The thesis defence of Mr. Tao JIANG (Supervisor: Prof. Joseph Matthew Kinsella & Prof. Yaoyao Fiona Zhao) has been scheduled to take place on Tuesday, November 27\textsuperscript{th}, 2018 at 1:00PM in Room MC603, McConnell Engineering Building.

**Bioprinting Soft Materials to Create 3D Heterogeneous Breast Cancer *in vitro* Models**

**Abstract**

Human tumor progression is a dynamic process involving diverse biological, biochemical, physical, and mechanical interactions occurring between cells and the tumor microenvironment. These events are difficult to reproduce in the lab using conventional cell culture or small animal models. These challenges can be overcome using bioprinting techniques to build heterogeneous 3D tissue models whereby, different types of cells are embedded.

In this thesis, the physical requirements to make soft materials bioprintable are first studied. It is found that the existence of apparent yield stress, as opposed to high viscosity, is the key to ensure printability. Two dimensionless numbers are introduced to systematically describe the printing quality. Next, the influences of mechanical and biological cues on cancer cell growth in bioprinted model systems are systematically studied. Tunable composite hydrogels composed of controlled concentrations of alginate and gelatin are developed. The initial mechanical characteristics of each composite hydrogel are correlated to cell proliferation rates and cell spheroid morphology spanning month long culture conditions. Ultimately, we have realized the design of a bioprinted heterogeneous cancer model that incorporates multiple cell types into a single model with initial spatiotemporal control. MDA-MB-231 breast cancer cells and IMR-90 cancer associated fibroblast cells are used and their interactions are observed for over 30 days of culture. During culture the IMR-90 cells can migrate through a non-cellularized region of the hydrogel matrix and infiltrate the MDA-MB-231 spheroids after ~15 days, creating mixed MDA-MB-231/IMR-90 multicellular tumor spheroids. This study provides insights into reconstructing biomimetic in vitro tissue co-culture models to study cell-cell interactions, cell-matrix interactions, and tumor spheroid formation mechanisms.

**Biography:**

I am a Ph.D. student supervised by Prof. Joseph Matthew Kinsella and Prof. Yaoyao Fiona Zhao. My research focuses on the mechanics of 3D bioprinting, biomaterial characterizations, and fabrication of in vitro heterogeneous breast cancer models. The methods include measurement of rheological properties of biomaterials, extrusion-based printing tests and quality quantifications, and creating physiological mimicking cancer relevant microenvironment. The project yields a quantitative understanding of the mechanics in the bioprinting processes, provides a guide for synthesizing new bioprinting materials, and also provides insights into reconstructing biomimetic in vitro tissue co-culture models to study cell-cell interactions, cell-matrix interactions, and tumor spheroid formation mechanisms.
The thesis defence of Mr. Mahmoud HASSAN (Supervisors: Prof. Helmi Attia, Prof. Vincent Thomson & Prof. Jozsef Kovecses) has been scheduled to take place on Tuesday, November 27th, 2018 at 2:00PM in Room MD497, Macdonald Engineering Building.

**Generalized Sensor-Based Tool Failure Detection and Prevention System for Intermittent Cutting Operations**

**Abstract**

Tool condition monitoring (TCM) systems are essential to achieve the desired competitive advantage in manufacturing in terms of reducing cost, increasing productivity, improving quality, and preventing damage to the machined part. In this research work, a new intelligent TCM system has been developed for accurate detection of tool wear failure as well as prediction of sudden tool chipping/breakage before damaging the machined part. The system analyzes process-born features gathered from multi-sensor feedback signals using advanced signal processing and machine learning methods to detect the tool condition during cutting processes. Communication between the developed system and a CNC machine controller has been implemented. The time required for signal processing, decision making and communication with the machine controller allows stopping the operation before part damage.

For tool wear detection, robust and real-time signal processing and decision-making algorithms were developed using feedback signals from the spindle drive motor. The proposed signal processing approach accentuates the tool condition effect on the extracted features while masking the effects of the cutting parameters. These features were employed in a machine learning algorithm to detect the tool condition. The results indicated the capability of the processing technique to minimize system learning effort by at least 75% and to detect tool wear with an accuracy above 95% and a confidence level above 90%. Such capability has never been achieved before. For sudden failure prediction, a novel signal processing approach for online prediction and prevention of tool chipping/breakage during intermittent machining was developed. The approach analyzes the acoustic emission waves associated with the generation of new surfaces during unstable crack propagation, which precede tool fracture. The features of the prefailure phase were identified using the Hilbert-Huang transformation method and the Teager-Kaiser Energy Operator, which can discriminate high energy/frequency events in the prefailure phase. Extensive experimental results demonstrated the accuracy of the developed system to consistently predict tool chipping. The system output has been shown to be independent of the cutting parameters and workpiece material. A correlation between the chipping size and the prefailure features was developed for decision making. No such system previously existed.

**Biography:**

Mr. Mahmoud Hassan is a mechanical engineering PhD candidate at McGill University and a Research Officer at the National Research Council Canada. His PhD research focus on intelligent unmanned manufacturing systems and process monitoring. The novelty of his work in tool condition monitoring systems for intermittent cutting operations, under the supervision of Prof. H. Attia, Prof. V. Thomson and Prof. J. Kovecses, has contributed to develop new capability towards sensor-based cyber-physical system and unmanned manufacturing. He has solid advanced knowledge in the application of sensing systems, advanced real-time signal processing techniques, machine learning algorithms and process optimization.

Mr. Hassan has a strong desire for continuous learning and self-development. He has good communication and interpersonal skills, as well as time management and planning skills.