McMaster University JELF Recipients & Project Descriptions
February 2017 Announcement

JELF recipient: Milena Head, professor, information systems
Project title: Flexible NeuroIS User Experience Lab
CFI funding: $284,411

Mobile Information and Communication Technologies (ICTs) are ubiquitous. Mobile devices such as phones and tablets have become essential to our contemporary professional, educational, and social activities. The purpose of the Flexible NeuroIS User Experience Lab is to study the influence of the widespread mobile ICT and Human Computer Interaction (HCI) phenomena on multiple co-located individuals simultaneously. This timely and critical research will allow us to investigate a myriad of contexts where ICT use has become prevalent. The novel versatile design of the lab emphasizes flexibility such that the space can be easily reconfigured to mimic different natural professional, educational, and social settings.

Research at the Flexible NeuroIS User Experience Lab will further the work of our interdisciplinary research team by allowing us to combine traditional behavioural research methods and cutting-edge neurophysiological techniques. Such triangulation will enable innovative research that provides deeper and richer insights on the contextual factors pertaining to mobile technology use and misuse. This timely research program will play a critical role in addressing the rising concerns on mobile ICT impacts on the Canadian society and economy. It will also function as a world class training facility for highly qualified personnel in this field. This in turn will make Canada a global leader, establishing best practices in a digital economy that is driven by innovations in ICT.

JELF recipient: Yu Lu, assistant professor, biochemistry and biomedical science
Project title: Proteomics Laboratory to Investigate Alternative Splicing Regulation in Stem Cell Differentiation
CFI funding: $400,000

Induced pluripotent stem cells hold great potential for cell therapies. Once triggered with the right conditions, these cells can quickly change gene expression profiles and terminally differentiate into any cell types for clinical use. Despite recent progress in optimizing differentiation protocols, production of specific cell populations from induced pluripotent stem cells remains empirical and inefficient, due to a lack of understanding in stem cell differentiation mechanisms. Discovering novel differentiation mechanisms using systematic tools like proteomics is crucial for development of effective stem cell therapies.

The proposed research will request a PROTEOMICS PLATFORM to establish a new proteomics laboratory in the Faculty of Health Sciences at McMaster University. The requested infrastructure is required for Dr. Lu to develop novel proteomics research methods to study alternative splicing regulatory mechanisms. Leveraging the existing research strengths in stem cell biology and bioinformatics at McMaster, he will collaborate with experts in these fields to investigate the mechanistic role of alternative splicing in stem cell differentiation. The proposed research program will directly contribute essential knowledge for development of stem cell therapies to treat human diseases and will directly address the great need to continuously improve human health. It will also train vitally needed high quality personnel demanded by Canada's booming biotechnology sector.

JELF recipient: Jonathan Bradley, assistant professor, engineering physics
Project title: Infrastructure for Development of Advanced Silicon Photonic Materials, Devices, and Microsystems
CFI Funding: $155,000

Driven by technologies such as social media, cloud computing, and streaming high definition video, society's bandwidth needs are growing rapidly. With no end to this growth in sight, the limits of current data communications systems will be reached soon. Silicon photonics, a platform where high-speed optical data links are integrated alongside electronic processors on tiny, energy-efficient, and low-cost silicon chips, can provide a scalable and economical solution to these rising demands. Nevertheless, fundamental challenges must still be solved for silicon photonic systems to reach their envisioned potential. Most critically, silicon is a poor light amplifying and emitting material. Thus, bulky off-chip components or complex integration approaches are currently required to generate light or re-generate weakened high-speed signals in silicon photonic networks.

In this project we will develop an alternative approach, whereby low cost materials such as rare-earth-doped oxides are integrated directly on the silicon chip to emit or manipulate light in ways that silicon cannot and amplify high-speed signals. In addition, these materials and methods will enable many other important devices and applications of silicon photonic microsystems in communications, environmental sensing, health care, and space. The research will lead to training and job creation in advanced technologies and ensure Canada remains a leader in photonics and next generation high-speed networks development.

JELF recipient: Charles de Lannoy, assistant professor, chemical engineering
Project title: Electro-Functional Membranes: Selective Separations and Catalytic Degradations of Environmental Contaminants
CFI funding: $125,000

A growing number of pollutants of human health and environmental concern are entering Canadian and global water and wastewater systems. Membrane separation is currently the most effective technology for purifying water, but conventional membranes are insufficient for the efficient separation of emerging pollutants. Furthermore, membranes lack mechanisms for pollutant degradation. The proposed research addresses these environmental challenges by leading advancements in a new frontier in membrane science - active membranes. Previous research has lead to the development of electrically conductive/active polymer nanocomposite membranes able to perform aqueous solute separations with high efficiency.

The proposed research aims to advance the field by developing a novel suite of active membranes for both separation and catalytic reduction of emerging pollutants. These novel active membranes will be able to both separate and treat solutes in situ. Not only will the study and development of such membranes push the boundaries of membrane science, but their use in water and wastewater treatment will improve the quality of Canadian waters and wastewater at greater efficiency and lower cost, thereby improving the health of Canadians, providing economic savings, protecting our environment, and adding innovation to the Canadian water industry.

JELF recipient: Mick Farquharson, professor, School of Interdisciplinary Science
Project title: The Development of a Clinical Environment Compatible Surgical Oncology Margin Detection System
CFI funding: $113,553

Breast cancer is responsible for 30% of deaths in Canada. There is a need to optimize speed and accuracy of diagnosis and maximize efficiency in treatment of this disease. The goal of breast cancer surgery is to remove the tumour completely, but leave as much healthy tissue as possible in place. Finding the tumour/healthy border can be problematic for surgeons while operating and complete removal may not be confirmed until several days later. Presently about 25% of breast cancer patients will require repeat surgery. The work outlined in this proposal will greatly improve the efficiency of breast cancer surgery by enabling complete removal of the tumour. Work already underway will be continued by the research team, developing a system that can examine breast tissue in real time during surgery and classify it as either cancer or normal allowing the surgeon to detect the cancer/healthy border quickly and accurately.

The work combines two techniques, an optical light system and an X-ray system. The data obtained will inform the surgeon if the border has been reached. The project has an expert team involving experienced researchers at McMaster University and breast cancer surgeons and pathologists at the Juravinski Cancer Centre. The results will benefit breast cancer patients resulting in more efficient surgery, reducing cases of repeat surgery, decreasing patient anxiety, improving the quality of life and saving valuable resources for Canada's health providers.

JELF recipient: David Ogborn, associate professor, communications studies and multimedia
Project title: Networked Imagination: A Laboratory for Network Music and Live Coding
CFI funding: $188,123

A massive expansion of electronic networking has led to fundamental changes in the way that human societies (small workgroups, large organizations, transnational entities) conduct their affairs. While networked collaboration has become an everyday reality, many of our practices and software interfaces emphasize models and metaphors based on the isolated worker. This hampers efficiency and creativity because such metaphors are inadequate to the complex systems in which we are immersed. The proposed Networked Imagination Laboratory will create software interfaces and practices in which the collaborative potentials of networking are unfolded into new models. What might work look (and sound) like if it were taken as axiomatic that human productivity is unavoidably collective, conversational, and networked?

Network music and live coding provide a concrete, arts-based research setting in which possible answers to this question can be rapidly conceived, implemented and tested. Network musicians perform with globally distributed collaborators over the Internet, while live coding performers write and rewrite programs, sharing both the results and the act of programming with an audience. In both fields, collaboration needs to happen very quickly, and situational awareness is a key resource and challenge. Approaches to collaboration that emerge from these highly time-sensitive contexts will be applied to other contexts such as data sonification and computational literacy.

JELF recipient: Oleg Rubel, assistant professor, materials science and engineering
Project title: Multiscale Functional Material Modelling for Energy Applications
CFI funding: $100,000

Climate change and current world dependency on fossil fuels are key challenges that drive the development of advanced options for power conversion devices, as well as a more efficient energy infrastructure including communication technologies. The ability to propose transformative solutions in energy areas relies on an understanding of functional materials and the relationship between their structure and properties. Material modelling accelerates technological advances through analysis and simulation of novel materials, which allows the assessment of their potential at an early stage.

The requested infrastructure will play a crucial role in studying the perspective solar cell materials with the goal of making solar energy cost competitive with conventional electricity sources. The efficiency of energy utilization will be addressed through improvement in lighting systems, as well as telecommunication networks that are integral components of future smart cities. The advancement is to be achieved by engineering materials with low intrinsic losses that are responsible for more than half of energy wasted in light-emitting diodes and lasers. This initiative facilitates the creation of high-tech industry jobs (electronic, energy, and functional materials industry), which accelerates material discoveries and helps introduce new technologies into the marketplace. This ultimately contributes to our economic prosperity and decoupling of the Canadian economy from the global oil market.