

## RESEARCH REPORT

|  |                   |
|--|-------------------|
| 1. Name: Jake Bobowski   | (ID No.: SP07401) |
| 2. Current affiliation:<br>Department of Physics and Astronomy, University of British Columbia   |                   |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences <b>X Mathematical and Physical Sciences</b><br>Chemistry                      Engineering Sciences                      Biological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences  |                   |
| 4. Host institution: Kyoto University  |                   |
| 5. Host researcher: Professor Yoshiteru Maeno  |                   |
| 6. Description of your current research<br><p>Materials with strong electron-electron interactions exhibit a wide variety of exotic behavior and are the subject of intense study in condensed matter physics. These strongly correlated materials have required that physicists abandon simple single electron pictures and develop new experimental and theoretical tools to investigate their electrodynamics.</p> <p>The Superconductivity group at the University of British Columbia (UBC) have developed a novel broadband apparatus to measure the microwave absorption of superconducting crystals as a continuous function of frequency. The unprecedented resolution of this apparatus allowed for the first experimental observation of the conductivity frequency spectrum expected for a clean <i>d</i>-wave superconductor in <math>\text{YBa}_2\text{Cu}_3\text{O}_{6+y}</math>.</p> <p>Up to this point, the broadband spectrometer has been limited to temperatures above 1 K. I have built a version of the experiment to operate with a <math>^3\text{He}/^4\text{He}</math> dilution refrigerator which will reach temperatures below 100 mK. With this expanded temperature range the broadband apparatus can be used to study a variety of new materials.</p> |                   |

## 7. Research implementation and results under the program

Title of your research plan:

Single Crystal Growth of Ultra-Pure  $\text{Sr}_2\text{RuO}_4$  by the Floating Zone Method

Description of the research activities:

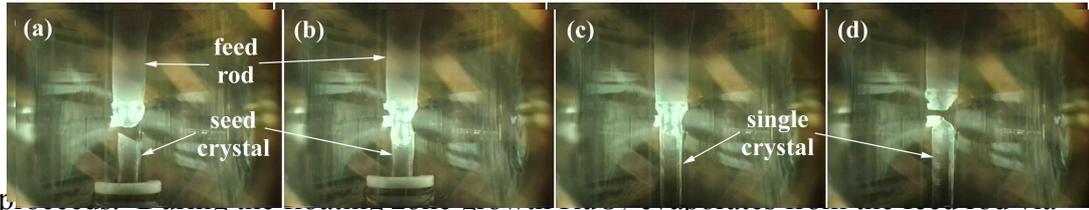
The electrical conductivity of metals is limited by the interaction of conduction electrons with the crystal lattice; mobile electrons are scattered by the thermal motion of the ions forming the lattice. In some metals (Pb, Sn, ...), the conduction electrons form pairs below a temperature  $T_c$ . Below  $T_c$ , the so-called Cooper pairs are bound by an energy  $\Delta$  that is greater than thermal energy of the ions and they propagate through the lattice with zero resistance, a phenomenon known as superconductivity.

In conventional superconductors, such as those listed above, the source of the attractive electron-electron interaction is understood. Yet, in a class of more complex unconventional superconductors, the mechanism driving the electron pairing remains unclear. Moreover, the Cooper pairs of unconventional superconductors exhibit exotic symmetries that drastically alter the electrodynamics of these materials.

$\text{Sr}_2\text{RuO}_4$  has been identified as a possible *spin triplet* superconductor, a material in which the spins of the electron pairs are symmetrically aligned. The goal of this project is to conclusively identify the symmetry of the Cooper pairs in  $\text{Sr}_2\text{RuO}_4$ .

Single crystals of  $\text{Sr}_2\text{RuO}_4$  are grown in an image furnace by the floating zone method. The image furnace focuses infrared light into a small region at the centre of the furnace where temperatures up to  $2500^\circ\text{C}$  are obtained. During the growth, the end of a polycrystalline feed rod is heated until molten (a) and brought into contact with a seed crystal (b). As the molten material is moved out of the focus of the light it solidifies as single crystal  $\text{Sr}_2\text{RuO}_4$  (c). Finally, the feed rod is disconnected from the single crystal (d). The typically  $\text{Sr}_2\text{RuO}_4$  crystals grown by this method are 5-8 cm long and  $2 \times 3 \text{ mm}^2$  in cross-section.

Since  $\text{RuO}_2$  actively evaporates during the single crystal growth, the starting composition needs to be carefully selected. The polycrystalline feed rod is prepared by mixing  $\text{SrCO}_3$  and  $\text{RuO}_2$  powders in the ratio  $2\text{SrCO}_3 + n \text{RuO}_2$ . The powder is then placed into a mold and compressed under high pressure. The resulting rod is baked at  $1420^\circ\text{C}$  and the reaction  $2\text{SrCO}_3 + n \text{RuO}_2 \rightarrow \text{Sr}_2\text{Ru}_n\text{O}_{2n+2} + 2\text{CO}_2$

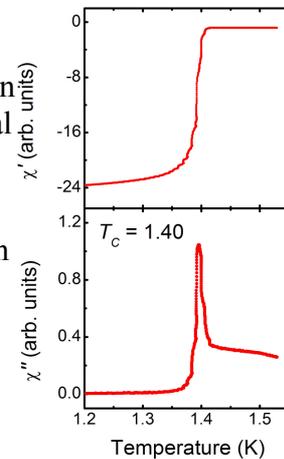


$\text{Sr}_2\text{Ru}_n\text{O}_{2n+2} \rightarrow \text{Sr}_2\text{Ru}_n\text{O}_{2n'+2} + (n - n') \text{RuO}_2$  and  $n$  must be chosen such that  $n' = 1$  is achieved.

The superconducting transition temperature and width are both very sensitive to impurities and crystalline defects. Two hallmark features of superconductivity are (1) zero electrical resistance and (2) the expulsion of magnetic fields from the bulk of the sample. We use the second feature to measure the superconducting transition of  $\text{Sr}_2\text{RuO}_4$ . Samples are placed in a magnetic field and the fraction of the field that is expelled from the sample is detected as temperature is varied.

The *maximum*  $T_c$  of pure  $\text{Sr}_2\text{RuO}_4$  is 1.50 K. The data to the right shows the superconducting transition of a sample I prepared which has a narrow transition and a near maximum  $T_c$ . There are two possible sources of the 100 mK suppression of  $T_c$ : (1) impurities that are either introduced during the crystal growth or are present in the original powders and (2) crystalline defects caused by local values of  $n' \neq 1$ .

During the JSPS program I successfully grew high purity  $\text{Sr}_2\text{RuO}_4$ . The best samples will be used in microwave absorption measurements at UBC



## RESEARCH REPORT

|   |                   |
|---|-------------------|
| 1. Name: Mandeep Pinky Gaidhu   | (ID No.: SP07402) |
| 2. Current affiliation: York University   |                   |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences                      Mathematical and Physical Sciences<br>Chemistry                      Engineering Sciences                      X Biological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences   |                   |
| 4. Host institution: Department of Metabolic Diseases, University of Tokyo  |                   |
| 5. Host researchers: Dr. Takashi Kadowaki and Dr. Toshimasa Yamauchi  |                   |
| 6. Description of your current research<br><p>My research objectives at York University under the supervision of Dr. Rolando Ceddia have focused on the metabolic pathways involved in glucose and lipid metabolism in isolated adipocytes. In particular, I have been studying the role that AMP-activated protein kinase (AMPK) plays in regulating several metabolic parameters in fat tissue. AMPK is an enzyme that has been proposed to monitor change in energy status of cells, and would therefore be a key regulator for whole body energy homeostasis. I have found some novel results in my current research, which demonstrated that fatty acid uptake and oxidation in adipocytes is inhibited in the presence of AICAR, a pharmacological activator of AMPK.</p> <p>As a follow-up to this study, I am also interested in the effects of endogenous activators of AMPK, such as adipokines. I would like to investigate the autocrine effects of adipokines secreted by the adipocyte itself and how it affects substrate metabolism via AMPK. Two important adipokines I am interested in investigating are adiponectin and leptin. These hormones have been the popular target of pharmaceutical research looking to alleviate obesity and its related metabolic disorders. Adiponectin and leptin both activate AMPK in adipose tissue, and would serve as a good complement to my current research looking at the metabolic effects of AMPK activation in fat cells using endogenously present AMPK activators. On a larger scale, this research gives molecular insights into the dissipation of fat storage in adipocytes, which may lead to therapeutic drug targets for obesity related disorders.</p> |                   |

## 7. Research implementation and results under the program

Title of your research plan:

Examining the role of adiponectin and AMPK activation in a variety of different tissues.

Description of the research activities:

Dr. Yamauchi is an investigator in Dr. Kadowaki's lab at the University of Tokyo, and he has examined the role of adiponectin on AMPK activation in muscle and liver. The main focus of my project in Japan was to learn techniques that are important in conducting research related to the action of adiponectin via AMPK, and this consisted of experiments as described below.

### 1) *Purification of adiponectin*

A major portion of my project relied on the successful propagation and purification of recombinant adiponectin using *E. Coli*. This technique is useful for many reasons. First, adiponectin is expensive; therefore in-house production of this hormone is ideal. Second, understanding the principles underlying the amplification and purification processes gave me great insight into how molecular biology is applied. There are many steps involved in purification of adiponectin: 1) amplifying the protein in bacteria, 2) purifying the protein, 3) confirming purity and concentration, and 4) testing its efficacy. We were able to purify adiponectin at a fairly high concentration, and are currently in the process of checking its efficacy in C<sub>2</sub>C<sub>12</sub> myotubes. In this lab, we treat C<sub>2</sub>C<sub>12</sub> muscle cells with adiponectin in varying concentrations for 5min and then assess AMPK and ACC phosphorylation using Western blotting analyses. Currently, we are completing this final step for adiponectin purification.

### 2) *Purification of adenovirus coding for DN-AMPK*

In my current research, I am using a pharmacological activator of AMPK called AICAR. Unfortunately, the side effects of drugs may cause AMPK-independent effects. In order to address this issue, I worked closely with Dr. Ueki in Dr. Kadowaki's group to learn how to amplify and purify a dominant-negative AMPK $\alpha$  adenovirus. This adenovirus would allow me to infect primary cells and reduce AMPK $\alpha$  activity more specifically instead of using pharmacological agents. During my stay in Japan, we were able to amplify and purify the DN-AMPK $\alpha$ 1 and  $\alpha$ 2 adenoviruses, infect primary hepatocytes isolated from mice, and effectively decrease AMPK phosphorylation under both basal and AICAR stimulated conditions (Figure 1).

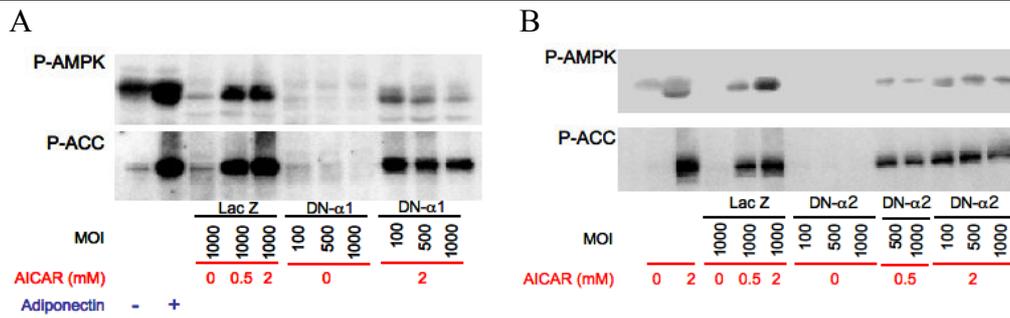


Figure 1: Successful use of adenovirus mediated gene transfer in isolated primary hepatocytes. Here, we used adenoviruses coding for LacZ (Control), dominant-negative AMPK $\alpha$ 1 (Panel A) and  $\alpha$ 2 (Panel B) (DN- $\alpha$ 1 and DN- $\alpha$ 2, respectively). We also stimulated the cells for 30min with varying concentrations of AICAR (0, 0.5, and 2mM) to see if the DN-AMPK $\alpha$  proteins could inhibit AMPK and ACC phosphorylation. Working with the DN-AMPK $\alpha$  proteins is beneficial to my current research because it eliminates confounding variables associated with pharmacological agents, and gives stronger evidence that the effects I am seeing are AMPK dependent.

8. Please add your comments (if any):

I am very fortunate to have had the opportunity to work in a lab on the cutting edge of research that investigates the molecular basis of obesity and the metabolic syndrome. I learned many valuable techniques, and I am indebted to my colleagues in Dr. Kadowaki's group for their patience and taking the time to explain concepts and demonstrate techniques. In particular, I would like to thank Dr. Kadowaki and Dr. Yamauchi for allowing me to work in their lab this summer. Thank you to Dr. Ueki and Dr. Awazawa for their extensive help in purifying adenoviruses and for taking the time to show me new techniques. I would also like to thank Hirose-san, who helped make Tokyo my home for the summer and worked with me to complete experiments.

I hope to stay in touch with all my colleagues that I met at Tokyo University, and I am looking forward to them all coming to visit me at York University in Canada!  
*Arigato gozaimashita.*

9. Advisor's remarks (if any):

It was very good to have Pinky in the lab and work on experiments with adiponectin and the dominant-negative AMPK $\alpha$  adenovirus. We hope that she enjoyed her time in Japan and working with different colleagues in Dr. Kadowaki's lab. We look forward to working with her in the future and maintain contact when she goes back to York University in Toronto, Canada.

## RESEARCH REPORT

|  |                    |
|--|--------------------|
| <b>1. Name:</b> Jeff Gostick   | (ID No.: SP07403 ) |
| <b>2. Current affiliation:</b> University of Waterloo  |                    |
| <b>3. Research fields and specialties:</b> Engineering Sciences , Chemical Engineering   |                    |
| <b>4. Host institution:</b> Tokyo Institute of Technology  |                    |
| <b>5. Host researcher:</b> Prof. Shuichiro Hirai   |                    |
| <b>6. Description of your current research</b> <p>My PhD work is focused on the mass transport and the two-phase flow phenomena occurring in the porous electrodes of polymer electrolyte membrane fuel cells. The main benefit of fuel cells for automotive application is that zero emissions are generated by the energy conversion; water is the only by-product of the internal reactions in a fuel cell. From a technical standpoint however, the water causes some difficulties since it must be effectively ejected from the cell. Water that is not ejected will condense and create significant blockages to the flow of reactant gases into the cell, thereby greatly reducing cell performance. The focus of my work is to understand the microscopic (i.e. pore-scale) behavior of liquid water in the fuel cell electrode so that improved strategies for water removal and gas transport can be identified.</p> <p>To date my work has focused on the ex-situ testing of transport through porous electrode materials as well as modeling of pore-scale phenomenon using percolation modeling. Future work will include the study of fuel cell performance as a function of electrode properties. The project I contributed to this summer was not specifically related to my research, but did expose me to the broader fuel cell picture.</p>   |                    |
| <b>7. Research implementation and results under the program</b>  |                    |
| <b>Title of your research plan:</b> Measurement of gas permeability through polymer electrolyte membranes.   |                    |
| <b>Description of the research activities:</b> <p>The research goals this summer were to develop a testing procedure for measuring the gas cross-over phenomena in polymer electrolyte membranes used in fuel cells. The cross-over of reactant gases from cathode to anode and <i>vice-versa</i> is a major cause of materials degradation and is also responsible for reduced cell performance and system efficiency. Understanding gas permeability properties of these materials is an important area of research for the advancement of fuel cell technology.</p> <p>The specific aims of this project were to use direct gas mass spectroscopy (DGMS) to monitor the composition of the exhaust gas from the cell. The presence of oxygen in the anode outlet and/or hydrogen in the cathode outlet, indicate the occurrence of gas cross-over through the membrane. Once developed, the technique can be used to monitor cross-over during cell operation, or to measure the fundamental transport properties of the membrane using controlled experiments. In the case of cross-over monitoring during cell operation, the operating conditions of the cell can be controlled, such as temperature, humidity and reactant gas composition, and the conditions that lead to the most significant cross-over, and therefore degradation, can be identified. Experiments can also be performed to study to fundamental properties of membrane materials or to understand the underlying processes of gas transport in ionomeric membranes. Knowledge of the intrinsic</p> |                    |

transport properties of these materials allows more accurate modeling and estimation of fuel cell performance. The ionomeric material also presents a challenge to traditional transport modeling since the material is a unique polymer that consists of two phases, the polymeric backbone and hydrophilic regions that provide ionic conductivity. The solubility of gases into, and transport through the material, are thought to be strongly controlled by the hydrophilic regions but the exact nature of the transport mechanism(s) is unclear. Controlled experiments combined with the ability to accurately measure the gas flux, using the DGMS system, will yield powerful new insights into these materials.

The progress achieved the summer consisted mostly of commissioning of the DGMS system. Much effort went into practical matters, such as fixing leaks and improving detection levels of the mass spectrometer. Eventually, however, some data were obtained concerning the amount of oxygen cross-over that occurs in a cell operating at open-circuit voltage. These results were submitted to an upcoming conference, The 4<sup>th</sup> International Conference on Flow Dynamics in Sendai, to be presented by a co-researcher. Other technical difficulties, such as broken equipment, long lead times on ordered parts and technical limitations of the mass spectrometer (i.e. difficult to use with humidified gases), prevented the completion further experiments. Nonetheless, the internship must be deemed successful since the system was commissioned successfully and acceptable preliminary results were obtained.

**8. Please add your comments (if any):**

Before coming to Japan I was warned by a friend who had previously been a JSPS intern not to expect to do any significant work in such a short time. Furthermore, a summer project based on experimental work is vulnerable to many unforeseeable practical problems and technical difficulties, as well as time constraints. This summer project was subjected to both time limitations and practical problems, but I feel that I still managed to accomplish something useful. At the very least, I am leaving behind functioning equipment that can now be used by future students of the lab. I also suggested an experiment to my co-researcher that allowed him to prove an important hypothesis related to his PhD, and this work is being presented at an upcoming conference. I'll be listed as a co-author, so this summer provided me with a tangible benefit as well.

**9. Advisor's remarks (if any):**

It was a very nice experience for me and our laboratory's members to host a JSPS researcher. Mr. Jeff Gostick brought our students a chance to have cultural exchange and to learn how to manage a daily life in a foreign country. I believe that it was also very good experience for him. Although a short time project I arranged for him was not an easy task, he devoted himself to the project during this summer and played an important role to establish a measuring system for the project. His valuable contribution will be shown in an international conference in this autumn and is being utilized in our laboratory from now on. I would like to show my acknowledgement on him for his coming and sharing his valuable time in this summer with us. I also would like to thank for the JSPS program.

## RESEARCH REPORT

|  |                    |
|--|--------------------|
| 1. Name:     ADNENE HAJJI  | (ID No.: SP07404 ) |
| 2. Current affiliation: QUEBEC UNIVERSITY: École de Technologie Supérieure   |                    |
| 3. Research fields and specialties:<br>Humanities                    Social Sciences                Mathematical and Physical Sciences<br>Chemistry                    X Engineering Sciences        Biological Sciences<br>Agricultural Sciences            Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences  |                    |
| 4. Host institution: Gifu University   |                    |
| 5. Host researcher: Pr. Hidehiko YAMAMOTO  |                    |
| 6. Description of your current research<br><br>This research deals with the operational-level manufacturing control problem in a supply chain environment. To handle the complexity of the problem, a sequential resolution approach is proposed. It combines mathematical modelling, numerical resolution as well as simulation, design of experiment and genetic algorithms. The first part of the approach is based on optimal and impulsive control theory which is essential to have a rigorous foundation making it possible to propose sub-optimal control strategies. Regarding the second part of the approach, it completes the first part so as to develop manufacturing activities decisional processes. Moreover, it offers more flexibility to handle possible extensions covering more complex systems.<br>In the first part of this research, we considered a stochastic optimal control problem of multi parts parallel and serial manufacturing systems. For parallel systems, we showed that the developed production and setup strategy guarantee better performance. For serial systems, we showed the great usefulness of the proposed combined approach which could be indispensable facing <i>NP</i> hard problems.<br>In the second part of this research, we considered the external environment of the manufacturing system. We developed an integrated production and replenishment strategies for stochastic supply chain with multiple suppliers. It was shown that, from a mathematical point of view, the considered problem is difficult to tackle and it calls upon, optimal and impulsive control theory notions. The results showed that the developed control policies are coupled. This fact confirms the necessity of considering the interactions present in the system in an integrated model so as to obtain more realistic control policies.<br>In the third part of this research, we developed an optimization module based on simulation, genetic algorithms and design of experiment. This module is essential to deal with the difficulties encountered in the first part regarding the number of the parameters to optimize and it could easily integrate other manufacturing activities like preventive maintenance strategies. Moreover, it makes it possible to consider in an integrated manner the transformation process and its external environment (i.e., suppliers).<br>In conclusion, this research should bring solutions to a class of manufacturing system modeling under uncertainty. Moreover, it applies a solid and applicable approach making it possible to develop decision making processes for realistic systems. This approach can overcome the complexity behind mathematical models resolution of big size systems. |                    |

## 7. Research implementation and results under the program

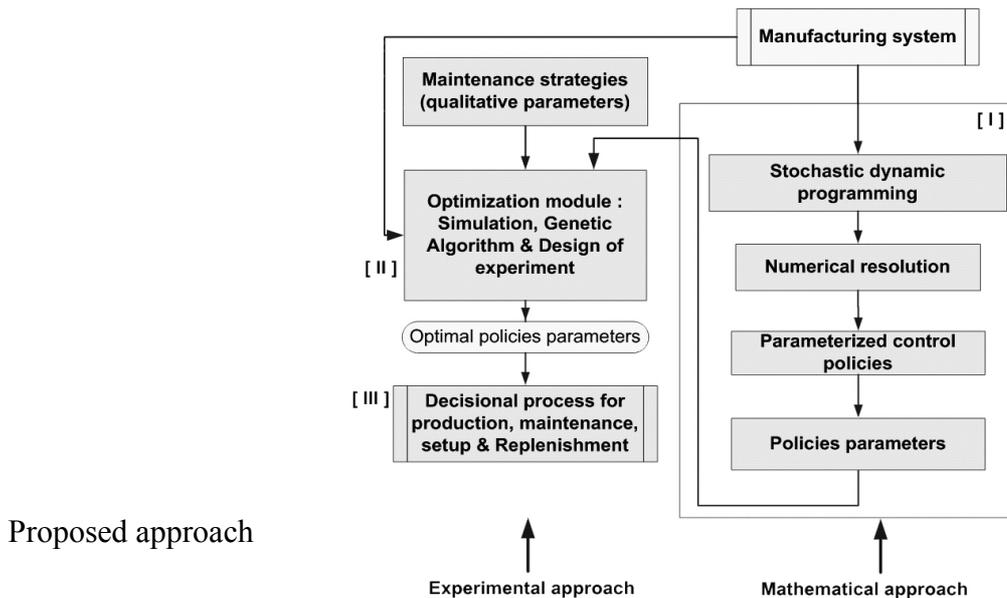
Title of your research plan:

### **Towards an integrated decision support system for operational and tactical planning under uncertainty**

Description of the research activities:

Under the supervision and the help of Pr. Yamamoto, I was able to use the existent installation and expertise of his research group to validate the two aforementioned parts of my thesis research and to finish the third part.

Two interesting results were found. The first one consists on a combined production and changeover control policies for buffered flow-shops multi parts manufacturing systems. The second one consists on developing an optimization module making it possible to find in a stochastic dynamic manner the best control parameters of the production, replenishment and setup actions simultaneously with the best maintenance scheduling between bloc, age or opportunistic strategies. It was shown that it is more profitable to consider in an integrated manner the manufacturing and supply control problems. In fact, for the case under study we found that the total incurred cost can be reduced up to **11 %**. Moreover, depending on the economic context, it is more profitable to consider more than one maintenance strategy and to adopt the best one in a given context.



### Optimization module

Under this research training, two papers were successfully completed and will be submitted to International Journal with lecture committee.

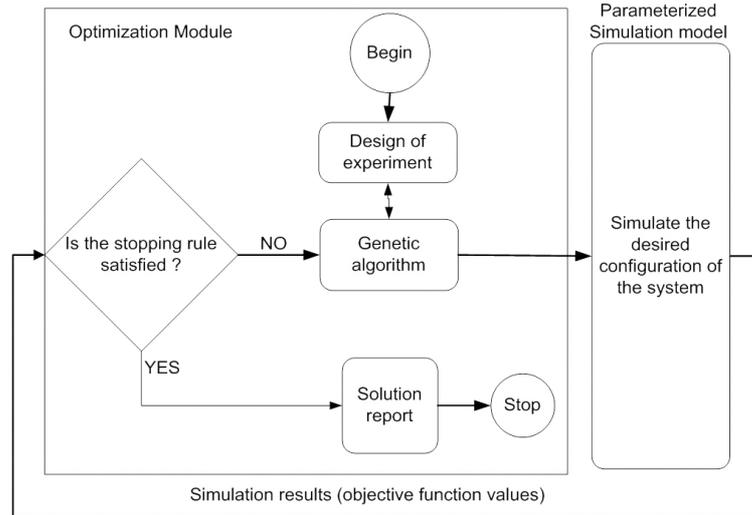
#### **«Production and changeover control policies of a class of failure prone buffered flow-shop»**

Adnène HAJJI <sup>a</sup>, Ali

GHARBI <sup>a</sup>, Jean Pierre KENNE <sup>b</sup>, Yamamoto HIDEHIKO <sup>c</sup>

#### **«Operational Level-Based Policies of unreliable flow-shops in a supply chain environment»**

Adnène HAJJI <sup>a</sup>, Ali GHARBI <sup>a</sup>, Jean Pierre KENNE <sup>b</sup>, Yamamoto HIDEHIKO <sup>c</sup>



8. Please add your comments (if any):

I would like to express my great gratitude to the JSPS and CE (CRSNG) for their support and this unique research experience. I would like also to express my great recognition to Pr. Yamamoto for his time and help. He enabled me to attend to several industrial visits and he provides me with all the required resources to advance in my research and the results (i.e., two journal papers) prove it.

The two months that I have spent in Japan were really successful. I was able to discover and enjoy the Japanese life style and the serenity of the Japanese people. I finally hope to be able to be back to Japan soon for a post doctoral research.

## RESEARCH REPORT

|  |                    |
|--|--------------------|
| 1. Name: Chukwunonyerem Samuel Ima   | (ID No.: SP07405 ) |
| 2. Current affiliation: University of Manitoba, Canada   |                    |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences                      Mathematical and Physical Sciences<br>Chemistry <input checked="" type="checkbox"/> Engineering Sciences                      Biological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences   |                    |
| 4. Host institution: Ritsumeikan University, BKC, Shiga, Japan   |                    |
| 5. Host researcher: Dr. Takashi Higuchi  |                    |
| 6. Description of your current research<br><p>Air pollution occurs as a result of emission of volatile organic compounds (VOCs) as well as other malodorous substances into the environment. Odorous gases are offensive and constitute a nuisance to the public. Several conventional methods (e.g., incineration) for treating contaminated air currently exist. However, these methods are very expensive. Secondly, they transfer pollutants from one phase to another, thereby generating secondary pollutants, which require further treatment. Biofiltration is a relatively new technology, which is very useful in treating odorous air as well as VOCs. It is a biological air pollution control technique in which microorganisms attached to a porous medium are utilized to break down contaminants contained in an air stream. The microorganisms utilize the contaminants for their growth and energy. Unlike the conventional air treatment methods, biofiltration allows for complete degradation of contaminants into harmless end products. In addition, biofiltration is very cost-efficient. Both capital and operation costs are relatively low. My current research examines control of odour emissions from livestock facilities (e.g., the hog barn) using biofiltration method. Secondly, as filter materials (especially, organic filter materials) used in biofiltration compact over time, they exert pressure on the walls of the biofilter. Wall pressure is a major factor that causes structural failure. Therefore, my research is also aimed at determining the wall load of different filter materials. The result obtained would aid in the design of more sustainable biofilter.</p> |                    |

## 7. Research implementation and results under the program

Title of your research plan:

Treatment of Toluene-Contaminated Air using a Rotary-Type Biofilter and Highly Porous Packing Material.

Description of the research activities:

VOCs are widely used in and emitted from many chemical industries. Recently, there has been an increasing stringent regulation against VOC emissions at both national and international levels. This is because most VOCs are potentially malodorous, toxic and carcinogenic, thereby posing a threat to public health. In addition, VOCs are important greenhouse gases contributing to greenhouse effect, photochemical smog, and global warming. Toluene ( $C_6H_5CH_3$ ) is a toxic, colourless, and flammable VOC, which is mostly obtained from petroleum refining processes and used extensively as a solvent and raw material for the production of wide variety of chemicals. It has the potential to adversely affect the kidney, lungs, and the central nervous system if inhaled or swallowed. In Japan, toluene is reported to be the chemical with the highest emission amount. As such, treatment of toluene-contaminated air is of necessity.

I conducted a research to treat an air stream contaminated with toluene using newly developed biofilter. The biofilter had a rotary mechanism and is quite unique both in its design and operation. The chamber was divided into four different units. Inlet air passed through three out the four units before exiting into the atmosphere. The fourth unit is subjected to a washing zone where the inlet air cannot pass through. The filter material used (polyvinyl formal) was also newly developed and had an excellent moisture retention capacity. The objectives of the research included: (1) to examine the operating parameters of the biofilter over a given period of time, (2) to investigate trend of nutrient (ammonium nitrogen) utilization, and (3) to determine the quantity of nitrogen nutrient trapped in a unit mass of the filter material. The parameters used to evaluate the performance of the biofilter were inlet load ( $gm^{-3}h^{-1}$ ), elimination capacity ( $gm^{-3}h^{-1}$ ), and removal efficiency (%).

Contaminated air consisting of a mixture of compressed clean air and toluene was fed into the biofilter in an upflow mode. Air samples were obtained from sampling ports and were analyzed with a gas chromatograph (GC) equipped with a flame ionization detector (FID). The GC has an injection, detector, and oven temperatures

of 135, 130, and 105°C, respectively. Nutrient solution was supplied daily to the filter bed to provide nitrogen. Nutrient samples were obtained daily and analyzed using indophenol blue method. Pressure drop, room temperature, and CO<sub>2</sub> concentrations were monitored daily. The results obtained showed that the biofilter and the packing material were very efficient in treating the toluene-contaminated air. As the inlet load increased, elimination capacity increased while removal efficiency decreased. The maximum inlet load, elimination capacity, and removal efficiency obtained were 162.3 gm<sup>-3</sup>h<sup>-1</sup>, 120.7 gm<sup>-3</sup>h<sup>-1</sup>, and 99.98%, respectively. Concentration of ammonium nitrogen in the nutrient solution decreased over time. This is because the microorganisms utilized the nitrogen for metabolic processes. The average mass of nitrogen trapped in a unit mass of the filter material was calculated to be 9.6 g.

8. Please add your comments (if any):

This is a great program – well designed and executed! I appreciate the international exposure and research experience I have obtained. Special thanks to JSPS, Canadian Embassy in Japan, and NSERC, Canada for giving me this wonderful opportunity. My sincere gratitude also goes to my host researcher, Dr. Takashi Higuchi and all the students in his laboratory. They are amazing! Dr. Higuchi opened the door of his heart and laboratory completely to me. He was always there to ensure I was doing fine. I definitely hope to collaborate more with him in the future. I strongly recommend the JSPS program for any students longing for an invaluable international research experience!

9. Advisor's remarks (if any):

It was my great pleasure to be a host researcher in this program. And I was lucky that the fellow, Mr. Samuel IMA, is a person who thinks and acts everything positively. And, of course, he implemented his research here as much as possible. I suppose that the subject I prepared for him did not suit completely for his current research, but I believe that his experience here gave him some another viewpoint and some technical skills. Now, I am strongly asking him for his next visit to my laboratory as a postdoc, and he will try to find the feasibility on it.

## RESEARCH REPORT

|  |                    |
|--|--------------------|
| 1. Name: Jamy Li   | (ID No.: SP07406 ) |
| 2. Current affiliation: University of Toronto  |                    |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences                      Mathematical and Physical Sciences<br>Chemistry <input checked="" type="checkbox"/> Engineering Sciences                      Biological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences   |                    |
| 4. Host institution: Keio University   |                    |
| 5. Host researcher: Professor Michiaki Yasumura  |                    |
| 6. Description of your current research<br><p>My research investigates the relationship between the personalities of people who write web logs (or “blogs”) and online community. First, I am looking at whether blog communities attract distinct personality types. Second, I am analyzing the written text of individual blogs to determine whether there are diagnostic words, emoticons or other written language features that distinguish between blog communities or between personality traits. Previous work has shown that natural language processing methods have potential to determine affect in blog posts, but few have looked at personality traits and none have related these ideas to online community. These missing components are crucial toward understanding how different people behave in the online world. The value of this research is that results may be used to develop methods of customizing messages to members of different virtual communities as well as to develop customized features (such as collaborative tagging) that better fit the characteristics (such as personality) of different virtual communities. In addition, this research also has value in addressing scientific questions relating to how effects that can be observed in everyday social interaction translate into online settings.</p> |                    |
| 7. Research implementation and results under the program<br><p>Title of your research plan:<br/>Messages in Movement: How People Perceive Gestures of a Low-Degree-of-Freedom Robot</p>  |                    |

### Description of the research activities:

We have all seen robots designed for personal use—robotic toys, animals, vacuum cleaners—but how many of us actually use these robots? Part of the problem is that humans use movement as a cue for sentience<sup>1</sup> but it is unclear how robots should move to elicit acceptable social interaction. Our research explores the effect of providing contextual information and the effect of gesture complexity on viewers' identification of a gesture's meaning. Unlike previous work that has focused on emotional expression (e.g.<sup>2</sup>), we look at both emotion and message communication in robot gestures. The results of this research may have important implications for the design of social robots and may aid understanding of how people's perception of body gestures translates into technology environments.

### *Study Design:*

We conducted two related studies with a low degree-of-freedom robot bear ("RobotPHONE"<sup>3</sup>), capable of moving only its head and both arms. In Study 1, four participants from Keio University manipulated the robot to create a gesture for each of 12 scenarios provided (e.g. "You pat the bear's head"). They also wrote down what meaning the gesture had. In Study 2, we presented the corpus of 48 gestures created in Study 1 to 12 participants by varying two within-subject experimental conditions: medium and context. For medium, participants viewed the gesture either as a software avatar or as a video of the bear robot. For context, subjects were either provided with the appropriate scenario before viewing the gesture or this information was excluded. Gestures also varied by complexity, which was measured in three ways: number of head movements, number of arm movements, and subjective ratings by two independent investigators (inter-correlation=.78). Study 2 participants were then asked to rate liking and lifelikeness of the gesture, and to select the message (e.g. "Take care of me") and emotion (e.g. "happy") they thought the gesture conveyed from a coded list. The dependent measures in this study were subjective ratings given by participants (liking, lifelikeness), and emotion and message identification accuracy (both viewer agreement with the gesture author, and viewer agreement with other viewers).

### *Analysis and Results:*

First, contextual knowledge was found to be beneficial to viewers. Two-way repeated measures analysis of variance (ANOVA) showed that listening to scenarios prior to viewing gestures significantly improved participants' message identification accuracy (from 20% to 56%,  $F(1,11) = 93.8$ ,  $p < .001$ ). In the case of the video medium, context also increased their ratings of liking ( $F(1,11) = 4.65$ ,  $p = .054$ ) and lifelikeness ( $F(1,11) = 5.48$ ,  $p = .039$ ), although these improvements were small (about half a point on a 7-point scale).

For all measures of complexity, higher complexity was found to be mostly beneficial—improving liking, lifelikeness and message identification (e.g., more arm movement increased author-viewer message agreement from 34.8% to 43.8%,  $F(1,11)=6.0$ ,  $p=.032$ ). Measures of emotion identification, however, decreased with higher complexity (e.g. more head movements reduced emotion identification from 36% to 29%,  $F(1,11)=413$ ,  $p<.001$ ), suggesting that emotional information is processed in a different way than messages.

These results provide important exploratory work on the design of robot gestures. First, our research shows that providing viewers with contextual knowledge is beneficial to message understanding. Second, simpler gestures aren't necessarily better: complex gestures are more liked, more lifelike and their messages are understood more accurately. Third, our research suggests that the perception of messages and emotions is different, and that some gestures may be better at conveying one type of meaning over the other.

1. Opfer, J. (2002) Identifying living and sentient kinds from dynamic information: the case of goal-directed versus aimless autonomous movement in conceptual change. *Cognition*, 86, 97-122.
2. Marui, N. and Matsumaru, T. (2005) Emotional Motion of Human-friendly Robot: Emotional Expression with Bodily Movement as the Motion Media. 第23回日本ロボット学会学術講演会.
3. Sekiguchi, D., Inami, M. and Tachi S. (2001) RobotPHONE: RUI for Interpersonal Communication. CHI2001: Extended Abstracts, 2001.

8. Please add your comments (if any):

This summer has been a wonderful learning experience—both personally and professionally. Currently I am preparing to publish results from this study with my host researcher, and will be conducting a similar study in Canada to investigate cross-cultural differences in robotic gesture perception. Thank you to Professor Yasumura, Keio University, SOKENDAI, JSPS and NSERC for their generous support.

9. Advisor's remarks (if any):

The visiting researcher, Jamy Li did a great work for such a short period. His research interest was coincident with us and we could interact with him more than I expected. His research result was not only useful for my laboratory but also for world wide, especially for those concerned with Robot-Human relations. I hope his continuous studies including cross-culture differences would also benefit our research activities.

I would like to thank JSPS for supporting Jamy's research activities.

## RESEARCH REPORT

|  |                    |
|--|--------------------|
| 1. Name: Sheena Luu  | (ID No.: SP07407 ) |
| 2. Current affiliation: University of Toronto  |                    |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences                      Mathematical and Physical Sciences<br>Chemistry                      X Engineering Sciences                      Biological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences  |                    |
| 4. Host institution: Kyushu University   |                    |
| 5. Host researcher: Dr. Shuji Mori   |                    |
| 6. Description of your current research<br>I am involved in on-going research in the Sensory Communications Lab at the University of Toronto, studying how the brain integrates information from different senses to create a coherent view of the world.<br><br>I am interested in two related aspects of multisensory integration. One is the perception of synchrony – how humans detect that two stimuli occurred at the same time. Another is crossmodal enhancement – how a stimulus in one modality presented synchronously with a stimulus in another modality can enhance the perception and/or detectability of the latter signal. |                    |

## 7. Research implementation and results under the program

Title of your research plan:

Audiovisual Enhancement: Exploring the significance of timing.

Description of the research activities:

Detection of auditory signals has been shown to be enhanced by a simultaneous visual signal. As a practical example, numerous studies have showed that seeing lip motion corresponding to speech gives the listener an advantage in detection and understanding the speech.

My research activities here have included both experimental and theoretical developments. Both have been focused on investigating the role timing plays in the mechanism underlying this crossmodal enhancement.

Experimentally we have used sinusoidally amplitude modulated audio and visual signals in order to provide temporal structure to simple stimuli. Through a set of three experiments we have determined that

1. A corresponding synchronous visual signal can improve auditory detection of a sinusoidally amplitude modulated tone significantly, by 2 dB on average.
2. The amount of enhancement is affected by frequency of the modulation of the audiovisual signals (i.e. how fast the audiovisual signal changes). For higher modulating frequencies (eg. 6Hz), enhancement disappears. This relationship between enhancement and modulation frequency is very similar to the temporal frequency characteristics of synchrony detection in humans. Indeed, these results show that both phenomenon (audiovisual enhancement and audiovisual synchrony detection) vary in a similar manner over the same range of frequencies.
3. The amount of enhancement cannot be explained simply by the visual signal providing a timing cue for when to listen for the high energy peaks of the auditory signal. Thus, although the ability to perceive synchrony plays a role, the role is not simply the providing of characteristic timing information of the signal.

I have also continued development of a computational model of audio-visual synchrony detection. The experimental work discussed above and interactions with other crossmodal researchers in Japan, have inspired me to further interpret and explore the mathematical characteristics of the windowed cross-correlator in order to see if it can explain how synchrony detection may occur in humans. This work includes

1. Interpreting the output of the cross-correlator as a population code.
2. Defining the signal-to-noise ratio of the cross-correlator output and investigating how this quantity changes with increasing temporal density of pulse stimuli.

8. Please add your comments (if any):

I have really enjoyed my summer in Japan. Thank you so much for the opportunity to come here and work with really top-level researchers. This summer has been very inspiring.

9. Advisor's remarks (if any):

Sheena worked very hard and made a significant progress on her research during the summer program. I enjoyed working with her very much. She also made a good impact on students in my lab, with her productivity and friendly attitude to them. I hope she will continue to make progress on her research.

## RESEARCH REPORT

|   |                   |
|---|-------------------|
| 1. Name: Sureshraj Neethirajan  | (ID No.: SP07408) |
| 2. Current affiliation:<br>University of Manitoba, Canada   |                   |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences                      Mathematical and Physical Sciences<br>Chemistry <b>X</b> Engineering Sciences                      Biological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences   |                   |
| 4. Host institution: Tohoku University  |                   |
| 5. Host researcher: Dr. Esashi Masayoshi and Dr. Takahito Ono   |                   |
| 6. Description of your current research<br>My research field is 'Agricultural Nanotechnology'. The projects I have worked on aim at solving agriculture problems using microelectronics and nanotechnology. I have used atomic force microscopy, plasma etching and UV-Ozone cleaning to characterize the starch granule surfaces of durum wheat for understanding the functional and physico-chemical properties and thereby providing essential information for plant breeders to develop new cultivars. For my Ph.D thesis, I am working on designing and developing an integrated Carbon-di-oxide and Odour sensor for food quality monitoring using nanotechnology. The other project that I am currently involved is 'Biomineralization for Growing Nanotechnology' in which I develop and design bottom up approach of synthesizing nanomaterials from biological systems. |                   |

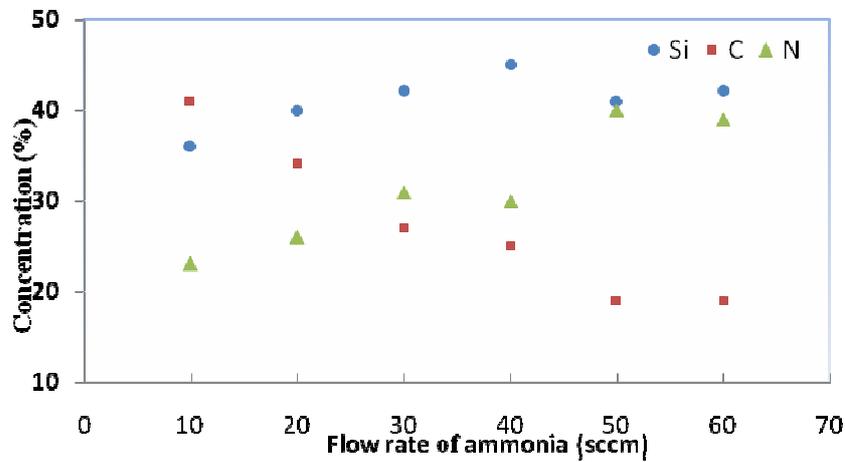
## 7. Research implementation and results under the program

Title of your research plan:

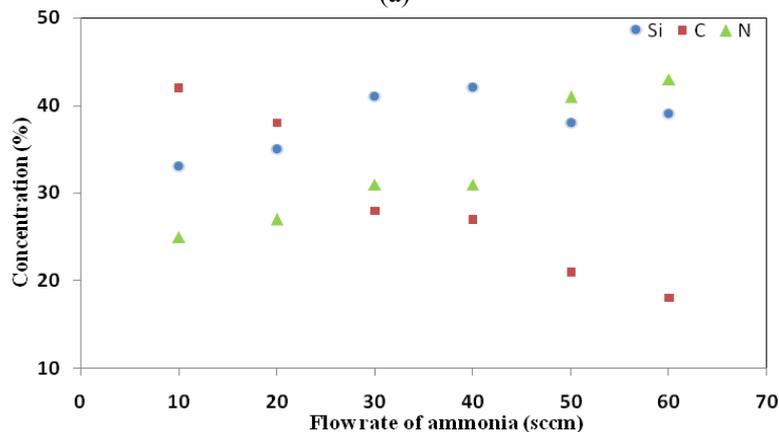
Characterization of catalytic chemical vapour deposited SiCN thin film coatings.

Description of the research activities:

Excellent thermo-mechanical properties and electrical conductivity make SiCN a best choice for fabricating sensors. The knowledge of process parameters in optimizing SiCN thin films deposition using catalytic chemical vapor deposition is essential to cut down process costs. The silicon carbonitride films were grown on silicon substrate using ammonia and argon gas sources with Hexamethyldisilazane (HMDS) as a catalyst by catalytic chemical vapor deposition process. Compositions of silicon, carbon and nitrogen in the SiCN films were varied by changing the flow rate of ammonia gas. The effect of deposition conditions on the structural, optical and mechanical properties of SiCN thin films were determined using X-ray Photoelectron Spectroscopy, Surface Profiler, Field Emission Scanning Electron Microscopy, Prism Coupler and Laser Interferometer.

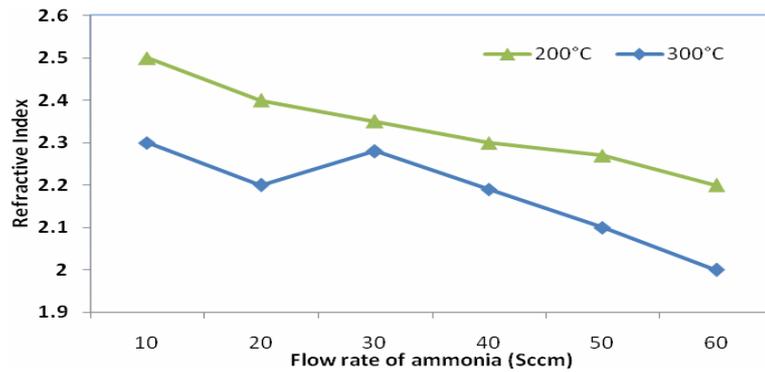


(a)

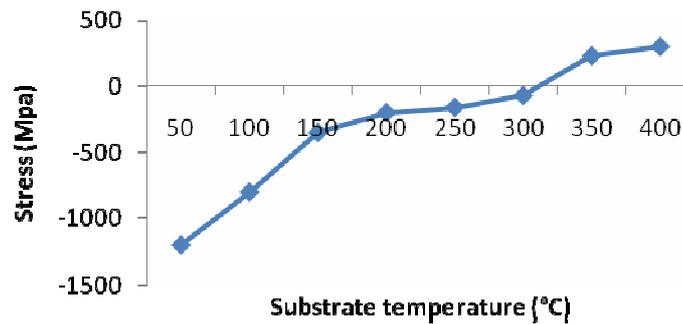


(b)

Relationship between ammonia flow rate and chemical composition of SiCN films (a) substrate temperature 200°C, (b) substrate temperature 300°C.



Variation of refractive index with ammonia flow rate for SiCN films



SiCN thin film residual stress as a function of substrate temperature

8. Please add your comments (if any):

I am grateful to JSPS-Japan and NSERC-Canada for providing this opportunity to experience Japanese research system. I would like to thank professor Dr. Ono, who has been very kind and patient to me in the past 2 months. This internship is certainly a valuable and a rewarding experience for me both personally and professionally.

9. Advisor's remarks (if any):

Mr. Sureshraj has started the construction of the cat-CVD systems for SiCN deposition after his arrival. This CVD system has a high potential in the field of microfabrication technology. He have worked actively and completed the fabrication, and evaluated the deposited SiCN films. Despite short period of stay, he has accomplished a lot of works thanks to Mr. Sureshraj's effort and his talents. This work will result in at least one conference and one journal publication.

## RESEARCH REPORT

|   |                    |
|---|--------------------|
| 1. Name: James E. Young   | (ID No.: SP07410 ) |
| 2. Current affiliation: University of Calgary   |                    |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences                      X                      Mathematical and Physical Sciences<br>Chemistry                      Engineering Sciences                      Biological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences  |                    |
| 4. Host institution: University of Tokyo  |                    |
| 5. Host researcher: Dr. Takeo Igarashi  |                    |
| 6. Description of your current research<br><p>Artists have an incredible ability to develop characters and personalities in various mediums such as movies, plays, and video games, a characteristic that leads to a strengthened suspension of disbelief and ultimately a more rewarding experience. With the new age of computers and robots, many of these entities are interactive. That is, their movements and actions are programmed to exhibit a particular behavior in reaction to various inputs or stimuli. For example, robots should react intelligently to people and objects in their environment and video game characters should interact directly and convincingly with a user's own character.</p> <p>The programming and creation of interactive character behaviors is a difficult problem, particularly when a designer is trying to achieve a certain personality or interaction style; the logical, step-by-step state-machine style endorsed by conventional programming languages is a very rigid tool not well suited to this kind of design. Furthermore, such tools are generally beyond the practical reach of artists, the real professionals, and are heavily influenced by computer scientists with little or no artistic experience. As such, character designers still often struggle with the problem of getting interactive behaviors to match their artistic intentions, even though they are very successful in developing convincing visual representations, dialogue, sound, and so forth.</p> <p>Our approach is to allow artists to directly show a computer their desired behavior, and have the computer learn it. Demonstrating an interactive behavior, while less precise than explicit rule-based systems, allows an artist to encapsulate personality and emotion that they may not be able to logically explain. While other programming-by-demonstration systems exist, we believe we are the first to present such a general, simple system that does not require preprocessing and directly tackles the problem of designing convincing interactive behavior by demonstration. This system has a very strong potential for application wherever interactive behaviors with personality and style are desirable.</p> |                    |

## 7. Research implementation and results under the program

Title of your research plan: Designing interactive behaviors through direct demonstration.

Description of the research activities: My activities during the summer program, under the supervision of my host researcher, consisted of the following activities and achievements:

- Successful development and implementation of an original computer system that learns character behaviors by having users simply demonstrate how one entity should react to another. The learned behavior can then be applied in real time, enabling the computer to generate an interactive character which has similar personality and style to the demonstration. In addition, we have built an original tangible interface for demonstration.
- This work is original and publishable within the field. We have currently created a full first draft of a research paper to be submitted to a respected international venue.

8. Please add your comments (if any): The JSPS program has provided me with an excellent opportunity to work with a world-class researcher in Japan. Not only has this program enabled me to participate in a very interesting and innovating research project, but it has given me the direct experience of working in a laboratory with a different culture in a different country. This has helped strengthen my view of research methods and approaches, and has really made me consider how I will continue to conduct research in the future.

## RESEARCH REPORT

|  |                   |
|--|-------------------|
| 1. Name: Nahuel Vicente Fittipaldi   | (ID No.: SP07411) |
| 2. Current affiliation: GREMIP, Faculty of Veterinary Medicine, University of Montreal.  |                   |
| 3. Research fields and specialties:<br>Humanities                      Social Sciences                      Mathematical and Physical Sciences<br>Chemistry                      Engineering Sciences                      XBiological Sciences<br>Agricultural Sciences                      Medical, Dental and Pharmaceutical Sciences<br>Interdisciplinary and Frontier Sciences |                   |
| 4. Host institution: National Institute of Animal Health, Tsukuba  |                   |
| 5. Host researcher: Dr. Tsutomu Sekizaki   |                   |

### 6. Description of your current research

*Streptococcus suis* is a swine pathogen and a zoonotic agent responsible for, among other diseases, meningitis in both swine and humans. To gain access to the central nervous system (CNS) *S. suis* has to cross the blood brain barrier (BBB). *S. suis* is able to invade porcine brain microvascular endothelial cells (PBMEC), one of the main cellular types of the BBB. However, little is known on the molecular mechanisms used by this bacterium that lead to invasion of PBMEC. In my PhD project I focused on the identification of genes that are preferentially expressed by *S. suis* upon interaction with this cellular type. Among the 28 genes I identified, some showing potential as virulence factors candidates were selected for further study, including one putatively encoding for a LepA-type signal peptidase. Interestingly, in the related species *Streptococcus agalactiae* (GBS), a LepA-type signal peptidase is the first gene in a pilus island. Recently described in Gram positive bacteria, pili have been shown to participate in adhesion to human epithelial cells and they might also play a role in adhesion to extracellular cell matrix proteins. Analyzing data from the *S. suis* sequencing projects, we identified downstream of the signal peptidase a putative class C sortase-like protein. Members of this class of sortases have been shown to be required for pilus assembly in Gram positive bacteria. Also, two LPXTG (the sorting signal recognized by sortase) proteins were found within the island. The genetic organization of this region in *S. suis* is strikingly similar to GBS PI-2b. Moreover, the LPXTG-proteins are highly homologous to the ancillary and main pilus subunits of GBS, respectively. Taken together, these facts strongly suggest that a pilus might be formed in *S. suis* and that it might participate in *S. suis* adhesion to or invasion of PBMEC and, by extension, be important for the virulence traits of this pathogen.

---

## 7. Research implementation and results under the program

Title of your research plan:

Characterization of a *Streptococcus suis* putative pili island

Description of the research activities:

In this project we aimed to demonstrate the presence of pili in *S. suis* and to characterize a putative *S. suis* pilus island. To accomplish these objectives we must first generate the required tools; it is to say mutant strains that lack the genes encoding the pilus and, in parallel, antibodies directed against the pilus protein subunits.

One of the strategies used to make a mutant involves the replacement by homologous recombination of the functional allele of a gene by a non functional one. This latter, often carried by a self-replicative element (these constructs are referred to as knock out vectors), is inserted into the wild type strain by appropriate means and recombination is allowed to occur. During the Summer Program, we have constructed the 4 knock out vectors required to carry out mutagenesis of the 4 genes of the pilus island. Briefly, mutant alleles of the genes targeted for deletion were generated by PCR and cloned into a thermosensitive suicide plasmid previously generated by the Japanese research team. With these constructs generated during the Summer program, we will carry out mutagenesis in Canada using standard procedures,

In addition, we have cloned, expressed and purified the 2 LPXTG-proteins composing the pilus. To this end, we have used a commercial vector allowing expression of proteins in *Escherichia coli* and standard cloning and purification techniques. The proteins obtained during the Summer program will be injected to rabbits to raise antibodies, which will be used for the identification of the pilus subunits by Western-blot in the cell wall fraction of wild type and mutant strains, and for electron-microscopy following immunogold labeling of the same strains (in Canada).

8. Please add your comments (if any):

I have enormous gratitude to Dr. Sekizaki, his research associates Dr. Takamatsu and Dr. Osaki, as well as to other members of his lab who were always available with helpful advice for my research. I have greatly benefited from my working experiences over the past two months. I have learned new techniques and, more importantly, I have had the opportunity of discussing about ongoing and future projects on *S. suis* with one of the world's leading groups on this pathogen.

9. Advisor's remarks (if any):

I greatly appreciate JSPS summer program that gave an opportunity to work with Mr. Nahuel V. Fittipaldi in our laboratory. This is really a good chance not only for him but also for our staffs because we could exchange research information and ideas more deeply than we had done through e-mails. He is an active and hardworking scientist so that he proceeded with his experiments more rapid than expected during his stay in our laboratory. I am convinced that his progressive attitude must have impressed our staffs. Finally, I am very satisfied with this collaboration that made great progress in the research works of both laboratories.

