

Many of the best Soviet scientists worked in the nuclear weapons program, and Hood said the partnership program was designed to give US industries access to that talent by doing joint research in Russia and Ukraine for much less money than the companies could do it in the US. Although businesses such as the Dow Chemical Co, DuPont, and General Atomics have joined the science centers and have done research projects with Russian scientists, efforts to get US companies to make longer-term investments have proven more difficult.

"You have to keep in mind that the science centers program is first and foremost a nonproliferation program," Hood said. "We're trying to keep these former Soviet scientists sitting where they are working on projects that are peaceful and civilian in nature."

The State Department puts the number of FSU weapons scientists at between 30 000 and 75 000, which makes for a very large "between." Program officials said it has been difficult to come up with a precise, reliable number on how many scientists the Soviet Union had working on its nuclear weapons program.

Since the centers began operating, they have engaged more than 50 000 scientists and engineers in research projects all across the FSU. The scientists work on everything from plasma physics for fusion reactors to materials synthesis and processing. All of the work is unclassified and nonmilitary.

"A surprising number of [the scientists], when we started, had never even set foot out of their nuclear closed cities where they were doing their weapons work," a program official said. "A lot of them had never set foot in the West, never left the Soviet Union."

The partners program has tried to build upon US funding for the centers (\$37 million in fiscal year 2002; \$32 million in FY 2003). When the partnerships work, an official said, "the scientists benefit because they have work and an income, the companies benefit because they have top talent and bargain rates, and the US benefits because Russian scientists do work on commercial civilian projects. They are not being enticed by Osama bin Laden or Iran."

That is an admirable goal, but it hasn't worked well. "US industries

can't protect their investments and they are terribly afraid of expropriation," said Thomas Neff, a senior researcher at the MIT Center for International Studies in Cambridge, Massachusetts. Neff originated the 1993 Highly Enriched Uranium Purchase Agreement that committed the US, through the privately-owned US Enrichment Corp, to buy 500 tons of highly enriched uranium derived from Russian nuclear weapons for reuse, in a blended down state, as fuel in US nuclear power reactors. The Russians receive about \$700 million a year for the enriched uranium, which now accounts for about 10% of US electricity generation.

"There are a host of things that stop US companies from investing in Russia," Neff said. "If you put money into developing intellectual capital, somebody may decide to start a business in Russia and run off with your capital. If you build things there, somebody may expropriate it. That's a fundamental problem, and it's a Russian problem."

Princeton University physicist Frank von Hippel, a professor of public and international affairs, agreed

Exact Change Needed, No Boom Boxes, Do Physics

Between the usual advertisements and exhortations, riders on the University of Massachusetts transit system can now find placards inviting them to puzzle over physics. "We would like to give people the idea that physics can be fun, that physics can be interesting, that physics deals not just with quarks and galaxies, but with everyday objects like tricycles and rowboats and thermostats," explains Amherst College's Robert Romer, who is spearheading the puzzler project with help from John King of MIT.

One set of placards, for example, invites riders to consider what will happen when an anchor is tossed over the side of the *S. S. Archimedes*. A dog and a cat debate the issue: Will the water level rise because the anchor displaces water, or will it fall because of the reduced weight of the boat? The anchor problem is one of six that are being posted in UMass buses. The problems, their solutions, and, in many cases, guidance for simple experiments to confirm the solutions may

be viewed on the Internet at <http://www.amherst.edu/~physicsqanda>.

Romer and King's project was inspired by a similar effort, Science on the Underground, initiated in London five years ago. The Massachusetts incarnation has cost about \$13 000 to date, with most of the expense covering the drawing and printing of the placards. Amherst College has picked up a generous portion of the initial cost and hosts the Web site, and UMass transit has donated space on the buses. Romer and King hope to expand their program, most likely to bus systems in other university towns, but will need additional funds to do so.

The placards were drawn by Bruce Aller of Upton, Massachusetts. Romer admits that both he and Aller are cat people. "Some of my friends say, 'The cat's always right, that's the clue.' They have a point, but we promise to have the dog get the physics right in some of our future drawings."

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