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Ground Shift

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Looking beyond mining and copper exports, Chile overhauls 10 top engineering schools in a bid to join the world's advanced economies.

Juan Carlos de la Llera is a rarity in Chile as both an academic and an entrepreneur. A struct engineer and dean of the School of Engineering at Chile's Pontificia Universidad Católica (PU Santiago, de la Llera founded Sirve, a company built on technology to protect buildings from earthquakes, in 2003. Sirve proved its worth seven years later, when an 8.8-magnitude quake devastated the capital. The temblor killed 520 people and caused $30 billion in damage. But t city's tallest building, the 52-story Torre Titanium La Portada, escaped structural damage, tha in large part to Sirve's steel dampers, which act like shock absorbers and dissipate damaging energy released from violently shaking earth.

By promising a measure of protection for earthquake-threatened structures around the globe, is a growing business. It's also the kind of world-beating young company Chile's leaders want see more of. So the National Agency for Innovation and Development, or CORFO, launched a $62.5 million project to shake up the country's leading engineering schools and get them to fo more on innovation, technology transfer, and entrepreneurship. Dubbed Chile New Engineeri 2030, the ambitious plan aims to combine "world-class, student-centered" teaching that attrac more smart applicants to the field and high-impact applied research, particularly in health, sustainability, and information technology. The ultimate goal is a competitive First World econ that is less dependent on exports of commodities, like copper.

Why haven't more Chilean engineering researchers followed de la Llera's path and spun off th research into start-ups? Many think it's because Chile's engineering schools focus too much o theoretical engineering science and fundamental research while eschewing applied research ignoring the needs of industry.

Pursuit of academic glory through esoteric research is a luxury that a country like Chile canno afford, argues Dario Morales Figueroa, who heads CORFO's Technological Center Directorat "That is all very well if we preferred to have mainly Ph.D.'s who win physics awards," he says does little to propel Chile from a developing to a developed economy. For that to happen, academics and students must be inspired to embrace enterprise and put their skills to use inventing new technologies and designing new products. "We're trying to motivate universities prepare more engineers to address the challenges of Chilean industry," Morales explains. Ad Marcia Varela Arriagada, CORFO's current deputy director for technology transfer and head o

Engineering 2030: “The more entrepreneurial your engineers, the more innovative you are as country.”

Beyond Mining

Chile is already one of Latin America’s political and economic bright spots. While not immune the governance crises and corruption that plague other Latin countries, Chile has been a rela stable democracy since the end of the Augusto Pinochet dictatorship in the late 1980s. Finan sound, the country enjoys an annual growth rate of 2.41 percent, close to that of the United S and a per capita gross domestic product well above those of Colombia and Brazil. Exports comprise a third of the nation’s economy. Mining, mainly copper, is its leading industry, but ot important sectors include fishing, fruit, wine, and paper. CORFO wants engineering schools n only to help modernize existing industries but also to come up with products for new growth a like advanced manufacturing and bioengineering, that can tantalize global markets.

Compared with most of its Southern Hemisphere neighbors, Chile starts from a strong positio engineering. A report on a 2000 workshop funded by U.S. and Chilean government research agencies called Chile’s computer science research community “the best in South America in t of numbers of publications and research proposals per capita,” and well positioned to be a re leader in information technology. Lately, the country has reinforced research and developmer with the University of California system that date to the early 1960s, particularly in agriculture water management. It’s also one of some 15 nations that welcome National Science Foundat graduate research fellows. Various Chilean universities have student exchanges or research with top U.S. engineering schools, including the University of Colorado, Boulder and Virginia

Still, observers have found flaws at Chilean engineering schools. While CORFO complains ab an over emphasis on basic research, a 2007 study by two scholars at the Universidad de Sar de Chile calls the schools’ research in general into question. They report that “many universiti state in their mission a strong commitment to research, which is not found to be the case in practice.” They also noted low graduation rates, a seven-year average time to graduation, an mismatch both between admission requirements and expected student performance and betv curricula and expected outcomes.

Outside Advice

If it succeeds, Chile New Engineering 2030 would point both research and educational offerin a new direction. The program began in earnest in 2013, when CORFO spent some $12.5 mill so universities could develop blueprints to overhaul their engineering schools. Their plans hac be ambitious, yet realistic, and explain how they would interact with industry. CORFO wanted see faculty thinking more about commercialization and applied R&D, along with flexible curric that incorporated more teamwork, hands-on learning, and practical experience with industry. agency also wanted schools to graduate engineers in five years instead of six or more.

A team of six international advisers helped CORFO pick five winning projects involving a total universities. Each project will get matching grants worth $7 million to $10 million each over six years to implement their plans. Advisers included Norman Fortenberry, ASEE's executive dire Johan Malmqvist, dean of education at Sweden's Chalmers University of Technology, and Diosdado P. (Dado) Banatao, Jr., an electrical engineer, Silicon Valley entrepreneur, and foun of Tallwood Venture Capital.

James Adams, a retired professor of industrial engineering at Stanford University, who was p the advisory team, applauded CORFO's effort as worthwhile, educational, and rewarding. "Th of the world should take note," Adams wrote on his blog, *People and Products.* He argued tha many engineering schools – in Chile and elsewhere – have been following the lead of top U.S European schools in embracing research of "high intellectual cachet" that may never have an application. "But do they really need MITs and Caltechs?" he asked.

If *Prism's* conversations with deans at three winning universities are representative, Chile's engineering schools recognized that the time was ripe for CORFO's intervention. There was indeed a need to refocus their schools more toward applied research and enterprise, the dean said, and to use more innovative teaching methods in their classrooms to get students excited about creating, designing, and building.

"We were very much devoted to fundamental research," admits Claudio Alfredo Zaror, dean o Universidad de Concepción (UC is partnered with the Universidad de Santiago de Chile and t Universidad Católica de Valparaiso). Alejandro Jadresic, dean of the engineering school at th Universidad Adolfo Ibáñez (UAI), notes that his school is historically devoted to business education, but a few years ago decided to strengthen its engineering college and remake it so works more closely with the business school. "We wanted to do research that was relevant to industry, and to have strong technical training that was also strong in application," Jadresic sa

Winning the CORFO grants “allows us to move faster.”

High-Quality Examples

In preparing their plans, the engineering schools looked for models at a wide range of prograı outside Chile. UC’s benchmark universities included MIT, Purdue, Chalmers, and Britain’s Cambridge and Oxford, while UAI’s included Olin College and Sydney, Australias University c Technology. PUC, which is partnered with the Universidad Tecnica Federico Santa Maria, ch MIT, Notre Dame, and the U.K.’s Imperial College and University College London.

The benchmarking made clear to de la Llera, PUC’s engineering dean, that the best schools ı only had an entrepreneurial mission but also were intent on pursuing research at the intersec engineering and other disciplines, including biology and medicine. “You have to try to identify opportunities at those boundaries,” he says. He now wants to see his own researchers workir with geoscientists to help predict natural disasters like quakes, landslides, and floods, and to devise technologies to mitigate those dangers. He’s also keen on coming up with technologie such as new wireless sensors, that would be useful to almost any industry. UC’s Zaror looks t improve mining with more automation, sensing, and modeling, and to develop new technolog advanced manufacturing and nuclear power.

Winning over faculty to an applied-research-and-innovation paradigm has been a challenge, Z and de la Llera say. “There are powerful incentives to do fundamental research,” Zaror says. research money comes from government agencies, he says, “and is very much tied to fundar research. We need more change at the national level.” De la Llera agrees. He sits on a comm working to develop a new ministry for science and engineering, and one of the big questions i faces is whether to put more money into applied or blue-sky research. There’s a strong move toward the practical, he says, but opponents counter that you cannot do applied research witl foundation of fundamental research. “So you need to do both.” CORFO is struggling to get er government funding to build technology parks adjacent to universities.

Jadresic’s faculty is more accepting of the pivot toward applied research, because their schoc relatively new and has only recently taken a plunge into R&D, he says: “We have a very motiv team of professors, most of whom are young and passionate. One advantage is we are more to try different things.” Many of his researchers are drawn to industrial processes and environmental and energy topics, including wastewater treatment.

An enthusiastic faculty is only part of the picture, of course; any innovations that emerge from labs still have to find a market. And transforming researchers into entrepreneurs is especially difficult in a small country with few sources of private venture capital. Accordingly, Jadresic ur his faculty – and students – to think globally and to look for investors outside Chile. “We enco that approach,” says CORFO’s Varela, who points out that the agency funds a Go to Market program that seeks to connect Chilean entrepreneurs with investors from Silicon Valley and tl high-tech community in Cambridge, England.

An Entrepreneurial Spirit?

Just as some faculty members resisted shifting their research priorities, some engineering instructors were reluctant to adopt the new active-learning pedagogy demanded as part of Ne Engineering 2030. But deans insist they’re making headway on that front. Eventually, faculty be persuaded by examples of success, they say. UC has instituted first-year classes that requ students to identify social, economic, or environmental problems, propose an optimal enginee solution, and, if applicable, submit a preliminary design. Classes, such as the third-semester Introduction to Chemical Engineering, use problem-based learning that involves local industry one example, students conduct mass and energy balances in industrial plants, collaborating v the engineering staff. “Most of the project-based courses have an entrepreneurial spirit,” Zaro says, noting that in the first-year Introduction to Engineering course one of the three projects requires students to make a business case for their invention that incorporates financing, marketing, and intellectual property protection.

At PUC, the mandatory first-year Engineering Challenges course requires students to divide i 70 teams of 10 members each and collaborate with industrial partners on designs. To further “strengthen the entrepreneurial ecosystem” at PUC, de la Llera says, the school has launche accelerators and incubators for students as well as faculty and is making some prototype fun available to students, as well as giving them opportunities to meet investors and industry lead

AIU, which stresses preparing students for the global workforce, requires them to take Englis another second language. Its curriculum includes a substantial amount of liberal arts, as well. AIU, and PUC have all implemented flipped classrooms in many of their courses, as well as a learning strategies. PUC has created an Engineering Education division to help foster a cultu change toward entrepreneur-oriented education and to work on new teaching methodologies. Moreover, de la Llera says, an effort is under way at PUC to make all the design labs

entrepreneurial, with students subjected to realistic situations and constraints.

CORFO's Morales stresses that none of the five winning projects is assured of getting the full funding. At the end of each year, all of the schools must report back to CORFO, which will loc 40 different indicators to determine if they are successfully executing their plans. One indicato example, is that they're increasing the number of students enrolled in engineering; another is the number of spin-offs created by faculty continues to grow. "If a project is not meeting its go we could cut off funding," Morales says. For now, at least, all of the projects appear to be safe of the end of the first academic year, all five were hitting their targets, Varela says. CORFO, s adds, was also impressed that all participating universities had created competitions to develo new technologies or applied R&D.

Chile New Engineering 2030 is just a step – though a big one – to a national overhaul of engineering education. The universities involved represent only a third of the country's engine schools. "What happens to the other two thirds? That is a major question," Morales admits. "Hopefully CORFO will be able to fund them in the future." For a country aspiring to the big leagues, setting up 10 centers of innovation and entrepreneurship is not a bad way to start.

By Thomas K. Grose

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