Remarks From Lead Sponsor, Government of Ontario

Bob Delaney, Parliamentary Assistant, Ministry of Research and Innovation

Science has always captured people's imaginations and inspired the greatest stories throughout the ages, Bob Delaney said. The job of science centres is to demystify science and lead people to want and expect more of it.

"As a government, our job is to ensure the education system can do what it needs to do to provide quality science training.... We also understand the importance of basic and applied research through innovation."

The work of science centres helps to foster a culture of innovation, imagination, and learning. Science centres are the places where a global consensus about how to address important issues like climate change will emerge, and it is critical that they be accessible to all.

Frontiers of Science (Part I)

Remarks from Plenary Sponsor, Natural Sciences and Engineering Research Council (NSERC)
Dr. Suzanne Fortier, President

NSERC is the primary federal agency for funding natural science and engineering research in Canada, Dr. Suzanne Fortier said. "Investing in people, discovery, and innovation is what we're all about, with a strong emphasis on attracting the next generation of scientists and engineers and giving them opportunities."

Long before they get involved in their research, though, something has to excite scientists about science and inspire them to pursue their careers, she said. Science centres should be appreciated because they are part of those first inspiring moments. "If we are going to seize opportunities and address the big challenges that face us, we'll need talented people to join together and work together to create solutions."

The morning's panelists are outstanding examples of Canada's science talent, Dr. Fortier said, and she invited each of them to present a brief summary of their cutting-edge research.

Pascale Champagne, Assistant Professor, Department of Civil Engineering, Queen's University

Dr. Pascale Champagne is researching biomass conversion, examining ways organic waste can be used to help create a sustainable bio-economy. By using biomass conversion technologies, such as gasification, bio-refining, and biological organisms, her work is examining ways to create fuels like bio-ethanol and bio-butenol, as well as using some of the materials produced for high-efficiency fuel cells.

Another promising part of Dr. Champagne's research focuses on converting waste materials to higher-value chemicals and bio-products. This involves processing building-block chemicals into bio-polymers and fibres that can be used in carpets, textiles, coatings, and plastics.

The key advantage in this process is that it does not consume materials that are needed elsewhere, as is the case when using corn or other food products to produce fuel. "We're talking about using materials that are problematic right now; we're taking waste and making it into something useful, and by doing so we're also reducing the need to consume other non-renewable resources."

Raymond Laflamme, Institute for Quantum Computing, University of Waterloo, and the Perimeter Institute for Theoretical Physics

Human evolution and development is a cycle of discovering forces of nature, understanding them, harnessing them, and creating devices that make them better, Dr. Raymond Laflamme said. He predicted that the quantum world would provide the next force of nature to transform humanity.

As micro-processing technology advances at a staggering pace, it will soon be possible to work at the atomic level, he said. At that point, a whole different set of laws of physics comes into play. Two things make quantum mechanics different from relativistic laws. The first is that one system can be in two states at one time. The second is a property called quantum cryptography, which dictates that systems cannot be observed without being perturbed.

By using quantum effects, Dr. Laflamme said, it is theoretically possible to greatly increase computation power by creating a new computing paradigm—quantum computing. His research has already succeeded in building simple quantum computers, a first step to doing things formerly considered impossible.

Jaymie Matthews, Associate Professor, Department of Physics and Astronomy, University of British Columbia

Dr. Jaymie Matthews presented a lively overview of some of his research using Canada's space telescope. "Right now it's in orbit around what we know is a habitable world, Earth. The issue of concern is how long it may remain habitable, so we study other stars and planets to learn more about our own world."

The Microvariability and Oscillations of STars (MOST) telescope is tiny by comparison with other telescopes, such as the Hubble. However, it is capable of observing and recording the most precise light changes in stars, changes of as little as one ten-thousandth of one percent. Dr. Matthews described some of MOST's observations, such as the star Tau Bootis, a star very much like our sun but whose planet is 20 times closer than Earth, triggering hot spots and flares in its sun.

By using MOST, it is possible to predict the weather on planets we cannot even see, and know how reflective planets are and what they are likely composed of. And very soon, Dr. Matthews predicted, we will be able to detect other Earth-like planets. "In hundreds of years they'll look back on this time the way we look back at Galileo."

John Parkinson, Molecular Structure and Function Scientist, Hospital for Sick Children

Parasites cause pain and suffering worldwide, Dr. John Parkinson said. They are extremely common and are the cause of serious diseases like malaria, which kills one million children under the age of five each year. Considering the significance of these organisms, very few treatments are available.

Parasitic adaptations are what allow them to flourish. Some have produced the ability to fool their hosts into thinking they are not there. Others develop anticoagulants to allow them to continue feeding on their hosts' blood. By understanding the genes responsible for these adaptations, it will become possible to develop effective treatments.

In the DNA sequences of parasites studied so far, there has been an incredible amount of genetic diversity, Dr. Parkinson said. Identifying genes that are relevant is a significant challenge. Once that has occurred, though, it could be possible to knock out parts of the organisms, effectively muting or eliminating their impacts on their hosts.

Carolyn Ren, Assistant Professor, Department of Mechanical and Mechatronics Engineering, University of Waterloo

Dr. Carolyn Ren's recent research is focused on developing chip devices for conducting biomedical and chemical assays. Her work promises to create whole laboratories that fit in the palm of one's hand, making it possible to bring the lab to the sample, instead of vice versa. Doing so could save significant sums of money and make it possible to address problems like E. coli bacterial contamination of water systems, particularly in the wake of natural disasters.

Dr. Ren demonstrated how microfluidic cell sorter devices can be used to sort and characterize different cells. These devices reduce costs and improve accuracy and reliability. In addition, because the chips are made of polymer, they are inexpensive and disposable, costing as little as $1 each.

Other promising developments include in-line filters and multi-layer fractionation devices, as well as microfluidic cell culture chips that can control reagent dosage to aid in drug therapies. And it is not just the devices that Ren is working on that will save money: her lab is also using computer simulation as a design tool to reduce costs and the time necessary for development.

Nikolaus Troje, Professor, Canada Research Chair, Department of Psychology and School of Computing, Queen's University

In all research, our senses are our ultimate tool, Dr. Nikolaus Troje noted. However, when studying perception, our senses are also the objects of our research. We routinely use adaptations of our perceptions to dictate our social interactions. For instance, we can often recognize a friend at a great distance by the way he or she walks. Although this sounds like a simple process, the implications of sensory perception of biological motion are enormous and quite complex.

Dr. Troje demonstrated how raw data is collected and characterized by the visual system. "The system is obviously very smart, because you can feed it all kinds of stimuli and it creates meaning and context." By creating models and simulators, it is possible to map data sets in three-dimensional space and correlate them to specific groups.

He showed an animated simulation of a person walking and how the gait and movement changed as data points were changed to correspond with more male or female characteristics. Better understanding of pattern recognition has potential for animators and computer graphics, but also is an ideal tool for translating pattern recognition research to the general public.

Warwick Vincent, Department of Biology, Université de Laval and member of the Centre d'études nordiques

By studying how micro-organisms respond to environmental change at Canada's northern edge, Dr. Warwick Vincent is endeavouring to understand the implications and effects of climate change. Arctic bio-systems are incredibly diverse, he said, and contain interesting food chains and different layers of microscopic life.

These microbial systems are helping scientists understand the limits to life and how life developed. But these environments are now rapidly changing, and an important part of the work is to measure how climate change is affecting these unique and diverse worlds.

For example, Dr. Vincent said, measurements of the ice shelves taken in 2002 show that some ecosystems have been destroyed because of the increasing fragility of the ice. Normally, ice shelves block in fresh water, allowing fresh and salt water systems to coexist, moving with the tides. However, in 2002, the ice cracked, allowing the fresh water to escape. As a result, the whole diversity of the micro-system was lost. "Every year we learn new things about life support systems and biodiversity—real insights into how fast our environment is changing."

Mary Anne White, University Research Professor, Department of Chemistry and Director of the Institute for Research in Materials, Dalhousie University

One important aspect of Dr. Mary Anne White's research focuses on how much energy we waste and the possibility of putting that energy to use. For example, only 25% of the energy produced in the internal combustion engine actually moves a car. The majority of the rest is released through the exhaust system.

Dr. White showed several devices that use innovative approaches to turn heat into power. One such device is the Ecofan, which sits atop woodstoves and circulates their heat. Thermoelectric devices use semiconductor elements that cause currents to flow, converting heat to power, which turns the fan blades.

The biggest challenge right now, Dr. White said, is to increase the efficiency of these devices and to develop new materials with reduced thermal conductivity that reduces the backflow of heat so that it will be easier to turn waste heat to power.

Paul Wilson, Canada Research Chair in DNA Profiling, Forensics and Functional Genomics, Trent University

Using genetic markers to identify people is standard in forensic identification. However, the same techniques, when applied to non-humans, can help preserve endangered species, reduce the environmental impact of mining and other activities, and be used to apprehend illegal hunters and poachers, Dr. Paul Wilson said.

Using robotic equipment, his laboratory can process thousands of samples daily and has developed DNA markers for biological materials that establish how many genetic populations of particular species exist; the level of genetic diversity; and the effects of climate change, harvesting, and human infiltration into their ecosystems.

The technology allows samples to be taken non-invasively. Over 2,000 individual caribou have been characterized using samples from scat without the animals actually being touched. The genetic information can also provide important data about breeding problems.

Another interesting facet of the work, Dr. Wilson said, is using high-sensitivity DNA diagnostics to test ivory and other animal products to determine whether they are from endangered species, or to compare samples from illegal hunt sites to samples collected from suspected poachers.