UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

Report No. 3541 Revised

MEMORANDUM

To: Executive Committee of Faculty Council (March 21, 2017)
Faculty Council (April 10, 2017)

From: Professor Markus Bussmann
Chair, Engineering Graduate Education Committee

Date: April 5, 2017

Re: **Collaborative Master's Specialization in Psychology and Engineering**

REPORT CLASSIFICATION

This is a major policy matter that will be considered by the Executive Committee for endorsing and forwarding to Faculty Council for vote as a regular motion (requiring a simple majority of members present and voting to carry).

RATIONALE

The Department of Mechanical & Industrial Engineering is proposing to create a Collaborative Master's Specialization in Psychology and Engineering (PsychEng), as described in the attached. This collaborative specialization will involve MIE and the Department of Psychology in the Faculty of Arts & Science, and will be led by FASE.

Establishing the collaborative specialization will benefit graduate students and faculty in both departments who are interested in the overlap between psychology and engineering by creating a community of practice – an intellectual and physical place where they can research, learn, practice and create.

PROCESS AND CONSULTATION

The proposal has been written by MIE with input from the Department of Psychology and the Dean's offices in the Faculty of Applied Science & Engineering and the Faculty of Arts & Science. It has been approved by the Engineering Graduate Education Committee, which includes the graduate chairs from graduate departments and institutes, and graduate student representatives, and will be considered for approval by the Councils of both Faculties.

PROPOSAL/MOTION

THAT the creation of a Collaborative Master's Specialization in Psychology and Engineering, as described in Report 3541, be approved effective September 2017.

UNIVERSITY OF TORONTO

New Graduate Collaborative Specialization: Major Modification Proposal

Psychology and Engineering

Department of Mechanical & Industrial Engineering
Faculty of Applied Science & Engineering
University of Toronto

This template has been developed in line with the University of Toronto's Quality Assurance Process.

Name of Proposed Collaborative Specialization:	Collaborative Master's Specialization in Psychology and Engineering
Lead Faculty:	Applied Science & Engineering
Lead Faculty Contact:	Professor Markus Bussmann, Vice-Dean, Graduate Studies
Lead Department Contact:	Professor Li Shu, Mechanical & Industrial Engineering
Anticipated Start Date of New Specialization:	September 2017
Version Date:	April 5, 2017

University of Toronto

New Graduate Collaborative Specialization: Major Modification Proposal

Psychology and Engineering

Department of Mechanical & Industrial Engineering
Faculty of Applied Science & Engineering
University of Toronto

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1. Specialization Rationale

This proposal is for the creation of a Collaborative Master's Specialization in Psychology and Engineering (PsychEng). This specialization will involve the Department of Mechanical & Industrial Engineering (MIE) in the Faculty of Applied Science & Engineering (FASE) and the Department of Psychology (PSY) in the Faculty of Arts & Science (FAS), and be led by FASE.

Engineering involves the creative application of science to the design of systems, processes, structures and technologies. Psychology is a science that focuses on the mind and behavior of people and animals to understand individuals and groups across all levels of analyses, from the cellular to the cultural. The Psychology and Engineering Collaborative Specialization will draw students interested in contributing to the growing interdisciplinary scholarship at the nexus of psychology and engineering, including the following potential areas of synergy:

- Engineers design and create many objects intended for use by humans. The field of human factors has long recognized the importance of how humans perceive and interact with such objects. Engineered systems that inadequately address human factors have led to injuries and fatalities through errors in medication dosage, automobile accidents, and nuclear power plant disasters. Products that effectively prioritize human factors are not only safer and easier to use, but also more pleasurable to use (e.g., Apple products), often setting new standards for such products.

- More recently, design theory and methodology has recognized the importance of cognitive aspects of design to the success of the engineering process, which despite progress towards automation, is still mostly human-driven. For example, the phenomenon of "design fixation", or being overly influenced by existing examples and prior experience when designing products, is currently receiving much attention. In addition to the functioning of human designers and operators (e.g., of automobiles, medical equipment, nuclear power plants), the behavior of human consumers is increasingly important to engineers. An emerging field within design theory and methodology aims to design products to modify human behavior, e.g., towards resource conservation. Such products could exploit cognitive and social biases, as well as potentially biases in awareness of perception.

- While psychologists study the reactions of individuals and groups to the world, including the designed world, engineers aim to change the designed world, potentially expanding the range of stimuli that can be studied by psychologists. For example, in addition to robotic systems that work alongside or are used by people, human-like social robots are being developed with the social functionalities and behavioral norms required to engage humans in natural assistive interactions, such as providing: 1) reminders, 2) health monitoring, and 3) social and cognitive training interventions. Not only can improved understanding of psychology better inform the design and creation of engineered systems, but the behavior of engineered systems may reveal insights and provide models that are not salient otherwise. In another example, the computational geometry used to create points, lines and surfaces may be relevant to how such features are recognized and processed by humans. Therefore, not only can cognitive processes act as models of computation, but models of computation may also inspire conceptual realizations of cognition.

- There are also numerous interactions between psychology and artificial intelligence within information engineering. The representation of common-sense knowledge for concepts such as time, space, shape, process, and physical objects, plays a critical role in both cognitive psychology and the implementation of enterprise information systems. Numerous applications support reasoning with this knowledge, and research about causal reasoning and scene recognition within cognitive psychology can form the basis for automated systems within advanced manufacturing.

- Finally, there is substantial opportunity to inform the field of operations research with modern psychological understanding of human abilities and biases. While operations research is primarily concerned with the optimization of quantitative representations of human and automated systems (e.g., a factory, an organization), there has traditionally been little representation of the psychological reality of individuals and groups within the optimized system. The ability to represent, quantify, and reason about the psychological reality of human behavior has the potential to provide much richer models of complex systems and concomitantly better solutions to the real problems that the models represent.

Establishing this Collaborative Specialization will benefit graduate students and faculty interested in the overlap between psychology and engineering, by creating a community of practice – an intellectual and physical place where faculty members and students can research, learn, practice, and create.

More broadly, this specialization will strengthen ties between the Faculty of Applied Science & Engineering and the Faculty of Arts & Science, and yield findings that may propel research of interest to both Faculties beyond what is possible individually.

2. Participating Programs, Degrees and Names of Units

Master of Applied Science (M.A.Sc.), Department of Mechanical & Industrial Engineering (MIE), Faculty of Applied Science & Engineering

Master of Arts (M.A.), Department of Psychology, Faculty of Arts & Science

3. Objectives, Added Value for Students

Academic Objectives

The overall objectives of the proposed Collaborative Specialization are to:

- Facilitate and promote applied research at the intersection of psychology and engineering:
    - enable engineering graduate students to apply psychology in their work, and

  - provide psychology graduate students with engineering applications, methods and tools for their work
- Produce graduate students with expertise at the intersection of psychology and engineering;
- Create a forum for faculty and students to develop and expand their interests in PsychEng;
- Establish a community and focal point for PsychEng scholarship at the University of Toronto.

The PsychEng Collaborative Specialization will serve masters-level students who are interested in the intersection of psychology and engineering by providing access to learning experiences that currently do not exist at the University of Toronto. The primary benefit to students is improved capacity to pursue, understand, discuss, and apply psychology to research in engineering, and to apply engineering to research in psychology. This specialization will allow students to obtain a unique combination of competencies not currently available through a formal program, by completing related courses and immersion in a like-minded cross-disciplinary community, and by pursuing independent PsychEng-related research through projects that will normally fit within one or a combination of the following areas:

1. Human-factors/human-centered engineering – designing and creating objects that address needs and anticipate human limitations, informed by advances in psychology;

2. Engineering design theory and methodology – applying results from social and cognitive psychology to improve the quality and effectiveness of the engineering design process;

3. Engineering-enabled psychology – expanding the range of stimuli that can be studied by psychologists – e.g., the creation of human-like social robots that implement existing models of behavior may further inform such models;

4. Interactions between psychology and artificial intelligence – within information engineering, studying the roles of common-sense knowledge for concepts, e.g., time, space, shape, process, and physical objects; reasoning with such knowledge in cognitive psychology and engineering;

5. Psychology-informed operations research – using modern psychological understanding of human behavior, abilities and biases to provide much richer models of complex systems and concomitantly better solutions to the real problems that such models represent;

6. Psychological and neurological health – applying engineering tools to actualize new psychological discoveries into applications and products that support psychological and neurological health.

Academic objectives specific to the masters-level programs are described in Section 5.

Size and Anticipated Demand of Specialization

The creation of a PsychEng Collaborative Specialization will best serve students by leveraging strengths existing in the more traditional fields of psychology and engineering. By bridging between these programs and building upon their solid foundations, the specialization will provide an enrichment that will expand students' career opportunities after graduation.

The proposed specialization will be modest, with a steady state enrolment of approximately 10 students, roughly evenly split between the MIE and Psychology departments. This corresponds to each core faculty member having on average, one half (e.g., potentially shared) student in the Collaborative Specialization at a given time. Attaining this enrolment would require that the participating departments each typically admit five master's level students per year. Satisfying this admission rate with high quality students should be achievable given:

i. The number of graduate students in each of the departments whose research already overlaps the other department;
ii. The students currently and planning to be co-supervised by faculty in the two departments;
iii. The recent growth and interest in PsychEng in the United States and globally.

There is already significant student interest in PsychEng-related graduate studies and research. This interest should increase with a formalized PsychEng Collaborative Specialization supported by a marketing campaign. In fact, current MIE graduate students in human factors (four faculty members) and in design theory and methodology (one faculty member) are already pursuing PsychEng-related thesis topics, and Psychology faculty members also already have engineering students in their laboratories. Currently, one graduate student is being co-supervised by MIE and PSY faculty members, and at least one more is planned. Further demonstrating a synergistic relationship between the two departments, at least one MIE faculty member obtained both undergraduate and graduate degrees in psychology, and at least one Psychology faculty member obtained both undergraduate and graduate degrees in the physical and computing sciences. Anticipating sufficient student interest following the creation and promotion of the proposed PsychEng Collaborative Specialization is thus realistic.

Some of the highest ranking US engineering programs have long recognized and supported the synergistic relationship between psychology and engineering, just three examples of which follow. At Georgia Tech, the School of Psychology offers five different research areas: Cognition and Brain Science, Cognitive Aging, Engineering Psychology, Industrial/Organizational Psychology, and Quantitative Psychology. At the University of Texas, Austin, a Behavioral Neuroscience program in the Department of Psychology includes faculty members in Engineering. The University of Illinois, Urbana-Champaign boasts exceptional research facilities including the Beckman Institute, a 313,000 square foot facility conducting interdisciplinary research across physical and biological sciences, engineering, psychology and neuroscience.

Benefits to Students and their Educational Experience

The educational experience of students will be enriched through the Collaborative Specialization's course requirements, multidisciplinary focus, exposure to other viewpoints, and topics of thesis research identified above. The specialization will create a vibrant community of practice and focal point for the pursuit of PsychEng scholarship. Students immersed in this diverse intellectual community will be able to enrich their training and research experience by interacting with PsychEng experts and exchanging ideas with likeminded colleagues. The collaborative structure will allow students access to the existing expertise and courses within the partner Faculty.

Upon completion of the specialization, students will receive a notation on their transcript acknowledging the knowledge and expertise they have acquired. Communicating the PsychEng objectives and student competency outcomes to Canadian universities and industry will raise awareness and comprehension of the added value of PsychEng graduates. Students completing the specialization will have knowledge at the nexus of psychology and engineering practice, in addition to expertise relevant to their home program of study. Through their PsychEng-related research and course work, they will acquire expertise in the application of psychological theory in the context of engineering and/or the use of engineering tools and methodologies in the field of psychology.

Depending on the topic of their research projects, students will gain in-depth knowledge of: human factors engineering, design methodology, information engineering, operations research, engineering-enabled psychology, and engineering to support psychological health. Thus completion of the PsychEng Collaborative Specialization may open the door to career options in addition to those normally available to graduates from the respective home programs, including:

- Academia, human-centered design and manufacturing (e.g., how to reduce worker fatigue and improve safety);
- Human resources and professional development (e.g., how to improve worker productivity and satisfaction);
- Behavior change fields in medicine and sustainability (e.g., how to improve health self-care and consumer care for the environment);
- Policy analysis for advocacy groups (e.g., how to improve societal acceptance and improved adoption of technological and other advances); and
- Government (e.g., developing tools to increase engagement of citizens, or procedures for reducing the risk of terrorism though the design of security systems).

The specialization will add value to students' educational experience by providing a multidisciplinary forum for learning, the exchange of ideas, and the pursuit of research.

Students will participate in a seminar course that will provide a common learning experience, and take two PsychEng-related elective half-courses. Completion of these courses will count towards meeting their home program requirements. Specialization and course requirements are described in Section 5.

Similarities and Distinctions from Existing Specializations

No specializations currently exist at the University of Toronto or in Canada for students with an interest in PsychEng. While these programs do exist internationally, it is worth noting that while the term “engineering psychology” is frequently used synonymously with “human-factors engineering”, the proposed specialization includes human-factors engineering and the other areas of synergy identified above. The collaborative structure of the specialization will allow students to build a solid foundation within a traditional field, while providing a bridge between fields. Students will thus acquire depth of expertise in engineering or psychology through their home programs, along with integrative expertise in engineering psychology through the collaborative elements.

4. Admission and Collaborative Specialization Requirements

Applicants must be accepted into one of the participating graduate degree programs (M.A.Sc. in the Department of Mechanical & Industrial Engineering or M.A. in the Department of Psychology) before being accepted into the Collaborative Specialization.

In addition to satisfying the home degree admission requirements, applicants will provide a statement of purpose in which they describe their background or experience relating to engineering, psychology, and their intersection, and why they are interested in pursuing graduate studies in PsychEng.

It will be the applicant’s responsibility to find an appropriate supervisor to supervise them and support their thesis research; thus applicants will be expected to contact and meet with potential supervisors among the core faculty of the Collaborative Specialization during the application process. The supervisor will provide a letter of recommendation in support of the student’s application to the Collaborative Specialization. As part of this process, the supervisor and student may choose to engage a subsidiary supervisor from the collaborating department. Envisioned is a possible co-supervision arrangement between the home-degree-program supervisor and another faculty member where the degree-program supervisor has primary responsibility for academic and administrative matters (i.e., responsible for ensuring the student is advised on the rules and regulations of the home-degree-program thesis process). One or both supervisors may choose to support the student’s application through discussions with the PsychEng Collaborative Specialization Director, and when needed, the PsychEng Collaborative Specialization Committee. The final decision to admit the student into the collaborative specialization is up to the Director and Committee.

Students will take a 0.0-weight seminar course APS1305Y PsychEng Seminar Series (CR/NCR) and complete two PsychEng half courses (totaling 1.0 FCE), at least one from the other participating department, as two of the electives within their home program course requirements. Further, as is normally the case for Collaborative Specializations, the thesis requirement for the home program will be focused on a topic in the area of PsychEng.

Upon certification by the Collaborative Specialization Director that all requirements of the Collaborative Specialization have been fulfilled, completion of the specialization will be noted on the student's transcript.

Specialization and Course Requirements

All students will take a common, required 0.0 weight Type I weekly seminar course, APS1305Y PsychEng Seminar Series (CR/NCR) for two sessions. M.A.Sc. students may elect to attend a second year if they find the seminar helpful for research. This will help build community among the students in the specialization. The seminars will also be open to other faculty and students, to further build the PsychEng community. This will be the common learning element of the Collaborative Specialization, and will contribute towards the MIE seminar requirement for MIE students.

Presentations, workshops, and discussion will be used in the seminar course to introduce theoretical foundations, methods, and techniques related to PsychEng research. Topics may change from year to year and may include: hypothesis generation, concept and knowledge mapping, survey design, mixed methods, ethics approvals, facilitating workshops, proposal writing, and preparation of manuscripts.

Faculty will present their relevant research, and students will present their work at various points to obtain feedback, with more advanced students having increasing involvement. Students will deliver a seminar on their research topic during their first term, and after designing and carrying out one or more experiments with input from other seminar participants, they will present their research results in their second term.

In addition to the core seminar course, students will complete two elective half courses as part of their existing home program requirements, cross-listed by the partner department as required. These will be chosen from a subset of the existing courses within Psychology and MIE. At least one course must be from the non-home faculty, subject to exclusions.

There are several MIE graduate courses that do not require extensive undergraduate background in engineering. Therefore, a combination of identifying these courses, and admission and advising of students will help psychology students succeed in their MIE course.

Examples of suitable MIE/KMD Courses include:

- MIE1070: Intelligent Robots for Society (Nejat)
- MIE1402: Experimental Methods in Human Factors Research (Chignell)
- MIE1403: Analytical Methods in Human Factors Research (Milgram)
- MIE1412: Human-Automation Interaction (Jamieson)
- MIE1415: Analysis and Design of Cognitive Work
- MIE1505: Enterprise Modeling (Grüninger)
- MIE1510: Formal Techniques in Ontology Engineering (Grüninger)

- MIE1720: Creativity in Conceptual Design (Shu)
- KMD2001: Human Centred Design (Chignell)

<u>PSY Courses</u>

PSY1000 Directed Studies
Under the direction of a two-person committee (one from each of the partner faculties if appropriate), students in the first year of the master's program will (a) complete a programme of prescribed reading in their general area of specialization (b) prepare a major paper, which will include a proposal for master's-level thesis research (c) defend the paper to the satisfaction of the two-person committee.

In addition to PSY1000, all graduate psychology courses offered in the 5000 series will be available to all students in the collaborative specialization. Not all 5000-level courses are available every year. Please consult the program for the courses available each year. Courses not available to MIE students in the specialization include PSY2001, PSY3001 and PSY2002.

The list of available courses may change periodically, and students may take alternative courses that better meet their academic needs, with approval of their supervisor. The Director of the PsychEng Collaborative Specialization would review annually and modify as needed the elective course list. Students are to select at least one elective course offered by the partner Faculty so as to broaden their educational experience.

<u>School of Graduate Studies Calendar Copy</u>

CALENDAR ENTRY

Psychology and Engineering

Lead Faculty:
Faculty of Applied Science and Engineering

Participating Degree Programs:
Mechanical & Industrial Engineering – M.A.Sc.
Psychology – M.A.

Supporting Unit:
Department of Mechanical & Industrial Engineering

Overview:
The Collaborative Master's Specialization in Psychology and Engineering (PsychEng) is between the Department of Mechanical & Industrial Engineering (MIE) in the Faculty of Applied Science & Engineering (FASE) and the Department of Psychology (PSY) in the Faculty of Arts & Science (FAS).

Engineering involves the creative application of science to the design of systems, processes, structures and technologies. Psychology is a science that focuses on the mind and behavior of people and animals to understand individuals and groups across all levels of analyses, from the cellular to the cultural. The Psychology and Engineering Collaborative Specialization supports graduate students and faculty interested in contributing to the growing interdisciplinary scholarship at the nexus of psychology and engineering. Fields of study that may benefit from this collaborative specialization include, but are not limited to: human factors, design theory and methodology, artificial intelligence and information engineering, operations research, and robotics. This specialization strengthens ties between the two departments, and may propel research of interest to both beyond what is possible individually.

Upon successful completion of the degree requirements of the participating home department and the collaborative specialization, students receive the notation “Completed Collaborative Specialization in Psychology and Engineering” on their transcript and parchment.

Contact and Address:
Web: http://gradstudies.engineering.utoronto.ca/
E-mail: psych_eng@mie.utoronto.ca
Telephone: 416-946-3028
Fax: 416-978-7753

Collaborative Specialization in Psychology and Engineering
Department of Mechanical & Industrial Engineering
5 King’s College Road
Toronto, Ontario M5S 3G8 Canada

Psychology and Engineering: Master’s Degree Level

Admission Requirements:

- Applicants to the collaborative specialization must apply to and be admitted to both the collaborative specialization and a graduate degree program in one of the collaborative departments. Applicant statement of purpose that describes background experience relating to Psychology and Engineering, and motivation for pursuing graduate studies in PsychEng.
- Supervisor letter of recommendation in support of student’s application to PsychEng.

Program Requirements:

- APS 1305Y PsychEng Seminar Series (CR/NCR)
- 2 half courses (1.0 FCE). Students must take one .5 FCE course in the other participating department
- Thesis focused on a topic in the area of the Collaborative Specialization.

Completion of Specialization Requirements:

- All students enrolled in the collaborative specialization must complete the requirements of the collaborative specialization, in addition to those requirements for the degree program in their home graduate unit. The collaborative specialization director and/or specialization committee is/are responsible for certifying the completion of the collaborative specialization requirements. The home graduate unit is solely responsible for the approval of the student's home degree requirements.

Course List

Core Course

APS 1305Y PsychEng Seminar Series

Elective Courses

Please note that these courses are not offered every year. Consult each unit's website for details

Mechanical & Industrial Engineering

MIE1070: Intelligent Robots for Society

MIE1402: Experimental Methods in Human Factors Research

MIE1403: Analytical Methods in Human Factors Research

MIE1412: Human-Automation Interaction

MIE1415: Analysis and Design of Cognitive Work

MIE1505: Enterprise Modeling

MIE1510: Formal Techniques in Ontology Engineering

MIE1720: Creativity in Conceptual Design

KMD2001: Human Centred Design

Psychology

PSY1000 Directed Studies

Department of Psychology courses offered in the 5000 series (see Department for exclusions)

5. Degree Level Expectations, Specialization Learning Outcomes and Structure

The collaborative specialization will provide students with access to multidisciplinary learning experiences relating to the intersection of psychology and engineering. The principal benefit to students will be an improved capacity to pursue, understand, discuss, critique, and apply research at this intersection. Students will primarily achieve this capacity through the independent pursuit of a PsychEng-related thesis supported by mentoring from an expert supervisor. This learning will be further supported by the completion of two or more related courses, and immersion in a learning community. Details on the degree-level expectations and learning outcomes for the Collaborative Specialization in Psychology and Engineering **beyond those** of the home program degree requirements are provided below.

Outcomes are goals that describe how a student will be different because of a learning experience. More specifically, learning outcomes are the knowledge, skills, attitudes, and habits of mind that students take with them from a learning experience.

Graduate students in the collaborative specialization will gain skills in acquiring and transferring knowledge from a significantly different, yet highly relevant field. Such skills will continue to serve them in their career, where they can continue to apply not just relevant information from the complementary field of the collaborative specialization (engineering or psychology), but also other fields of relevance that may arise in their careers.

The course requirement provides graduate students in the collaborative specialization with background in the complementary field (engineering or psychology). They will then apply this background in their thesis work.

A collaborative specialization is intended to provide an additional multidisciplinary experience for students enrolled in and completing the requirements of a degree program. The requirements for the Collaborative Specialization in Psychology and Engineering are in addition to the degree requirements and are not meant to extend the student's time to degree.

The primary purpose of the specialization is to provide students in engineering and psychology the knowledge in the complementary field, as well as experience to apply this knowledge in their research.

Table 1: Master's DLEs

MASTER'S DEGREE LEVEL EXPECTATIONS (M.A. and M.A.Sc.)	**COLLABORATIVE SPECIALIZATION LEARNING OBJECTIVES AND OUTCOMES** (In addition to the Master's DLEs)	**HOW THE COLLABORATIVAE SPECIALIZATION DESIGN AND REQUIREMENT ELEMENTS SUPPORT THE ATTAINMENT OF THE LEARNING OBJECTIVES AND OUTCOMES**
EXPECTATIONS: ***The Psychology and Engineering (PsychEng) Collaborative Specialization designator is awarded to students who have demonstrated:***		

MASTER'S DEGREE LEVEL EXPECTATIONS (M.A. and M.A.Sc.)	**COLLABORATIVE SPECIALIZATION LEARNING OBJECTIVES AND OUTCOMES** (In addition to the Master's DLEs)	**HOW THE COLLABORATIVAE SPECIALIZATION DESIGN AND REQUIREMENT ELEMENTS SUPPORT THE ATTAINMENT OF THE LEARNING OBJECTIVES AND OUTCOMES**
1. Depth and Breadth of Knowledge Defined in Psychology and Engineering as: (a) A systematic understanding of engineering and psychology knowledge including, where appropriate, relevant knowledge outside both psychology and engineering; and (b) A critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of their psychology and/or engineering discipline.	Depth and breadth of knowledge in PsychEng is reflected in students who are able to: • Discuss and critique PsychEng-related research studies, identifying knowledge gaps they address, the strengths and limitations of the research methodologies, and the broader context and implications of the research.	The specialization design and requirement elements that ensure these student outcomes for depth and breadth of knowledge are: • The Seminar Series core course which covers a broad range of PsychEng-related research topics, frameworks, and methodologies, journal publication critiques, and discussion of current student research studies. • The two half-elective courses, at least one from the non-home department.
2. Research and Scholarship Defined in Psychology and Engineering as a conceptual understanding and methodological competence that: (a) Enables a working comprehension of how established techniques of research and inquiry are used to create and interpret knowledge in the discipline; (b) Enables a critical evaluation of current research and advanced research and scholarship in the discipline; (c) Enables a treatment of complex issues and judgments based on established principles and techniques; and on the basis of that competence, has shown both of the following: (d) The development and support of a sustained argument in written form; and	Research and Scholarship in PsychEng is reflected in students who are able to: • Prepare a clearly written master's level dissertation outlining the context, methods and novel, knowledge-generating aspects of the project and implications of the research at the intersection of Psychology and Engineering. The dissertation should meet the home program's master's level requirements.	The specialization design and requirement elements that ensure these student outcomes for research and scholarship are: • Expert supervision and guidance that helps students develop a PsychEng research project and articulate research findings in a comprehensive, written dissertation submitted at the conclusion of the specialization.

MASTER'S DEGREE LEVEL EXPECTATIONS (M.A. and M.A.Sc.)	COLLABORATIVE SPECIALIZATION LEARNING OBJECTIVES AND OUTCOMES (In addition to the Master's DLEs)	HOW THE COLLABORATIVAE SPECIALIZATION DESIGN AND REQUIREMENT ELEMENTS SUPPORT THE ATTAINMENT OF THE LEARNING OBJECTIVES AND OUTCOMES
(e) Originality in the application of engineering or psychology knowledge.		
3. Level of Application of Knowledge Defined in Psychology and Engineering as: (a) Competence in the research process by applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting; and (b) The ability to exercise leadership in research innovation.	Application of Knowledge in PsychEng is reflected in students who are able to: • Translate research findings into strategies for implementation in applications that require both psychology and engineering perspectives.	The specialization design and requirement elements that ensure these student outcomes for level and application of knowledge are: • Applying coursework from the partner department (i.e., Psychology for Engineering students, and Engineering for Psychology students to their independent project and/or dissertation research).
4. Professional Capacity/Autonomy Defined in Psychology and Engineering as: (a) The qualities and transferable skills necessary for employment requiring: (i) The exercise of initiative and of personal responsibility and accountability; and (ii) Decision-making in complex situations; (b) The intellectual independence required for continuing professional development including the ability for self-directed life-long learning; (c) The ethical behaviour consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and (d) The ability to appreciate the broader implications of	Professional Capacity/Autonomy in PsychEng is reflected in students who are able to: • Demonstrate familiarity with and rigorous adherence to ethical principles in academic conduct and research practices involving students and other human participants. • Describe the broad implications and impacts of PsychEng research findings on products, processes, their design and use in research and broader society.	The specialization design and requirement elements that ensure these student outcomes for professional capacity/autonomy are: • Seminars in the Seminar Series course addressing academic integrity, research ethics, and/or submission of ethics approvals required for the pursuit of research. • Discussions with expert supervisors and student peers about the implications and impacts of PsychEng research.

MASTER'S DEGREE LEVEL EXPECTATIONS (M.A. and M.A.Sc.)	COLLABORATIVE SPECIALIZATION LEARNING OBJECTIVES AND OUTCOMES (In addition to the Master's DLEs)	HOW THE COLLABORATIVAE SPECIALIZATION DESIGN AND REQUIREMENT ELEMENTS SUPPORT THE ATTAINMENT OF THE LEARNING OBJECTIVES AND OUTCOMES
applying knowledge to particular context.		
5. Level of Communications Skills Defined in Psychology and Engineering as the ability to communicate ideas, issues, and conclusions clearly in oral and written form.	Communications Skills in PsychEng are reflected in students who are able to: • Design and present a lecture, seminar or workshop to explain difficult concepts, novel approaches, or conflicting results relating to PsychEng in a clear and articulate manner with appropriate consideration of their audience. • Lead, encourage and engage in peer-level advanced scientific discourse on topics related to PsychEng, making claims and constructing credible arguments, and defending them logically and concisely using appropriate supporting evidence.	The specialization design and requirement elements that ensure these student outcomes for level of communication skills is: • The seminar series course will provide students with feedback on their presentation skills and a forum to practice, observe and improve these skills.

6. Assessment of Learning

Assessment of learning will occur both directly through formal mechanisms and indirectly. Formal assessment will be based on:

- Academic performance according to course evaluation criteria in the elective half courses.
- A PsychEng-related research thesis and its defense through an oral examination.

Peer and instructor feedback based upon:

- Presentation of a research seminar in the seminar course.
- Presentation of final or interim research results in the seminar course.

7. Resources

The collaborative specialization's core faculty members are available to students in the home program as advisors or supervisors. A core faculty member in the student's home department will be involved in thesis supervision. Core faculty members contribute to the collaborative specialization through teaching of the elective courses, participating in the delivery of seminars, or supervising students. Some faculty may teach courses in the subject area of the collaborative specialization in the home program. Not all core faculty members are active in the collaborative specialization every year and, in many cases, simply may remain available to interested students. The initial list of core faculty members is available in Appendix B. Each participating degree program contributes to the collaborative specialization through student enrolments, although not necessarily every year.

The collaborative specialization will have a Director and a Collaborative Specialization Committee. Together they will be responsible for admitting students to the specialization and ensuring that the faculty associated with the specialization have the capacity to supervise all specialization students. Consequently, an assessment of supervisory capacity will occur twice: once when students are admitted to their home degree program, and once on their application to the collaborative specialization is approved.

The University finds that participation in a collaborative specialization should not normally add significantly to a faculty member's supervisory load. For the most part, students in the collaborative specialization will continue to have their thesis supervised by a faculty member in their home program who also participates in the collaborative specialization.

See Appendix B for a list of core graduate faculty by participating program.

8. Administration

See Appendix C: Memorandum of Agreement.

9. Governance Process

Development within Unit • Department of Mechanical & Industrial Engineering	Sep-Dec 2016
Consultation • Department of Mechanical & Industrial Engineering • Department of Psychology • Faculty of Applied Science & Engineering Dean's Office • Faculty of Arts & Science Dean's Office • Office of the Vice-Provost, Academic Programs • School of Graduate Studies	Jan-Mar 2017
Approval of Graduate Units • Faculty of Applied Science & Engineering • Faculty of Arts & Science	Feb 2017 Feb 2017

Approval of Faculty/Divisional Governance • Council of the Faculty of Applied Science & Engineering (Lead Faculty) • Council of the Faculty of Arts & Science	 Apr 10, 2017 Apr 19, 2017
Submission to Provost's Office	Apr 2017
Report to AP&P for Information	May 2017
Report to Ontario Quality Council for Information	Jun-Jul 2017

Appendix A: Collaborative Specialization Requirements and Degree Program Requirements

Department of Mechanical & Industrial Engineering:

- **M.A.Sc. in Mechanical & Industrial Engineering**

  M.A.Sc. Requirements: 0.0 FCEs required courses (JDE1000H, 0.0 FCE, and two terms of SRM3333H MIE Seminar Series for M.A.Sc. Students 0.0 FCE)
  2.0 FCEs electives

  1.0 FCEs required for the collaborative specialization may be counted as electives – no additional courses are required.

Department of Psychology:

- **M.A. in Psychology**

  M.A. Requirements: 1.0 FCEs required courses (PSY1000H, 0.5 FCE, and PSY2001H, 0.5 FCE)
  1.0 FCEs electives

  1.0 FCEs required for the collaborative specialization may be counted as electives – no additional courses are required.

Appendix B: Core Faculty Research Synopses

Participating MIE Faculty Members and Research Foci (All SGS full members)

1. J. Christopher Beck, Operations Research and Artificial Intelligence
2. Amy Bilton, Design for the Developing World
3. Mark Chignell, Applied Cognition and User Interface Design
4. Birsen Donmez, Human Factors and Transportation
5. Michael Grüninger, Information Engineering and Knowledge Representation
6. Greg A. Jamieson, Human Factors and Automation
7. Paul Milgram, Human Factors and Medicine
8. Goldie Nejat, Robotics and Human-Robot Interaction
9. Li Shu, Design Theory and Methodology

Participating Psychology Faculty Members and Research Foci (All SGS full members)

1. Morgan Barense, Perception/Cognition/Cognitive Neuroscience
2. Dirk Bernhardt-Walther, Perception/Cognition/Cognitive Neuroscience
3. Daphna Buchsbaum, Development and Perception/Cognition/Cognitive
4. Wil Cunningham, Social/Personality/Abnormal & Perception/Cognition/Cog. Neuro.
5. Katherine Duncan, Perception/Cognition/Cognitive Neuroscience
6. Susanne Ferber, Perception/Cognition/Cognitive Neuroscience
7. Amy Finn, Perception/Cognition/Cognitive Neuroscience/Development
8. Elizabeth Page-Gould, Social Cognition
9. Jason Plaks, Social/Personality/Abnormal
10. Jay Pratt, Perception/Cognition/Cognitive Neuroscience

All teaching staff identified as members of the collaborative specialization are core faculty of the participating approved graduate programs and have been approved by the chair/director of their home unit for cross-appointment to the collaborative specialization. In addition to being approved members of the graduate teaching staff, all proposed faculty are active in the area of the collaborative specialization. The following lists highlighted peer review publications by the approved faculty members in the collaborative specialization area.

Participating MIE Faculty Members and Research Foci (All SGS full members)

J. Christopher Beck, Artificial Intelligence and Operations Research
http://www.mie.utoronto.ca/faculty/profile.php?id=10
My research interests that would benefit from the collaborative specialization focus on *the planning and scheduling in human-centered systems*. Engineers optimize systems subject to a set of constraints and an objective function. In systems where human interaction is increasingly mediated by information systems and even robots, the abilities, limitations, and desires of the people are often not understood, much less represented. The long-term viability these planning and scheduling algorithms depends on the ability to incorporate human psychological reality. I seek to develop richer human-centered models and develop mathematical optimization techniques that can reason about them. I have worked on three such human-centered systems.

Scheduling of Chemo-Therapy Treatment
We studied the scheduling of chemo-therapy appointments at a major Toronto cancer centre. Our models took into account the pattern of treatments different patients receive, the frequent changes in treatment due to patient condition, and the tasks of the staff responsible for scheduling. While we achieved schedule that increased traditional measures of quality such as throughput, we had no insight into whether the schedules were better from the perspective of the patients.

Hahn-Goldberg, S., Beck, J.C., Carter, M.W., Trudeau, M., Sousa, P. & Beattie, K., Solving the Chemotherapy Outpatient Scheduling Problem with Constraint Programming, *Journal of Applied Operations Research*, 6, 135-144, 2014.
Hahn-Goldberg, S., Carter, M.W., Beck, J.C., Trudeau, M., Sousa, P. & Beattie, K., Dynamic Optimization of Chemotherapy Outpatient Scheduling With Uncertainty, *Health Care Management Science*, 17, 379-392, 2014.

Planning and Scheduling of Autonomous Robots in Long-Term Care Homes
Given our aging society, computer and robotic technology is increasingly being developed to interact with and care for the elderly. As part of a long-term collaborative project, I have studied planning and scheduling of social robots in long-term care homes. While my collaborator (G. Nejat) has taken into account human factors in the direct human-robot interaction, there is no insight into psychological impacts of the daily schedules of the robots that we are producing.

Booth, K.E.C., Tran, T.T., Nejat, G., & Beck J.C., Mixed-Integer and Constraint Programming Techniques for Mobile Robot Task Planning, *IEEE Robotics and Automation Letters*, 1(1), 500-507, 2016.
Louie, W.-Y.G., Vaquero, T.S., Nejat, G., & Beck, J.C., "An Autonomous Assistive Robot for Planning, Scheduling and Facilitating Multi-User Activities", *Proceedings of the 2014 International Conference on Robotics and Automation,* (ICRA2014), 5292-5298, 2014.

Planning and Scheduling of Social Services: Non-Urgent Senior Transportation
Very recently, I have partnered with non-profit organizations that provide transportation services to seniors (e.g., to non-urgent medical appointments or adult day programs). While there are no publications yet, the same pattern as above is repeated: aside from some expressed preferences, there is no modeling of the psychological quality of the trips that the schedules create. Yet social psychological benefits, especially in the case of adult day programs, are a key goal of the service.

MIExxxx: Introduction to Computer Programming for Graduate Students
I teach an introduction to computer programming course for first-year engineering students. I could potentially modify this course to target graduate students who have never programmed before. Students would apply course concepts towards specific problems in their research. Such a course would prepare them to take more advanced programming courses needed to undertake their research.

Amy Bilton, Energy and Water System Design for Developing World
http://www.mie.utoronto.ca/faculty/profile.php?id=152
Energy systems; water purification and desalination; design for the developing world; computer-aided design methods; design optimization under uncertainty; control system design.
My research interests that would benefit from the collaborative specialization include:

Design for the Developing World
We develop systems for clean water and energy in the developing world. Recent work has focused on the development of solar powered water desalination systems and solar powered systems to improve water quality for fish aquaculture.

Elasaad, H., Bilton, A. M., Kelley, L. C., Duayhe, O., and Dubowsky, S. "Field evaluation of a community scale solar powered water purification technology: A case study of a remote Mexican community application," Desalination, Vol 375, pp. 71-80, 2015.
Mahmoud, A, Quang, T, Pavlov, E, and Bilton, A. M., "Development of a Solar Updraft Aeration System for Pond Aquaculture in Resource-Constrained Environments," *IEEE Global Humanitarian Technology Conference* 2015, October 8-11, 2015, Seattle, WA, USA.

Development of Computer-Based Design Methods
We developed computer-based design architectures which blend analysis methods conducted by skilled engineers and optimization methods to configure water and energy infrastructure. Recent work has focused on solar desalination systems and micro-grid optimization.

Freire-Gormaly, M. and Bilton, A. M, "Optimization of Renewable Power Systems for Remote Communities," *ASME International Design Engineering Technical Conferences 2015*, August 2-5, 2015, Boston, MA, USA.
Bilton, A.M., and Dubowsky, S., "A Computer Architecture for the Automatic Design of Modular Systems with Application to Photovoltaic Reverse Osmosis," ASME Journal of Mechanical Design, Vol 136, No. 10, 2014.

Mark Chignell, Applied Cognition and User Interface Design
http://www.mie.utoronto.ca/faculty/profile.php?id=18
My research interests that would benefit from the collaborative specialization include:

Cognitive Distraction Due to In-Vehicle Technologies
This work examined the moderating effect of executive function abilities on the impact of cognitive distraction due to the use of in-vehicle technologies.

Mizobuchi S, Chignell M, Delange T, Ho W (2014, September) Sensitivity of a Voluntary Interruption of Occlusion Measure to Cognitive Distraction During a Pedal Tracking Task. Proc. Human Factors and Ergonomics Society Annual Meeting (Vol. 58, No. 1, pp. 2229-2233). SAGE Publications.
Effect of Secondary Task Timing and Difficulty on Driving-Related Performance and Modality Selection. Presented at the 20th ITS world congress Tokyo 2013.
Mizobuchi S, Chignell M, Canella D, Eizenman M (2013) Individual Differences in Driving-Related Multitasking. Proc. 3rd International Conference on Driver Distraction and Inattention (DDI2013), Gothenburg, Sweden, Sept. 4-6, 2013.
Mizobuchi S, Chignell M, Suzuki J, Koga K, Nawa K (2013) Shifting Between Cognitive and Visual Distraction: The Impact of Cognitive Ability on Distraction Caused by Secondary Tasks. Proc. 7th Int. Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design (DA2013), p. 142-148.
Mizobuchi S, Chignell MH, Canella D, Eizenman M, Yoshizu S, Sannomiya C, Nawa K (2013) Looking or Listening? Impacts of Secondary Task Timing and Difficulty on Tracking Performance and Modality Selection. Proc. Human Factors and Ergonomics Society's 56th Annual Meeting. San Diego, CA

Social Interaction in People and Robots
This work explored the impact of technology-mediated social interaction.

Li J, Chignell MH (2010) Emotion Generation and Perception of Simple Robot Gestures, International Journal of Social Robots. 3(2), 125-142.

Li J, Chignell MH ((2010). Personality and Blogs: Do Bloggers of a Feather Flock Together? International Journal of Human-Computer Studies, 68, 589-602.

Li J, Chignell MH, Mizobuchi S, Yasumura M (2009). Emotions and Messages in Simple Robot Gestures. In J.A. Jacko (Ed.): Human-Computer Interaction. Novel Interaction Methods and Techniques, 13th International HCI International Conference Proceedings, Part II. Lecture Notes in Computer Science 5611, pp. 331-340.

Emotion Assessment During Interaction

Lottridge D, Chignell M, Yasumura M (2012) Identifying cultural differences in emotion through implicit, and explicit, measures. IEEE Transactions on Affective Computing, 3(2), 199-210.

Lottridge D, Chignell MH, Jovicic A (2011) Affective Interaction. Understanding, Evaluating, and Designing for Human Emotion. Chapter 5 in P. de Lucia (Ed.), (Ed.) Review of Human Factors and Ergonomics, Volume 7, pp. 197-237. Santa Monica, CA: Human Factors and Ergonomics Society.

Lottridge DM, Chignell MH (2010) Sliders Rate Valence but not Arousal: Psychometrics of Self-Reported Emotion Assessment. Proc. Human Factors and Ergonomics Soc, 2010.

Lottridge DM, Chignell MH (2009) Emotional Bandwidth: Information Theory Analysis of Affective Response Ratings Using a Continuous Slider. In, Gross, T. et al (Eds.): Human-Computer Interaction - INTERACT 2009, Lecture Notes in Computer Science 5726, pp. 111-114.

Lottridge D, Chignell MH (2009) Emotrace: Tracing emotions through human-product interaction. Proceedings of the 53rd Annual Meeting of the Human Factors and Ergonomics Society, pp. 1541-1545.

Recently I have extended this work on affective interaction to the problem of measuring customer experience in relation to the technical quality of online video (research funded by TELUS and by an NSERC CRD). Recent papers in that topic area include:

Chignell MH, Li W, Leon-Garcia A, Zucherman L, Jiang J (2015) Enhancing Reliability through Screening and Segmentation: An Online Video Subjective Quality of Experience Case Study. Proc. 7th Int. Conference on Advances in Information Technology, Bangkok, Thailand, November. Procedia Computer Science, 69, 55-65.

Spachos P, Li W, Chignell M, Leon-Garcia A, Zucherman L, Jiang J (2015, June) Acceptability and Quality of Experience in over the top video. In Communication Workshop (ICCW), 2015 IEEE International Conference on (pp. 1693-1698). IEEE.

Li W, Ur-Rehman H, Chignell M, Leon-Garcia A, Zucherman L, Jiang J (2014, November) Impact of Retainability Failures on Video Quality of Experience. In Signal-Image Technology and Internet-Based Systems (SITIS), 2014 Tenth International Conference on (pp. 524-531). IEEE.

Li W, Rehman HU, Kaya D, Chignell M, Leon-Garcia A, Zucherman L, Jiang J (2014, August) Video quality of experience in the presence of accessibility and retainability failures. In Heterogeneous Networking for Quality, Reliability, Security and Robustness (QShine), 2014 10th International Conference on (pp. 1-7). IEEE.

Serious Games for Cognitive Assessment. Papers that we have published on this topic include:

Tong T, Chignell M, Tierney MC, Lee J. Engaging Elderly Adults with Interactive Serious Games as a Method for Cognitive Assessment. Journal of Medical Internet Research: Serious Games (in press).

Tong T, Chignell M, Lam P, Tierney MC, Lee J (2014, June) Designing Serious Games for Cognitive Assessment of the Elderly. In Proceedings of the International Symposium of Human Factors and Ergonomics in Healthcare (Vol. 3, No. 1, pp. 28-35). SAGE Publications.

Tong T, Chignell M (2014) Developing a serious game for cognitive assessment: choosing settings and measuring performance. Proc. 2nd Int. Symposium of Chinese CHI (Chinese CHI '14). ACM, New York, NY, USA, 70-79.

Tong T, Chignell MH (2013) Designing Game-Based Cognitive Assessments for Elderly Adults. To appear in Proceedings of Gamification 2013: Gameful Design, Research, and Applications. Waterloo, Ontario, October 2-4, 2013.

I currently teach an undergraduate course in psychology for engineers (MIE 242) and I would be interested in creating a graduate version of the course that would be relevant to this collaborative specialization:

MIE14xx: Psychology for Engineers and Designers
This course is intended to provide a solid introduction to mind and brain for engineering students. In a world dominated by smart phones, and devices and software interfaces of all kinds, engineers and designers need a good grounding in psychology. The focus will be on understanding how mental processes are implemented in the brain. In addition to learning psychological principles, students will learn how to recognize psychological processes working in real world contexts. The topics covered are major ones in higher-level cognition and perception, and include: perception, object recognition, long-term memory, working memory, attention, executive control, emotion, and decision making.

Birsen Donmez, Human Factors and Transportation https://www.mie.utoronto.ca/faculty/profile.php?id=122
My research focuses on:
1) Understanding human behaviours, in particular attention allocation, and designing feedback to guide these behaviours for the domains of vehicle control (mainly passenger vehicles with some extensions to haul trucks and automated vehicles); healthcare settings; office settings
2) Understanding and supporting human evidence based decision making (such as based on historical evidence), in situations characterized by time pressure and uncertainty in emergency medical transport and in vehicle control
3) Identifying and implementing appropriate human-automation collaboration within feedback systems and decision support tools.

Given this focus, my entire research program would benefit from the proposed collaborative specialization. Below I list example publications for these three focus areas.

<u>Operator Attention in Multitask Activities</u>

Chen, H. Y. W. & Donmez, B. (2016). What drives technology-based distractions? A structural equation model on social-psychological factors of technology-based driver distraction engagement. Accident Analysis and Prevention, 91, 166-174.

Sasangohar, F., Donmez, B., Easty, A. C., & Trbovich, P. L. (2015). Mitigating non-urgent interruptions during high-severity ICU tasks using a task-severity awareness tool: a quasi-controlled observational study. Journal of Critical Care, 30(5), 1150.e1-1150.e6.

<u>Decision Support under Uncertainty</u>

Stahl, P., Donmez, B., & Jamieson, G. A. (2016). Supporting anticipation in driving through attentional and interpretational in-vehicle displays. Accident Analysis and Prevention, 91, 103-113.

Stahl, P., Donmez, B., & Jamieson, G. A. (2014). Anticipation in driving: The role of experience in the efficacy of pre-event conflict cues. IEEE Transactions on Human-Machine Systems, 44(5), 603-613.

Giang, W., Donmez, B., Fatahi, A., Ahghari, M., & MacDonald, R. D. (2014). Supporting air versus ground vehicle decisions for interfacility medical transport using historical data. IEEE Transactions on Human-Machine Systems, 44(1), 55-65.

<u>Human Automation Interaction</u>

Donmez, B. & Cummings, M. L. (2011). Metric selection for evaluating human supervisory control of unmanned vehicles. International Journal of Intelligent Control and Systems, Special Issue: Quantifying the Performance of Intelligent Systems, 16(2), 67-78.

Donmez, B., Nehme, C., & Cummings, M. L. (2010). Modeling workload impact in multiple unmanned vehicle supervisory control. IEEE Transactions on Systems, Man, and Cybernetics A 40(6), 1180-1190.

I currently teach a graduate course that would be relevant to this collaborative specialization:

MIE1413H: Statistical Models in Empirical Research
This course covers various statistical models used in empirical research, in particular human factors research, including linear regression, mixed linear models, non-parametric models, generalized linear models, time series modeling, and cluster analysis. For various observational and experimental data, students will be proficient in generating relevant hypotheses to answer research questions, selecting and building appropriate statistical models, and effectively communicating these results through interpretation and presentation of results. Basic knowledge in probability, statistics, and experimental design is required. The course will not focus on the design of experiments. In addition to homework assignments and exams, the students will review and critique journal articles and conference papers for the validity of the use of various statistical models. The students will work on a term long project of their choice and will be encouraged to relate this assignment to their current research projects. The examples used in class and the assignments will be drawn from human factors research. However, the students will not be required to use human factors data for their project.

Michael Grüninger, Information Engineering

https://www.mie.utoronto.ca/faculty/profile.php?id=25
Research: Ontologies; semantic integration; process modelling; enterprise integration; semantic web; knowledge representation; mathematical logic.

As mentioned in the specialization rationale, there are numerous interactions between psychology and artificial intelligence within information engineering. The representation of common-sense knowledge for concepts such as time, space, shape, process, and physical objects, plays critical roles in both cognitive psychology and the implementation of enterprise information systems. Numerous applications support reasoning with this knowledge, and research about causal reasoning and scene recognition within cognitive psychology can form the basis for automated systems within advanced manufacturing.

Sample publications relevant to this collaborative specialization include:

Grüninger, M. and Ong, D. (2011) Verification of Time Ontologies with Points and Intervals, 18th International Symposium on Temporal Representation and Reasoning, Lübeck, Germany.

Hahmann, T. and Grüninger, M. (2011) Multidimensional Mereotopology with Betweenness, Internation Joint Conference on Artificial Intelligence (IJCAI-11), Barcelona, Spain.

Hahmann, T. and Grüninger, M. (2011) A naive theory for qualitative spatial relations, Tenth International Symposium on Logical Formalizations of Commonsense Reasoning , Palo Alto, CA, USA.

Graduate courses I teach that would be relevant to this collaborative specialization are:

MIE1505H: Enterprise Modeling
To remain competitive, enterprises must become increasingly agile and integrated across their functions. Enterprise models play a critical role in this integration, enabling improved designs for enterprises, analysis of their performance, and management of their operations. This course motivates the need for enterprise models and introduces the concepts of generic and deductive enterprise models. It reviews research to date on enterprise modelling, including emerging standards and implementation technologies.

MIE1510H: Formal Techniques in Ontology Engineering
This course will explore theoretical techniques for the design and analysis of formal ontologies. Topics will include the design of verified ontologies, methodologies for proving properties about ontologies, and applications of classification theorems from mathematics. These techniques will be applied to ontologies that are currently being used in government and industry.

Greg A. Jamieson, Human Factors and Automation
http://www.mie.utoronto.ca/faculty/profile.php?id=27
My research interests that would benefit from the collaborative specialization include:

Modeling Appropriate Automation Reliance Behaviour
People using less than perfectly-reliable automated tools have to decide when to rely on these fallible tools. We are particularly interested in the effect of reliability disclosure. Our results show that disclosing automation reliability information to operators shifts their decision bias in the appropriate direction, but not to the extent deemed optimal (i.e., the sluggish beta effect). In addition, effectively designed displays of reliability can positively impact both sensitivity and decision bias.

Effects of Adaptive Automation Behaviours on Human Performance
Technology users are increasingly confronted with systems that respond to changes in context by adjusting the selection and timing of tasks delegated to the human, or by adapting the content and manner of interaction. Those changes can be triggered by the user state, by spatial or temporal cues, or by states or events in the system, mission, or environment. With the exception of adaptive function allocation triggered by user state (e.g., workload), little is known about the comparative effects of these triggers and behaviours. A new research program seeks to survey this adaptive automation space.

Sample publications relevant to this collaborative specialization include:
Trinh, K. & Jamieson, G. A. "Feedback Design Heuristics for Energy Conservation." Ergonomics in Design, 22(2), 13-21, 2014.
Lau, N., Jamieson, G. A., & Skraaning Jr., G. "Inter-rater Reliability of Query/Probe-based Techniques for Measuring Situation Awareness." Ergonomics 57, 959-972, 2014.
Stahl, P., Donmez, B., & Jamieson, G. A. "Anticipation in Driving: The Role of Experience in the Efficacy of Pre-event Conflict Cues." IEEE Trans. on Human-Machine Systems, 44, 603-613, 2014.
Hilliard, A., Jamieson, G. A., & Jorjani, D. (2014). "Communicating a Model-Based Energy Performance Indicator." Ergonomics in Design: The Quarterly of Human Factors Applications, 22(4), 21–29.

I currently teach/plan to teach graduate courses that would be relevant to this collaborative specialization:
MIE1412: Human-Automation Interaction
This course has two primary learning objectives. First, the students learn to analyze, synthesize, and evaluate canonical writings in the human-automation interaction literature. Second, they learn to value and characterize that literature in the context of their own professional, academic, or personal interests. The course is taught in a seminar format in two parts. In the first part, I lead discussions on foundational human-automation interaction literature, giving emphasis to contrasting claims expressed by past and contemporary researchers. In the second part, students plan and deliver a seminar on a topic of their choice. Finally, the students prepare an individual relevance assignment applying the course concepts to a topic of professional, academic, or personal interest. While many students write term papers, others have composed music, written a graphical short story, written and performed poetry and comedic scenes, and developed software.

MIE14XX: Human Factors Engineering
I have an agreement with my Associate Chair, Graduate and Department Chair to introduce a new graduate course in 2017-18. The course would provide an introduction to principles, methods, and tools for the analysis, design and evaluation of human-centred systems. Emphasis would be given to the consideration of the impacts of human perceptual and cognitive factors on the design and use of engineered systems, including shiftwork, workload, human error and reliability, and human factors standards. The target audience for the course is Masters of Engineering students across FASE programs. The course could also be made suitable for Masters-level students in Psychology by replacing the cognitive science elements with concepts in systems engineering.

Paul Milgram, Human Factors
http://www.mie.utoronto.ca/faculty/profile.php?id=35
Human Factors issues related to navigation, manipulation and control in 3D environments; human-machine interfaces for teleoperation; human factors issues in medicine, especially surgery and anaesthesiology; modelling of attentional workload.

Sample publications relevant to this collaborative specialization include:

M Otsuki, H Kuzuoka, P Milgram (2015) Analysis of depth perception with virtual mask in stereoscopic AR, Proceedings of the 25th International Conference on Artificial Reality and Telexistence and 20th Eurographics Symposium on Virtual Environments.

G D'Egidio, R Patel, B Rashidi, M Mansour, E Sabri, P Milgram (2014) A study of the efficacy of flashing lights to increase the salience of alcohol-gel dispensers for improving hand hygiene compliance, American journal of infection control 42 (8), 852-855

Current graduate courses I teach that would be relevant to this collaborative specialization include:
MIE1403H: Analytical Methods in Human Factors Research
This course is intended for people carrying out graduate level research in Human Factors. It covers a variety of techniques for recording and analysing empirical data. Topics to be covered include psychophysical methods, subjective scaling, questionnaires, signal detection theory, information theory, tracking and manual control modeling. There is no textbook for the course. Evaluation is based on a series of assignments related to the topics covered in class.

MIE5xx: Engineering Psychology and Human Performance
An examination of the relation between behavioural science and the design of human-machine systems, with special attention to advanced control room design. Human limitations on perception, attention, memory and decision making, and the design of displays and intelligent machines to supplement them. The human operator in process control and the supervisory control of automated and robotic systems. Laboratory exercises to introduce techniques of evaluating human performance.
Pre-requisites: MIE231H1 F/MIE236H1/STA286H1 or equivalent; MIE237H1 S or equivalent recommended

Goldie Nejat, Robotics and Human-Robot Interaction
http://asblab.mie.utoronto.ca/
My research interests that would benefit from the collaborative specialization include:

Human-Robot Interaction
Human-robot interaction (HRI) addresses the design, understanding, and evaluation of robotic systems which are used by people or work alongside them. These robots interact through various forms of communication in different real-world environments. Namely, HRI encompasses both physical and social interactions with a robot in a broad range of applications, such as physical and cognitive rehabilitation, tele-operation for surgery, surveillance and others. Through understanding these interactions we can better design robots to suit the functional, ergonomic, aesthetic, and emotional requirements of different user. One user group especially of importance in our research is the elderly population.

Social and Personal Robots
Our research in this area focuses on the development of human-like social robots with the social functionalities and behavioral norms required to engage humans in natural assistive interactions such as providing: 1) reminders, 2) health monitoring, and 3) social and cognitive training interventions. In order for these robots to successfully partake in social HRI, they must be able to interpret human social cues. This can be achieved by perceiving and interpreting the natural communication modes of a human, such as speech, paralanguage (intonation, pitch, and volume of voice), body language and facial expressions.

Publications on the aforementioned topics can be found at: http://asblab.mie.utoronto.ca/publications, including:

D. McColl, G. Jiang, and G. Nejat (2016) "Classifying a Person's Degree of Accessibility from Natural Body Language During Social Human–Robot Interactions," IEEE Transactions on Cybernetics, DOI: 10.1109/TCYB.2016.2520367.

A. Hong, Y. Tsuboi, G. Nejat, and B. Benhabib (2016) "Affective Voice Recognition of Older Adults," Journal of Medical Devices-Transactions of the ASME, vol. 10, no. 2, 020931.

D. McColl, A. Hong, N. Hatakeyama, G. Nejat and B. Benhabib (2016) "A Survey of Autonomous Human Affect Detection Methods for Social Robots Engaged in Natural HRI," Journal of Intelligent and Robotic Systems, vol. 82, pp. 101-133.

M. Ficocelli, J. Terao, and G. Nejat (2015) "Promoting Interactions Between Humans and Robots using Robotic Emotional Behavior," IEEE Transactions on Cybernetics, DOI 10.1109/TCYB.2015.2492999.

I currently teach a graduate course that would be relevant to this collaborative specialization:
MIE1070: Intelligent Robots for Society
This course introduces the design of intelligent robots – focusing on the principles and algorithms needed for robots to function in real world environments with people. Topics that will be covered include autonomy, social and rational intelligence, multi-modal sensing, biologically inspired and anthropomorphic robots, and human-robot interaction. Class discussions will centre on the interactive, personal, assistive and service robotics fields.

Li Shu, Design Theory and Methodology

http://www.mie.utoronto.ca/faculty/profile.php?id=41
My research interests that would benefit from the collaborative specialization include:

Identifying Metrics to Predict and Overcome Individual Tendency for Fixation
Fixation is a term used to describe the state of being overly influenced by experience and existing examples in design. Our recent work has shown that Kruglanski's Need for Closure scale can be used to predict tendency for fixation. Subsequent work aims to develop individualized interventions for overcoming design fixation.

Lai S, Shu LH (2016) Individual Differences in Tendency for Design Fixation. Proc. Design Computing and Cognition, 27-29 June 2016, Northwestern University, Evanston (Chicago), USA.

Identifying and Overcoming Obstacles to Personal Environmentally Conscious Behavior
We aim to develop products that encourage sustainable behavior in consumers. Several social-psychological models of motivation are clearly relevant. Work proposed with Jason Plaks aims to apply (Higgins') Approach vs. Avoidance to develop product design.
Publications: http://shulab.mie.utoronto.ca/publications/#environ include:

Srivastava, J., Shu, L.H. (2015) Considering Different Motivations in Design for Consumer-Behavior Change, Proc. ASME IDETC/CIE, August 2-5, Boston, MA, USA, DETC2015-47625.

Novel Methods for Identifying and Creating Object Affordances
Recent work used "lead users" to identify novel product affordances to reduce resource consumption. In addition, we explored the "affordance of absence", i.e., whether removing features from products and objects clarify possible as well as required affordances.
Publications: http://shulab.mie.utoronto.ca/publications/

Identifying and Applying Analogies to Inspire and Explain Concepts
Past work focused on identifying biological analogies as sources of inspiration for designers. More recent work explored the use of analogies to explain concepts.
Publications: http://shulab.mie.utoronto.ca/publications/#bio

Methods to Increase Creativity in Designers
In addition to the above, our other work examined the use of language as stimuli in conceptual design, as well as the limitations of data collection and cognitive biases on the design process.
Publications: http://shulab.mie.utoronto.ca/publications/#creativity

Teaching relevant to the collaborative specialization:
MIE1720: Creativity in Conceptual Design
This course will present established methods that aim to enhance creativity during conceptual design. In addition, current research relevant to creativity and conceptual design will be incorporated. Students will select current research conducted at a variety of international institutions, identify limitations of reported results, determine and perform further research that can be conducted within a course, and report results. Established creativity methods will be presented during lecture. Knowledge of this material will be evaluated through written examinations. Skills in identifying, planning, conducting and reporting relevant research will be evaluated through oral presentations and written reports.

Subset of Participating Psychology Faculty Members and Research Foci (All SGS full members)

Morgan Barense, Perception/Cognition/Cognitive Neuroscience
Associate Professor and Canada Research Chair
http://www.psych.utoronto.ca/users/barense/

As cognitive neuroscientists, we seek to understand how the brain enables the mind. That is, we want to know how biological mechanisms in the brain give rise to cognition. Our lab's specific focus is on understanding how the brain supports memory, and how memory is affected by brain damage or disease. To answer these questions, we draw on the complementary strengths of multiple experimental modalities, including neuropsychological investigations of patients with memory disorders, the examination of brain activity with neuroimaging techniques (e.g., fMRI and EEG), eye tracking studies, and behavioural experiments in healthy individuals.

Why Does Brain Damage Impair Memory? Memory impairment is the most common and devastating result of neurological insult, yet we do not fully understand why damage to some parts of the brain so badly affects memory. We have suggested that some memory deficits may actually reflect a more fundamental impairment in creating precise representations of items and events. In short, we have suggested that perceiving a stimulus may be inextricably linked to subsequently remembering it. This view challenges long-standing notions that memory and perception are functionally and anatomically segregated. Instead, we suggest that they rely on shared neural representations and computational mechanisms.

Can We Use Cognitive Neuroscience to Develop More Effective Interventions for Memory Impaired Individuals? We seek to apply recent advances in cognitive neuroscience to develop more targeted and evidence-based rehabilitative strategies based on how the brain supports memory. This research program involves the development of novel neuroscience-guided memory prosthetics for individuals with varying degrees of memory impairment, as well as characterizing the neurobiological effects of such interventions.

How Does the Brain Cope with the Massive Amount of Visual Information it Encounters in Everyday Life? The world can be visually overwhelming. Many objects in our lives look very similar to one another, yet we are still able to tell them apart and remember which is ours. We are working to understand the neural mechanisms that underlie this ability to resolve visual interference, and are characterizing how it may be impacted by brain damage or the earliest stages of dementia.

How Does the Brain Combine Information from Different Sensory Modalities to Create a Coherent Representation of a Multisensory Stimulus? When we think of a frog, we call to mind characteristics that are visual (it is green), motoric (it hops), tactile (it is slimy), and auditory (it goes "ribbit") in a complex multisensory representation of a "frog". Similarly, when engaged in conversation, we listen to what the speaker is saying but we also watch how the speaker's mouth moves to utter the words. In this line of research, we seek to understand the neural mechanisms that underlie this fundamental cognitive ability, and how these mechanisms may be altered in conditions such as autism spectrum disorder.

How Does our Conceptual Knowledge about the World Affect How We Perceive It? We have asked how the act of perceiving superficial visual attributes of an object may be guided by – and inseparable from – the act of understanding what that object actually is. This research program focuses on how surface details of an item (e.g., its shape, sound, texture) give rise to semantically meaningful concepts. How does our brain distinguish between a pear and a lightbulb, despite being visually similar, while also grouping together a Great Dane and a Chihuahua, which are visually very different?

Sample Publications
Rondina, R., Curtiss, K., Meltzer, J.A., Barense, M.D., & Ryan, J.D. (2016). The organization of spatial and temporal relations in memory. Memory. http://dx.doi.org/10.1080/09658211.2016.1182553

Lowe, M.X., Stevenson, R.A., Wilson, K.E., Ouslis, N.E., Barense, M.D., Cant, J.S., Ferber, S. (2016). Sensory processing patterns predict the integration of information held in visual working memory. Journal of Experimental Psychology: Human Perception and Performance, 42(2), 294-301.

Graduate Teaching

PSY5205HS Memory: The Cognitive Neuroscience of Memory

Memory is one of the most complex functions performed by the human brain. In this course we will consider prominent theories regarding the nature of memory and how the brain is able to perform this remarkable feat. We will survey current research in the field, focusing on controversial areas of inquiry. The goal of this approach is to provide insight into how details of experimental design can influence how theoretical models are developed.

Dirk Bernhardt-Walther, Visual perception of real-world environments

http://bwlab.utoronto.ca/research/

My research interests that would benefit from the collaborative specialization include:

Neural and Computational Principles of High-Level Sensory Perception

We employ neuroimaging (fMRI, MEG, EEG), psychophysics, eye tracking, and computational modeling to explore how people see and hear their real-world environments.

Recent Publications:

Heeyoung Choo, Jack Nasar, Bardia Nikrahei, Dirk B Walther (under review), Neural codes of architectural styles. http://www.biorxiv.org/content/early/2016/03/16/044156

Heeyoung Choo and Dirk B. Walther (2016), Contour junctions underlie neural representations of scene categories in high-level human visual cortex. Neuroimage, in press.

Thomas O'Connell and Dirk B. Walther (2015) Dissociation of salience-driven and content-driven spatial attention to scene category with predictive decoding of gaze patterns, Journal of Vision, 12(5):20, 1-13, doi:10.1167/15.5.20

Dirk B. Walther and Dandan Shen (2014) Non-accidental properties underlie human categorization of complex natural scenes, Psychological Science, 25: 851-860.

Kyungtae Kim, Kai-Hsiang Lin, Dirk B. Walther, Mark A. Hasegawa-Johnson, Tomas S. Huang (2014) Automatic Detection of Auditory Salience with Optimized Linear Filters Derived from Human Annotation, Pattern Recognition Letters, 38: 78-85. dx.doi.org/10.1016/j.patrec.2013.11.010

New Techniques for Analyzing Neuroimaging Data. Recent publications include:

Emanuele Olivetti and Dirk B. Walther (2015) A Bayesian Test for Comparing Classifier Errors, Proceedings of the 5th International Workshop on Pattern Recognition in NeuroImaging: 69-72, Stanford, CA.

Dirk B. Walther (2013) Using confusion matrices to estimate mutual information between two categorical measurements, Proceedings of the 3rd International Workshop on Pattern Recognition in NeuroImaging: 220-224. Philadelphia, PA.

More publications at: http://bwlab.utoronto.ca/publications/

Teaching

Functional MR imaging of the visual system

I will be teaching a graduate class on "Functional MR imaging of the visual system" in winter 2017.

Daphna Buchsbaum, Development and Perception/Cognition/Cognitive

http://cocodev.psych.utoronto.ca/

As children grow up a major challenge they face is uncovering the world's causal structure, including understanding the causes and consequences of other people's behaviour. How do children learn these kinds of causal relationships, especially when the world presents them with sparse, ambiguous data or with multiple, conflicting sources of evidence? Are these sophisticated abilities unique to humans, or are they shared with other animals?

My research interests that would benefit from the collaborative specialization include:

Using Social Knowledge and Statistical Cues in Causal Reasoning: This line of work looks at children's and non-human animal's imitation of causal action sequences, examining how different kinds of learners decide which of the actions they see another agent performing are the ones that are necessary to bring about a desirable outcome. My colleagues and I developed a Bayesian analysis of causal inference from repeated action sequence demonstrations that makes behavioral predictions based on both information about statistics and about the actor's knowledge and intentional stance.

Action Segmentation and Causal Variable Discovery: Infants are able to parse dynamic human action well before they are thought to have a fully developed theory of mind. This suggests that there may be low-level cues to intentional action structure available in human motion. In this line of work, I am developing a series of computational models that make very few representational assumptions about what is observed when watching videos of human action. To the extent that these models correspond to human segmentation judgments, and correctly recognizes actions, we will know that there are cues in surface level image changes that can be used to both segment and identify human behavior.

Explore/Exploit Trade-offs In Inference: Many computational algorithms face an explore/exploit trade-off, where faster, more efficient algorithms are also more likely to get stuck in local optima. Human learners may face a similar problem when exploring a hypothesis space of possible problem solutions. Ongoing experimental and computational work in my lab and others suggests that older individuals are more likely to exploit what they already know—quickly applying adequate but not necessarily optimal solutions—whereas younger children tend to explore hypotheses more broadly – and are therefore more likely to correctly discover unusual causal relationships, though they may also consider many incorrect solutions in the process.

Learning from Majority and Cultural Evolution: Recent work in developmental psychology suggests that children frequently conform to a majority, and computational models of cultural evolution have suggested that conformity can be a useful and adaptive social learning strategy. Yet, these models also suggest that high levels of conformity can make it difficult for innovations to spread, limiting cumulative culture. This work explores how children extend trust to informants based on the quality of their knowledge, and how they weigh this information against majority and minority opinions.

Sample Publication:
D. Buchsbaum, T. L. Griffiths, D. Plunkett, A. Gopnik, D. Baldwin (2015). Inferring Action Structure and Causal Relationships in Continuous Sequences of Human Action, Cognitive Psychology. 76, 30-77.

Teaching:
Recently approved computation in psychology UG course (eventually adapt for graduate students), starting 2017-2018 (or 2018-2019, depending on course scheduling)

Wil Cunningham, Social/Personality/Abnormal and Perception/Cognition/Cognitive Neuroscience
http://socialneuro.psych.utoronto.ca/research.html
My primary research question concerns how the human mind creates representations of value. This ubiquitous act of assigning positive or negative valence is crucial for survival, whether it involves guiding behavior toward or away from an immediate significant object or anticipation of future rewards and punishments in goal pursuit. Attitudes (i.e., relatively stable ideas about whether something is good or bad) exert powerful influences on people's evaluations (i.e., their current appraisals) and these, in turn, influence people's choices (e.g., their choices of friends, careers, consumer products, and presidents). To better understand these processes, research in my lab takes a multi-disciplinary approach that attempts to integrate behavioral observations with neuroscience methods and theory. Incorporating knowledge regarding brain function into our understanding of attitudes and evaluations promises to lead to the refinement of theoretical models and generation of novel hypotheses. We have proposed

an initial multilevel framework for understanding some of the core operating characteristics of the human evaluative system – *The Iterative Reprocessing Model*. We have recently expanded the model to understand how distinct emotional responses can emerge from more elemental computational principles.

The Structure of Evaluative Responses: The IR model proposes that the evaluative system is built upon multiple component processes that work in concert to make judgments about the world. These processes do not work in an all-or-none fashion, but rather, unique combinations of processes can generate qualitatively different evaluative outcomes. According to the model, stimulus representations (e.g., people, objects, or abstract concepts) initiate an iterative sequence of evaluative processes—the evaluative cycle—through which the stimuli are interpreted and re-interpreted in light of an increasingly rich set of contextually meaningful representations. The neural networks involved in evaluation are hierarchically arranged, such that a common set of processes continues to be involved in generating evaluations throughout the cycle, whereas additional processes come online at different points in the cycle. Whereas evaluations based on few iterations of the evaluative cycle are relatively automatic in that they are obligatory and may occur without conscious monitoring, evaluations based on additional iterations and computations are relatively reflective.

Cunningham, W.A., & Zelazo, P.D. (2007). Attitudes and evaluations: A social cognitive neuroscience perspective. Trends in Cognitive Sciences, 11, 97–104.
Cunningham, W. A., Van Bavel, J. J., & Johnsen, I. R. (2008). Affective flexibility: Evaluative processing goals shape amygdala activity. Psychological Science, 19, 152–160.

The Structure of Emotional Experience: Psychological constructivist models of emotion propose that emotions arise from the combinations of multiple processes, many of which are not emotion specific. These models attempt to describe both the homogeneity of instances of an emotional "kind" (why are fears similar?) and the heterogeneity of instances (why are different fears quite different?). We propose the iterative reprocessing model of affect that suggests that emotions, at least in part, arise from the processing of dynamical unfolding representations of valence across time. Critical to this model is the hypothesis that affective trajectories—over time—provide important information that helps build emotional states.

Cunningham, W. A., Dunfield, K. A., & Stillman, P. (2013). Emotional states from affective dynamics. Emotion Review, 5, 344–355.
Kirkland, T. & Cunningham, W. A. (2012). Mapping Emotions through Time: How Affective Trajectories Inform the Language of Emotion. Emotion, 12, 268–282.

I currently teach the following graduate courses that would be relevant to this collaborative specialization:
PSY2001HF Design of Experiments: The General Linear Model
This course is designed to introduce the student to the General Linear Model and two of its most common expression: Analysis of Variance and Multiple Regression. Additionally, student will be asked to familiarize themselves with some of the current theoretical issues in realm of data analysis itself, e.g., the value of testing the null hypothesis.

Katherine Duncan, Learning and Memory in the Human Brain
http://www.duncanlab.org
My research interests that would benefit from the collaborative specialization include:

Optimizing fMRI Data Processing and Analysis Approaches
Functional magnetic neuroimaging (fMRI) plays a central role in our investigation of the neural basis of learning and memory. Developing tailored neuroimaging analysis tools is essential for this work. For example, we have previously developed new approaches to measuring functional interactions between brain regions and approaches to measuring the neural reactivation of specific memories. We also plan to optimize automated noise reduction algorithms for task-based fMRI data and develop multivariate approaches to characterizing dynamic shifts in brain 'states.'

Duncan K, Tompary A, Davachi L. (2014) Associative encoding and retrieval are predicted by functional connectivity in distinct hippocampal area CA1 pathways. Journal of Neuroscience 34, 11188-11198.
Tompary A, Duncan K, Davachi L. (In Press) High-resolution investigation of memory-specific reinstatement in the hippocampus and perirhinal cortex. Hippocampus.

Adaptively Modulating Memory Formation and Retrieval
Drawing on the physiological effects of neurochemicals, we developed a framework for predicting how the salient events known to trigger the release of these neurochemicals influence specific aspects of cognition. For example, we have identified memory processes that are facilitated by recent exposure to novelty and others that are facilitated by recent exposure to familiarity. Because these behavioral manipulations are simple to administer and lead to remarkably reliable cognitive outcomes, they could be readily developed into educational and training technologies that evoke memory states that target specific learning outcomes.

Duncan K, Sadanand A, Davachi L (2012) Memory's penumbra: Episodic memory decisions induce lingering mnemonic biases. Science 337: 485-487.

Identifying How Different Forms of Learning and Memory Guide our Decisions
People's choices are often guided by their past experience. The discovery of neurally distinct forms of memory, such as habits and memories of distinct events, raises questions about how different forms of memory interact to influence decisions. Our work aims to characterize how these memories guide our actions, at both computational and neural levels, and to identify factors that arbitrate between the uses of each.

Doll BB, Duncan K, Simon D, Shohamy D, Daw N. (2015) Model-based choices involve prospective neural activity. Nature Neuroscience 18, 767–772.

I will be developing the following graduate course that could be relevant to this collaborative specialization:
PSYxxxx: Cognitive Dysfunction in Neurological Disorders:
This course will offer an in-depth examination of the cognitive dysfunction found in neurological disorders, including Alzheimer's disease, Parkinson's disease, and Schizophrenia. The course will focus on how cognitive impairments relate to current neuropsychological models of the disease. A better understanding of neurological disorders and their associated cognitive profiles could inspire the development of compensatory technologies.

Susanne Ferber, Perception/Cognition/Cognitive Neuroscience
http://www.psych.utoronto.ca/users/ferber/
My research interests fall within the realm of Cognitive Neuroscience. The long-term goal of my research is to understand the cognitive and neural processes that support awareness of perception. As such, my work speaks to issues regarding the basic principles of the neural representation of visual perception and visually guided action. To examine the relationship between awareness and perception, my research program comprises diverse methodological approaches, such as the investigation of cognitive impairments in neurological patients (e.g., patients with spatial neglect or simultanagnosia), cognitive experiments in healthy individuals, and the examination of brain activity with modern neuroimaging techniques (fMRI and ERP).

Sample publications relevant to the collaborative specialization:
Rajsic J., Sun S.Z., Huxtable L., Pratt J., Ferber S. (2016). Pop-out and pop-in: Visual working memory advantages for unique items. Psychonomic Bulletin and Review.
Goodhew S.C., Edward M., Ferber S., Pratt J. (2015). Altered visual perception near the hands: A critical review of attentional and neurophysiological models. Neuroscience and Biobehavioral Reviews, 55:223-33.
Sun S.Z., Shen J, Shaw M., Cant J.S., Ferber S. (2015). Automatic capture of attention by conceptually generated working memory templates. Attention, Perception, & Psychophysics, 77(6):1841-7.

Amy Finn
http://finnlandlab.org/
My research interests that would benefit from the collaborative specialization include:

Understanding How Brain Development Influences Learning and Memory: We are interested in the fact that changes in core memory systems happen at different rates, something that is tied to and possibly even caused by ongoing brain development. Our work seeks to understand what asynchronies in the developmental profiles of core memory systems means for learning across domains, especially for language learning and learning measured in educational contexts. To understand these dynamics better, our work has so far investigated the development of memory systems focusing largely on working memory, procedural memory ("knowing how" or unconscious/experience-dependent learning) and declarative memory. This work would be greatly enhanced by collaboration with engineering to inform the mechanism of how changes relate to different outcomes in learning.

Understanding How the Environment Shapes Learning: It is commonly presumed that early or accelerated development of memory systems, especially working memory, is desirable. (Indeed, the goal of many training programs is to improve memory in children.) However, this practice might impact the operation of other memory systems in unpredicted ways: decreasing working memory demands can facilitate the formation of procedural memories in adults and increasing them can have the opposite effect, interfering with the formation of new procedural memories. Slow development might be best. Our work seeks to understand whether extended plasticity (openness to environmental input) is indeed best for memory ability (including interactions) and learning outcomes across domains—language and education. An important part of this work is characterizing children's environments. Slow might not be best in less "enriching" and/or stressful environments that can be associated with poverty.

Understanding Why Adults Cannot Learn Language When Children Can: Language is perhaps the only known learning feat in which adults are worse than children. Why? This exception in learning may hold important clues about how the maturing mind and brain trades off between developmentally programmed strengths and limitations in learning. Our work has explored three factors that may contribute to adult's poor learning relative to children. Counterintuitively (at least at first glance), these are all aspects of adult-cognition that underpin their success in other areas. These include adults' (1) larger knowledge base, (2) mature, language-specific neural networks, and (3) mature executive functions and declarative memories.

Sample publications from http://finnlandlab.org/publications/
Cain, M.S., Leonard, J.A., Gabrieli, J.D.E. & Finn, A.S. (2016) Media multitasking in adolescence. Psychonomic Bulletin & Review. 1-10.

Finn, A.S., Kalra, P.B., Goetz, C., Leonard, J.A., Sheridan, M.A. & Gabrieli, J.D.E (2016) Developmental Dissociation Between the Maturation of Procedural Memory and Declarative Memory. Journal of Experimental Child Psychology. 142, 212-220.

Finn, A.S. & Hudson Kam, C.L. (2015). Why segmentation matters: experience-driven segmentation errors impair "morpheme" learning. Journal of Experimental Psychology: Learning, Memory and Cognition, 41, 1560-1569.

Graduate course relevant to this collaborative specialization:
PSY5220HS: Developmental Cognitive Neuroscience: This course will ask how changes in the developing brain can influence theories of cognitive development. We will ask whether and how methods in human neuroscience can help our understanding of cognitive development. To this end, we will explore the utility of human cognitive neuroscience methods in pediatric populations. We will then ask how these methods, and neuroscience more broadly, can inform classic debates about 1) the role of nature versus nurture, and 2) how neural plasticity influences developmental change in variety cognitive domains. These areas will include perception, object representation, navigation, number, concepts, memory, executive function, categories, language, and social cognition among others. This course will ask how findings in developmental cognitive neuroscience can, do, and/or should influence medicine, education and the law.

Elizabeth Page-Gould, http://page-gould.com
Research at the Social Psychophysiological Research & Quantitative Methods Laboratory (SPRQL) focuses on how social interactions between strangers and friends affect the way people think about and approach the world, particularly within the domain of intergroup relations. The lab specializes in multi-person, longitudinal, psychophysiological, and behavioural data collection across both laboratory and field settings. The lab also specializes in advanced statistical analysis and quantitative innovation. Both the research conducted in SPRQL and the training environment the lab offers represent a unique combination of advanced research methods from social psychology, psychophysiology, and statistics.

Lab projects either cut across the domains of social psychology, psychophysiology, and quantitative methods or can be focused within one domain. The primary question that drives research in SPRQL is how social interactions with friends and strangers affect our attitudes and behaviour towards people who are different than us as well as personal health and achievement. The ultimate goal of this research is to understand successful diverse societies: how can people with different backgrounds and perspectives work together to build communities where everyone has a chance to thrive? By combining laboratory experiments with longitudinal field studies, we are able to examine social interactions in controlled settings while situating this knowledge in the messiness of interactions that occur in the real world. In addition to this primary research question, the lab dss sq also conducts basic psychophysiological and quantitative methods research, such as (a) uncovering the function and processes involved in physiological synchrony between people engaged in social interactions, (b) exploring the unclear relationship between stress hormones and subjective stress, and (c) developing methods for harnessing the full power of linear models for point estimation and prediction.

The lab takes a multi-method approach to answer these complex questions, frequently combining self-report surveys, physiological measurement, and behavioural observation within the same study. We combine these methods to capture a rich picture of the nuanced and complex social world in which we live.

Page-Gould, E., & Sharples, A. (2016). Bootstrapping accurate indirect effects in multilevel models. Manuscript in preparation.
Page-Gould, E. (2016). The existent variability in Type I Error rates as a function of effect size and sample size. Manuscript in preparation.
Akinola, M., Page-Gould, E., Mehta, P., & Lu, J. (In Press). Collective hormonal profiles predict group performance. Proceedings of the National Academy of Sciences.
Page-Gould, E. (In Press). Multilevel Modeling. To appear in J. T. Cacioppo, L. Tassinary, & G. Berntson (Eds.), The Handbook of Psychophysiology (4th ed.). New York, NY, US: Cambridge University Press.
Page-Gould, E. & Akinola, M. (2015). Neuroendocrinology in intergroup relations. Group Processes and Intergroup Relations, 18, 366-383.
Page-Gould, E. (2017). Mastering Statistics. SAGE Publications: London, UK.
Hayes, A. F., Montoya, A. K., Preacher, K. J., & Page-Gould, E. (2018). Statistical Mediation Analysis. Guilford Publications: New York, NY, US.

Teaching relevant to the collaborative specialization:
PSY2002HS Design of Experiments II
This course will provide a practical introduction to advanced statistical methods used in modern psychological research. Specifically, the course will cover the following topics: (1) Path analysis and Mediation; (2) Multilevel modelling, also known as HLM; (3) Non-gaussian statistics and bootstrapping; (4) Bayesian Hypothesis Testing; (5) Factor analysis, including exploratory factor analysis/principal components analysis, confirmatory factor analysis, and cluster analysis; (6) Structural Equation Modelling; and, (7) Time-based analysis like time series, lagged regression, and latent growth curves. The course will place a strong emphasis on practical application, such that every class will include demonstrations, electronic copies of sample syntax in SPSS and R, and brief computer-based data analysis exercises. You will also learn to be an active consumer of quantitative psychology articles, as well as develop generalizable strategies for statistical reporting. You will only need to be familiar with one of the following statistical packages: SPSS, R, or SAS. The course will have a final project where you will be required to use one of the analyses you learn in class to analyze your own data or public data and then write methods, results, and discussion sections that describe your findings. You will also be expected to complete lab assignments that involve

conducting analyses on example datasets in the statistical software package of your choice. The goal is for you to leave the class with an understanding of when and how to apply each of the statistical techniques you learn. Knowledge of these modern statistical tools will increase the flexibility of your research designs and the statistical rigour with which you analyze your data.

Jason Plaks, Motivation-Cognition Interface
http://plaks.socialpsychology.org/
My research interests that would benefit from the collaborative specialization include:

Leveraging Psychological Principles of Motivation to Create Products that Encourage Environmentally-Conscious Behavior
In partnership with L. Shu and others, we aim to develop products that encourage sustainable behavior in consumers by capitalizing on well-established theories and principles of human motivation. One specific line of work aims to apply Regulatory Focus Theory (Higgins, 1998; Plaks & Higgins, 2000) to tailor products to match users' approach-related or avoidance-related tendencies.

Methods to Increase Creativity in Designers
Much recent research in the psychology of motivation has focused on increasing worker creativity. Two particular well-regarded research programs, Regulatory Focus Theory (Higgins, 1998) and Lay Epistemics Theory (Kruglanski & Webster, 1994), have reported ways to increase creativity in undergraduates on a range of problem-solving tasks. In partnership with L. Shu and others, we aim to apply these principles toward product designers in particular, to address the problem of design fixation (known as "stereotypy" in psychology).

Sample publications relevant to the collaborative specialization:
Xu, X. & Plaks, J.E. (2015). The neural correlates of implicit theory violation. Social Neuroscience, 10, 431-447.
Plaks, J. E. (Ed.). (2011). The social psychology of motivation. Toronto: Oxford University Press.
Cesario, J., Plaks, J. E., Hagiwara, N., Navarrete, C.D., & Higgins, E. T. (2010). The ecology of automaticity: How situational contingencies shape action semantics and social behavior. Psychological Science, 21, 1311-1317.

I currently teach a graduate course that would be relevant to this collaborative specialization:
PSY5432HF Advanced Topics in Social Psychology III: Motivational Theories in Social Psychology
This course involves reading and discussion of seminal articles on motivation in the social psychology literature. A key emphasis will be on how motivation and cognition mutually influence each other to produce behavior. At an abstract level, this course will explore such key issues as: the influence of emotions, values, and desires on one's thought; goal setting and goal pursuit; self-regulation and self-control. At a concrete level, this course will investigate such key topics as achievement motivation, social comparison, persuasion, and emotion.

Jay Pratt, Perception/Cognition/Cognitive Neuroscience
http://www.psych.utoronto.ca/users/pratt/
My research interests that would benefit from the collaborative specialization include:

Hand Position Influences Attention and Perception
The human attention/perceptual systems have a reciprocal relationship with the action systems. Our research has shown that placing the hands near visual stimuli bias processing in the magnocellular visual channel and the dorsal (action) pathway while placing the hands away from visual stimuli biases processing in the parvocellular visual channel and the ventral (object perception) pathway. These hand position effects can be found in attention, vision, and eye movements.

Top-Down and Bottom-Up Control of Visual Attention: The ability to successfully select important visual information, and ignore distracting information, relies on the moment-to-moment balance to bottom-up (reflexive) and top-down (volition) attention process. Our research has shown several modulations of this balance of processes; object-based attention is reflexive in some situations but volitional in others, the onset of motion and animate motion are reflexive, and the temporal prioritization of events is under volitional control.

Conceptual Information Guides Attention and Vision: Bottom-up and top-down attentional processes have traditionally been viewed as a dichotomy, but our research has shown that they are better conceived as ends of continuum, and attention can be oriented to object and/or locations in space by what we have termed "conceptual cues". These cues, such as uninformative arrows, directional words (left, right), temporal words (past, future), divine words (god, devil), and numbers (1, 9) orient attention is an automatic manner but do not involve peripheral events (i.e., they are neither entirely bottom-up nor top-down).

Ideomotor Theory: Understanding the Relationship of Thought and Action: When we begin to plan an action, we fundamentally change the manner in which we attend and perceive objects and events in the visual field. For example, we have shown that planning a limb movement in a specific direction reduces the capture of attention by events moving in the same direction, and that people can learn an association between a response and a top-down attentional filter so that, for example, planning a left response will only allow attention to be allocated to red items.

Motor Control Processes in Guided Limb Movements and Saccadic Eye Movements: The planning and production of limb and eye movements require the optimization of motor programming and on-line control processes. We have shown that is it possible to violate Fitts' Law by providing structured visual information during motor programming, that saccadic eye movements – long considered entirely ballistic in nature – are sensitive to on-line control processes, and that heavily practiced video game players learn complex movement patterns more efficiently than non-video game players.

Sample publications relevant to the collaborative specialization:

Gozli, D., Huffman, G., & Pratt, J. (2016 in press). Acting and anticipating: Impact of outcome-compatible distractor depends on response selection efficiency. Journal of Experimental Psychology: Human Perception & Performance.

Taylor, J. E. T., Rajsic, J. & Pratt, J. (2016). Object-based selection is contingent on attentional control settings. Attention, Perception, & Psychophysics, 78, 988-995.

Gozli, D., Aslam, H., & Pratt, J. (2016). Visuospatial cueing by self-caused features: Orienting of attention and action-outcome association learning. Psychonomic Bulletin & Review, 44, 459-467

Teaching that would be relevant to this collaborative program:

PSY5204HF Attention and action: Then and Now: Pratt

This seminar will examine current research in the areas of visual attention and action (motor control) in the context of some of the classic research papers in the respective fields. The topics covered in include attentional capture, attentional control sets, inhibition of return, the gap effect, action-based attention, object-based attention, and component submovements of rapid aimed limb movements.