

U math institute bugs its way to record grant

Mary Jane Smetanka, Star Tribune
July 20, 2005 MATH0720

Put a cockroach expert in a room with mathematicians and electrical engineers at the University of Minnesota and what do you get? A six-legged robot that looks like a bug and might someday scamper over the rocky surface of Mars.

The idea was hatched at the Institute for Mathematics and its Applications (IMA), the recipient of the largest single math research grant ever made by the National Science Foundation: \$19.5 million over five years.

The grant, to be announced this morning, "firmly establishes the IMA as the top math institute in the country," according to university President Robert Bruininks.

The institute is one of the few places where mathematicians meet to talk with biologists, engineers, psychologists -- and even people who study linguistics and speech -- to give practical application to a sometimes abstract discipline.

Researchers associated with the institute have tackled devising an undetectable system to spot enemy aircraft, using a math-based system to diagnose serious heart problems and figuring out how to better develop mixes of metals that can be reshaped with magnetism. The stretchable alloys could be used to open and close valves in implantable devices in the human body.

"Math used to be very inward-looking. Mathematicians would work alone and do very esoteric work and no one understood what they were doing," said institute director and university math Prof. Douglas Arnold.

"Our view was to connect mathematicians with other scientists and technicians who need problems to be solved."

Each year, the institute has a central theme for research and workshops. Imaging is the subject for the coming year, when 1,000 to 1,300 people will come to the institute for study, workshops and research.

Why imaging? Arnold said one of the great successes of math in the 20th century was the CAT scan, which shoots a pencil of light through flesh and uses math to reconstruct an image that allows a glimpse inside the body. Math also forms the basis of how radar systems work, how scientists

Bug + Brain = Bot

Math adds up to scientific breakthroughs at the Institute for Mathematics at the University of Minnesota. The institute won a large federal grant to further research, such as the kind that helped turn cockroach biology into a six-legged robot that may one day scuttle across Mars.



A mathematical model of insect movements was used to build a new class of six-legged robots with unprecedented mobility.



To see tests of the robot in motion go to <http://www.physorg.com/news1193.html>

Other recent projects developed by researchers affiliated with the IMA:

- A new system to detect enemy aircraft while remaining undetectable.
- A math-based system to diagnose potentially fatal cardiac irregularities via electrical conduction patterns.
- A mathematical theory that led to the development of alloys whose shapes can be modified with magnetism.

Sources: University of Minnesota, University of California Berkeley

Mark Boswell/Star Tribune

capture images of atomic matter and how technicians restore old movies by sharpening image resolution and removing scratches.

Those issues will be studied in workshops this year. "All of this very fancy stuff has math behind it," Arnold said.

The new grant, which raises the IMA's National Science Foundation funding by 77 percent, will be used partly to bring in leading scientists for longer periods of time. The institute specializes in bringing together experts who are interested in similar issues -- but often work in wildly different areas -- to brainstorm and tackle problems. Some scientists, graduate students and post-doctoral fellows stay for a year or two.

While others' visits are fleeting -- most workshops last only a week -- the influence of ideas and research that jell at the institute can be long lasting.

The six-legged robot RHex (pronounced "rex") that researchers want to see on Mars was inspired at a weeklong 1998 institute workshop on animal locomotion and robotics.

One of the participants was biologist Robert Full from the University of California, Berkeley, who is famous for his studies on how geckos stick to walls and why cockroaches can scuttle over substances ranging from jello to rocks without faltering.

At the meeting, he wondered aloud whether the insects' legs felt the surfaces and if nerves adjusted their gait in response or whether their legs somehow worked independently.

Mathematicians devised a simple mechanical model that would explain how legs could move independently, effectively bridging the gap between biology and engineering. A group from different universities who were at the workshop, including Full, mathematicians and engineers, won a major grant to develop the robot.

Now several universities have websites showing RHex scuttling over curbs and down stairs, tumbling down a pile of boulders and righting itself, swimming and standing erect on a pair of legs, and chugging down a hallway and around a corner. The developers hope the robot will be considered for use for future space missions.

The scientists, not the math institute, invented the robot. But, Arnold said, "very few places run meetings of biologists and engineers and mathematicians and computer scientists. We're the gardeners, and we planted the seed."

Mary Jane Smetanka is at smetan@startribune.com.

StarTribune [Copyright 2005](#) Star Tribune. All rights reserved.