Armed Resistance

Nature assesses the aftermath of a series of nanotechnology-lab bombings in Mexico — and asks how the country became a target of eco-anarchists.

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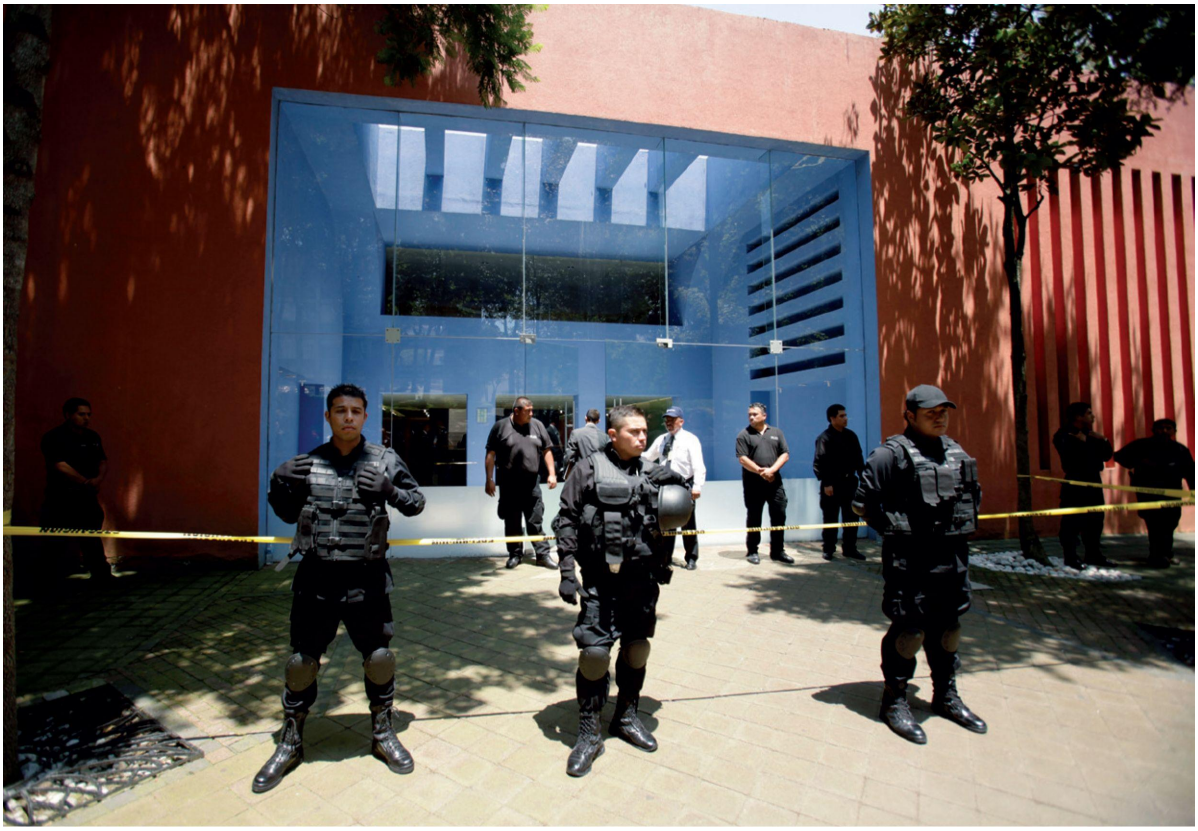


Under attack: policemen stand guard outside the Monterrey Institute of Technology and Higher Education after a letter bomb exploded there in August 2011.
A. Franco/AP/Press Association Images

The shoe-box-sized package was addressed to Armando Herrera Corral. It stated that he was the recipient of an award and it was covered in official-looking stamps. Herrera, a computer scientist at the Monterrey Institute of Technology and Higher Education in Mexico City, shook the box a number of times, and something solid jiggled inside. What could it be? He was excited and a little nervous — so much so, that he walked down the hall to the office of a colleague, robotics researcher Alejandro Aceves Lopez, and asked Aceves to open it for him.

Aceves sat down at his desk to tear the box open. So when the 20-centimetre-long pipe bomb inside exploded, on 8 August 2011, Aceves took the full force in his chest. Metal pierced one of his lungs. "He was in intensive care. He was really bad," says Herrera's brother Gerardo, a theoretical physicist at the nearby Centre for Research and Advanced Studies of the National Polytechnic Institute (Cinvestav). Armando Herrera Corral, who was standing nearby when the bomb went off, escaped with a burst eardrum and burns to his legs.

The next day, an eco-anarchist group calling itself Individuals Tending Towards Savagery (ITS) claimed responsibility for the bombing in a 5,500-word diatribe against

nanotechnology that it published online. Police found a charred copy of a similar text in the detritus of the explosion. The bombers said that Herrera had been targeted for his role as director of the technology-transfer centre at the Monterrey Institute of Technology and Higher Education (commonly known as Monterrey Tec), "one of the major universities that has staked everything on the development of nanotechnology". The text talked of the potential for the field to cause environmental "nanocontamination", and concluded that technology and civilization as a whole should be held responsible for any environmental catastrophe. Chillingly, the bombers listed another five researchers at Monterrey Tec as presumptive targets, as well as a further six universities.

The incident had precedent. The ITS had already claimed responsibility for bomb attacks in April and May 2011, both targeting Carlos Alberto Camacho Olgum, head of engineering and nanotechnology at the Polytechnic University of the Valley of Mexico in Tultitlan. The first bomb wounded a security guard; the second was identified and disposed of before anyone could be hurt. Last December, the group struck again — this time at the Polytechnic University of Pachuca, where a package containing gunpowder exploded in the hand of a teacher, causing minor burns (see 'A litany of letter bombs'). No other developing country has suffered a comparable string of anti-technology attacks.

Closing Ranks

One year on from the bombing at Monterrey Tec, the repercussions are still being felt. Armando Herrera Corral and Aceves will not speak to Nature about what happened. "It's too sensitive, you understand?" is all Aceves would say. Herrera has left his job as director of the university's technology park and is now head of postgraduate studies. Other Mexican universities with nanotechnology research programmes have evacuated campuses in response to bomb threats, and universities across the country have introduced stringent security measures. Some researchers are anxious for their own safety; some are furious about being targets. But all the researchers that Nature spoke to in Mexico are adamant that the attacks will not discourage them from their research or dissuade students from entering the field. So far, there has been little explanation of where the vitriol is coming from. Why are radical environmental groups targeting nanotechnology? Is this field being confronted with the same sort of militant hostility that has dogged genetic-modification research and animal testing? And why Mexico?

Reporting by Nature suggests that several broad trends have come together to precipitate the violence. Over the past decade, Mexico has invested heavily in nanotechnology relative to other developing countries, because it sees the field as a route to economic development; mainstream green groups worldwide have grown increasingly concerned about nanotechnology's health and environmental risks; and there has been a shift towards extreme ideas and tactics among radical environmentalists critical

of technology. In Mexico, this has been set against a general background of growing violence and political upheaval.

The bombings come at a pivotal moment. Those who study public perception of risk say that the public discourse about nanotechnology is currently fairly moderate but could easily become more polarized. Until the bombings, the radical environmental movement had mostly restricted itself to non-violent actions and property destruction, says Richard Widick, a sociologist at the University of California, Santa Barbara. But, he says, the global economic crisis and the growing perception that ecological catastrophe is imminent could fuel further attacks. "More and more people who have hitherto been able to restrain themselves will just go over the edge," says Widick. "We are going deeper still into an era of deepening and proliferating extremisms. I see a future of environmental struggles marred by violence of every variety."

That violence leaves scars. According to Gerardo Herrera Corral, Aceves "still has problems and will do for the rest of his life. There's a piece of shrapnel in his lung they couldn't take out, close to his heart." And only amateurism by the bombers prevented the attack at Monterrey Tec from having more tragic consequences: the police say that only about 8 centimetres of the dynamite in the pipe detonated. The bombers had packed it in such a way that the rest did not burn.

If all the dynamite had gone off, the police say, it could have destroyed the whole building — as well as Herrera, Aceves and dozens of researchers who work alongside them.

Mexico started a concerted nanotechnology push in 2002, when the government identified the field as a strategic sector for development. Dozens of public research institutes signed agreements with foreign institutions, companies and the military, and many opened graduate courses focused on nanotechnology research. Along with other Latin American countries that have invested in the field — Brazil and Argentina, in particular — Mexico views nanotechnology as a pathway to a more powerful research and industrial base. "They see it as a recipe for transition to the knowledge economy. It's less an option than a necessity," says Guillermo Foladori, an anthropologist at the Autonomous University of Zacatecas in Mexico and coordinator of a group of academics studying the regional growth of the field. The most important university in Mexico for nanotechnology, says Foladori, is Monterrey Tec.

Technology Backlash

As nanotechnology has been growing in Latin America, a violent eco-anarchist philosophy has taken root among certain radical groups in Mexico. Mexican intelligence services believe that the perpetrators of the bombings last year were mainly young and well educated: their communiques are littered with references to English-language texts unlikely to have been translated into Spanish. Intelligence services say that the eco-anarchist groups have been around for about a decade. They started off protesting

against Mexico's economic and political system by setting off small explosives that destroyed bank machines.

But around 2008, certain groups began to adopt an 'anarcho-primitivist' perspective.

(Locally, they are called primativistas, says Gerardo Herrera Corral.) This philosophy had won little notice until the past few years, but with increasing media reports of looming global climate disaster, some radical green activists have latched on to it. California-based environmental writer Derrick Jensen — whose popular books call for an underground network of 'Deep Green Resistance' cells — is a highly influential figure in this otherwise leaderless movement, which argues that industrial civilization is responsible for environmental destruction and must be dismantled.

In their writings, anarcho-primitivist groups often express deep anxiety about a range of advanced research subjects, including genetic engineering, cloning, synthetic biology, geoengineering and neurosciences. But it is nanotechnology, a common subject for science-fiction doomsday scenarios, that most clearly symbolizes to them the power of modern science run amok. "Nanotechnology is the furthest advancement that may yet exist in the history of anthropocentric progress," the ITS wrote in its first communique, in April 2011.

The same network of 'anti-civilization' anarchists has graduated to violence elsewhere. Attacks include the 2010 attempted bombing of IBM's flagship nanotechnology lab near Zurich, Switzerland, and the non-lethal shooting in May this year of Roberto Adinolfi, a nuclear engineer for a subsidiary of Italian industrial conglomerate Finmeccanica, which was targeted for its links to nanotechnology (see Nature **485,** 561; 2012).

In Mexico, the existing social and political climate may have helped light the fuse, says Miguel Mendez Rojas, coordinator ofthe department of nanotechnology and molecular engineering at the University of the Americas Puebla in Mexico. He says that the bombings cannot be understood outside the context of what he describes as a dangerous cocktail of poverty and poor education, widespread ignorance of science, ongoing social upheaval and a climate of violence. In July, Mexico City saw some of the country's largest-ever protests, over alleged fraud in this year's presidential election. And since 2006, wars with the major drug gangs have resulted in around 55,000 deaths. Human-rights groups have accused the military and police of illegal arrests, secret and prolonged detention, torture, rape and extrajudicial execution. "I think we are in just the moment for a social explosion," says Mendez Rojas.

Taken together, all these developments made Mexican universities, with their burgeoning nanotechnology industry, a target for violence. In its communique from May last year, the ITS warned professors and students: "It would be best for them to walk carefully within and outside the university, that they take warning of every suspicious shape in rooms, buildings, parking areas and campus, because one of these days, we are going to make them pay for everything that they want to do to the Earth with these kinds of nano-scale technologies."

Escalating Tension

The "boom in eco-anarchism" — as CNN Mexico describes it — has had widespread consequences. In the wake of the bombings, officials at Monterrey Tec introduced a slew of security procedures, including sniffer dogs and campus sweeps. Similar procedures have been put in place at the University of the Americas. The institution's Puebla campus was home to the first nanotechnology lab in Mexico, and its site in Monterrey was the first campus in Latin America to offer an undergraduate programme in the field.

"We were very worried that we could be a target," says Mendez Rojas, whose research encompasses the development of nanomaterials for tackling cancer and simple toxicology tests on nanoparticles. After the first attacks last year, he was warned that the ITS was going to target campuses outside Mexico City. On his suggestion, he says, the university formed a task force of professors, security staff and administrators to respond to threats. The campus implemented car checks and a policy that visitors can meet professors only with an appointment; a visitor today undergoes a 15-minute identity check, and is escorted to their meeting by two security guards. Mendez Rojas says that he doesn't receive some visitors as a result, but that, despite the hassles, "I feel safer".

There have been false alarms, including one at Mendez Rojas' university last August. In all, at least ten campuses have received bomb threats, although it is unclear whether they were sent by the ITS or copycats. Greenpeace Mexico, criticized by the ITS for having a soft stance on environmental issues, received an incendiary device from the group last November. Universities in seven states and the capital city have implemented increased security controls, including random bag checks and bomb-evacuation drills, but the Mexican National Association of Universities and Higher Education Institutions warns that only one-third of campuses in the country have taken sufficient action.

The increased security has met with criticism from some quarters. In March, Hugo Aboites, an education specialist at the Autonomous Metropolitan University in Xochimilco, told La Jornada, one of the country's leading national daily newspapers, that stringent security precautions could create an environment of "institutionalized fear". The role of universities, he said, is to "train and impart knowledge, not to reproduce police control of the population".

But Mendez Rojas says that research activities have not been thrown off course. Despite the attacks, he says, the number of students enrolled in nanotechnology programmes across the country rose to 800 this year, up from 500 in 2011. "Apart from the fear some people may be feeling about the subject, not much will change in the academic community. Researchers in nanoscience and nanotechnology won't switch. They'd lose decades' worth of work and millions in investment," he says.

Some researchers in Mexico say that more-moderate groups are stoking fears about nanotechnology. One such body is the Action Group on Erosion, Technology and Con-

centration (ETC, pronounced et cetera), a small but vocal non-profit organization based in Ottawa, Canada, which was one of the first to raise concerns about nanotechnology and has to a large extent framed the international discussion. Silvia Ribeiro, the group's Latin America director, based in Mexico City, says that the organization has no links to the ITS. The bombings were a "sick development", she says. "These kinds of attacks — they are benefiting the development of nanotechnology," she says. "It polarized the discussion. Do you want nanotech or the bomb?"

ETC wants to see a moratorium on all nanotechnology research, says Ribeiro, who is the lead author on many of the group's reports criticizing nanotechnology research and commercialization. She says that there have not been enough toxicological studies on engineered nanoparticles, and that no government has developed a regulatory regime that explicitly addresses risk at the nanoscale.

However, ETC also infuriates researchers by issuing warnings of a more speculative nature. For example, it has latched on to the concept of 'grey goo' — self-replicating nanorobots run wild — that was raised in the book Engines of Creation (Doubleday, 1986) by nanotechnology engineer Eric Drexler. In ETC's primer on nanoscale technologies, it says that the "likely future threat is that the merger of living and non-living matter will result in hybrid organisms and products that are not easy to control and behave in unpredictable ways".

Ribeiro has also criticized genetic modification and vaccination against human papillomavirus in a weekly column in La Jornada. Mendez Rojas says that ETC "promotes beliefs, but they are not based on facts, and we need a public discussion of the facts".

The sentiment is echoed by Beatriz Xoconostle Cazares, a biotechnology researcher at Cinvestav, who is experimenting with transgenic crops resistant to drought and insects — and who regularly debates with ETC in public forums. Last September, Xoconostle arrived at work to find that her lab had been set on fire. A month later, arsonists attacked the lab of a neighbouring researcher.

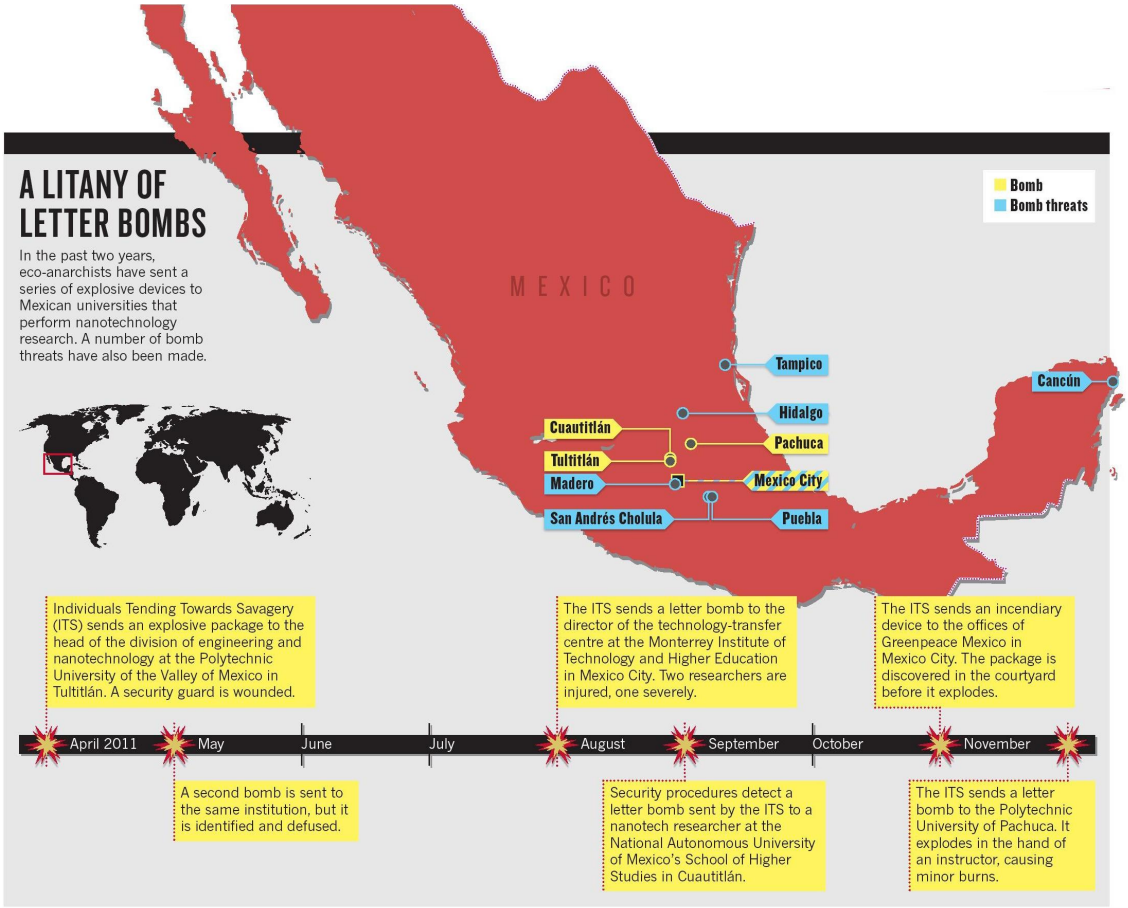
Open Debate

Xoconostle does not accuse ETC of responsibility for these acts, but she worries that the organization's communications are helping to spread fears about technology. "These are small groups. But they know how to communicate, and that's a huge advantage. It's becoming a larger group of people who oppose these things." Xoconostle fears that extremist groups might adopt such views and use them to support their acts.

Ribeiro denies that ETC's reports are not based on facts and says that "we have nothing to do with ITS and we strongly and publicly have condemned their violence. Those who exercise violence and those who bluntly and uncritically defend nanotech coincide in hindering a real public open debate on the facts."

The real question now is whether the violence will recur — or spread. The nanotechnology-activist movement does seem to be gaining momentum. For the past

four years, nano-critical groups have held an annual International Nanotechnology Activist Summit; the one last October welcomed 14 environmental and consumer-advocacy groups worldwide, including the European Environmental Bureau — a Brussels-based federation of European green groups, which says it represents a combined membership of 15 million people.



Opposition to nanotechnology has sometimes been hostile outside Mexico. In 2009 and 2010, protesters in France shut down public debates on nanotechnology in Grenoble, Rennes, Lyons and Marseilles. Pieces et Main d'Oeuvre (Parts and Labour), a Grenoblebased group, has organized protests in the city outside Minatec, France's flagship nanotechnology research centre.

But Barbara Harthorn, director of the Center for Nanotechnology in Society at the University of California, Santa Barbara, says that most debate about nanotechnology so far has been measured. She has tracked 125 green groups around the world in an ongoing study of engagement in nanotechnology by nongovernmental organizations. She says that most groups restrict themselves to issues of environmental health and safety rather than the more speculative scenarios painted by ETC and the ITS.

At the same time, public awareness of the topic is extremely low, says Harthorn. She collaborated on a meta-analysis of 22 surveys done in the United States, Canada, Europe and Japan between 2002 and 2009, which found that, on average, more than 51% of survey respondents report that they know "nothing at all" about nanotechnology (T. Satterfield et al. Nature *Nanotechnol.* ***4,*** 752-758; 2009).

"There's a huge public that is undecided, which means that opinion is still highly malleable," says Harthorn. Her own surveys have shown no evidence that the public in general has the same aversion to nanotechnology that has been seen for genetic engineering, because nanotechnology is not viewed as 'messing with nature' in the same way. But subjects' reactions depend on the type of nanotechnology being considered: applications in clean energy are embraced, but uses in food or the far-reaching idea of human 'nano-enhancement' elicit a sharply negative reaction. All this means that there is still a lot to play for in public perception, says Harthorn. If the discourse becomes framed by more speculative notions, the moderate public stance could be lost.

And that creates an opportunity for scientists to tip the debate. Most nanotechnology researchers acknowledge that some areas of their work raise legitimate environmental, health and safety concerns. The most important response, says Gerardo Herrera Corral, is for scientists to engage with the public to address and dispel concerns. Herrera is head of Mexico's only experiment at CERN, Europe's particle-physics laboratory near Geneva, Switzerland, and he points to how CERN dealt with public fears that its Large Hadron Collider could create a black hole that would swallow Earth. "We set up a committee to deal with this. We looked into the real dangers. There were journal articles and we answered all the e-mails we got from people. I mean top-level physicists answering thousands of e-mails."

"But this is work we should all be doing," says Herrera. "Even if it's extra work on top of all the other things we have to do. It's just part of our job now."

In Mexico, bomb threats are also becoming part of the job. On 31 May, a hoax threat forced evacuations at the University of Xalapa. The same day, emergency services and military forces descended on the faculty of engineering at the University of Veracruz in Boca del Rio after a suspicious device was found. It turned out to be a professor's forgotten briefcase.

For Xoconostle, the fear is taking its toll. "The fact is I am kind of worried. I'm terrified of these people," the soft-spoken scientist says. "We are in a fight."

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