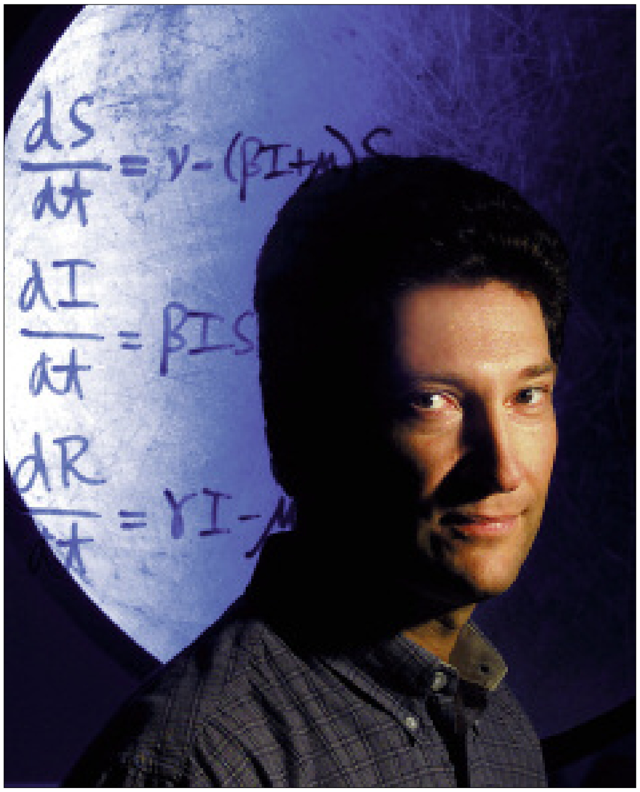
PROFILES FROM THE FRONTIERS OF RESEARCH AND INNOVATION IN ONTARIO

Ideas on the Edge



“YOU ACTUALLY BUILD A MODEL THAT SIMULATES AN EPIDEMIC.”

Epidemics by the Numbers

MCMASTER RESEARCHER DAVID EARN USES MATH TO BUILD MODEL EPIDEMICS. AND WHAT HE’S FINDING OUT MAY HELP US DEAL WITH THE REAL THING.

If you’ve ever folded a paper airplane, tossed it, and then refined your design, you’ll have some inkling of what Dr. David Earn does.

Dr. Earn is professor of applied mathematics at McMaster University and his specialty is constructing mathematical models. Just as a paper airplane provides a representation of how real aircraft work, so Dr. Earn’s models represent other real world processes.

In the example of a paper airplane, you probably experimented with how to make it twirl, climb and dip by folding the wingtips in different ways. If Dr. Earn were modeling the process—and he could—he’d create a set of equations that expressed everything mathematically—the angle and direction of the folds, the variables of temperature and wind and the constants of the laws of aerodynamics.

The resulting hash of lines, numbers and letters might be unintelligible to a layperson. But with testing and refinement, it would be capable of predicting what flight patterns could result from any set of folds and air conditions.

Dr. Earn’s models, however, deal with biological processes with life and death significance. Recently, for example, he’s been focused on creating mathematical models of the spread of infectious disease. Because these models have the power to predict the dynamics of

RESEARCH THAT MATTERS

REAL-WORLD BENEFITS FOR ONTARIANS:

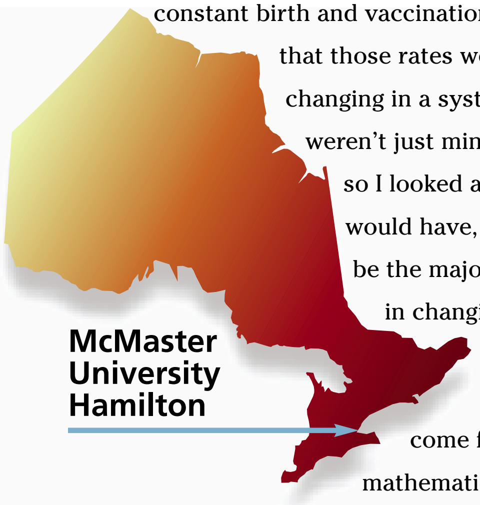
- better understanding and control of infectious disease
- world-class expertise in the widely applicable field of mathematical modeling

an epidemic, they are important tools in devising and testing strategies for vaccination and control.

“You actually build a model that simulates an epidemic,” he explains. “And then you ask yourself whether the mechanisms that you tried to model lead to the sorts of behaviour that you see in the real world.”

One of the key challenges in the creation of any successful mathematical model is determining which variables to include, and which to exclude because they won’t have significant impact. (For example, does the colour of my paper airplane have any effect on its performance? Maybe or maybe not.) As Dr. Earn began to look closely at existing data on the transmission of infectious disease, he realized that previous models of the process had been built on the assumption of relatively constant birth and vaccination rates. “It struck me that those rates were probably changing in a systematic way, and weren’t just minor fluctuations. And so I looked at what impact that would have, and it turned out to be the major driving mechanism in changing patterns of epidemics.

“Things like that come from thinking mathematically,” he continues. “Mathematical models enable you to formalize your assumptions and determine what follows from those assumptions—what really follows, not what intuitively seems to follow. And that’s a big difference.”



Testing, refining and using a mathematical model can demand significant computing resources, especially where large sets of data and complex variables are involved. To that end, the Ontario Innovation Trust has invested in Dr. Earn’s research by helping to fund the purchase of powerful computers and the development of sophisticated software.

Dr. Earn has applied those resources—and his expertise—in other areas of mathematical biology as well. In one example, his mathematical analysis showed that the creation of wildlife corridors may potentially be a factor in the destruction of endangered species, rather than their preservation. The culprit once again is an assumption: that the free movement of a species is always healthy. Dr. Earn’s analysis showed that, under certain circumstances, corridors can synchronize population dynamics. If a population is dwindling in one location, the trend may therefore be duplicated in other areas connected by a corridor, increasing the overall probability of extinction.

But his primary focus remains on modeling infectious disease in humans.

“If we can build a model that successfully explains past patterns of epidemics, then we can use that model to help design improved control strategies, whether that’s through vaccination or through distribution of anti-viral drugs or social distancing measures... It would give me a lot of satisfaction if a strategy that I helped develop was used and helped to save lives.”

Project: Mathematical Biology Research and Computing Infrastructure
Institution: McMaster University
Research Discipline: Natural Sciences/Applied Mathematics
Principal Investigator: David Earn
Trust Investment: $178,041
CFI Investment: $178,041
Total research investment from all sources: $445,102

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Infrastructure for Innovation
About the Ontario Innovation Trust

The Ontario Innovation Trust was created in 1999 by the Government of Ontario to invest in research equipment and facilities at Ontario’s universities, colleges, hospitals and other non-profit research institutions. The Trust is governed by a volunteer Board of Directors, according to the terms of a Trust agreement established by the Ontario government. A small permanent staff looks after day-to-day operations.

Since its inception, the Trust has committed almost $843 million to strengthen Ontario’s position in the global marketplace of ideas. This represents more than a third of the 2.44 billion in total funding that has been invested in Trust-supported projects.