

## INNOVATION

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For three weeks this summer, masons and mechanics, farmers and welders, scientists and a pastor threw themselves into creating low-tech solutions to big problems that persist across the globe.

Converging here at the Massachusetts Institute of Technology, these 61 inventors from 20 countries divided into multilingual teams, each drafting and tinkering with their own device that will hopefully make life for the world's poor a little easier.

There was no grand prize to be won at this second-annual International Development Design Summit (IDDS), but members sometimes skipped meals and stayed up late – sawing, hammering, and welding – to per-

Right now, people who make charcoal from corncobs stomp on bags of burned cobs or beat the sacks with heavy sticks. When they empty the bags, the crusher is momentarily engulfed in a black cloud, inhaling the dust, Vechakul says. Also, after a few stomping sessions, the bags must be replaced – a recurring expense. “It is one messy job,” says Ms. Vechakul.

Bernard Kiwia, a bike mechanic from Tanzania, will take his team's design to his home country. There, his job will be to persuade rural communities to use the hand-cranked device instead of cutting down trees for fuel. This alternative fuel from agricultural waste might be cheap overall, but, as some rural poor see it, wood costs nothing but time and effort, says Mr. Kiwia.

Unless they understand the huge environmental cost of chopping down trees on a

for educational games, says Derek Lomas, the design team leader.

Earlier this year in Bangalore, India, Mr. Lomas strolled through a bazaar and noticed an educational video-game system based on the Japanese Nintendo Famicom, for which patents have run out. Just for a lark, he bought the set for \$12.50. The generic system came with two game cartridges, a keyboard, and a couple of controllers.

Such a cheap, TV-based computer got his IDDS team brainstorming. Facilities in Ghanaian public high schools are significantly lacking compared with private schools, says teammate and Ghanaian pastor George Fuachie. Some cleverly designed educational software with reasonable price tags could give disadvantaged kids much-

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>> **ONLINE: VIDEO**  
To watch the IDDS teams test their designs, go to:  
[csmonitor.com/innovation](http://csmonitor.com/innovation)

# 3 designs for a better world

DIVERSE TEAMS BRAINSTORM AND BUILD SIMPLE TECH TO HELP DEVELOPING NATIONS.

fect and build their designs.

Soon, their prototypes will be rebuilt and refined in the developing world by artisans using locally available materials and tested ultimately by consumers who live on less than a dollar a day.

While the 10 teams constructed a wide variety of devices – from an inexpensive incubator for low-birth-weight babies to a rope system that could help craftswomen in the Himalayas get their products to market – here are three of the most interesting inventions to emerge from this year's IDDS:

## The charcoal crusher

Each summer, Americans fire up their charcoal grill for an outdoor barbecue.

In many developing countries, charcoal is an everyday fuel and used with indoor kitchen stoves. But the smoke-flavored food carries a health risk.

Charcoal is not clean-burning, and one IDDS team says the resultant indoor pollution has been linked to deaths on the same scale as malaria and tuberculosis globally.

One way to make charcoal produce fewer emissions is to pulverize the charred agricultural waste – like corncobs or crushed sugar cane – and pack it into denser briquettes.

A \$2 metal press is already available for crushing powder into charcoal, says Jessica Vechakul, an engineer from MIT. What is missing in the market is a device to crush the burnt cobs into powder – so her IDDS team decided to build one. Their prototype looks like an oversized mouse trap with a hand crank. The user spins the crank and feeds the blackened cobs through a hopper. The grinder drops the powder into a container where it's mixed with other ingredients into a cookie-dough consistency for briquettes. The simple contraption can crush six pounds of cobs in 10 minutes.

**SIMPLE SOLUTIONS:** A hand-cranked charcoal crushing machine (above) helps make cheap briquettes from burned corncobs. Another IDDS team (right) designed software for a super-low-cost computer that hooks up directly to television sets and costs between \$10 and \$20.

regular basis, those in the countryside have little incentive to switch to a cleaner fuel, he says. Getting the target audience to invest in the IDDS device appears to be toughest part of the design game.

## Educational, supercheap computers

Video-game cartridges from the 1980s may strike some as quaint relics from an 8-bit era. But an IDDS team sought to convert the outmoded systems into an inexpensive learning tool for schoolchildren in developing countries.

Computers are prohibitively expensive for many in developing nations. But TV sets are common and could work as a platform



PHOTOS BY MARY KNOX MERRILL – STAFF



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## New sea change forecasts present a slimy picture

Earth's oceans are on the brink of massive change. You see it in such details as the hordes of Pacific mollusks that researchers have identified as ready to invade the North Atlantic as a thawing Arctic Ocean opens the way. You also see it in broad trends: A new overview warns that such relentless human impacts as overfishing or agricultural pollution – as well as global warming – threaten mass extinctions of marine life.

Jeremy Jackson at Scripps Institution of Oceanography, who made that overview, notes that this is “not a happy picture.”



**onscience**  
BY ROBERT C. COWEN

He says that “the only way to keep one’s sanity and try to achieve real success is to carve out sectors of the problem that can be addressed in effective terms and get on with it as quickly as possible.”

For example, policymakers and governments can work aggressively to get international agreement on sustainable fishing practices that really work.

They can vigorously pursue development and implementation of nonpolluting farming.

Change is a way of life in the ocean. It’s been going on since the planet formed. Even the potential mollusk invasion has a long history. Geerat Vermeij with the University of California at Davis and Peter Roopnarine at the California Academy of Sciences traced that history in last week’s issue of the journal *Science*. Pacific Ocean mollusks were invading the North Atlantic during a relatively warm period 3.5 million years ago. The scientists note that computer-based climate forecasts expect similar conditions to return by 2050 with a nearly ice-free Arctic Ocean.

Millions of years ago, abundant food and stiff competition in the Bering and Chuckchi Seas developed a population of shellfish bigger and tougher than Atlantic animals. These tough guys rode a northward water flow across the ice-free North Pole into the Atlantic. The researchers now have identified at least 77 lineages of equally rugged shallow-water shellfish in the Bering Sea that are ready to make that trip again. They explain that the earlier invasion led to new North Atlantic species but did not cause significant extinctions. They say that a new invasion will also change the makeup of North Atlantic communities. They add: “But whether that will harm local fisheries is an open question. Humans may have to adapt as well.”

Millions of years ago, only nature was at work. Now the human impacts Professor Jackson reviewed last week in the online Proceedings of the National Academy of Sciences have become a wild card in the game. Jackson explains that mass extinction does not mean loss of all ocean life. But key elements of long established healthy food webs such as fish and sharks are disappearing. He warns that intricate food webs that feature large animals are being converted into simplistic ecosystems dominated by microbes, toxic algal blooms, jellyfish, and disease. It’s what the Scripps’ announcement of this research calls the “rise of slime.”

Jackson identifies coral reefs and estuaries and coastal seas that suffer from overfishing and farm runoff as “critically endangered.” Saving these critically endangered ecosystems would be a good place to start the long-term efforts to save the entire ocean from man-made devastation.

## horizons

What’s new in sci-tech

### Ship emissions: sizing up a big problem

Those who go down to the sea in ships – or go to see them in port – may soon be able to breathe easier. Scientists have made the first measurements of ship emissions involving particles less than a millionth of a meter in size. They say it’s an important step in establishing and monitoring the effectiveness of air-pollution regulations for ships.

Until now, researchers in port cities have had a hard time figuring out what proportion of fine sulfate particles come from ships burning high-sulfur bunker oil, compared to the diesel trucks or trains that serve the cities. These fine particles are less than 1-millionth of a meter across. Once inhaled, these particles stay put, researchers say, constituting a potential public-health hazard.

Scientists at the University of California at San Diego found that ships approaching or in port can account for almost half of the fine sulfate particles found over coastal southern California. No one expected ship emissions of these particles to be so high, according to Mark Thiemens, a UCSD biochemist who led the study. The team applied an approach that has been used to tease out sources for other chemicals in the atmosphere.

Combined with wind patterns, the team’s technique allowed it to trace the origin of plumes to locations as far away as the Port of Los Angeles. The technique holds the promise of helping local officials better understand sources of pollution undercutting air quality, the researchers say. In July 2009, California will require ships to shift from bunker fuel to cleaner fuels when they approach within 24 miles of the coast. The results appear in this week’s issue of the Proceedings of the National Academy of Sciences.

### Evergreens scrub out the poultry smell

Scientists looking for ways to take the “phew” out of poultry farming – at least for the farms’ neighbors – may have found an answer in trees. Researchers

from the University of Delaware have found that by ringing a farm with trees, they could cut off-site ammonia and dust emissions by more than half and odors by nearly 20 percent. So far, the best arrangement appears to consist of a border of broadleaf trees or trees with waxy leaves, enclosed within two additional rows of evergreens. The broadleaves catch the heavy particles during summer, when a farm’s exhaust fans are working hardest. The evergreens scrub the finer particles that get by the first row. In winter, when the broadleaf trees have dropped their foliage, the evergreens do all the scrubbing.

The research began in response to complaints after farms on the Delmarva Peninsula began installing more effective ventilation systems for their poultry houses. The team, led by George Malone with the university’s College of Agriculture and Natural Resources, spent six years exploring different trees and configurations. To date, roughly 35 percent of the 2,000 poultry farms on the peninsula have planted these tree-based “scrubbers,” Dr. Malone notes. The team summarized its results Wednesday at the American Chemical Society’s annual meeting in Philadelphia.

– Peter N. Spotts



**MIGHTY VACUUM:** This 2,500 pound bonnet collected the emissions from a ship in the Port of Long Beach, Calif. on June 19, 2008.

## IDDs: Teams design low-tech solutions

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needed help and computer training. Off the shelf, this rudimentary computer can run a graphic user interface with a mouse and has some built-in programming capability. The team’s job is to design software appropriate for the classroom.

“It can run 8-bit games like Oregon Trail, Lemonade Stand, PAWS teaches typing, and Number Munchers, which I enjoyed playing as a kid,” says Lomas. Eventually, students could start creating their own locally relevant games on this system. Imagine children in Africa playing ethnic board games like Mancala – or a regional variation – on a television screen, he says.

The team researched hardware modifications to the TV-computer that will enable users to connect to text-only Internet sites – they declare it doable. Within a month, they also assembled a software development kit that makes it easier for open-source developers to produce new games and educational content for the system.

Going from the design concept to a commercial product is the task that lies ahead. When that happens, Lomas can consider his \$12.50 investment a decent bargain.

### Power generation from everyday chores

Globally, 1.6 billion people have no access to electricity and use fuel lamps or stay in darkness every night. Going about their daytime chores – pumping water,

grinding dough, or getting around on bicycles – these off-the-grid people physically exert themselves to run machines. One IDDS team worked on a bit of modern alchemy – converting mechanical energy from everyday labor into stored electrical energy.

Few consumers will labor away to generate electrical power. “But if the effort is incidental as they go about some regular task, people don’t seem to mind putting in that extra 10 percent,” says Jay Pagnis, a mechanical engineering student from India. His team focused on treadle pumps – foot-operated devices used to irrigate farmland in Asia and Africa. Many country farmers step on and off these StairMaster-like contraptions to pump water for an average of four hours a day.

The team’s generator attachment fits in a wooden frame and hooks the pump’s treadle to a turning wheel, which charges a couple of store-bought batteries. After the day’s work, a farmer can unhook the rechargeable batteries and use the power to light a 5-watt compact fluorescent lamp – the equivalent of a regular 25 watt incandescent lamp – for four hours, says Mr. Pagnis.

This may not seem like much, but this lighting is more efficient compared with kerosene lamps currently in use in such places, points out teammate Suprio Das, an Indian electrical engineer. What’s more, this set-up can pay for itself in six months, they say. And, if it breaks down, the mechanism is simple enough to be repaired by a local bike mechanic.