architectural remains of sanctuaries elsewhere in the region built during the same era. It is envisioned as a complex of richly painted and gilded courts, constructed with cedar, fir and sandalwood. The

rooms would have been built around an inner sanctum—the Holy of Holies—where the ark of the covenant, an acacia-wood chest covered with gold and containing the original Ten Commandments, was said to have been stored.

Until recently, Palestinians generally acknowledged that the Beit Hamikdash existed. A 1929 publication, *A Brief Guide to the Haram al-Sharif*, written by Waqf historian Aref al Aref, declares that the Mount's "identity with the site of Solomon's temple is beyond dispute. This too is the spot, according to universal belief, on which David built there an altar unto the Lord, and offered burnt and peace offerings." But in recent decades, amid the intensifying quarrel over the sovereignty of East Jerusalem, a growing number of Palestinian officials and academics have voiced doubts. "I will not allow it to be written of me that I have...confirmed the existence of the so-called Temple beneath the Mount," Palestinian leader Yasir Arafat told President Bill Clinton at the Camp David peace talks in 2000. Arafat suggested the site of the Temple Mount might have been in the West Bank town of Nablus, known as Shechem in ancient times.

Five years after the Camp David talks, Barkay's sifting project turned up a lump of black clay with a seal impression inscribed with the name, in ancient Hebrew, "[Gea]lyahu [son of] Immer." In the Book of Jeremiah, a son of Immer—Pashur—is identified as chief administrator of the First Temple. Barkay suggests that the seal's owner could have been Pashur's brother. If so, it's a "significant find," he says—the first Hebrew inscription from the First Temple period to be found on the Mount itself.

But Natsheh—sipping Arabic coffee in his office at Waqf headquarters, a 700-year-old former Sufi monastery in the Muslim Quarter of the Old City—is dubious. He says he's also frustrated by Israeli dismissal of Palestinian claims to the sacred compound where, he says, the Muslim presence—excepting the Crusader period (A.D. 1099-1187)—"extends for 1,400 years." Natsheh won't say if he believes in the existence of the First Temple, given the current political climate. "Whether I say 'yes' or 'no,' it would be misused," he tells me, fidgeting. "I would not like to answer."

According to contemporary accounts, the Babylonian Army destroyed the First Temple in 586 B.C. The ark of the covenant disappeared, possibly hidden from the conquerors. Following the conquest of Jerusalem by the Persians in 539 B.C., the Jews returned from exile and, according to the Book of Ezra, constructed a Second Temple on the site.

In the first century B.C., King Herod undertook a massive reshaping of the Temple Mount. He filled up the slopes surrounding the mount's summit and expanded it to its present size. He enclosed the holy site within a 100-foot-high retaining wall constructed of limestone blocks quarried from the Jerusalem Hills and constructed a far more expansive version of the Second Temple. "Herod's attitude was, 'Anything you can do, I can do better and larger,'" says Barkay. "It was part of his megalomania. He wanted also to compete with God."

Barkay says he and his co-workers have turned up physical evidence that hints at the grandeur of the Second Temple, including pieces of what appear to be opus sectile floor tiles—elements of a technique in Herod's time that used stone of various colors and shapes to create geometric patterns. (Describing the temple, the ancient historian Josephus wrote of an open-air courtyard "laid with stones of all sorts.") Other discoveries might offer glimpses of daily religious rituals—notably ivory and bone combs that could have been used in preparation for a ritual mikvah, or purifying bath, before entering the courts' sanctified interior.

On a cloudless morning, I join historian Meiron for a tour of the Temple Mount. We enter the Old City through the Dung Gate and then arrive at the Western Wall plaza. When the Romans destroyed Herod's temple in A.D. 70, they knocked the retaining wall down piece by piece. But the stones from the top tumbled down and formed a protective barrier that preserved the wall's lower portions. Today, hundreds of Orthodox Jews are gathered in devotion before the remnant of that wall—a ritual that perhaps first occurred in the fourth century A.D. and has been practiced continually since the early 16th century, after the Ottoman conquest of Jerusalem.

During the Ottoman Empire and the British Mandate, this area was a warren of Arab houses, and Jews who wanted to pray here had to squeeze into a 12-foot-wide corridor in front of the Herodian stones. "My father came here as a child and he told me, 'We used to go through alleys; we entered a door; and there was the wall on top of us,' " Meiron tells me. After Israel claimed sovereignty over East Jerusalem in 1967, it demolished the Arab houses, creating the plaza.

Meiron and I climb a "temporary" wooden walkway that leads above the Western Wall to the Mughrabi Gate, the only entry point to the Temple Mount for non-Muslims—and a symbol of how any attempt to change the

site's geography can upset the delicate status quo. Israel erected the wooden structure after an earthen ramp collapsed in 2004, following an earthquake and heavy snowfall. In 2007, the IAA approved the construction of a permanent bridge that would stretch from the Old City's Dung Gate to the Mughrabi Gate.

But members of both the Jewish and Muslim communities opposed the plan. Some Israeli archaeologists raised an outcry over the bridge's proposed path through the Jerusalem Archaeological Park—the site of excavations conducted in the Old City—saying the construction could damage artifacts. The late Ehud Netzer, the archaeologist who discovered King Herod's tomb in 2007, argued that moving the entrance ramp could effectively cut off the Western Wall's connection to the Temple Mount, thereby undermining Israel's claims to sovereignty over the sacred compound. And the Israeli activist group Peace Now warned the project might alarm Muslims since the new route and size of the bridge (three times the original ramp) would increase non-Muslim traffic to the Mount.

Indeed, when Israel began a legally required archaeological survey of the planned construction site, Palestinians and Arab Israelis joined in a chorus of protest. They claimed the Israeli excavations—although conducted several yards outside the walls of the sacred compound—threatened the foundations of the Al-Aqsa Mosque. Some even said that it was Israel's covert plan to unearth remains of the First and Second Temples in order to solidify its historic claim to the Mount. For the time being, non-Muslim visitors continue to use the temporary wooden bridge that has been in place for seven years.

Such disputes inevitably send ripples throughout the international community. Both the Jordanian and Turkish governments protested Israel's plans for the new walkway. And in November 2010, the Palestinian Authority created a diplomatic kerfuffle when it published a study declaring the Western Wall was not a Jewish holy site at all, but part of the Al-Aqsa Mosque. The study contended, "This wall was never part of the so-called Temple Mount, but Muslim tolerance allowed the Jews to stand in front of it and weep over its destruction," which the U.S. State Department called "factually incorrect, insensitive and highly provocative."

Today, the scene is calm. At various spots on the wide, leafy plaza Palestinian men gather in study groups, reading the Koran. We ascend steps toward the magnificent Dome of the Rock—which was built during the same period as the Al-Aqsa Mosque to the south, between A.D. 685 and 715. The Dome of the Rock is built on top of the Foundation Stone, which is sacred to both Jews and Muslims. According to Jewish tradition, the stone is the "navel of the Earth"—the place where creation began, and the site where Abraham was poised to sacrifice Isaac. For Muslims, the stone marks the place where the Prophet Muhammad ascended to the Divine Presence.

On the east side of the Temple Mount's retaining wall, Meiron shows me the Golden Gate, an elaborate gatehouse and portal. Its provenance remains a subject of debate among historians, pitting the majority, who claim early Muslims built it, against those who insist it is a Byzantine Christian structure.

Historians who argue that the Byzantines didn't build the gate point to ancient accounts describing how early Christians turned the Mount into a garbage heap. The Byzantines, scholars say, saw the destruction of the Second Temple as vindication of Jesus' prophecy that "not one stone shall be left here upon another" and as a symbol of Judaism's downfall. But other historians counter that the eastern entrance to the Mount, where the Golden Gate was built, was important to the Byzantines because their interpretation of the Gospel of Matthew holds that Jesus entered the Temple Mount from the Mount of Olives to the east when he joined his disciples for the Passover meal. And in A.D. 614, when the Persian Empire conquered and briefly ruled Jerusalem, they took back to Persia parts of the True Cross (believed to be the cross of the Crucifixion) from the Church of the Holy Sepulchre. Fifteen years later, after defeating the Persians, Heraclius, a Byzantine emperor, is said to have brought the True Cross back to the holy city—passing from the Mount of Olives to the Temple Mount, and then to the Holy Sepulchre. "Thus you had two triumphant entrances: Jesus and Heraclius," says Meiron. "That's enough to explain why the Byzantines would invest in building that gate."

While Barkay is in the camp that believes the Golden Gate is an early Muslim structure, Meiron thinks the sifting project's discovery of Byzantine-era crosses, coins and ornamental columns supports the theory that the gate was built by the Byzantines. "Now we're not so sure the Temple Mount fell into disrepair," Meiron says. In addition, Barkay has found archival photographs taken during renovations of the Al-Aqsa Mosque in the late 1930s that appear to reveal Byzantine mosaics beneath the structure—further evidence that some sort of public building had been constructed at the site.

I visited Barkay at his modest apartment in East Talpiot, a Jewish suburb of East Jerusalem. The grizzled, chain-smoking archaeologist was born in Budapest in 1944, the very day the Nazis sent his family to the

city's Jewish ghetto. After the war his father—who had spent a year in a Nazi forced labor camp in Ukraine—established the first Israeli delegation in Budapest, and the family emigrated to Israel in 1950. Barkay earned his doctorate in archaeology at Tel Aviv University. In 1979, exploring a series of ancient burial caves in an area of Jerusalem above the Valley of Hinnom, he made a remarkable discovery: two 2,700-year-old silver scrolls delicately etched with the priestly blessing that Aaron and his sons bestowed on the children of Israel, as mentioned in the Book of Numbers. Barkay describes the scrolls, which contain the earliest-known fragments of a biblical text, as "the most important find of my life."

Barkay and I get into my car and drive toward Mount Scopus. I ask him about Natsheh's charge that the sifting project is infused with a political agenda. He shrugs. "Sneezing in Jerusalem is an intensely political activity. You can do it to the right, to the left, on the face of an Arab or a Jew. Whatever you do, or don't do, is political."

Still, some criticism of Barkay stems not from politics but from skepticism about his methodology. Natsheh is not the only archaeologist to raise questions about the value of artifacts not found in situ. The dirt excavated by the Waqf is landfill from previous eras. Part of that landfill, Barkay says, comes from the Mount's eastern section, which the Waqf paved over in 2001. But most of it, he says, was taken from vacant parts of the Mount when an entrance to Solomon's Stables was blocked, sometime between the reign of the Fatimid and Ayyubid dynasties. Collectively, he says, the landfill includes artifacts from all periods of the site.

But Israeli archaeologist Danny Bahat told the *Jerusalem Post* that, since the dirt was filler, the layers do not represent a meaningful chronology. "What they did is like putting the remains in a blender," adds Jerusalem region archaeologist Seligman about the Waqf excavation. "All the layers are now mixed and damaged."

Archaeologist Meir Ben-Dov, a specialist on the Old City, has raised doubts as to whether all the landfill even originated on the Temple Mount. Some of it, he suggests, was brought there from Jerusalem's Jewish Quarter. Barkay, not surprisingly, rejects this suggestion, citing the frequent finds of Ottoman glazed wall-tile fragments from the Dome of the Rock, dating back to the 16th century, when Sultan Suleiman the Magnificent repaired and beautified the shrine. And, though the excavated soil is not in situ, he says that, even if one were to discount the scientific value of the artifacts by 80 percent, "we are left with 20 percent, which is a lot more than zero."

Barkay identifies and dates the artifacts through "typology": he compares his finds with similarly made objects in which a timeline has been firmly established. For instance, the opus sectile pieces Barkay found in the soil were precisely the same—in terms of material, shape and dimensions—as those that Herod used in palaces at Jericho, Masada and Herodium.

We arrive at Barkay's salvaging operation, and he greets a handful of staffers. Then he leads the way to a worktable and shows me a sampling of a single day's efforts. "Here's a bowl fragment from the First Temple period," he says. "A Byzantine coin here. A Crusader arrowhead made of iron. This is a Hasmonean coin, from the dynasty that ruled Judah in the second century B.C." Barkay tells me that volunteers by the hundreds arrive each week to help with the sifting—even ultra-Orthodox Jews, who traditionally oppose archaeological excavations in the Holy Land. "They say all the evidence is in the [scriptural] sources, you don't need physical proof. But they're willing to make an exception, because it's the Temple Mount." Barkay pauses. "If I look at some of the volunteers, and I see the excitement in their eyes, that they with their own fingers can touch the history of Jerusalem, this is irreplaceable." He admits the project has attracted "very few" Palestinians or Arab Israelis.

Leading me outside the plastic-covered building, Barkay squints into the sunlight. We can see the Temple Mount in the distance, the sunlight glinting off the golden-topped Dome of the Rock. "We've been working for six years, and we've gone through 20 percent of the material," he says, pointing to huge heaps of earth that fill an olive grove below the tent. "We have another 15 to 20 years to go."

**Joshua Hammer** wrote about the Bamiyan Buddhas in the November 2010 issue. **Kate Brooks** is an Istanbul-based photojournalist who has worked in Iraq, Lebanon and Afghanistan.

Find this article at:
http://www.smithsonianmag.com/history-archaeology/What-is-Beneath-the-Temple-Mount.html

**One, two, many: The prehistory of counting**

- 22 April 2011 by **Michael Barany**
- Magazine issue 2808. **Subscribe and save**

Francis Galton's dealing with the Damara tribe shaped later evolutionary theories (Image: Narrative of an explorer in tropical South Africa)

*The Victorian idea that "primitive" tribes can't count has cast a long shadow over efforts to understand the origins of mathematics*

LOOKING back, Francis Galton would call it "our most difficult day". It was 4 March 1851, and the young English explorer was beginning to appreciate the obstacles confronting his attempts to map out the Lake Ngami region of south-western Africa. Struggling to navigate a narrow ridge of jagged rock, his wagon had "crashed and thundered and thumped" while his oxen "charged like wild buffaloes".

To make matters worse, Galton had little faith in his local guides from the Damara tribe, who appeared to lack even an understanding of basic arithmetic - a situation Galton found "very annoying". He recounts that having established an exchange rate of one sheep for two sticks of tobacco, he handed four sticks to a local herdsman in the expectation of purchasing two sheep. Having put two sticks in front of the first sheep, the man seemed surprised that two sticks remained to pay for the second. "His mind got hazy and confused," Galton reported, and the transaction had to be abandoned and the sheep purchased separately.

As further evidence of the apparent ignorance of the Damara, Galton wrote that they "use no numeral greater than three" and that they managed to keep track of their oxen only by recognising their faces, rather than by counting them. At a most inopportune time for his expedition, Galton seemed to have stumbled into a world without numbers.

To a modern reader, these tales in Galton's 1853 *Narrative of an Explorer in Tropical South Africa* seem little more than pithy anecdotes that reflect his prejudices as a gentleman of the growing Victorian empire. (His preoccupation with the supposed inferiority of other peoples persisted in his later work in eugenics.) Within 10 years, however, those same reports of primitive innumeracy were being used by the finest scientific minds of Victorian Britain to glimpse the savage condition of prehistoric humans.

The reports' influence did not stop there. As I have traced this trend over the ensuing decades, it has become clear just how important these speculations were in shaping the anthropological study of numbers, with ramifications for psychology, linguistics and the philosophy of mathematics. Its legacy still lingers, 100 years after Galton's death. So just how did his account become so central to such a broad swathe of 19th-century science?

*Narrative of an Explorer in Tropical South Africa* initially launched Galton to prominence as an explorer and travel writer, thrilling readers with tales of strange worlds occupied by ignorant peoples. Among his many fans, his cousin Charles Darwin wrote to profess "how very much I admire the spirit and style of your book". He became the toast of the Royal Geographical Society, though few scientists at that point read his tales for anything more than entertainment.

All that would change in 1859. In September of that year, leading geologist Sir Charles Lyell addressed the British Association for the Advancement of Science at its annual meeting in Aberdeen. Lyell had been prominent among those who were sceptical of the idea that humans may have roamed the Earth tens or even hundreds of thousands of years ago, but that day he finally declared before a rapt audience "that the date of man must be carried further back than we had heretofore imagined". Among his evidence, Lyell cited a forthcoming book that would become one of the most influential tomes ever written: Darwin's *On the Origin of Species*.

Almost overnight, the field of prehistory was born. Britain's leading scientists raced to discover how humans had evolved from primitive cave dwellers to the species that included intellectuals like Newton and Darwin. Some looked to fossils and stone tools for their evidence, but these were in short supply and difficult to interpret, so many instead turned to the study of present-day peoples. By examining those least influenced by advanced civilisations, they argued, one could identify traits common to all societies and determine how they evolved.

Numeracy looked like the perfect starting point. Explorers, missionaries, merchants and colonists alike needed to exchange numerical information with the people they encountered; when compiling dictionaries and reports of strange languages and peoples, numbers could hardly be avoided. Personal anecdotes proved particularly helpful for scientists trying to imagine how a society could do without numbers, and none were more widely read and lauded than Galton's, whose writings were quoted in nearly every significant work on numbers in prehistoric societies in the decade after Lyell's speech.

Why Galton? Though his writing was full of inconsistencies, and he was prone to exaggeration, his tale was quick, amusing, suggestive, flexible and popular. This made him a towering figure in the prehistory of counting, without him ever intending to be one.

**Glimpsing antiquity**

Daniel Wilson, a professor at University College in Toronto, Canada, and John Crawfurd, the president and chair of the Ethnological Society of London, were two of the earliest figures to turn to Galton's accounts, both within three years of Lyell's speech. They were swiftly followed by John Lubbock, the English banker and naturalist who popularised the term "prehistory" in Britain.

For Lubbock, numbers were definitive proof that societies had developed on a path of ever-increasing intelligence. After all, once a group could count to 10 it seemed impossible for them to "unlearn a piece of knowledge so easy and yet so useful". To illustrate the low end of the scale, Lubbock quotes Galton's reports of the Damara in both *Prehistoric Times* of 1865 and *The Origin of Civilisation* of 1870. The tale, he wrote, is "so admirable" and "so amusing" that he "cannot resist quoting it in full".

Lubbock proved to be influential in establishing the study of so-called "savages" as a promising line of inquiry. In a review of *Prehistoric Times* for the fourth issue of *Nature* (vol 1, p103), comparative anthropologist and linguist Edward Burnett Tylor declared that "the condition of mankind in the remote antiquity of the race is not unfairly represented by modern savage tribes".

Tylor's own account of humanity's evolution, his 1871 *Primitive Culture*, turned out to be even more important. In the book, he laid out a complex scientific argument about the progressive development of language, religion and culture, while numeracy provided him with a benchmark for comparing different peoples, as well as a model for his general method of analysis. Tylor's views caught the attention of many high-profile figures: Darwin, for instance, approvingly cited the work in his account of human evolution in *The Descent of Man*.

Tylor's work was enormously influential on many fronts, including the question of how numeracy itself evolved. He aimed to prove the widely shared view that hands and fingers must have been crucial in the development of counting. The earliest societies, he posited, might distinguish the one from the many, often with a separate word for "two". Anything else would be signalled with gestures, or vague words that meant "many". Galton's Damara, for example, who were barely past this stage, used fingers "as formidable instruments of calculation" to indicate greater numbers.

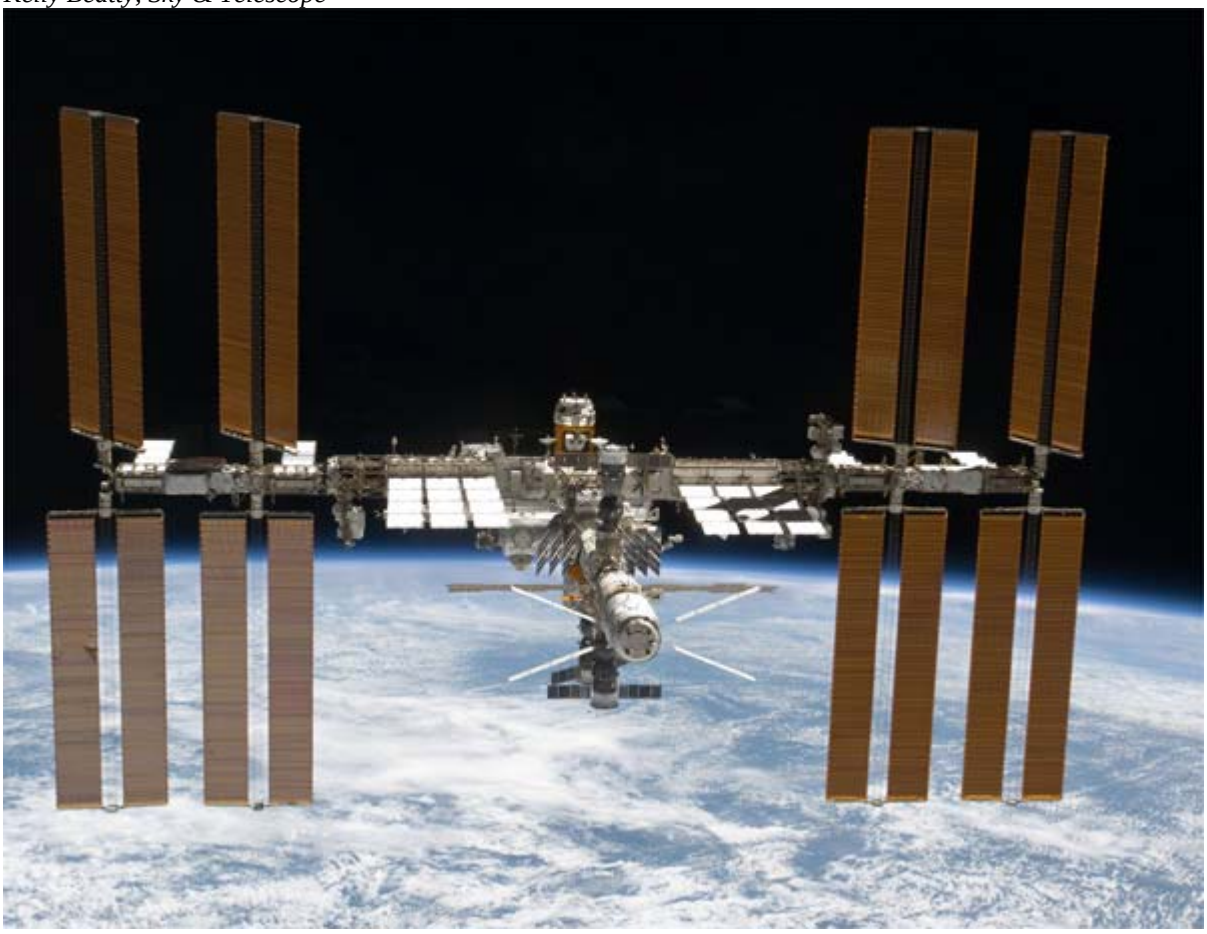
Gradually, however, hands became not just a practical but also a symbolic way of representing numbers. As evidence, Tylor cites three common counting systems in the "uncivilised" cultures - the quinary system of base 5 (using one hand), the decimal system of base 10 (using both hands) and the vigesimal system of base 20 (using both hands and feet). "The tendency of the higher nations," he concluded, "has been to avoid the one as too scanty, and the other as too cumbrous, and to use the intermediate decimal system."

Other accounts soon followed in a similar vein. Among them was Connecticut historian James Hammond Trumbull's exhaustive 1874 report for the American Philological Association on the number systems of North American Indians, in which he meticulously identified linguistic links between numbers and the names of particular body parts. The work persisted well into the 20th century as a standard reference on the topic.
Eventually, numeracy became so closely associated with human evolution that it was used to theorise about other features of our prehistory. Australian amateur anthropologist Edward Micklethwaite Curr, for example, spent a decade collecting vocabulary lists from across the Australian continent. His work, published in 1886, suggested that Australian Aborigines must have migrated from Africa in the distant past, since many Africans had since learned to "count as high as thousands", while native Australians could not count past 3.
By today's standards, Curr's work seems deeply unscientific. His conclusion that Australians could not count past 3, for instance, was based on word lists that included only numbers up to 4 - the last of which Curr assumed "means any number over 3". Thanks to Galton and his successors, Curr "knew" that primitive peoples were unable to count, so why waste energy researching it further?
By the end of the 19th century, scholars wrote whole books reviewing the anthropological and linguistic study of numbers, though stories like Galton's were already fading in importance. The expanding reach of colonisation and trade made it harder to find societies untouched by outside civilisation. Meanwhile, other sources of evidence had begun to become more central, including the study of children, animals, and the increasing body of archaeological finds.
Yet the ideas have lingered, influencing many areas of science. Tylor's accounts of primitive peoples counting on their fingers, for instance, figured in early theories of child development that drew on historical speculations to explain how children begin to learn the concept of number using their digits. Susan Cunnington, an educator in the early 1900s, summarised the viewpoint best: "In the nursery and the school we may see, writ small, the story of long ages of the human race." Traces of this can even be found in the seminal work of Jean Piaget.
Today, we are still attempting to understand the origins of numeracy, using whatever methods are available. Some researchers look to comparatively less-educated members of their own societies to try to discover our innate mathematical skills. Thus, studies of deaf "homesigners" in Nicaragua, who have developed sign languages without signs for precise numbers, argue that the ability to use exact numbers above 3 relies on a linguistic numerical system (*Proceedings of the National Academy of Sciences*, vol 108, p 3163).
Others are taking an approach that is even closer to Tylor's methods. Some present-day Amazonian tribes such as the Mundurucú, which many linguists and psychologists believe lack number words beyond 5, may offer the closest parallel to the Galton's Damara, and these innumerate peoples are again being studied in the hope of identifying universal characteristics of human cognition. One recent study, for example, argues that without the use of symbols or counting words, humans tend to compare quantities logarithmically, in terms of their rough ratios, rather than linearly, based on the strict numerical difference (*Science*, vol 320, p 1217). When asked to represent various quantities of dots on a number line, for example, the Mundurucú will put 5 much closer to 10 than 1, since 10 is only twice as big as 5, but 5 is five times as big as 1.
As for Galton's story of the Damara, it is now rarely quoted in the way that Lubbock and his peers once used it, though it continues to crop up as an anecdotal aside.
With this legacy, you may wonder whether Galton ever returned to the subject himself. He lived long enough to have seen his story figure in decades of scientific argument, yet despite his many connections to the leading scholars of prehistory, he never took part in their debates. His research moved instead to other matters, like statistics and the roles of nature versus nurture in our development, ultimately turning to the eugenic betterment of his race. While others were preoccupied with human civilisation's past, Galton's eyes were squarely on his vision of its future.
***Michael Barany*** *researches the history of science at Princeton University. He has submitted his latest work to the British Journal for the History of Science.*

*http://www.newscientist.com/article/mg21028081.500-one-two-many-the-prehistory-of-counting.html?*

**How to spot the space station in the sky**

21:03 21 April 2011
Science In Society
Space
*Kelly Beatty, Sky & Telescope*



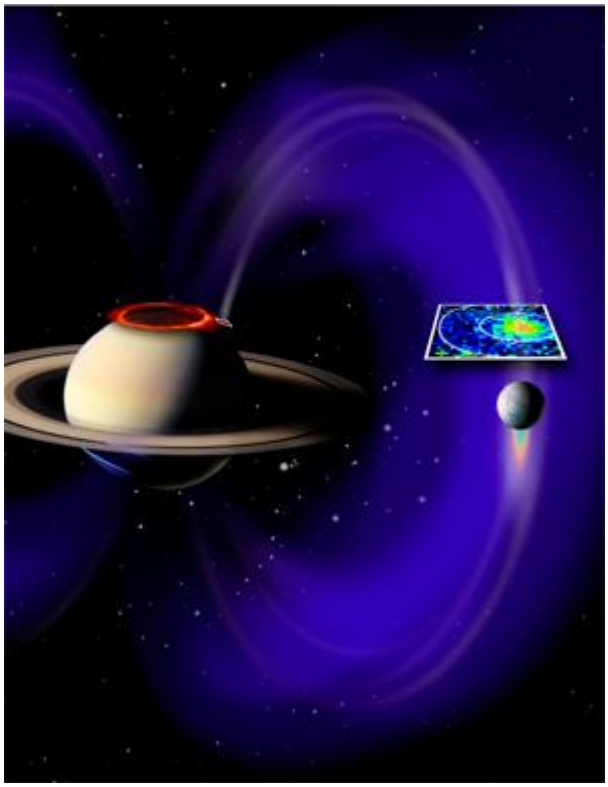
*(Image: NASA)*
The word from Houston is that NASA managers have settled on April 29th for space shuttle Endeavour's final launch. That's timed so that the orbiter can easily chase down the International Space Station and deliver its billion-dollar cargo, the Alpha Magnetic Spectrometer.
Not coincidentally, these shuttle launches also coincide with periods when the ISS repeatedly passes over North America in the hours just after sunset. So not only do you get a chance to see the mammoth, football-field-size assembly glide across the evening sky, but you also might glimpse the shuttle in hot orbital pursuit.
I'm always a little surprised when I run into skywatchers who've never seen the ISS pass overhead, because it's slam-dunk easy to spot – if you know where and when to look. Due to its relatively low orbit, 360 kilometres up, the spacecraft circles Earth about 16 times each day. We can see it whenever we're in darkness on the ground and the spacecraft is still in sunlight – which means the hours just after sunset or just before sunrise. Sighting predictions for your location are just a click away.
Whenever the space station cruises overhead, it's generally travelling west to east, the direction of its motion around Earth. However, depending on the specific pass, it could be going northwest to southeast, southwest to east, and so forth. Even though it's zipping along at 8 kilometres per second, you'll see that it takes a few

minutes to cross the sky. Look for a bright steady beacon that's gliding along a smooth, stately path – not a quick flash like a meteor.
When the first station module reached orbit way back in 1998, I pinged some of my NASA contacts to see if anyone had calculated how bright the space station would appear once all the pieces came together. Surprisingly, no one knew. But now that it's completely tricked out (pending Endeavour's final additions), the answer seems to be about magnitude -3.8. That outshines every nighttime star and every planet except Venus. So sometime in the next couple of weeks, head outside and wave to the station's six cosmonauts and astronauts as they coast overhead. The ISS is now so huge – the size of a football field, including the end zones – that you can detect its shape through a decent pair of binoculars.
Courtesy of *Sky & Telescope* magazine

http://www.newscientist.com/blogs/shortsharpscience/2011/04/how-to-spot-the-space-station.html

**Geyser moon puts its mark on Saturn**

- 18:00 20 April 2011 by **David Shiga**



A glowing patch of ultraviolet light near Saturn's north pole occurs at the magnetic connection between Saturn and its moon Enceladus (Image: K Moscati/A Rymer/NASA/JPL/JHUAPL/U of Colorado/Central Arizona College/SSI)

An electrical current is flowing from Saturn's moon Enceladus to the ringed planet, creating a glowing patch in the planet's atmosphere.

Ultraviolet images taken by the Cassini spacecraft revealed the patch, which is distinct from the planet's auroras. It lies near Saturn's north pole – exactly where electrons emitted by Enceladus would hit after being chanelled along the planet's magnetic field lines, report Wayne Pryor of Central Arizona College in Coolidge and colleagues.

Where do the electrons come from? The team believes that sunlight knocks them off water molecules spewed by geysers at Enceladus's south pole.

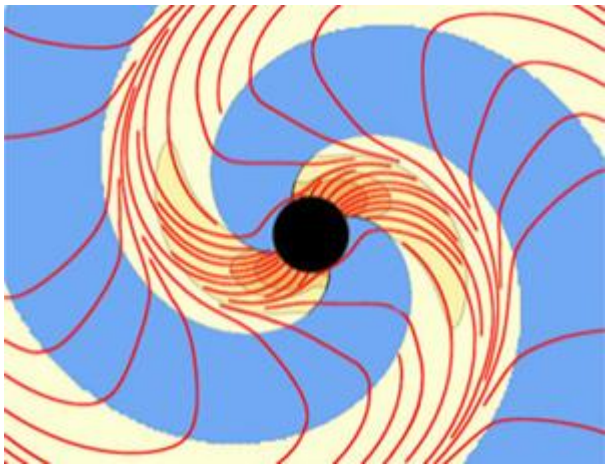
The brightness of the patch varies, which could be due to variations in the amount of water vapour released by Enceladus, says the team.

Journal reference: *Nature*, DOI: 10.1038/nature09928

http://www.newscientist.com/article/dn20399-geyser-moon-puts-its-mark-on-saturn.html?full=true&print=true

**'Tendex' lines help visualise black holes**

- 21:06 13 April 2011 by **David Shiga**



Vortex lines (red) represent the twisting effects of warped space-time that would wring an object like a towel (Image: Caltech/Cornell SXS collaboration)

Physicists have a new tool to picture how black holes warp the fabric of space-time around them. Just as magnetic field lines show how magnetic forces vary in space, a new study suggests that "tendex" and "vortex" lines show how gravity warps space.

The technique offers new insight into why some black holes get a kick after undergoing a merger, and could help in the search for gravitational waves.

Einstein's general theory of relativity predicts that space-time deforms around massive objects, such as black holes. But this warping is notoriously difficult to visualise, since the theory states that each point in space-time is associated with 10 different numbers.

Now a team of physicists led by Robert Owen of Cornell University in Ithaca, New York, says relatively simple patterns of lines can capture its essence, providing a new perspective on phenomena such as merging black holes and gravitational waves.

"We've found ways to visualise warped space-time like never before," says team member Kip Thorne of Caltech in Pasadena.

**'Tendex' lines**

The numbers associated with each point in space-time can be represented by sets of little arrows, like tiny compass needles that fill space. In the new method, these arrows are linked together to make long lines, analogous to the magnetic field lines that emanate from the poles of a magnet.

The lines come in two varieties that capture two key properties of warped space-time.

One set describes the stretching and compressing forces that can rip apart and crush objects that venture near black holes. The team calls them tendex lines, based on the Latin word *tendere*, which means to stretch.

The other set of lines, called vortex lines, represent the twisting effects of warped space-time that would wring an object like a towel.

**Black hole kicks**

"Using these tools, we can now make much better sense of the tremendous amount of data that's produced in our computer simulations," says team member Mark Scheel of Caltech.

For example, it suggests an explanation for a puzzling phenomenon seen in simulations of merging pairs of black holes. In the simulations, the merged black hole gets flung away from its birthplace.

Such kicks may eject supermassive black holes from their host galaxies, leaving them to journey through space alone. Astronomers think they may have even spotted some of these lonely wanderers.

Black hole kicks are thought to be a recoil effect due to the black hole emitting gravitational waves asymmetrically. But physicists have struggled to understand why this asymmetry happens in the first place.

**Cancelled out**

According to Owen and his colleagues, this appears to be due to the interplay of the vortex and tendex lines, which are closely associated with gravitational waves. In the team's simulation of a black hole merger, they found the two types of lines cancelled out each other's effects on one side of the black hole but reinforced each other on the other side, spawning copious gravitational waves that produce the kick.

"This is very exciting because the generation of the superkicks has not been well understood," says Yosef Zlochower of the Rochester Institute of Technology in New York, who was not involved in the study.

Using the new technique could also help physicists more accurately predict the properties of gravitational waves emitted by merging black holes, the team says. That in turn could help physicists searching for these waves in data from detectors like the Laser Gravitational Wave Observatory, the team says.

The new technique is "an interesting and novel way to try to understand curved space-time geometries", says Frans Pretorius of Princeton University in New Jersey, who was not involved in the study. But physicists will have to try it out on a wider variety of phenomena to determine how useful it will really be, he adds.

Journal reference: *Physical Review Letters*, DOI: 10.1103/PhysRevLett.106.151101

http://www.newscientist.com/article/dn20379-tendex-lines-help-visualise-black-holes.html

**Hobbyist photos used to recreate comet orbit**

- 10:29 13 April 2011 by **Cian O'Luanaigh**

Comet Holmes in montage (Image: Dustin Lang and David W. Hogg)

Hobbyist astronomers may be scientists without even realising – as long as they put their snaps online.

On 27 October 2007, Comet Holmes grew 10,000 times brighter in just a few hours, becoming visible to the naked eye as the dust and gas around it flared to the size of Jupiter. Amateur astronomers were watching and posted their photos online.

Dustin Lang of Princeton University and David Hogg of New York University wondered if these images might be useful to science.

"The comet was a good candidate because its explosion and sudden brightening made it both an object of interest and bright enough that a lot of people were able to photograph it," says Lang.

**Montage makers**

An online search threw up almost 2500 photos. The pair then used the web tool Astrometry.net to position each image in the sky to create a montage of the comet.

Using this and a statistical model, Lang and Hogg pieced together the path of Holmes's orbit around the sun, without knowing where the photos were taken, or by whom.

Though "citizen science" projects such as Galaxy Zoo exist, this is the first in which the contributors were unwitting.

"The particularly interesting thing about this is they have managed to take such a heterogeneous collection of data and put it together in such an elegant way," says Galaxy Zoo's Steven Bamford at the University of Nottingham, UK. "The fact that you can get information like that out of such a varied dataset is exciting."

**Surprise supernova**

One limitation of the method is that amateur astronomers tend to take pictures with small telescopes, so will be limited to the brightest objects in the sky, which tend to be easily studied by professionals, says Bamford.

However, the method could still lead to new discoveries. "If you have a picture of one area of the sky taken by many people over a period of time, then you could search for objects which change," he says.

"Perhaps one could find unanticipated transient objects, such as supernovae or gamma ray bursts," adds Avi Loeb of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts.

Reference: arxiv.org/abs/1103.6038v1

http://www.newscientist.com/article/dn20371-hobbyist-photos-used-to-recreate-comet-orbit.html

**Exo-evolution: Aliens who hide, survive**

- 17:39 08 April 2011 by **Mark Buchanan**

An evolutionary catastrophe? (Image: Kevin McCoy)

Has ET evolved to be discreet? An evolutionary tendency for inconspicuous aliens would solve a nagging paradox – and also suggest that we Earthlings should think twice before advertising our own existence.

As physicist Enrico Fermi argued in 1950, unless the evolution of life is unique to Earth, there must be many intelligent species out there. So why have they neither phoned home nor been detected by us?

"It's a real paradox," says Adrian Kent of the Perimeter Institute in Waterloo, Ontario, Canada.

In order to explain the Fermi paradox, Kent turns to natural selection – and suggests that it may favour quiet aliens.

**Violent universe**

He argues that it's plausible that there is a competition for resources on a cosmic scale, driving an evolutionary process between alien species on different planets. Advanced species, for example, might want to exploit other planets for their own purposes.

If so, the universe would be a violent place, and evolutionary selection may favour the inconspicuous – those who lie low on purpose, or who simply lack the skill or ambition to venture forth or advertise their existence.

"This is an interesting idea," says alien hunter Seth Shostak of the SETI institute in Mountain View, California. "If I let the cosmos know I exist, then I might be subject to extermination."

However, he is wary of assuming a "straitjacket" on the activities of intelligent species, who might not be able to resist the intellectual pull to develop advanced technologies detectable by others.

"If interstellar violence is possible, the bad news is that all societies are required to constrain their endeavours to activities that could never be detected at a distance," says Shostak.

**Voyager danger**

The theory joins a long list of attempts to explain the Fermi paradox, from the suggestion that aliens' communications are indistinguishable from background noise, to calculations concluding that ET just hasn't had enough time to find us.

Kent acknowledges that his hypothesis is speculative. But he also warns that it could have real consequences for the near future: vehicles such as NASA's two Voyager probes, which are hurtling away from the solar system, may alert imperialist aliens to our existence and require retrieval, he says.

He adds that it may not take much for a truly advanced civilisation to wipe us out pretty quickly. "The hyper-advanced aliens might not have to send their interstellar battle fleet to conquer Earth," he notes. "It might only take three bored undergraduate aliens with borrowed lab equipment."

Reference: http://arxiv.org/abs/1104.0624

http://www.newscientist.com/article/dn20361-exoevolution-aliens-who-hide-survive.html?full=true&print=true

**Covert hard drive fragmentation embeds a spy's secrets**

- 21 April 2011 by **Paul Marks**
- Magazine issue 2809

You'll have to try harder than that (Image: Ryan McVay/Getty)

GOOD news for spies. There is now a way to hide data on a hard drive without using encryption. Instead of using a cipher to scramble text, the method involves manipulating the location of data fragments.

The inventors say their method makes it possible to encode a 20-megabyte message on a 160-gigabyte portable hard drive. It hides data so well that its existence would be "unreasonably complex" to detect, they say.

Encryption should sometimes be avoided, says Hassan Khan at the University of Southern California in Los Angeles, because the gobbledegook it creates is a dead giveaway: it shows someone might have something to hide. That could spell disaster for someone trying to smuggle information out of a repressive country.

So "steganography", hiding data in plain sight, is coming to the fore. Normally, data intended to be secret is added to the pixels in digital images, or used to change the transmission timing of internet packets. But these techniques are well known and easily detected, says Khan. So, with colleagues at the National University of Science and Technology in Islamabad, Pakistan, he has developed an alternative.

Their technique exploits the way hard drives store file data in numerous small chunks, called clusters. The operating system stores these clusters all over the disc, wherever there is free space between fragments of other files.

Khan and his colleagues have written software that ensures clusters of a file, rather than being positioned at the whim of the disc drive controller chip, as is usually the case, are positioned according to a code. All the person at the other end needs to know is which file's cluster positions have been encoded.

The code depends on whether sequential clusters in a file are situated adjacent to each other on the hard disc or not. If they are adjacent, this corresponds to a binary 1 in the secret message. If sequential clusters are stored in different places on the disc, this encodes a binary 0 (*Computers and Security*, DOI: 10.1016/j.cose.2010.10.005). The recipient then uses the same software to tell them the file's cluster positions, and hence the message. The researchers intend to make their software open source.

"An investigator can't tell the cluster fragmentation pattern is intentional- it looks like what you'd get after addition and deletion of files over time," says Khan. Tests show the technique works, as long as none of the files on the hard disc are modified before handover.

"The real strength of this technique is that even a completely full drive can still have secret data added to it – simply by rearranging the clusters," adds Khan.

Others are impressed with the technique but see limitations.

"This type of steganography could be used by spies, police or informants - but the risk is that it requires direct contact to physically exchange the USB device containing the secret data," says Wojciech Mazurcyk, a

steganographer at Warsaw University of Technology in Poland. "So it lacks the flexibility of internet steganography. Once you embed the secret data on the disk it is not easy to modify it."
But won't making the covert hard disk software open source – as the group plans - encourage its use by criminals and terror groups?
"It's how security vulnerability disclosure works," says Khan. "We have identified that this is possible. Now security agencies can devise techniques to detect it." He adds that his team have had no issues with either US or Pakistani security agencies over their development of this secret medium - despite current political tensions between the two nations.
"The use of steganographic techniques like this is likely to increase," says Fred Piper, director of information security at Royal Holloway, University of London. "Eavesdroppers can learn much from the fact that somebody is encrypting a message."

http://www.newscientist.com/article/mg21028095.200-covert-hard-drive-fragmentation-embeds-a-spys-secrets.html?full=true&print=true

**Wind and wave farms could affect Earth's energy balance**

- 30 March 2011 by **Mark Buchanan**
- Magazine issue 2806.

Engines of fantasy (Image: KeystoneUSA-ZUMA/Rex Features)

**UPDATE, April 6**: *This article has elicited a considerable amount of interest, and some criticism. We always welcome discussions of the stories we publish. Some readers felt the original headline (Wind and wave energies are not renewable after all) was misleading, so to address these concerns we have changed it. We have also been made aware of a wider debate about Kleidon's research that we did not address in the original article: we will continue to follow this issue and report back on what we find.*

*The idea that we can draw endless supplies of clean energy from the wind and waves just doesn't add up*

WITNESS a howling gale or an ocean storm, and it's hard to believe that humans could make a dent in the awesome natural forces that created them. Yet that is the provocative suggestion of one physicist who has done the sums.

He concludes that it is a mistake to assume that energy sources like wind and waves are truly renewable. Build enough wind farms to replace fossil fuels, he says, and we could seriously deplete the energy available in the atmosphere, with consequences as dire as severe climate change.

Axel Kleidon of the Max Planck Institute for Biogeochemistry in Jena, Germany, says that efforts to satisfy a large proportion of our energy needs from the wind and waves will sap a significant proportion of the usable energy available from the sun. In effect, he says, we will be depleting green energy sources. His logic rests on the laws of thermodynamics, which point inescapably to the fact that only a fraction of the solar energy reaching Earth can be exploited to generate energy we can use.

When energy from the sun reaches our atmosphere, some of it drives the winds and ocean currents, and evaporates water from the ground, raising it high into the air. Much of the rest is dissipated as heat, which we cannot harness.

At present, humans use only about 1 part in 10,000 of the total energy that comes to Earth from the sun. But this ratio is misleading, Kleidon says. Instead, we should be looking at how much useful energy - called "free" energy in the parlance of thermodynamics - is available from the global system, and our impact on that.

Humans currently use energy at the rate of 47 terawatts (TW) or trillions of watts, mostly by burning fossil fuels and harvesting farmed plants, Kleidon calculates in a paper to be published in *Philosophical Transactions of the Royal Society*. This corresponds to roughly 5 to 10 per cent of the free energy generated by the global system.

"It's hard to put a precise number on the fraction," he says, "but we certainly use more of the free energy than [is used by] all geological processes." In other words, we have a greater effect on Earth's energy balance than all the earthquakes, volcanoes and tectonic plate movements put together.

Radical as his thesis sounds, it is being taken seriously. "Kleidon is at the forefront of a new wave of research, and the potential prize is huge," says Peter Cox, who studies climate system dynamics at the University of Exeter, UK. "A theory of the thermodynamics of the Earth system could help us understand the constraints on humankind's sustainable use of resources." Indeed, Kleidon's calculations have profound implications for attempts to transform our energy supply.

Of the 47 TW of energy that we use, about 17 TW comes from burning fossil fuels. So to replace this, we would need to build enough sustainable energy installations to generate at least 17 TW. And because no technology can ever be perfectly efficient, some of the free energy harnessed by wind and wave generators will be lost as heat. So by setting up wind and wave farms, we convert part of the sun's useful energy into unusable heat.

"Large-scale exploitation of wind energy will inevitably leave an imprint in the atmosphere," says Kleidon. "Because we use so much free energy, and more every year, we'll deplete the reservoir of energy." He says this would probably show up first in wind farms themselves, where the gains expected from massive facilities just won't pan out as the energy of the Earth system is depleted.

Using a model of global circulation, Kleidon found that the amount of energy which we can expect to harness from the wind is reduced by a factor of 100 if you take into account the depletion of free energy by wind farms. It remains theoretically possible to extract up to 70 TW globally, but doing so would have serious consequences.

Although the winds will not die, sucking that much energy out of the atmosphere in Kleidon's model changed precipitation, turbulence and the amount of solar radiation reaching the Earth's surface. The magnitude of the changes was comparable to the changes to the climate caused by doubling atmospheric concentrations of carbon dioxide (*Earth System Dynamics*, DOI: 10.5194/esd-2-1-2011).

"This is an intriguing point of view and potentially very important," says meteorologist Maarten Ambaum of the University of Reading, UK. "Human consumption of energy is substantial when compared to free energy production in the Earth system. If we don't think in terms of free energy, we may be a bit misled by the potential for using natural energy resources."

This by no means spells the end for renewable energy, however. Photosynthesis also generates free energy, but without producing waste heat. Increasing the fraction of the Earth covered by light-harvesting vegetation - for example, through projects aimed at "greening the deserts" - would mean more free energy would get stored. Photovoltaic solar cells can also increase the amount of free energy gathered from incoming radiation, though there are still major obstacles to doing this sustainably (see "Is solar electricity the answer?").

In any event, says Kleidon, we are going to need to think about these fundamental principles much more clearly than we have in the past. "We have a hard time convincing engineers working on wind power that the ultimate limitation isn't how efficient an engine or wind farm is, but how much useful energy nature can generate." As Kleidon sees it, the idea that we can harvest unlimited amounts of renewable energy from our environment is as much of a fantasy as a perpetual motion machine.

**Is solar electricity the answer?**

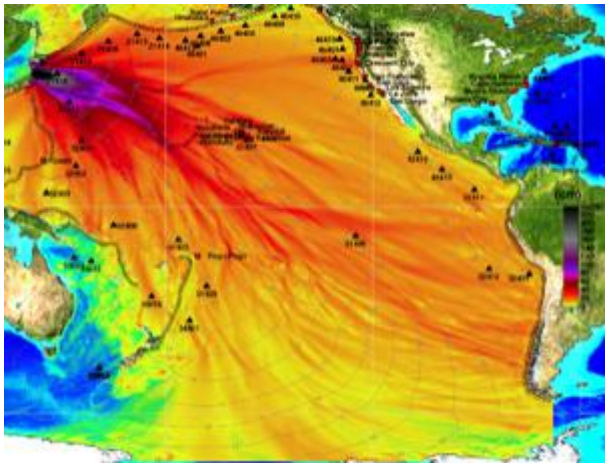
A solar energy industry large enough to make a real impact will require cheap and efficient solar cells. Unfortunately, many of the most efficient of today's thin-film solar cells require rare elements such as indium and tellurium, whose global supplies could be depleted within decades.

For photovoltaic technology to be sustainable, it will have to be based on cheaper and more readily available materials such as zinc and copper, says Kasturi Chopra of the Indian Institute of Technology, New Delhi. Researchers at IBM showed last year that they could produce solar cells from these elements along with tin, sulphur and the relatively rare element selenium. These "kesterite" cells already have an efficiency comparable with commercially competitive cells, and it may one day be possible to do without the selenium. Even if solar cells like this are eventually built and put to work, they will still contribute to global warming. That is because they convert only a small fraction of the light that hits them, and absorb most of the rest, converting it to heat that spills into the environment. Sustainable solar energy may therefore require cells that reflect the light they cannot use.

http://www.newscientist.com/article/mg21028063.300-wind-and-wave-energies-are-not-renewable-after-all.html

**Starburst megaquake: Japan quake overturns geology**

- 19 April 2011 by **Ferris Jabr**
- Magazine issue 2809.



Shaking previous models (Image: KeystoneUSA-ZUMA/Rex Features)

*The Tohoku earthquake is likely to be the best-studied of all quakes, and the first analyses suggest we may have to rethink how megathrust quakes happen*

THE Tohoku earthquake that rocked Japan last month has sent geologists reeling. As the first analyses of what may well become the best studied earthquake in history start to filter through, there is already talk of rewriting the rule book on how "megathrust" quakes happen. And all countries around the world that sit on subduction zones may now need to reconsider whether they are at risk of a similar devastating event.

At the annual meeting of the Seismological Society of America in Memphis, Tennessee, on 14 April, geologists from around the world presented early analyses of the magnitude-9 megathrust earthquake. "Few earthquakes of this size have been subjected to this kind of intense post-mortem," says Emile Okal of Northwestern University in Evanston, Illinois. "The Japanese have an incredibly dense network of GPS and seismic coverage."

The findings, which describe the event in unprecedented detail, have convinced some that they must throw away standard theoretical frameworks, which simply cannot explain how the Earth flinched and heaved beneath the ocean floor near Japan. The event, they say, demands that we change not only our scientific understanding of large subduction quakes, known as "megaquakes", but also our assessment of the regions around the world at risk of such events.

"There are many things we thought we knew and it's now painfully clear we just don't,"says Okal. Barbara Romanowicz, director of the Berkeley Seismological Laboratory at the University of California, agrees: "A lot of ideas will be shattered because of this quake."

Eric Kiser of Harvard University and his colleagues studied measurements by the US Transportable Array - a fleet of 400 high-end seismographs dotted around North America - as the energy released by the quake rippled around the world. They found the quake's rupture behaviour to be far more complex than any other. Typically a subduction earthquake - in which one tectonic plate pushes beneath another - rips in one or two directions along a fault: on a north-south fault line, say, a rupture heads north, south, or north and south at the same time. But Kiser and his colleagues found that the Tohoku quake ripped left, right and centre along the fault like the starbursts of a fireworks display (see diagram).

"When we imaged the main shock, the propagation of energy was all over the place," says Kiser. "We believe this is the most complex rupture behaviour ever observed." The team reckons the pattern may partially explain why the quake was so ferocious.

Some fault zones are highly heterogeneous, with patches where the rock catches like Velcro and others where it slips as though oiled, says Matt Pritchard of Cornell University in Ithaca, New York. It is possible that the

Japanese fault consists of a dangerous mixture of Velcro and "oily" patches. The Velcro keeps the plates glued together and absorbs the strain of subduction, but when they gave way in March, oily patches allowed the plates to slip all over the place - accounting for the complex rupture and boosting the quake's energy release.

Kiser's results have revealed that on 11 March, the bursts of energy ripped four separate patches that have all individually generated quakes in the past. More than any other factor, he thinks, this aggregate rupture accounts for the quake's phenomenal size.

He points out that the entire rupture zone within which the starburst rips took place was about 40,000 square kilometres, far smaller than what might typically produce a magnitude-9 quake. That area becomes much larger - roughly 100,000 square kilometres - if you include the region covered by the hundreds of aftershocks that hit in the weeks following 11 March. Had this entire area ruptured on 11 March, the quake would have easily exceeded magnitude 9, Kiser says.

Back in Memphis, Hiroo Kanamori of the California Institute of Technology in Pasadena says that the relatively small zone that ruptured on 11 March can be split into two areas. His analysis has highlighted one rupture zone along the Pacific Ocean's Japan trench, which he believes was largely responsible for the tsunami, and another rupture deeper along the fault line and closer to the coast that caused most of the shaking. "We have never seen anything like this," he says (see diagram).

Takeshi Sagiya of Nagoya University in Japan and Guangfu Shao of the University of California at Santa Barbara presented analyses that point to another factor which contributed to the vast amounts of energy released by the event. Their latest estimates of how far the tectonic plates slid past one another suggest that at its maximum the slip was 60 metres - a figure so big that every researcher *New Scientist* contacted asked in astonishment for the figure to be repeated. Such a massive shift is unprecedented in the recorded history of earthquakes.

Kanamori says it's possible that a structure on the sea floor, like a seamount, locked the plates together allowing stress to build up for thousands of years before it was released in one huge burst.

The huge slip happened on a fault that was not a candidate for a megathrust quake. Traditionally, young, hot, swiftly subducting plates are considered far more likely to produce megathrust earthquakes than their older, cooler, denser and more sluggish counterparts. The ocean crust off the north-east coast of Japan is about 140 million years old. It's hardly the Usain Bolt of tectonic plates, yet it generated Japan's largest recorded quake.

More remarkable still - the event may not be an exception, but could define a new rule. The subducting India plate that caused the 2004 Indian Ocean earthquake and tsunami is 80 to 90 million years old and is not particularly swift, says Okal. Yet it generated the third-largest earthquake ever recorded - a magnitude-9.2 event. "The standard models say give me the age of the subducting plates and the rate of subduction and I will tell you the maximum magnitude of an earthquake in that area. It says an old plate moving slowly can't produce much beyond a magnitude 7," says Okal. "This is now a model we essentially have to abandon."

"What we have to realise now," says Pritchard, "is that pretty much any subduction zone is a candidate for a magnitude-9 quake." Romanowicz agrees: "As prepared as Japan was for earthquakes, it did not expect such a large quake in that particular place. This is the lesson to learn. It's not just about Japan: many other places in the world could generate giant earthquakes in ways that people just aren't paying attention to."

http://www.newscientist.com/article/mg21028093.600-starburst-megaquake-japan-quake-overturns-geology.html?full=true&print=true