



Brock University

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Brock Strategic Research Plan

Brock is well on its path to becoming a comprehensive and more research-intensive university. In its progress toward this goal, Brock continues to value equally excellence in teaching and in scholarship. Indeed, research-led teaching by "teacher-scholars" can be viewed as one of the underlying principles of the university experience at the undergraduate and graduate levels. Brock has ensured that this commitment to teaching and research is in word and deed.

Creating a research-intensive university requires policies and procedures, adequate and appropriate administrative support structures, and financial resources to encourage and support research faculty and students to effectively conduct their research.

Over the last six years, Brock has invested significantly in new teaching facilities (e.g., Academic South) as well as research laboratories, particularly in Applied Health Sciences, Mathematics and Sciences and Social Sciences. As I noted in a previous column, the University does need to develop a "Strategic Research Plan" (SRP). A SRP will help determine what it means to be a research-intensive university and outline the ways in which the University will achieve this status. The development of a SRP will take time, but I am hopeful that with the assistance of the Standing Committee on Teaching and Research Policy and the Deans, we can develop a SRP for presentation to Senate in the autumn of 2005.

In the late spring, we will initiate a series of consultations with faculty members, graduate students, administrative staff, and external sponsors of research to prepare the report to Senate. My anticipation is that the SRP will help set the stage for establishing goals that will lead to strategic investments in research and scholarship over the next five years.



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Brock Professor searches for answers to aging

What if we could age more slowly or age without developing debilitating declines in physiological performance? Jeff Stuart, an Assistant Professor with the Department of Biological Sciences, is working to discover how the aging process works. It is his belief that if we can understand how cells age, then perhaps one day we will be able to prevent some of the disorders that plague the aged.

Dr. Stuart's research focuses on mitochondria. A popular theory of aging suggests that an underlying cause of human aging can be traced to mitochondria, the tiny energy producing structures found within every human cell. Energy produced by mitochondria is required for all of the things that cells do in the body — in muscles, nerves, liver — everywhere. Without the energy mitochondria provide, cells and people cannot live.

But the process by which mitochondria make energy — oxidative phosphorylation, can be downright dangerous. During oxidative phosphorylation, voltage differentials are set up across the mitochondrial membrane, and high energy electrons are passed from place to place during a series of chemical reactions. Even under ideal conditions, some of these high energy electrons escape containment and undergo undesirable reactions with

oxygen to form highly toxic chemicals called free radicals.

Free radicals are the bane of the youth-obsessed, and the target of a myriad of antioxidant pills, creams

and salves. Stuart says, "This is because free radicals 'hit' parts of the cell including DNA, and undergo

chemical reactions that cause all kinds of damage." Free radical damage has been implicated as an underlying cause not only of aging, but also of cancer and neurodegenerative diseases like Alzheimer's and Parkinson's.

This is where the mitochondrial theory of aging fits in. "Mitochondria have their own DNA which is completely separate from the DNA in the nucleus that everyone knows about," says Stuart. Because mitochondrial DNA is located right next to where free radicals are being produced all the time, it takes a lot of hits, thus sustaining considerable damage. The result is the formation of mutations that can eventually destroy the integrity of mitochondrial DNA, leaving the mitochondria unable to produce energy for the cell. This seems to be happening in the cells of aging humans.

Luckily, mitochondria contain enzymes that scan their DNA, finding areas damaged by free radicals and fixing them. This keeps the

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Dr. Jeff Stuart

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mitochondrial genetic code from becoming mutated — it's like the continual proofreading and correcting of a manuscript in which new errors keep popping up. Most of these DNA repair enzymes were discovered in mitochondria only quite recently, within the past five to 10 years. So, how they work is still something of a mystery. Equally mysterious, is how cells control and regulate the DNA repair process in mitochondria.

Dr. Stuart believes that if we could understand these processes, then perhaps we could discover how to trick cells into doing a better job of repairing the DNA, and more effectively counter the accumulation of free radical damage with time.

This could help us to keep mitochondria working properly and postpone some of the physiological deterioration that accompanies aging.

His research is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC), the Canadian Foundation for Innovation (CFI) and the Ontario Innovation Trust (OIT).

The aging process can be one of uncertainty and fear, but with research like Dr. Stuart's, when the mystery of how we grow older is solved, then perhaps we won't look to old age with trepidation, but rather understanding.

~ Allen McCreath

The power of numbers: How mathematics formulas are impacting our lives

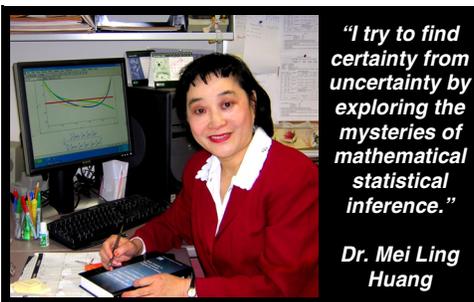
Dr. Mei Ling Huang likes to create order from chaos. This mathematics professor says, "I try to find certainty from uncertainty by exploring the mysteries of mathematical statistical inference." An intimidating term, she explains how she will utilize the theory, tools and technologies of statistics to analyze undiscovered patterns in databases. Simply stated, statistical inference applies mathematical ideas to the organization of numerical data in order to draw conclusions or to draw inferences from it.

A distinguished Brock researcher since 1991, Dr. Huang began her study of mathematics at the Hobei Normal University in China where she received her BA. She then received her MSc at the China Academy of Railway Science, and after coming to Canada to pursue her education at the University of Windsor, obtained her second MSc. In 1987, while embarking on her PhD thesis, Dr. Huang's involvement in application of medical research influenced her to develop mathematical formulas that could be applied to medical research, agriculture and telecommunications systems.

The study of statistical inference involves searching for the optimal statistical methods for accuracy estimation, prediction and modeling to measure true values. While studying and developing new theories in the field of *nonparametric quantile and regression inference*, Dr. Huang is challenged with the reality that not all data is normally distributed. She says, "This particular research is very important because it allows you to discover the characteristics of the *true* population based on a random sample."

Statistical inference can be applied to risk analysis, economics and quality control. Dr. Huang explains that while work-

ing on both theory and computational simulations regarding Internet waiting time, it is important to estimate the waiting time distribution, mean and variation for designing an Internet network based on random samples. "In order to compute the probability of losing customers, it is also important to estimate and design how



many telephone lines are needed in a telephone network based on these samples," she says.

In many situations, data are missing and censored. Based on these incomplete data, Dr. Huang has studied the best estimation and prediction methods — applying *inference methods for truncated and censored data* to biostatistics, industrial engineering and other fields. For example, the recovery time of a cancer patient can be estimated based on random samples. When medical factorial design analysis is implemented, the best medical treatment and predicted recovery time of the cancer patient can be achieved by examining variables such as drug selection, treatment options, type of cancer, gender and age of patients.

Dr. Huang, who has worked closely with Environment Canada, explains that factorial design analysis can be applied to agriculture as a means of quality control in order to help improve flavour and cure diseases in fruit before seeding. During the

last 10 years, third and fourth year Brock students have been engaged in projects involving several different treatments being tested and compared over a growing season.

According to Dr. Huang, statistical inference is a decision procedure with conclusions and predictions resulting from observing chance outcomes that occur in carefully planned experiments or investigations of an unknown population. This challenging work has consumed much of her time over the last 20 years, and she admits that making it understandable for the average layperson may be just about as difficult.

Dr. Huang's focus is to apply mathematics to the real world. She describes her research as interesting, very useful and important — benefiting a wide field. She says, "A mathematics formula is a powerful tool that can be applied to many different things. It is used to conquer problems and challenges in regards to improving the quality of human life, ultimately creating a better world." Dr. Huang's research delves into the chaos that is uncertainty and leaves us with stability and assurance.

~ Lynne German

The Office of Research Services is embarking on a strategic planning exercise. As a first step in this process, ORS is conducting a self-study of services it provides to faculty members and to sponsors. Late in February, ORS will be circulating a survey to faculty members to seek their assessment — what it is that we do, what we do well and not so well, and what additional services we should be providing.