RESEARCH REPORT

1. Name: Lisa Adams （ID No.: SP07001 ）

2. Current affiliation: University of Hawai`i at Hilo

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of the Ryukyus

5. Host researcher: Dr. Michio Hidaka

6. Description of your current research:

Unicellular algae, known as zooxanthellae, of the genus *Symbiodinium*, are found symbiotically in a variety of marine invertebrates, such as reef corals. *Symbiodinium* contributes to coral nutrition by transferring photosynthetic products and efficiently recycling nutrients, making this association critical to coral survival. Acquisition of free-living *Symbiodinium* gives non-symbiotic larvae and juvenile corals the opportunity to associate with the most ecologically fit strain of *Symbiodinium* for the local environmental conditions. In addition, following disturbances such as bleaching where most zooxanthellae die or are expelled, uptake of free-living *Symbiodinium* may be key for recovery and future resilience. In order for these processes to occur there must be pools of viable, free-living *Symbiodinium* in the environment that is accessible to the symbiotic invertebrates. One of the long-standing mysteries of *Symbiodinium* is the basic ecology of its free-living stage. My research is aimed at finding this environmental pool of free-living *Symbiodinium* and identifying their potential as symbionts to increase our understanding of their ecology.

Sediment samples from reef substrata and water samples of the sea surface will be taken from various sites around the world including Hawai`i, Northwest Hawaiian Islands, Okinawa, Florida, and possibly Australia. Molecular analysis will be performed to determine the diversity of free-living populations. Free-living populations are expected to exhibit high diversity due to the high *Symbiodinium* diversity found among symbiotic invertebrates. To capture this diversity, primers that amplify all clades will be used to target the region of interest using polymerase chain reaction (PCR). PCR products will contain multiple copies, which will be separated out by cloning and then sequenced to identify the genetic clades present. In addition, by sub-sampling these clone libraries, we will estimate the relative abundance of *Symbiodinium* clades found in the samples. Sequences will be used to type the *Symbiodinium* clades present in each sample. I will also examine the sequences for regional differences in diversity.

7. Research implementation and results under the program

Title of your research plan: Ecology of free-living *Symbiodinium*

Description of the research activities:

In addition to my extensive sampling for the diversity portion of my research, further research is necessary to draw the link between free-living and symbiotic *Symbiodinium* populations. In Okinawa, I performed a variety of experiments to test the accessibility and viability of these different free-living populations that maybe utilized by non-symbiotic coral larvae and juveniles to acquire their symbiotic partner. In addition, my experiments tested what the relative importance of these different free-living populations are to non-symbiotic corals.

Scleractinian corals *Acropora nobilis, Acropora tenuis, Acropora digitifera* and *Acropora monticulosa* all have large, asymbiotic larvae and adult colonies are easily accessible on the reefs around Okinawa and Akajima, making these species ideal for my acquisition studies. Colonies from each coral species were collected just before expected spawning time each month and maintained in aquaria until spawning occurred. Fertilized eggs were reared into larvae at which time, some were induced to settle using a peptide (Hym-248). Four treatments, each with three replicates, were used to investigate the source of *Symbiodinium* that are acquired by the asymbiotic coral recruits and larvae: 1) filtered seawater with no sediment (a control); 2) filtered seawater with sediment (tests the sediment for free-living *Symbiodinium*); 3) non-filtered seawater without sediment (tests the water column for free-living *Symbiodinium*); and 4) non-filtered seawater with sediment (simulates the natural environment). All sediment and seawater was collected directly from the reef. Aquaria were regularly cleaned and changed out (every 2-5 days) to maintain good water quality. This process also ensured the exposure of free-living *Symbiodinium* to asymbiotic corals in case *Symbiodinium* cells were not collected during each sampling. Coral recruits and larvae were examined regularly for the presence of *Symbiodinium* under an epiflourescent light microscope. Here, the larvae fluoresce green and the zooxanthellae are bright red, making infection very easy to identify

Due to the absence of knowledge regarding *Symbiodinium* in their free-living stage, many experiments were performed to test for acquisition in larvae and coral polyps. Acquisition occurred in only one experiment, whereby 100 larvae of the species *Acropora monticulosa*, were added to treatments with a little bubbling as an oxygen supply. In addition, to try to replicate the natural environment as much as possible, aquaria were exposed to a 12 hour light cycle and maintained at a temperature closely representing average sea temperature. At each sampling survey, ten larvae were viewed for acquisition. After three days, 40% of larvae had acquired zooxanthellae in all aquaria with sediments. Larvae generally contained between 3-5 zooxanthellae cells. No acquisition was seen in the filtered seawater or seawater

treatments. At six days, 80-90% of larvae in all sediment aquaria had acquisition as well as 20% of larvae in the seawater treatment. Larvae in the sediment aquaria had large variation in the number of zooxanthellae seen. Some larvae had low acquisition at 2-4 cells, others had near 40 cells and some contained nearly 200 zooxanthellae. In the seawater treatments, all but one symbiotic larvae had only one zooxanthellae cell, and the one larvae had eight zooxanthellae. Sediment treatments were stopped at day 6 due to a growing concern that larval mortality might dramatically increase as water quality decreases, as aquaria get old. With such high acquisition in sediment treatments there was little reason to keep these treatments going. Larvae were thus 'rescued' at day six and cultured in filtered seawater to allow the zooxanthellae concentrations to increase for future DNA analysis. The seawater and control experiments were maintained for an additional 6 days. At twelve days, there were still only 20% of larvae that acquired zooxanthellae, with very low zooxanthellae densities (averaging 1-2 cells per larvae).

The results seen in this experiment indicates the presence of free-living *Symbiodinium* in sea surface waters and reef sediments. These populations are both viable, accessible, and utilized by coral larvae. The increased acquisition seen in the sediment treatments, however, indicates this population is utilized more by coral larvae. After spawning and fertilization, larvae are known to scout the substrate for suitable settlement grounds. Acquisition of *Symbiodinium* is most likely to occur at this time, while larvae are in direct contact with the sediment. These results are a good start to understanding free-living *Symbiodinium* and the relationships with symbiotic invertebrates like reef corals. More research is needed to test additional species and environmental conditions that might affect this interaction.

RESEARCH REPORT

1. Name: J. Roman Arguello (ID No.: SP07003)

2. Current affiliation: University of Chicago

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: The Graduate Institute for Advanced Studies Sokendai

5. Host researcher: Hideki Innan

6. Description of your current research

My research is an investigation of the population genetics and molecular evolution of the 4th chromosome of *D. melanogaster, D. yakuba, and D. simulans*. The 4th chromosome has largely believed to be nonrecombining. Classical genetics as well as several previous examinations of nucleotide diversity have largely supported this view. However, recently, more detailed population surveys in *D. melanogaster* and *D. simulans* revealed unexpected levels of nucleotide diversity as well as additional evidence that recombination does occur along the right arm of the 4th. To investigate this chromosome in more detail, a large sequencing effort was carried out (previous to arriving in Japan) on the above three species. We targeted ~60 regions for sequencing, each of about 600 bp, distributed fairly evenly over the right arm. With this data, we aim to address the relative roles that crossing over and gene conversion play within this chromosome. We also aim to utilize this data to inform the patterns of divergence that has occurred for this chromosome between the three species.

7. Research implementation and results under the program

Title of your research plan:

The Molecular Evolution and Population Genetics of the 4th Chromosome in *D. melanogaster, D. simulans* and *D. yakuba*.

Description of the research activities:

The activities have been a combination of writing programs as well as learning and implementing existing software.

1. Data quality check and data partitioning

Multiple manual checks of sequence quality were carried out. After filtering data, several partitions of the data were made for each species: sets including heterozygous lines, sets including singletons and each of these set's complements.

2. Haplotype inference

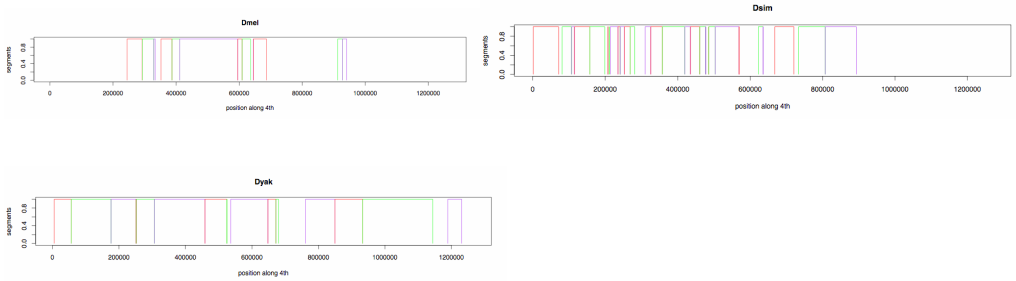
For datasets containing heterozygous lines, several haplotype inference methods were applied and compared (PHASE*, the EM method, and the Parsimony method. While there was some agreement, the resulting haplotypes are method-dependent. Each of these inferred haplotypes have been stored and will be used to access the robustness of our results in later analyses.

*Stephens, M., & Donnelly, P. (2003) Am. J. Hum. Genet. 73: 1162-1169.

3. Estimating the minimal number of recombination events

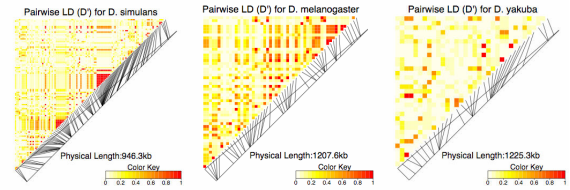
Scripts were written to infer the minimum number of recombination events based on the algorithm of Hudson and Kaplan*.

*Hudson, R.R., & Kaplan, N.L (1985) Genetics. 111:147-167.



4. LD estimation

Estimates of linkage disequilibrium (LD) were made from the data using several common estimates (r2 and D'; examples of D' estimates below).



5. A start to implementing computation methods for estimating conversion and crossing over given SNP conformation data.

Given the resulting data, time was spent figuring out the most appropriate methods to infer cross over and conversion events. Two coalescent-based methods were chosen (Wall's* 3-site likelihood method and a rejection sampling method similar to Padhukasahasramet al.'s#). I have started work to apply and develop software to employ these methods.

* Wall, J.D. (2004) Genetics, 167: 1461-1473.

Padhukasahasram et al. (2004) Am. J. Hum. Genet. 75: 386-397.

RESEARCH REPORT

1. Name: Neil C. Aschliman （ID No.: SP07004）

2. Current affiliation: Florida State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Ocean Research Institute, University of Tokyo

5. Host researcher: Professor Mutsumi Nishida

6. Description of your current research

Batoids are a bizarre group of fishes comprising the skates, stingrays and their relatives. Their remarkable morphological diversity ranges from the aberrant sawfishes with elongate rostral saws to seven meter-wide planktivorous mantas to benthic, ovoid electric rays. Despite their broad collective diversity, there are subsets of batoids that exhibit the opposite trend: they are species rich yet morphologically highly conserved. Skates are the best example. They comprise half of the 500 batoid species but were until recently largely assigned to a single genus because of this similarity.

What processes could simultaneously promote extreme functional diversification in some taxa while suppressing innovation and change in close relatives? Are these forces environmentally driven or patterned by differences in genetic architecture? Answering these questions requires (1) tracing the morphological transformations that likely occurred between ancestors and descendents, (2) an evolutionary time frame in which to search for environmental correlates, and (3) an exploration of potential co-associated developmental mechanisms that may have been responsible for the innovation or constraint. In other words, an accurate phylogeny, a comprehensive fossil record, and knowledge of the form and development of traits associated with diversification and constraint. The lack of a reliable phylogenetic hypothesis remains the most critical impediment to an improved understanding of the alternative forces of innovation and constraint in batoid evolution.

The Nishida laboratory at the University of Tokyo uses complete mitochondrial genome (mtGenome) sequence data to investigate higher-level relationships of teleost fishes, which are a group of comparable age to batoids. In addition to offering ~17 kilobases of easily aligned DNA sequence data, the mtGenome structure itself can be phylogenetically informative. For example, gene rearrangements are unusual but known in teleosts and may in many cases be considered homologous.

The complete mitogenome and additional nuclear genes (not discussed) will be amplified by the polymerase chain reaction (PCR). The entire mtGenome will first be amplified in two or three fragments using Long PCR. These fragments will be used as templates for shorter (~1kb) PCR amplifications, yielding products fit for Sanger DNA sequencing. Aligned mtGenomes will be subjected to comprehensive phylogenetic analysis using maximum likelihood and Bayesian methods. Resulting phylogenetic trees, or hypotheses of descent, will be used to test predictions made by previous morphological studies and reinterpret character transformations (not discussed).

7. Research implementation and results under the program

Title of your research plan:

Reconstructing the evolutionary relationships of skates and rays (Chondrichthyes: Batoidea) using mitochondrial genome DNA sequence data

Description of the research activities:

My program of research at the Nishida laboratory first required adaptation of existing protocols for Long PCR. These protocols were originally developed and fine-tuned to amplify mtGenomes of bony fishes but are not generally successful in the novel, highly diverged batoid system. Additionally, these trials of revised protocols found a successful compromise between performance and increased economy of the expensive PCR reagents.

Next, I screened all of the DNA samples brought to Japan using the Long PCR primer pairs that are most often successful in batoids. Unfortunately, the failure of most of these amplifications when compared to some identical replicates performed earlier at Florida State University (FSU) suggested that much of these DNA templates were unsuitable for PCR, possibly due to degradation in transit.

The first phase of data collection focused on those few mtGenomes that were successfully amplified by Long PCR. Most notably, the nearly complete mtGenomes of four batoids were generated: *Myliobatis australis* (Myliobatiformes: Myliobatidae, >95% complete), *Potamotrygon histrix* (Myliobatiformes: Potamotryognidae, >95% complete), *Bathyraja parmifera* (Rajiformes: Rajidae, 85-90% complete), and *Rajella fyllae* (Rajidae, 95%). These completion estimates are tentative, pending manual inspection of recently sequenced genes. Three of these specimens fill important gaps in the taxonomic sampling of batoids. The interrelationships of *Myliobatis* and the other pelagic rays are, according to recent molecular and morphological evidence, unresolved. *Potamotrygon* represents the clade of South American freshwater river rays of uncertain affinity to other stingrays. *Bathyraja* is a member of the skate subfamily Arhynchobatinae, which unlike the Rajinae (*e.g. R. fyllae*) does not have a published mtGenome.

Poor template quality made attempts at sequencing additional complete mtGenomes uneconomical, so the second phase of data collection sought to patch holes of missing sequence data in incomplete mtGenomes. This first required the construction of a new multiple sequence alignment of all available complete and partial mtGenomes. All genes were partitioned, protein-coding genes were aligned by amino acid translations, and tRNA secondary structures were evaluated to determine probable positional homologies. This alignment was used to design a set of 84 primers bridging gaps in the four new mtGenomes as well as seven additional partial mtGenomes previously generated at FSU.

The resulting 200 PCR reactions were over 80% successful, providing ~60kb of new sequence data (including multiple coverage for difficult-to-amplify regions such as ND1, COIII, and gaps between Long PCR fragments). Pending manual evaluation of these data, estimates of completion for these seven mtGenomes follow:

Aetobatus narinari (Myliobatiformes: Myliobatidae): ~100%

Dasyatis brevis (Myliobatiformes: Dasyatidae): >95%

Dasyatis kuhlii (Myliobatiformes: Dasyatidae): >85%

Narcine tasmaniensis (Torpediniformes: Narcinidae): 75%

Rhina ancylostoma (Rajiformes: Rhinidae): 80%

Rhynchobatus djiddensis (Rajiformes: Rhynchobatidae): 80%

Urolophus cruciatus (Myliobatiformes: Urolophidae): >95%

In sum, this summer's efforts generated approximately six complete mtGenomes worth of sequence data, bringing my number of nearly or fully complete batoid mtGenomes to 11. Experienced researchers working in optimal conditions (teleost model system, good DNA templates, shallow divergence times) may expect to sequence one mtGenome a week. Six mtGenomes generated in eight weeks in a novel and ancient system, working with subpar DNA samples, is a welcome outcome and provides a wealth of new data for phylogenetic analyses to be performed at FSU.

8. Please add your comments (if any):

I am deeply grateful to Professor Nishida for hosting me this summer and generously providing the expensive reagents necessary for PCR and DNA sequencing. This has been a very rewarding and successful experience.

RESEARCH REPORT

1. Name: John Benedict （ID No.: SP07005）

2. Current affiliation: Arizona State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Chuo University

5. Host researcher: Prof. Harufumi Nishida

6. Description of your current research

My current research involves studying and identifying the silicified plant fossil remains from the late Middle Miocene (~12mya) of Shimokawa, Hokkaido, Japan. The Simokawa Group is a rare silicified flora, which provides an excellent opportunity to study the cellular anatomy as well as the morphology of the fossils. Preliminary studies of the flora have described leaves and cones of gymnosperms as well as rhizomes of some ferns, but most of the angiosperms in this flora have yet to be formally described. My research of this flora involves identifying these unknown flowering plants and providing further information about the species previously described.

During this summer program I have surveyed the flora and have discovered over 12 fruits, around 200 isolated seeds, 13 flowers bearing pollen, numerous sporangia bearing spores and possibly a single sporangium attached to a fern frond. My current analysis of this flora's undescribed species shows 10 distinct fruit types (i.e., morphotypes), 16 seed morphotypes, and at least 3 flower morphotypes. All the fruits and flowers can be attributed to unknown angiosperms, while the seeds are a mixture of gymnosperms and angiosperms.

I have also recorded many organs from previously described plants in the flora that will aid in a deeper understanding of these species. I have found two cones from the described *Glyptostrobus* species that contain seeds. The original description of this plant does not include the seeds. In addition, I have discovered the fruit, wood, and small alternating buds that belong to the *Decodon* species that has been reported at Shimokawa. Lastly, I have found flowers with pollen, and a single attached fruit of the *Alnus* species at Shimokawa, which will allow for a whole plant reconstruction of this species.

These two months of research have produced many new findings within the Shimokawa flora and I have plans to write three articles with the help of Prof. H. Nishida, Dr. M. Matsumoto, and my advisor Dr. K. Pigg.

7. Research implementation and results under the program

Title of your research plan:

Silicified plant fossils from Hokkaido, Japan: Evolution of late Middle Miocene vegetation in response to climate change

Description of the research activities:

My research activities while in Japan included: going to the field sight in Shimokawa, Hokkaido to collect specimens, then sectioning, preparing, mounting and photographing the specimens for study. Visiting the field site with Prof. H. Nishida, Dr. M. Matsumoto, and Mr. Legrand was very important, not only to increase the sample size of the study, but also to observe the formation where the fossils are from. There are many different silicious layers in the Shimokawa flora, and from my visit to the site, I observed different plants within each of the different layers. During the excursion, we collected over 60 blocks of material for further study at Chuo University.

Once back at Chuo University, I began my investigation of the Shimokawa flora by studying the specimens already prepared by Dr. M. Matsumoto. After surveying these specimens, I spent most of my time sectioning the new blocks of material using both an oil-cooled rock saw, as well as a water-cooled rock saw. I had never used a water-cooled rock saw before, and learning how to use the new machine was very beneficial technique to learn. After I sectioned the blocks I used the cellulose-acetate peel technique modified for hydrofluoric acid to observe the fossil plant material incased in the blocks (this technique involves dissolving the Silica in the silicified rocks with hydrofluoric, which exposes a fine layer of organic plant material, and then imbedding that plant material on a transparent sheet of plastic to make a ‘peel’). After making numerous ‘peels’ of the Shimokawa fossils, I searched for new plant organs. Any new specimens were then mounted on glass slides, measured, photographed, given preliminary anatomical and morphological descriptions, and classified into different morphotypes.

On one occasion this summer I met with Dr. M. Okuda from the Natural History Museum and Institute, Chiba, to discuss the affinities of the pollen found within many floral organs from the Shimokawa flora.

While at Chuo University I was fortunate enough to have had first hand experience with a microscopic X-ray CT-scanner located in Prof. Nishida’s laboratory. This machine provides very high-resolution 3D images, and we used it to analyze the 3D structure of some of the fossils from Shimokawa. Unfortunately the mode of preservation of the Simokawa flora did not yield very vivid images, but the scan allowed for an accurate reconstruction of the shape and volume of the fossils.

During this summer program I also had the pleasure of giving two presentations on my research, one at Chuo University hosted by Prof. H. Nishida and the other at Chiba University hosted by Dr. M. Matsumoto.

8. Please add your comments (if any):

This summer program was very enjoyable and a great learning experience. Members of my host lab along with Dr. M. Matsumoto's lab were very welcoming and always took the time to explain the way the two labs work. I had a great time working along side Japanese graduate students and trying to discuss different techniques and ideas about paleobotany. Not only was this research program helpful for my education and graduate research, it really opened my eyes to how international the scientific community is, and how important it is to work together and share ideas.

RESEARCH REPORT

1. Name: Christina Bentrup (ID No.: SP07006)

2. Current affiliation: Northern Arizona University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Kobe University

5. Host researcher: Dr. Yoichi Kanazawa

6. Description of your current research

The hydraulic architecture of plants describes how water is distributed throughout the plant body. In trees, hydraulic architecture is highly dependent on branching patterns. Young trees follow hierarchical branching patterns with each new branch unit developing sequentially from a previous larger unit. Older, mature trees follow polyarchical branching patterns where new growth is not necessarily sequentially or spatially connected to terminal growth. Epicormic shoots are one type of non-sequential branching structure that become increasingly common with advanced age. Epicormic branches arise from delayed or suppressed buds proximal to the sequentially developing growth in the outer crown, or terminal growth. These branches reduce the pathlength and number of junctions that water must cross to reach developing foliage, thereby reducing total resistance to hydraulic flow. The production of epicormic shoots changes the hydraulic architecture of the tree and may be an adaptive mechanism to maximize growth for trees that are spatially or hydraulically limited in their environment, as most large, old trees are.

7. Research implementation and results under the program

Title of your research plan:

Do adaptive branching patterns promote favorable condcuctivity in large old trees?

Description of the research activities:

Large, old trees represent the maximum heights and widths that plants can achieve, providing insight into the physical limits underlying the essential water transport mechanisms in plant species. I measured hydraulic conductivity and the vulnerability of the hydraulic pathway in mature Cinnamomum camphora trees. Two types of branches were chosen to measure hydraulic parameters: terminal branches in the outer canopy and epicormic branches sprouting from suppressed buds in the inner canopy. Terminal branches are the furthest extensions of plant growth and allow access to premium light while pushing the limits of hydraulic supply. Epicormic branches, on the other hand, potentially take advantage of space constraints by finding ways to maximize available resources in the inner canopy.

Conductivity and vulnerability of the hydraulic pathway were measured in three 400 year old trees preserved in a semi-natural forest in a sacred shrine. Anatomical properties related to hydraulic flow including vessel length, vessel diameter and wall span in the xylem, conductive cells of the plant, were also determined. Trees were accessed by ropes, and sampled branches brought back to the laboratory for investigation.

My study found that the hydraulic pathways of terminal branches are more vulnerable to increased water stress than epicormic branches, following the initial hypothesis. However, I found no difference in the conductivity of the two types of branches under investigation. This study sets the framework for understanding how older and large trees that are spatially limited in their environment maintain growth even under limiting conditions. More thorough analysis of the measured parameters will allow for determination of how branching patterns affect hydraulic flow in large old trees.

RESEARCH REPORT

1. Name: Dmitry Berenson （ID No.: SP07007 ）

2. Current affiliation: Carnegie Mellon University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: AIST Tokyo Waterfront: Digital Human Research Center

5. Host researcher: Satoshi Kagami

6. Description of your current research

In recent years, researchers in Humanoid Robotics have begun to focus on autonomous manipulation. However, much humanoid grasping currently still relies on tele-operation or hand-scripted grasps. We approach the problem of grasp selection and manipulation planning from a wholistic point of view. The goal is not only to select a grasp that is stable for a given object, but also to ensure it is feasible.

Our approach is similar to many papers in that we use force closure to evaluate good grasps when the object is alone in the environment. We discretely sample our grasp-parameter input space to find a set of successful grasps for each object of interest. However, once we have computed a set of valid grasps for the given object, we are presented with a problem: Out of the potentially thousands of precomputed grasps, which one do we choose for a given environment? Many grasps can be infeasible because of collisions with environment obstacles, still more can be unreachable because of the kinematics of the robot arm. The naive approach is to keep trying grasps in an arbitrary order and take the first one that is collision-free and reachable. Because of the potentially huge number of grasps in our grasp set, this approach is extremely time-consuming. Of course it is possible to prune the grasp set; however, there is always the risk that pruning can eliminate the only feasible grasp in the environment.

Instead we propose a more intelligent framework for grasp selection that combines the force-closure scores of our grasp set with the features of the object's local environment and features of the robot kinematics to produce an overall *grasp-scoring* function. We use this function to evaluate each grasp and compute a plan using Bidirectional RRTs that takes the arm1 to the desired position and closes the fingers appropriately.

Our method of grasp planning consists of two main steps: a precomputation step and an online computation step. In the precomputation step, we use a geometric model of our manipulator and the object we wish to grasp to build a set of feasible grasps in terms of force-closure. In the online computation step, we compute the score of each grasp for the given environment using our Grasp-scoring Function. The grasps are ranked in order of the scores assigned by the Grasp-scoring Function and validated using collision checking

and Inverse Kinematics(IK) algorithms. Once a feasible grasp is found, we plan a reaching motion for the arm of the robot to reach and grasp the object using Bidirectional RRTs.

The process is detailed below:

Precomputation: First, sample a set of grasp parameters from the grasp-parameter space. Second, compute the final manipulator pose by executing a grasping policy on those parameters for the given manipulator and object. Third, Compute the force-closure scores of all grasps and store the ones that have force closure in the grasp set.

On-line Computation: Fourth, evaluate the grasp set using a grasp-scoring function that takes into account the force closure score, the object's local environment, and the kinematics of the robot. Use the scores assigned by this function to rank the set of grasps. Fifth, test the grasps in order of their rank for collisions in the environment and reachability. Sixth, plan an arm trajectory to achieve the first valid grasp, if the plan fails, try the next valid grasp and so on.

7. Research implementation and results under the program

Title of your research plan: Grasp Planning in Complex Scenes

Description of the research activities:

Benchmark Experiment

In order to benchmark our algorithm's effectiveness, we compare it to a more naive approach to grasp selection. In the naive approach, a table of valid grasps is created in exactly the same manner as in our approach. However, instead of sorting the grasp set, the grasps are tested on the object in the given scene in a random order. The question we seek to answer is: how many grasps must we test before finding a successful one when using the grasp-scoring function vs. the naive method? We compare the statistics for 50 randomly generated scenes. When using the naive approach, we re-run the validation 10 times for each scene, each time re-ordering the set randomly. We record the indices of the first successful grasp of each run and compute their mean. This mean is compared to the index of the first successful grasp when using the grasp-scoring function to sort the grasp set. No rerunning is necessary when using the grasp-scoring function because our algorithm does not use any random variables.

This experiment is run for three different objects and two different robots in simulation. The robots used were an HRP2 robot and a Puma 560 robot with a Barrett hand. The two robots have very different kinematics and reachability ranges. The manipulators are also very different; the HRP2's manipulator is designed to wrap-around objects, while the Barrett hand is meant for more precision and dexterous grasping.

For both robots and all objects, the grasp-scoring function clearly outperforms the naive approach to grasp selection. For the HRP2, grasp-scoring outperformed the naive method in 98%, 100%, and 98% of scenes for objects 1, 2, and 3, respectively. For each scene, grasp scoring performed 57.06, 11.51, and 10.59 times better on average than the naive approach for objects 1, 2 and 3, respectively. For the Puma robot, grasp-scoring outperformed the naive method in 96%, 72%, and 98% of scenes. Grasp scoring performed 6.861, 3.101, and 12.54 times better on average than the naive approach. The results for the Puma robot are less impressive because the Puma has a far larger reachability, thus many more grasps have an IK solution and there is a greater chance that a random grasp is reachable.

Experiments with the real HRP2

To evaluate our method in a real environment with a real robot, we ran several experiments on the HRP2. We used a motion capture system to get the position of the robot and the objects in our scene. The task was for the HRP2 to reach and grasp an object and then pick it up and put it in a "trash can." We required all trajectories to be collision-free and required the object to stay within the robot's grasp during the trajectory to reach the trash can. The experiment was meant to simulate a clean-up task, where some object(s) in the environment must be thrown away, which is one of the target applications for many humanoid robots. Since we compute the grasp-scoring function online, the robot is able to compensate for changing scenes and the addition/removal of obstacles and objects to grasp. The clean-up task experiments were successful and the resulting videos can be seen on the author's website.

We also implemented a task on the real HRP2 that required regrasping. In this task, the robot needed to pick up object 2 from one side of a table and place it upside-down on the other side. Since the sides were far apart, the robot could not do this by using only one arm. Thus, the robot had to pick up the object with its right hand, regrasp the object with its left hand place the object into the goal position. These experiments were also successful and the videos can be seen on the author's website.

8. Please add your comments (if any): This was an excellent summer for me. I am very happy I was given the opportunity to participate in this great program.

RESEARCH REPORT

1. **Name**: Robert Jory Brinkerhoff （ID No.: SP07008 ）

2. **Current affiliation**: University of Colorado, Dept. of Ecology and Evolutionary Biology, Boulder, CO 80309-0334

3. **Research fields and specialties**:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences **X**Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. **Host institution**: Nihon University, College of Bioresource Science, Department of Veterinary Medicine, Laboratory of Veterinary Public Health, Fujisawa, Kanagawa

5. **Host researcher**: Dr. Soichi Maruyama

6. **Description of your current research**: My research at the University of Colorado focuses on relationships between pathogens, arthropod vectors, and their mammalian hosts, and how these relationships might be used to understand disease transmission among species. Specifically, I am interested in transmission dynamics of sylvatic plague, a recently (~100 years ago) introduced, flea-transmitted disease caused by the bacterium *Yersinia pestis*. For the past three years, I have collected blood and flea samples from wild mammals associated with black-tailed prairie dogs, a species of conservation concern whose persistence is threatened by sylvatic plague. I am trying to determine spatial and temporal patterns of plague exposure in wild mammals and to understand which mammal and flea species are most likely to be involved in plague transmission. I am also studying the population genetic structure of the prairie dog flea, *Oropsylla hirsuta*, to understand potential movement patterns of plague among a group of prairie dog colonies in Boulder County, Colorado. Other aspects of my research involve describing and testing spatial and temporal patterns of flea occurrence on a variety of mammal species. In conjunction with collaborators from the Centers for Disease Control and Kansas State University, I have also documented novel ecological influences of prairie dogs on the flea assemblages of the small rodents that share prairie dog burrows. The ultimate purpose of my research is to describe ecological patterns of mammal and vector occurrence that may be used to better understand emergence and dynamics of disease ecology in natural systems.

7. Research implementation and results under the program

Title of your research plan: Vector specificity among species and strain of the bacterial pathogen, *Bartonella*

Description of the research activities: The bacterial genus *Bartonella* consists of several zoonotic species and subspecies that are pathogenic to humans as well as wildlife. Some *Bartonella* species are found in a wide variety of hosts, however, clear associations exist between some *Bartonella* species and mammalian host species. Strong host-pathogen relationships could arise for at least two, non-mutually exclusive reasons. First, associations between a host species and *Bartonella* species could arise from host-specificity of vector species. Alternatively, host species may show "preferential infectivity" meaning a host species is only susceptible to infection by one species or subspecies of *Bartonella*, regardless of how diverse the array of *Bartonella* it encounters. My research goal for the JSPS summer program was to analyze *Bartonella* species diversity in a variety of flea species to determine whether or not fleas carry multiple *Bartonella* species/strains and to find out whether the *Bartonella* isolated from fleas is characteristic of the hosts from which the fleas were collected.

In may 2007, I sent 11 fleas, representing 5 species, to the laboratory of Dr. Soichi Maruyama at Nihon University College of Bioresource Science in Fujisawa Japan. The fleas were from prairie dogs, deermice, and red fox in Boulder County, Colorado in 2006. Prairie dogs and deermice have known associations with different Bartonella species; relationships between red fox and specific *Bartonella* species are unstudied. Four of the five flea species are specific to one mammal species while the fifth is more of a host generalist. Upon my arrival at Nihon University, I learned methods for dissecting and separating various flea tissues so that anatomical associations with *Bartonella* infection can be studied. From each flea, I separated hemolymph, midgut, and reporoductive (ovary or testis) tissues and tested these tissues independently for presence of *Bartonella*. I extracted DNA from each tissue sample and used *Bartonella* specific markers to test for *Bartonella* presence. For those samples that tested positive, I collected DNA sequence data from the target *gltA* gene and used this information to determine which *Bartonella* species was present in each tissue by comparing the test sequences to *Bartonella* type strains. To test for co-occurrence of multiple *Bartonella* strains or species, I cloned four isolates from each tissue sample and used vector DNA sequencing to obtain replicate sequences from a single tissue sample.

A total of 9 out of the 11 fleas I tested were infected with *Bartonella* in at least one tissue. Five individuals were infected in multiple tissues and two individuals showed con-infection by multiple species of *Bartonella;* from one individual, the different *Bartonella* isolates were collected from different tissues (ovary and midgut) and from the other individual, both species were collected from the same tissue (ovary). A total of four tissues collected from two individuals were co-infected by multiple distinct genotypes of the same *Bartonella* species.

Successful isolation of *Bartonella* bacteria from multiple tissue types within a flea indicates that *Bartonella* is more wide-spread within a flea than was previously believed and its isolation from reproductive tissue suggests the possibility of vertical (generation to generation) transmission. The *Bartonella* collected from fleas in this study did not always match the *Bartonella* specific to the host from which the flea was collected. Three fleas carried exclusively the *Bartonella* species that is characteristic of its host while four individuals carried only *Bartonella* that is specific to a host other than that from which the flea was collected. Two fleas carried multiple species of *Bartonella*. These results suggest that fleas are exposed to and harbor richer *Bartonella* assemblages than their hosts and that mammals are exposed to a wider spectrum of *Bartonella* than that which causes persistent bacteremia. In other words, a mammal might be exposed to a variety of *Bartonella* species, but only one of these is pathogenic and leads to infection while others are presumably suppressed by its immune system. These infection dynamics have not been previously reported and are potentially very important to the maintenance and transmission of *Bartonella* among wildlife species.

8. Please add your comments (if any): The results of this study are preliminary and are subject to further analysis. However, even with the relatively small sample size presented here, I intend to submit these findings for publication as a joint project between myself and my host laboratory. I hope to continue investigation along the lines of my summer project and to maintain the collaboration that I have built with Dr. Maruyama and his laboratory members.

RESEARCH REPORT

1. Name: Jocelyne Bruand （ID No.: SP07009）

2. Current affiliation: University of California, San Diego

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
X Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Satoru Miyano

6. Description of your current research

With the accumulation of knowledge of biological entities and networks, there is a growing need for a general framework to understand this information at a system level. To deal with this, several formats of biological pathways have been proposed, e.g. System Biology Markup Language (SBML) 2.1, CellML 1.1, Cell System Markup Language (CSML) 1.9, and BioPAX 2.0. For future understanding of life as system, a formal description of system-dynamics with semantic validation will be necessary. Unfortunately, these formats lack the formal definitions of each term, e.g. SBML 2.1, CellML 1.1 and CSML 1.9, or miss the system dynamics behavior, e.g. BioPAX 2.0. Thus, we have developed a new system-dynamics centered ontology called the Cell System Ontology (CSO) and reconstructed CSML 1.9 into CSML 3.0 with the background of CSO. CSML 3.0 is also a native model description language of Cell Illustrator, which is software that allows scientists to visualize and construct biological pathways, and to simulate their complex underlining mechanisms.

SBML is a commonly used format representing biological systems and BioModel database stores more than fifty pathways with the format. In order for CSML to be beneficial to as large as a community as possible, it is crucial to provide an interface to convert files of SBML into CSML format. Converters from SBML to CSML 1.9 and from CSML 1.9 to CSML 3.0 are currently available. However, because CSML 1.9 does not support as many features as CSML 3.0 does, some information from SBML that CSML 3.0 has the capability of storing is lost in the intermediate step. Therefore, we develop a new converter, which directly changes the SBML format into CSML 3.0 format.

7. Research implementation and results under the program

Title of your research plan:

A converter from SBML 2.0 to CSML 3.0 and its implementation.

Description of the research activities:

The new converter maps the SBML 2.1 features directly into CSML 3.0. The mapping rules from SBML 2.1 to CSML 1.9 and CSML 3.0 are summarized in Table 1 (It must be noted that some tags in CSML 3.0, e.g. <filter>, <subModel> and <log> are not defined in SBML 2.1.) As seen in this table, all tags in SBML 2.1 are supported in CSML 3.0. Differences in structural organization between CSML 1.9 and CSML 3.0 are also handled during the conversion. Newly introduced tags in CSML 3.0 – such as <csml:functionSet> and <csml:fact> – are applied for better conversion from SBML and previously lost information – marked as N/A in the middle column in Table 1 – is now stored using those new elements. Moreover, changes in the structure have also improved information retention. For example, the previously lost SBML species compartment is now represented by the biolocation attribute in the entity element is CSML 3.0, and previously lost comments are retained in the comments tag. The converter is implemented in Java and thus works on many platforms, i.e. Windows, Linux and Mac OS X. The creation of CSML 3.0 and the implementation of converter from SBML to CSML should allow for better usability of both the CSML format and Cell Illustrator for the scientific community.

Table 1. Conversion map between SBML 2.0 and CSML 3.0.

SBML	CSML 1.9	CSML 3.0
<sbml:sbml>	<csml:model>	<csml:project>
<sbml:model>	<csml:net>	<csml:model>
<sbml:functionDefinition>	N/A	<csml:functionSet>
<sbml:unitDefinition>	<csml:unitDefs>	<csml:unitSet>
<sbml:compartment>	<csml:entity>	<csml:entity> with global flag
<sbml:species>	<csml:entity>	<csml:entity>
<sbml:parameter>	<csml:entity>	<csml:entity>
<sbml:algebraicRule>	N/A	<csml:fact>
<sbml:assignmentRule>	<csml:entity>	<csml:entity>
<sbml:rateRule>	<csml:process>	<csml:process>
<sbml:reaction>	<csml:process>	<csml:process>
<sbml:event>	<csml:process> and <csml:entity>	<csml:process> and <csml:entity>
<mathml:math>	Pnuts script	Pnuts script
<sbml:annotations>	N/A	<csml:references>
N/A	N/A	<csml:filter>, <csml:subModel>, ...

The new converter also has new features not available in the previous versions. First of all, given an appropriate Gene Ontology ID in the SBML file, the new converter can successfully determine which figures to use to represent compartments.

Moreover, if the compartment type has an associated membrane type, the converter will also add this element to the model (figure 1). Another new feature is that the converter will automatically place the SBML species, processes, parameters and events for better readability. The entities are directly placed into the proper compartments. Sizes of compartments are automatically increased if they are too small to contain the entities. The processes, parameters and events are placed outside all compartments. The processes are placed at the bottom, the parameters on the right-hand side, and the events below the parameters.

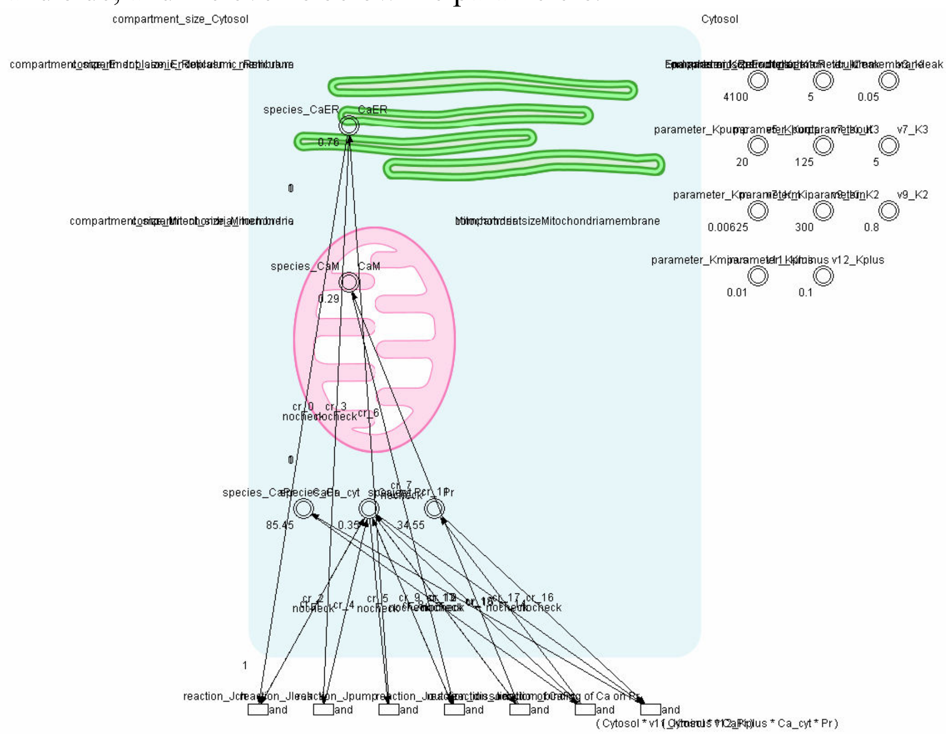


Figure 1. SBML 2.0 model BIOMD0000000039 (BioModels Database, www.ebi.ac.uk/biomodels) as converted to CSML 3.0 by the new converter.

8. Please add your comments (if any):

This work was presented during the poster session of IBSB 2007. We also intend to submit an application note to *Bioinformatics*.

RESEARCH REPORT

1. Name: Lane Burgette （ID No.: SP07010 ）

2. Current affiliation: University of Wisconsin-Madison

3. Research fields and specialties:

Humanities X Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo University

5. Host researcher: Dr. Yasuhiro Omori

6. Description of your current research

My current research interest is applying Bayesian statistical methods to problems in the social sciences. In particular, this summer I have worked on designing and estimating a model that describes the retirement preferences and outcomes of respondents to the Wisconsin Longitudinal Study (WLS). The model is an extension of one that is commonly used in the social sciences, often called the Heckman selection model. However, the model in which I am interested is different in three main ways. Primarily, the standard Heckman model considers only two groups of interest, whereas this model deals with three. Also, the Heckman model most often has a continuous response, while this model has a multinomial response. Finally, we use Bayesian methods instead of frequentist ones.

Bayesian methods take full advantage of the power of modern computing, allowing the researcher great flexibility in choosing the most appropriate model. However, efficiently implementing such computer programs can be difficult. Getting the estimation to run quickly and accurately has been the focus of much of my energy.

This research is of interest because it can provide insights into which factors are most important in terms of allowing people to achieve their retirement goals. From a policy point of view, this research can identify which factors are most likely to allow workers to continue working at an age when most are retired. This sort of research is important for Japan, since the population is rapidly aging. If workers are able to extend their careers later, it may soften some of the economic impacts of this demographic shift.

7. Research implementation and results under the program

Title of your research plan:

Modeling Retirement Plans and Outcomes in the WLS

Description of the research activities:

This summer's research activities can be broken down into three parts. The first was reading papers giving background on what other researchers have done to implement similar models. The second part was to formally specify the model and derive the mathematical devices necessary to estimate the model using a technique known as Markov chain Monte Carlo (MCMC). The last part was programming and debugging the MCMC routine.

The first two parts of this have been carried out, though the last step is still in progress. Essentially the problem now is that the program is not running efficiently enough. When the MCMC sampler visits areas with low posterior probability, the algorithm slows too much. There are methods in the literature that should overcome this problem, but it will take some time to adjust them to this application. After this problem is resolved, we will still need to consider a few alternate models, do diagnostics to check that convergence has been achieved and interpret the results.

In addition to this research, I was able to meet many researchers during my stay. Prof. Omori was extremely helpful in all aspects of this summer's research and I feel I have learned a lot from him. A collaborator on the WLS project, Prof. James Raymo, is a long-term visitor at Osaka University, so it was nice being able to meet in person to discuss the project. I was fortunate to be able to have meetings with Prof. Nobuhisa Kashiwagi at the Institute of Statistical Mathematics and Prof. Hideo Kozumi at Kobe University in addition to informal meetings with professors around Tokyo University. Also, I was able to attend the International Meeting of the Psychometric Society, which was a good opportunity to meet researchers in a related but different field. Finally, some of the Prof. Omori's graduate students have similar research interests, so I was able to discuss research and get ideas from them. I hope to maintain some of these contacts for future collaboration.

RESEARCH REPORT

1. Name: Richard D. Burstein （ID No.: SP07011 ）

2. Current affiliation:

University of California, Berkeley

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Professor Yasuyuki Kawahigashi

6. Description of your current research

A hyperfinite subfactor of type II_1 may be constructed from a commuting square of finite-dimensional Von Neumann algebras via iteration of the basic construction. This subfactor will always be strongly amenable, and is therefore completely classified by its standard invariant. For commuting square subfactors, it is possible to compute the *n*th level of the standard invariant in finite time by solving a large system of linear equations. Therefore if the subfactor is of finite depth (i.e., the standard invariant is completely determined by its first *n* levels for some finite *n*), it is theoretically possible to compute the whole standard invariant using linear algebra. In practice, the above system grows exponentially, so this computation cannot be carried out except in the very simplest cases.

I am interested in determining the standard invariants of commuting-square subfactors. As a first step, I try to find the principal graphs only, which contain somewhat less data. As a further simplification, I consider only those commuting squares coming from Hadamard matrices. A Hadamard matrix, which may be real or complex, is an *n* by *n* unitary matrix all of whose entries have the same complex magnitude. Each such matrix uniquely determines a commuting square, and therefore a subfactor (of Jones index *n*). These commuting squares are in many ways as simple as possible, so they are a good place to start.

Even with these restrictions, and despite the fact that everything is finitely computable, very little is currently known. The full principal graph is only known for a handful of finite-depth Hadamard subfactors, most of which are depth 2 (i.e., associated with a particular abelian group). There are no published examples of infinite-depth Hadamard subfactors with index greater than 4. No principal graph is fully known in any nontrivial case where the first relative commutant of the subfactor has dimension 2, although it has been conjectured that the standard invariant is always the Temperley-Lieb-Jones algebras in this case.

7. Research implementation and results under the program

Title of your research plan:

Subfactors of Bisch-Haagerup Type Arising From Commuting Squares

Description of the research activities:

Following a suggestion of my thesis advisor, Professor V. Jones, I examined those Hadamard matrices arising from the twisted tensor product. This is a way of combining two Hadamard matrices of size *n* and *m* (along with an *n* by *m* twist matrix) to yield a new Hadamard matrix of size *nm*. I relied on a 1996 paper [BH] in which the authors find principal graph for subfactors obtained by combining two depth-2 subfactors in a particular way. I was able to show that, if the original two Hadamard matrices yield depth-2 subfactors, then their twisted tensor product is of the type described in [BH].

Suppose that the two smaller Hadamard matrices are associated with groups G and H respectively. These groups will act via outer automorphisms on a certain intermediate subfactor. The methods in [BH] for finding the principal graph require computation of the group generated by the actions of G and H, modulo inner automorphisms. By using the iterated axiomatic shift of Ocneanu, I was able to reduce this computation to a finite problem in linear algebra. I implemented the algorithm in MATLAB, and thereby automated the procedure of finding the principal graph for any finite-depth twisted tensor product Hadamard subfactor.

Using this procedure, among many other examples I was able to find the principal graphs for all index-4 Hadamard subfactors, I was also able to prove that certain Hadamard subfactors with index greater than 4 were infinite depth (hence with infinite principal graphs). My computer program only works for finite graphs, but in some infinite-depth cases I was able to compute the principal graph by hand.

Following a suggestion of Professor N. Sato, I have also considered generalizations of this result to other (non-Hadamard) commuting squares. I have identified a class of non-Hadamard commuting-square subfactors which are of Bisch-Haagerup type. The necessary computations are considerably more complicated for general commuting squares, but I believe it will be possible to find the complete principal graphs using the methods of [BH] here as well. Professors M. Izumi and Y. Watatani have also made useful suggestions for future extensions of my result.

I am grateful to Professor Y. Kawahigashi for sponsoring me for EAPSI 2007, as well as for his help over the summer.

References:

[BH]. D. Bisch and U. Haagerup, *Composition of subfactors: new examples of infinite depth subfactors,* Ann. Scient. Ec. Norm. Sup. **29 (**1996), 329--383

9. Advisor's remarks (if any): Richard Burstein discussed various problems on the Hadamard subfactors with M. Izumi, N. Sato, Y. Watatani and me, and made a very good progress. I am certainly very happy to have had him at Tokyo.

RESEARCH REPORT

1. Name: Annie Butler ID No.: SP07012

2. Current affiliation: Northwestern University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

X Chemistry Engineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Dr. Atsuhiro Osuka

6. Description of your current research

My current research looks at electron-transfer reactions between organic molecules. A thorough understanding of electron-transfer reactions is fundamental for the development of artificial photosynthetic systems for solar energy and for use in molecular electronics. My research looks at linear donor-bridge-acceptor (D-B-A) systems that have specifically been designed in order to focus on the role of bridge dynamics in electron transfer. Currently, the role of bridge dynamics in controlling electron transfer and wire-like properties is not completely understood. The donor, 3,5-dimethyljulolidine-anthracene, has a high electron injection potential and restricted torsional dynamics. The acceptor, naphthalenediimide, is easily reduced. The bridges are 9-fluorenone, diphenylacetylene, and oligo-p-phenylene, among others. Most of these bridges have Raman active features that enable us to use femtosecond stimulated Raman spectroscopy (FSRS) to acquire vibrational spectra with sub-picosecond time resolution, and thereby probe the structural dynamics of electron transfer in D-B-A molecules. One aspect of molecular wires that I would like to explore is the use porphyrin compounds in D-B-A molecules. A porphyrin is a heterocylic macrocycle and is highly conjugated, which makes it an ideal candidate for use in a D-B-A system. Many porphyrins occur in nature, and since evolution has shaped natural systems to be highly optimized and efficient, it is important to look to nature for inspiration when designing synthetic systems. My research in Japan involved working with porphyrin compounds in order to gain a better understanding of how to make and use them.

7. Research implementation and results under the program

Title of your research plan:

Synthesis of a Mobiüs Aromatic Molecule: triphenylphosphino, *meso*-hexakis(2,6-dichlorophenyl) substituted [28]hexaphyrin(1.1.1.1.1.1)

Description of the research activities:

My research involved synthesizing an expanded porphyrin compound, *meso*-hexakis(2,6-dichlorophenyl) substituted [26]hexaphyrin(1.1.1.1.1.1) and then reducing it to make the triphenylphosphino, *meso*-hexakis(2,6-dichlorophenyl) substituted [28]hexaphyrin(1.1.1.1.1.1). Previously, in the Osuka group, a student had synthesized a similar compound that was shown to have Mobiüs aromaticity. Aromaticity is a property in which the stabilization of the compound is great. Mobiüs aromaticity is a specific type of aromaticity in which it has been argued that no unambiguous examples of such molecules have been identified. My goal was to synthesize this expanded porphyrin compound to find another example of Mobiüs aromaticity. Having never done porphyrin chemistry before, this project was a great starting point from which to learn the basics. I was able to synthesize and partially characterize two products: the above mentioned triphenylphosphino expanded porphyrin and an oxidized version of the same expanded porphyrin. Due to time constraints, I was unable to grow a crystal of either product, which is needed for full characterization. Preliminary results suggest that this expanded porphyrin does exhibit Mobiüs aromatic qualities, however further analysis is needed.

RESEARCH REPORT

1. Name: Jake K. Byrnes （ID No.: SP07013）

2. Current affiliation: University of Chicago

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Center for Advanced Graduate Studies – SOKENDAI

5. Host researcher: Dr. Hideki Innan

6. Description of your current research

Molecular evolutionists rely on the patterns of nucleotide substitution to make inferences about DNA sequence evolution, including the dating of individual events such as gene duplication. By assuming a clock-like rate for the stochastic process of nucleotide substitution and independent sequence evolution, the date of a duplication event can be estimated using the number of nucleotide differences between the pair of duplicates. However, there are a number of molecular processes that interfere with the reliability of the molecular clock assumption. In the case of dating a duplication, non-reciprocal exchange of sequence between duplicates due to recombination causes underestimation of the duplication date by erasing sequence differences. This exchange is called **intergenic (nonallelic) gene conversion**. Currently, I am preparing a manuscript detailing the development of a hidden Markov model for identifying intergenic gene conversion events. This model identifies regions of the duplicate sequence alignment with a reduction in sequence divergence caused by gene conversion. Although it is a simple model, it is capable of outperforming the commonly used GENECONV algorithm. Further developments will involve the addition of more realistic nucleotide substitution models and testing of the sensitivity and specificity of the method.

I am also developing a method for performing comparative analyses of tiling microarray data. Tiling microarray technology provides a detailed snapshot of mRNA expression across the entire genome. I have again employed the use of a hidden Markov model to identify the boundaries of genomic regions that are differentially expressed between two or more samples. The method is extremely general and widely applicable to many studies. The initial model is completed and I have begun to collaborate with multiple groups in the analysis of array data to answer various evolutionary questions regarding alternative splicing and early expression divergence.

7. Research implementation and results under the program

Title of your research plan: A Hidden Markov Model for Identifying Gene Conversions Using Sequence Polymorphism

Description of the research activities:

Propsal: In my application, I proposed to:

1) Develop a hidden Markov model relying on the patterns of nucleotide polymorphism to identify intergenic gene conversion events between duplicate genes.
2) Test this model on simulated data using Dr. Innan's coalescent model for the evolution of duplicate genes with gene conversion.
3) Apply the model to the identification of conversion events within selected biological sequence examples. Specifically, I can compare the results of my previous, divergence-based algorithm to the new approach using a set of duplicate genes from *D. melanogaster* for which polymorphism data is available.

Results: My time in Dr. Innan's laboratory was productive. I was able to develop a prototype of the model and make some early tests. Although the model appears to be effective at identification of individual regions of active conversion (Figure 1), my discussions about the process of gene conversion with various members of the lab have led me rethink the type of model I am using and to search for a more appropriate statistical tool. I spent a significant amount of my research time reading statistical literature and a number of Dr. Innan's theoretical papers on gene conversion. I have settled on a type of model known as a hierarchical Dirichlet process (hDP). Where my original model fails to allow for the possibility of multiple gene conversion events in the same sequence, the hDP has the flexibility to identify any number of gene conversion events. I began to program the model and made a significant amount of progress in setting it up. I was however unable to complete the initial development in time to begin testing the model. I will continue to collaborate with Dr. Innan in the future to test this model once it is fully developed.

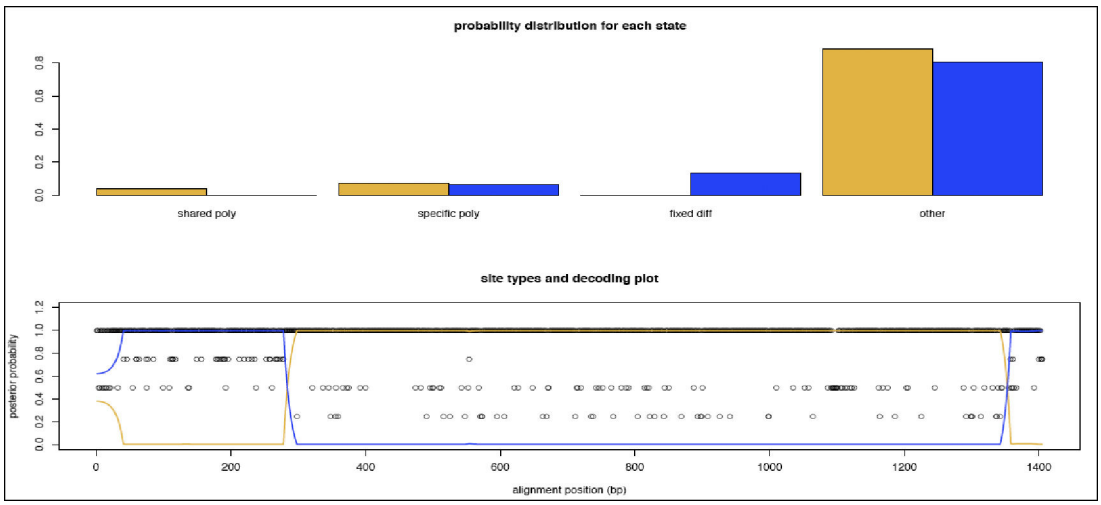


Figure 1: HMM identification of the converting region (orange) and the non-converting region (blue) from a pair of duplicate genes from *D. yakuba* (*DyakOr67a-1* and *DyakOr67a-2* from J. R. Arguello). The site type probability distributions (as from Innan) for the two regions are distinct (upper graph). The lower graph plots the site types, shared polymorphisms, specific polymorphisms, fixed differences, and other as 0.25, 0.5, 0.75, and 1.0 respectively along the alignment. The center two-thirds of the alignment has a high posterior probability of being a region of active conversion (orange line), while the flanking regions have a high posterior probability of having diverged to such a degree that conversion is no longer possible.

8. Please add your comments (if any):

This was a fantastic experience. Although I accomplished far less than I wanted to while here, I have made what I believe will be a lasting connection with Dr. Innan that will continue in collaboration. We will use Dr. Innan's software to simulate data to test both the current model and the future hDP. I also had a wonderful opportunity to meet some of the most important Japanese scientists in population genetics.

RESEARCH REPORT

1. Name: Siyu Chen （ID No.: SP07014）

2. Current affiliation: University of California – Berkeley

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Women's Medical University

5. Host researcher: Professor Masayuki Yamato

6. Description of your current research

Microfluidic technology is poised to play an important role in the quantitative study of biology. Falling within the category of BioMEMS (Bio-Micro-Electro-Mechanical Systems), biologically-oriented microfluidic devices are typically fabricated by casting elastomeric polymers against micro- or nanoscale negative relief structures made using traditional silicon microfabrication techniques (photolithography and other etching techniques). By bonding the polymer face-down to glass or other substrates, a network of micro- or nanoscale channels are formed.With external or built-in pumps and valves, mixers, filters, and other small-scale tools, microfluidic devices can be designed to perform tasks such as size-based particle sorting, perfusion cell culture, or even complex multi-step biochemical processes such as DNA sequencing[1].

Since cells themselves are on the micron-scale, the microfluidic toolbox is widely applicable to the study of cellular-scale phenomena. For example, microfluidic devices are capable of generating linear gradients of soluble stimuli (say, to investigate the properties of chemotaxis)[2] or patch-clamping many individual cells in parallel[3]. My interest in the use of microfluidics and other microscale technology is for the study of cell-cell communication in cell networks.

In contrast, the Okano lab at Tokyo Women's Medical University (of which Yamato-sensei is a member), is primarily a polymer science and tissue engineering laboratory. Most of the research here centers around the thermoresponsive polymer poly(N-isopropylacrylamide) (PIPAAm), which is used as a cell culture substrate for the temperature-mediated release of intact cell sheets. During normal cell culture temperatures (37C), the polymer is cell-adhesive, but lowering the temperature disrupts the cell-adhesive properties, thus releasing the cultured cells from their bottom surface. Because the cell-cell interactions stay intact during this detachment, a fully connected "cell sheet" can be harvested for use in tissue engineering applications.

Specifically, the purpose of my research here was twofold: 1) to learn about thermoresponsive substrates and its applications to tissue engineering and 2) to adapt microfluidic cell patterning to the thermoresponsive culture surfaces to create 2D cell patterns that can be layered. If achieved, these patterned 3D cell constructs may have important applications in tissue engineering or the study of cell network behavior.

References:

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2. Irimia D**,** Geba DA**,** Toner M**.** Universal microfluidic gradient generator. Anal Chem. 2006 May 15; 78(10):3472-7.
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7. Research implementation and results under the program

Title of your research plan: Integration of microfluidic cell patterning and cell sheet engineering for aligned 3D cell constructs.

Description of the research activities:

My goal was essentially to develop a methodology for using microchannels to create cell patterns onto the PIPAAm substrate. First, I designed and fabricated silicon masters for the microchannels by casting TSMR-iN1000 photoresist to a 50 um height and exposing a digital pattern using the in-house maskless photolithography system. Polydimethylsiloxane (PDMS) is then cast against this mold, cured at 80C for one hour and then cut to shape using razor blade.

After fabricating the channels, I performed a leakage experiment to ascertain whether conformal contact between the patterned PDMS channels and PIPAAm-grafted polysterene dishes was tight enough to prevent fluid from leaking (since typically, microdevices are covalently bound to the substrates). I introduced a fluorescent solution into the microchannels and observed the channels for several days. No leakage occurred on either the PIPAAm-grafted polysterene dishes or the tissue culture polysterene dishes.

In-channel cell culture experiments revealed that pre-incubation using fibronectin is required for proper cell adhesion and growth inside the channels. However, I was using cell lines (3T3 and bovine aortic endothelial cells) which do not normally require fibronectin during culture on PIPAAm dishes. Because these cells are

normally very adhesive and secrete high amounts of extracellular matrix proteins (such as fibronectin) on their own, I found that the fibronectin pre-incubation actually interferes with the temperature-dependent detachment process. Therefore, repeating the experiments with other cell types may yield better results.

Although confluent cell cultures showed difficulty detaching when fibronectin incubation was used, the patterned cells did exhibit temperature-mediated detachment when transferred using a recently developed gelatin stamping procedure. However, the pattern was vastly degraded by the end of the procedure, probably a combined result of excess fluid shear during medium replacement and the poor detachment properties resulting from fibronectin incubation. More characterization must be done to determine the effect of pattern size on detachment properties and the appropriate ranges of fibronectin to use for each cell type.

8. Please add your comments (if any):

This program afforded me the rare and precious opportunity to explore research across cultural and disciplinary boundaries. As this was my first time to work in a non English-speaking country, I gained a great deal of experience and wisdom about communicating effectively across language and cultural barriers.

Because my host institution was a medical university, I was fortunate to encounter dramatically different academic perspectives. Many of the professors were trained as doctors, others as polymer scientists or biologists or engineers. Interacting with them and learning about their research gives me tremendous inspiration as I am now setting the stage for my eventual thesis research.

RESEARCH REPORT

1. Name: Rosen Diankov （ID No.: SP07015 ）

2. Current affiliation: Carnegie Mellon University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Advanced Industrial Science and Technology

5. Host researcher: Satoshi Kagami

6. Description of your current research

This research focused on developing algorithms for autonomous humanoid robots for the use of common everyday house chores. One of the most important tasks for humanoid robots is manipulation with everyday obstacles. The final system we developed consisted of an automatic method of teaching the robot how to grasp unknown obstacles. The robot autonomously used these grasp models to complete a simple pick-up and thrown-in-trash task. Another important issue is safety of the robot and the human around the environment. We created a system to dynamically monitor the environment for unexpected changes. While the robot is executing its trajectory, it will carefully monitor if it will collide with any object in the future; if so, the robot will compensate its movement to avoid collisions. In the end, we submitted a paper of our results to the international Humanoids 2007 conference.

No matter the cost, the robot must always avoid harming humans. In order to do this, the robot first has to find where every human is with its vision system. During the summer, we also developed a robust system for tracking humans. The system first detects the face of the person and then extracts the person's clothing information. Tracking clothes in addition to the face greatly increases the robustness of the system.

7. Research implementation and results under the program

Title of your research plan:

Towards Autonomous Humanoid Robots in Households

Description of the research activities:

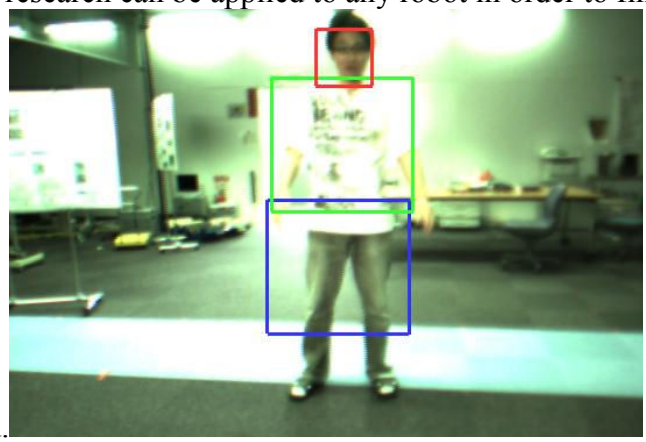
The robot system I worked on was divided into three main parts: the low level control to the robot hardware, the vision system, and higher level thinking like planning and modeling the environment. When I first arrived at Japan, the low level control system was already done and the lab had a motion capture system that can calculate any changes in the environment at a relatively quick rate. My job was to create the intelligence of the robot so that it can autonomously reason about how to grasp objects and put them in a trash can. The novelty of the system is that up to now researchers have manually told the robot where to grasp a specific object. If it turns out that the robot cannot achieve that specific grasp because the environment doesn't allow it, then the robot will just return a failure to complete the task. However, the reality is that an object can be grasped from many places and the best grasp depends on many factors like the robot's gripper, the particular object's geometry, the friction coefficients between the object's surface and robot, the object's mass, the surrounding environment, and the robot's kinematics. The system we developed allows the robot to autonomously consider all these factors when choosing how to grasp and move obstacles.

Before coming to Japan, I had developed an open source planning test bed called OpenRAVE in order to test various planning algorithms in simulation before applying it to the robot. Within two weeks of coming to the Advanced Industrial Science and Technology lab in Japan, we had the humanoid robot HRP2 perform all the necessary actions in simulation. The next task was to create the network system and communication protocols in order to move the real robot. The core processing of the whole system was done by OpenRAVE. OpenRAVE updated the environment in real-time from the motion capture system, created collision-free trajectories, and sent them over the network to the robot hardware. Because the robot had to manipulate objects, a lot of safety precautions had to be taken in order not to break the robot's motors. OpenRAVE itself is written in C++ and has a lot of capabilities. C++ programs are notorious for many bugs and long turn-around times for changes to the code. Therefore, we developed a network protocol for scripting that allowed MATLAB to connected to OpenRAVE and directly control the flow of the whole system without any recompilation. It was very easy to spot bugs and make online changes to the robot's behavior.

Most of my time in Japan was spent programming in the lab. I worked on the robot together with Dmitry Berenson, another JSPS researcher. The researchers at AIST were extremely helpful in any problems we had. We immediately had access to

computers and any information required to run the robot. Before anything could be run on the real robot, we had to show very convincing simulations.

The rest of my time was spent working on a person tracking system using a vision camera. The system can track in real-time any person that walks in its field of view. First the system finds a person by its face, then it computes the height of the person by measuring the distance to the floor computed by stereo vision. Once a rough estimate of the person is known, the system creates a model of the person's clothes and uses them along with the person's face to track where the person goes. From our tests, the system is very robot against noise and sudden changes in the person's movement. This research can be applied to any robot in order to find and avoid people in the household.



8. Please add your comments (if any):

The research was intense, but at the same time it was exciting. I plan to continue working with my Japanese colleagues to further the advancement of the robotics field.

9. Advisor's remarks by Satoshi Kagami:

Rosen has been preparing an autonomous grasping function before he joined to our laboratory. The system receives hand configuration and target object shape, then it pre-computes possible "good" grasping candidates. In application stage, with environmental obstacles, it calculates the best candidates to grasp without colliding obstacles. After he arrived, he uses our humanoid robot HRP2-DHRC with our MOCAP based online target positioning system, he solved problems that happens by real robot limitations, then he achieved successful grasp to given objects in different configurations. Then he submitted his results to the IEEE/RSJ International Conference on Humanoid Robots 2008. I think such a success is rarely seen, and it shows his preparation, perspective to the real robot, and also programming skill. I hope this collaboration started by this JSPS summer program will continue on to bridge robotics in US and Japan in the future.

RESEARCH REPORT

1. Name: Matthew J. Eckelman （ID No.: SP07016）

2. Current affiliation: Yale University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry **X** Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Advanced Industrial Science and Technology

5. Host researcher: Dr. Masaaki Fuse

6. Description of your current research

My doctoral research focuses on integrated environmental assessments of energy and materials use, primarily for metals and metal-containing products. Specifically, I analyze toxicity effects from releases of various metals to the environment and greenhouse gas emissions associated with different life-cycle stages of these metals. These life-cycle stages include mining and milling, concentrating and refining the ore, fabricating metal into products, using these products, and end-of-life processing and disposal, as well as trade at every stage. My analyses use quantitative data, socio-economic models, and the principle of mass balance to quantify metal flows (for example, the amount of chromium contained in products discarded to waste management in Japan). These flows are then linked with toxicity and greenhouse gas emissions using Life-Cycle Assessment (LCA), which is a standardized framework for quantifying the environmental impacts associated with a particular product, process, or system. The goal of this work is to aid with complex policy and planning decisions involving many environmental trade-offs by showing which choices are best from a resource optimization / sustainability point of view.

Due to an acute shortage of landfill space as well as a lack of primary metal resources, the Japanese have one of the most advanced waste processing and recycling systems in the world. They also have an active research communities for studying the environmental impacts of materials use and collect comprehensive statistics on many aspects of waste management. This makes Japan an ideal subject for preliminary research.

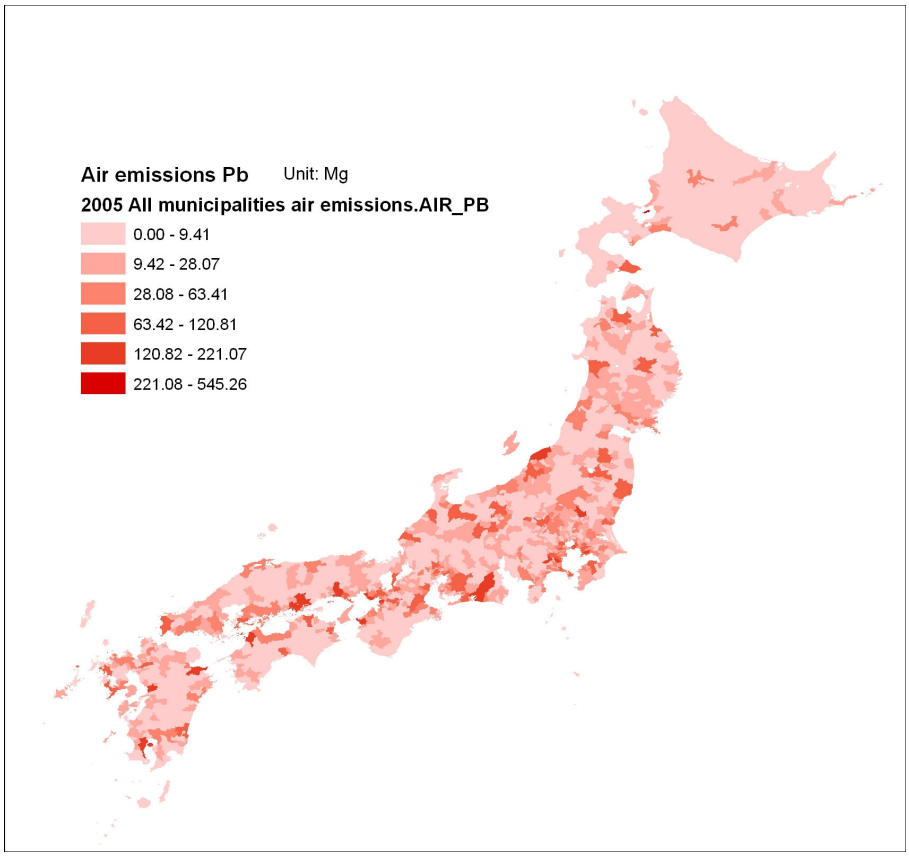
7. Research implementation and results under the program

Title of your research plan:

Spatial mapping and modeling of metal flows in the Japanese waste management sector

Description of the research activities:

Using data from a variety of sources in Japan, I built a spatial model of metal flows through the waste management system in Japan for twelve metals (Al, As, Bi, Cd, Cr, Cu, Fe, Pb, Sb, Se, Sn, Zn) for the year 2005. These metals were chosen based on their technological importance, as well as toxicity and primary resource depletion concerns. This analysis included flows of metal in waste generation, incineration, ash melting, bulky waste shredding and sorting, direct recycling (of the cans and bottles type), electronic appliance recycling, car disassembly and shredding, and final disposal. The flows were then aggregated in GIS to create a series of spatial maps depicting metal recovery and emissions to air and soil.



In the process of collecting relevant data, I visited several waste processing facilities, including a car shredder, a municipal solid waste incinerator/ash melting plant, and a large iron and steel production facility. I also met with Japanese metals researchers from Hokkaido University, University of Tokyo, Tohoku University, Okayama University, and the National Institute for Environmental Studies. Much of the raw data was taken from the Ministry of Environment and Japanese literature sources, all of which required translation

into English.

Spatial data on metal recovery were combined with data on greenhouse gas emissions taken from Japanese LCA inventories in order to quantify one of the major environmental impacts associated with materials reprocessing. By combining these energy/resource maps with the locations of metal remelting facilities (and thus incorporating transport distances), it is possible to evaluate which metal resources are most environmentally beneficial to recover and which are not. This is useful for siting new facilities as well as creating appropriate waste management policies.

The spatial maps on waste management emissions will be combined with similar maps of emissions from point-source combustion and metals production and fabrication facilities to create complete national emissions inventories, in collaboration with Japanese researchers. These can then be used to model heavy metals deposition and accumulation in soils and waters.

I was also able to participate in a number of smaller research projects:

— A workshop on metals and waste management analysis using economic models, held at Tohoku University

— A national workshop on the estimation of Japan's in-use metal stock

A collaboration with a researcher from the University of Tokyo on estimating the average global technological lifetime of copper, incorporating all trade and regional differences in use patterns.

8. Please add your comments (if any):

My host researcher Dr. Fuse was exceptionally helpful in providing data, connecting me with other researchers, accompanying me on site visits, and helping with logistics such as translation. This work would have been nearly impossible to do without him and I am extremely grateful.

9. Advisor's remarks (if any):

Mr. Matthew Eckelman has been an excellent assistant in my research works. He showed himself to be aggressive and enthusiastic in every way for this program period. I feel confident that the experience obtained through this program will contribute great success to his doctoral thesis.

RESEARCH REPORT

1. Name: Neil A. Gray （ID No.: SP07017 ）

2. Current affiliation: Columbia University, Center for Neurobiology and Behavior

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo, Graduate School of Pharmaceutical Sciences

5. Host researcher: Yuji Ikegaya, Ph.D.

6. Description of your current research

Within the brain, the neurochemical serotonin has long been implicated in emotional functions, including mood and anxiety disorders. However, the net effect of serotonin on neuronal function is complicated by a wide diversity of excitatory and inhibitory receptor subtypes and target cell populations. Electrophysiological studies are limited in their ability to monitor single or very small numbers of neurons concurrently. Recently, functional multineuronal calcium imaging (fMCI) has emerged as a powerful new technique for observing the activity of hundreds of neurons in parallel. fMCI relies on the use of calcium-sensitive fluorophores and spinning-disk confocal microscopy to allow the detection of calcium transients (an indicator of neuronal firing) with subsecond precision.

In the current research, we are using fMCI to evaluate the action of serotonin on spontaneous activity in the hippocampus. Rat pups are sacrificed at day 7, and 200μm thick cross-sections of the hippocampus are cultured for 7-14 days before use. Following loading of the dye, ninety-second movies of spontaneous activity in the CA3 subfield are observed. Serotonin and specific agonists and antagonists are then bath applied via the perfusion medium, and further movies are collected. Data is analyzed in a multi-step process using MatLab: 1) movies are coregistered to correct for any drift, 2) cell contours are defined manually, creating calcium time-fluorescence ‘traces’ 3) spikes are detected in semi-automatically, creating a raster plot of activity over time. Following imaging, slices may be further processed for immunohistochemistry, in order to identify inhibitory interneurons within the observed region.

7. Research implementation and results under the program

Title of your research plan:

Studying the Effects of the Neuromodulator Serotonin on Spontaneous Hippocampal Activity: a Functional Multineuronal Calcium Imaging Study.

Description of the research activities:

Serotonin was found to inhibit spontaneous activity at concentrations (50nM) far lower than observed in prior electrophysiological studies of evoked activity (~1 – 10μM). This enhanced sensitivity of spontaneous activity likely results from additive effects across multiple neurons on recurrent excitation. Interestingly, these effects were found to only partially depend on the primary inhibitory serotonin receptor (5-HT1A) expressed in the hippocampus. This result suggests that excitatory actions on interneurons may lead to inhibition of the principal pyramidal cells of the hippocampal CA3 region.

There was also a substanstial variability in the effect of serotonin, both between slices, and between individual neurons within the same slice. Ongoing work is directed at immunohistochemically determining whether serotonin effects are cell-type specific. Further studies will also investigate the effect of corticosterone and early life stressors, which have previously been shown to modulate serotonin actions in the hippocampus.

RESEARCH REPORT

1. Name: Paul S Grisham （ID No.: SP07018）

2. Current affiliation: The University of Texas at Austin

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Nara Institute of Science and Technology

5. Host researcher: Dr. Hajimu Iida

6. Description of your current research

Software design science is a science of the artificial, in which observable phenomena, the laws that govern them, and the instruments used to measure them are artificial constructs. Even more than other design sciences, software technology solutions change the real-world activities they are created to support. In traditional engineering domains, designers use predictive models discovered by the physical sciences to test designs for specific properties. Unfortunately, the mathematical foundations of computer science have failed to provide accurate models for evaluating software designs for relevant economic (cost estimation) and runtime (performance, security) properties. Empirical studies in the field have yet to produce reliable statistical models. In addition, properties discovered in scale models—e.g., prototypes—often do not scale to the whole system. Without a foundational science upon which to base its design science, software engineering relies strongly on the experience and judgment of designers for early evaluation of designs

When creating software systems, architects and designers make choices throughout the entire development process with certain purposes and goals in mind. They select design options and exclude others based the problem-solving context and their own experience. The resulting design captures the end result of the design process, but any situational and expert knowledge that produced the design is lost. Moreover, implied design constraints are difficult to infer from the final system design and implementation. To understand systems and guide their evolution, software maintainers are dependent on understanding the original designers' intent and the design context to decide what can be changed without violating design constraints. We use the term design intent to describe these decision-making factors.

The idea of using design rationale modeling in software architecture derivation is not new, but unfortunately, much of this work focuses on the development of modeling systems and ignores the people and processes they are meant to support. As a result, it is difficult to empirically validate claims of cost and benefit, compare existing modeling systems, and identify new areas for improvement. The goal of my research is to develop an empirical basis for evaluating tools and notational systems for capturing, sharing, and reusing architectural design rationale and other design knowledge.

7. Research implementation and results under the program

Title of your research plan:

Empirical Analysis of Software Design Intent Systems

Description of the research activities:

Empirical research in software engineering is immature, in part because of the relative newness of the technology of software, but also because of the difficulty in setting up and replicating studies of software development activities. As with any field in the behavioral and social sciences, including management science, working with human beings in context is challenging. However, software engineering empirical studies are even more difficult because intellectual property concerns obstruct sharing of data, and independent replication and validation of results is nearly impossible due to economic factors. In the United States, there is a culture of secrecy in the software industry preventing the sharing of any design or process data. Most empirical research in software engineering uses small-scale projects on graduate student research teams as the basis for testing. These projects may be useful for hypothesis building but are useless for generalizing results to industrial practice.

The Software Design Laboratory at the Nara Institute of Science and Technology is part of a multi-university/multi-industry partnership to collect, share, and analyze empirical software engineering data called EASE—Empirical Approach to Software Engineering. The Knowledge Feedback Cycle (KFC) is a model that describes how industrial data can be gathered, processed, and shared by both academic researchers and industrial process engineers. Data is collected by a tool called the Empirical Process Monitor (EPM) and visualized using the Project Replayer. Data can be desensitized so sensitive intellectual property or trade secrets are not revealed.

Our goal this summer was to develop ongoing research collaborations between EASE and the Empirical Software Engineering Laboratory at the University of Texas. As the foundation for this collaboration, we conducted the following research activities:

1. We considered how to capture software design and design intent data using the EPM. Industrial software designs tend to be documented using ad hoc tools such as word processors and spreadsheets instead of specialized design tools. We considered how EPM could capture these designs as the basis for producing a historical record of changes to software design. We identified candidate industrial projects for long-term studies of software design. This data will feed directly into research on design intent and maintenance.
2. We used historical data from a large-scale, industrial project (Lucent Technologies 5ESS) to validate the utility of the Project Replayer in visualizing process phenomena. The 5ESS project has been used for many previous studies. We now have a set of tools for selecting and extracting empirical data from the 5ESS project records. We hope to use the Project Replayer and other EASE tools for new studies on the 5ESS data.
3. We discussed enhancements to EPM for a range of new studies on software evolution and defects. Specifically, we began work on how to add a plug-in to EPM for semantic interference checking

As EPM tool development proceeds, we hope to be able to share data and ideas that will benefit researchers on both sides of the Pacific. Our research results for the summer are currently being included in several research and position papers in preparation for submission.

RESEARCH REPORT

1. Name: Nick Groll （ID No.: SP07019）

2. Current affiliation: National High Magnetic Field Laboratory, Florida State University

3. Research fields and specialties:

Humanities Social Sciences XMathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Environmental and Fundamental Research Laboratories, NEC Corporation

5. Host researcher: Yasunobu Nakamura

6. Description of your current research

My current research aims to use advanced technology developed in the fields of atomic and optical physics and apply it to the field of condensed matter physics, particularly for the use of on-chip cavities. With the long range goal of quantum computation, this research is concerned with the measurement of the quantum state of a two level system that I will refer to as our qubit (quantum bit). I will be considering a qubit inductively coupled to a high quality resonant cavity (Q-factor on the order of 10^4-10^5), which could be a superconducting flux qubit or magnetic molecules. The inductive coupling of the qubit to the resonant cavity will depend on the quantum state of the qubit, and thus the inductance of the system will have a state dependant inductance. This will cause a small shift in the resonant frequency of the cavity that can be seen by looking at either the phase or amplitude of a transmitted microwave through the cavity. Using IQ mixers, these parameters can be measured directly. The method to be used is homodyne detection where an RF signal is mixed with a local oscillator of the same frequency producing two DC signals in which the phase and amplitude of the RF signal is encoded. However when the signal to be measured is very small, the imperfections in the IQ mixers begin to dominate and measurement accuracy diminishes to the point where it becomes incoherent. To work now in this low power range, a method of calibration is required in order to precisely separate the signal from the background. There are two ways that calibration can occur, through hardware or software calibration. The later calibration method was performed this summer as it is more dynamic in that it can be used with different mixers, and greatly broadening the bandwidth possibilities for the measurement.

7. Research implementation and results under the program

Title of your research plan: Software calibration of IQ mixers for use in low power homodyne detection.

Description of the research activities:

The summer was spent mapping the properties of IQ mixers in 3-18GHz frequency range for use in a homodyne detection scheme. IQ mixers use a local oscillator (LO port) and mix it with a reference frequency (RF port) to produce intermediate frequencies at I and Q ports with a phase difference of 90 degrees (sine and cosine). With homodyne detection, the same frequency is used on both RF and LO ports thus producing a DC output at I and Q ports that can easily be measured by any oscilloscope. In low power applications any imbalance in amplitude, phase or DC offset of I and Q ports can result in a skewed or completely unusable measurement. By measuring and studying the scaling properties of the IQ port amplitude asymmetry, phase imbalance, and DC offset over the several mixer's frequency ranges I was able to develop a calibration technique that would allow for low power phase detection.

8. Please add your comments (if any): This summer has been very beneficial to me both professionally and personally. I am very grateful to NEC, NSF, and JSPS for providing me with this summer opportunity as I have learned a great deal in my short stay here in Japan.

RESEARCH REPORT

1. Name: Alexandra Harryman （ID No.: SP07020 ）

2. Current affiliation: University of Maryland, Baltimore County

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: RIKEN, Wako

5. Host researcher: Dr. Ichiro Nishii

6. Description of your current research

Multicellularity has evolved many times during the history of life on earth, but very little is known about the molecular genetic events that have promoted these major developmental transitions. The ultimate goal of my research is to understand the molecular framework that fostered the evolution of multicellularity in *Volvox carteri*, a close relative of the unicellular green alga *Chlamydomonas reinhardtii*. *V. carteri* possesses just two cell types: small, terminally differentiated somatic cells and large reproductive cells. Maintenance of the somatic-cell fate is controlled by the *regA* gene, which encodes a protein that is expressed only in somatic cells and represses expression of genes required for reproduction. *V. carteri* possesses four genes that are closely related to *regA* (*rlsA-rlsD,* for *regA-like sequence)*, while *C. reinhardtii* has only one (*RLS1*). *rlsD* is orthologous to *RLS1*, while *regA* and *rlsA-C* arose following amplification of an *rlsD/RLS1* ancestor specifically in the *V. carteri* lineage. I am characterizing these *rls* genes to test the ideas that 1) like *regA,* they might also act as repressors of reproduction, and 2) *rlsD* might carry out the ancestral function of *rls* genes, which I hypothesize was to repress reproduction in response to stress.

7. Research implementation and results under the program

Title of your research plan: Investigating the Roles of *regA* and other VARL genes in cellular differentiation in *Volvox cateri*.

Description of the research activities: My research goals at RIKEN for the duration of the EAPSI program were to determine the cell-type and developmental-stage specific expression patterns of *rlsA-D* during *V. carteri* development. To do this, I used real time PCR to quantify gene expression levels at various timepoints throughout *V. carteri* development. Prior to performing PCR, it was necessary to purify RNA samples and prepare cDNA from these samples. Once primers were selected, samples were run in triplicate. Inclusion of a dissociation stage was used to ensure the purity of products formed. My work this summer provided me with baseline information about the expression patterns of *rlsA-D* in *V. carteri*. However, I need to continue these studies, and include more samples in my study at other time points during *V. carteri* development.

RESEARCH REPORT

1. Name: Craig Herbold （ID No.: SP07021）

2. Current affiliation: University of California, Los Angeles

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Shizuoka University

5. Host researcher: Dr. Kenji Kato

6. Description of your current research

We are interested in the identification and characterization of the organisms involved in nitrogen cycling in the Matsuzawa catchment basin in the Kiryu Experimental Watershed (KEW). The current research is focused on the denitrifying community found in groundwater and soil samples from KEW. Denitrifier diversity and community composition are being studied by molecular methods, targeting nitrite reductase (nirK and *nirS*). From these studies, we can predict which samples contain communities that have the genetic potential for carrying out denitrification. Denitrification is regulated by the environment, however, so the presence of a gene in a particular sample does not necessarily imply that denitrification is carried out in the soil or groundwater from which the sample came. Therefore, we are supplementing our molecular studies with stable isotope tracer experiments to assay samples for *in-situ* denitrification activity. These experiments are compared to similar experiments targeting nitrification and anammox processes so that the nitrogen cycle at KEW may be better understood.

7. Research implementation and results under the program

Title of your research plan:

Characterization of the denitrification community found in the Kiryu Experimental Watershed

Description of the research activities:

Soil and groundwater samples from Kiryu Experimental Watershed were collected in June and in July. Physical and chemical characteristics of the soil and groundwater were measured. Denitrification activity (as well as nitrification and anammox activities) was measured by stable isotope tracer experiments. Bulk DNA was collected from soil samples and was used as a template for PCR-amplification of nirK and nirS genes, using previously published primers, and clone libraries have been constructed. Sequencing of these clones will be carried out at a later time.

An archaeal 16S clone library was built from previously collected soil and groundwater samples and then was sequenced. The soil library consists primarily of methanogen 16S sequences, while the groundwater archaeal library contained no methanogen sequences, only mesophilic crenarchaeal sequences. Because it is possible that all mesophilic crenarchaea oxidize ammonia, we designed PCR primers specific for crenarchaeal *amoA*. The primer design was based on an alignment of crenarchaeal sequences that were chosen to maximize molecular diversity and to target terrestrial amoA sequences.

8. Please add your comments (if any):

This summer has been exceptional. The research I participated in while in Japan differs somewhat from my thesis work, and is much more related to my long-term career plans. Dr. Kato and his lab members have been extremely patient and helpful during my travel through the learning curve, and I am grateful for this opportunity to collaborate with them!

RESEARCH REPORT

1. Name: Christine Ho （ID No.: SP07022 ）

2. Current affiliation: UC Berkeley – Materials Science and Engineering Department

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry **Engineering Sciences** Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:
Nanotechnology Research Institute,
National Institute of Advanced Industrial Science and Technology (AIST, Tsukuba)

5. Host researcher: Dr. Kazuhiro Murata

6. Description of your current research

Autonomous electronic devices, such as wireless sensors and RFIDs, show great potential in applications that benefit from an enrichment of information to the user. There has been a great effort directed towards the goal of miniaturizing the sensor nodes to millimeter dimensions, while also integrating a self-sufficient power supply to last the lifetime of the device. Challenges associated with the design of an adequate power supply include the physical and processing limitations imposed as they are reduced. A proposed micropower system for wireless sensors combines an energy harvesting device (ie. solar, vibrations, or thermal energy) with an energy storage system that couples a microbattery and an electrochemical capacitor. My research at Berkeley includes the characterization of energy materials, and the optimization of their properties through the design and fabrication of devices.

The footprint area allocated for energy components such as batteries and capacitors on a small electronic device will inherently be limited, consequently restricting the maximum possible energy capacity if traditional two dimensional planar geometries are used. Alternatively, three dimensional architectures are being investigated as a method to increase the energy and power densities of energy storage components. Direct write processes are being recognized as a viable method for patterning materials into unique three-dimensional structures. Recent advances in solutions processing and materials synthesis have allowed for micron-scale deposition, intricate designs, and patterning of atypical material chemistries not easily produced using current microfabrication technology. Printing techniques, including ink-jet and dispenser systems, are able to fabricate structures rapidly in ambient, room-temperature conditions, while reducing the number of processing steps in comparison to standard lithography. Most processes utilized by standard lithographic techniques are considered wasteful and the solvents used are often hazardous to the environment. Because direct-write printing is an additive process, it produces much less waste. Furthermore, direct-write printing is neither materials nor substrate chemistry specific. Because of its flexibility, direct write processes are good candidates for developing 3D structures directly on a substrate. These structures can be used to make high surface area and volume micro electrodes for energy storage devices. The successful incorporation of an integrated micropower system will help enable next generation wireless sensor networks to become truly ubiquitous, and with it the

ability to change and improve the way people interact with the information made available through technology.

7. Research implementation and results under the program

Title of your research plan:

Super Ink Jet Printing of 3D Micro Energy Storage Devices

Description of the research activities:

Super ink jet printing (SIJP), developed by Dr. Murata and his research group at AIST, is a novel direct write deposition tool able to deposit solutions containing nano-scale active materials (such as metals, ceramics, and polymers) with sub-micron accuracy. The SIJP dispenses ink droplets three orders of magnitude smaller than commercial ink jet printing systems, and can print sub-micron linewidths two orders of magnitude smaller than commercial ink jet printers.

With the SIJP, unique micron-scale 2D geometries and 3D structures have been demonstrated. This summer, high aspect ratio 3D silver nanopaste structures were fabricated using the SIJP. Architectures that were printed include arrays of micro rods and interdigitated walls.

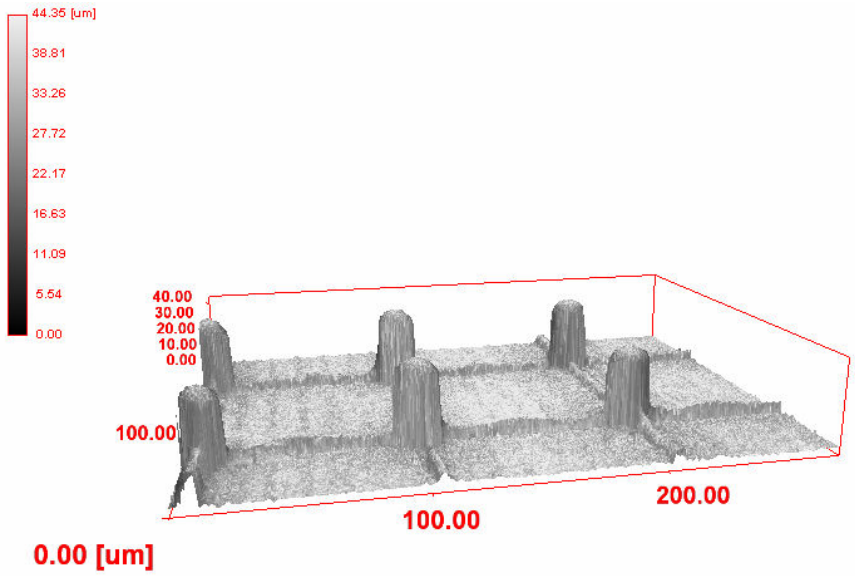


Figure 1. Array of printed silver microrods.

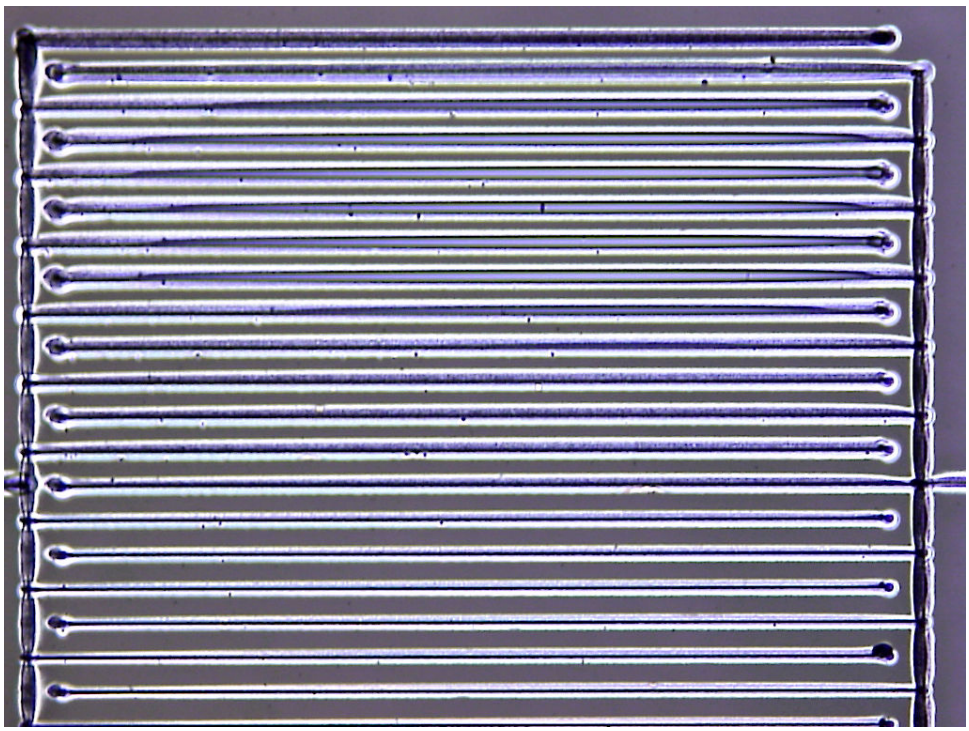


Figure 2. Printed silver interdigitated high aspect ratio walls.

These structures were then used to construct silver-zinc battery devices by placing two parallel arrays in an alkaline electrolyte and depositing zinc onto one electrode scaffold from solution. The batteries were then electrochemically tested and typical cycling behavior was observed, showing the validity of this processing method for making dense 3D structures for enhancing the performance of microbattery devices.

RESEARCH REPORT

1. Name: Vivek Kalia （ID No.: SP07023 ）

2. Current affiliation: The Johns Hopkins University School of Medicine

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo Graduate School of Medicine

5. Host researcher: Haruhiko Bito, Associate Professor of Neurochemistry

6. Description of your current research

I am currently studying calcium/calmodulin-dependent protein kinase type IV (CaMKIV) and cAMP response element-binding (CREB) signaling. A kinase cascade consisting of CaMK kinase (CAMKK) and CaMKIV is an essential signaling pathway that links long-term synaptic plasticity-inducing neuronal activity to CREB activation. To conduct my study, I constructed four different lentivirus vectors to be introduced into mouse cultured hippocampal neurons. I constructed the following vectors: CSIV-shNega-prSynI-IRES2-Venus, CSIV-shCaMKIV-prSynI-IRES2-Venus, CSIV-shNega-pCaMKII-IRES2-Venus, and CSIV-shCaMKIV-pCaMKII-IRES2-Venus. In my study, I aimed to build a lentivirus vector knockdown model for CaMKIV in hippocampal neuronal cultures using a CaMKIV-specific short hairpin-RNA (shRNA). In addition to the shRNA cassette, I further added two different promoters for a second expression cassette with a view to testing which one would allow a better re-expression of rescue gene constructs, in the neurons in which the viral vector has knocked down the expression of target gene CaMKIV. Preliminary data in my hands suggest that in accord with the vector design, infection of neurons with the lentiviral RNAi vectors does indeed result in a substantial degree of CaMKIV knockdown. In the future, the Bito lab will take advantage of this breakthrough to quantitatively manipulate downstream targets of CaMKIV action, such as the degree of phosphorylated CREB (pCREB). If CaMKIV knockdown reduces stimulus-induces CREB phosphorylation, then rescuing the knockdown using an shRNA-resistant CaMKIV re-expression will be carried out to consolidate this quantitative and causal relationship. These results will be used to further clarify the exact subsets of genes that CREB upregulates and downregulates, in vivo and in a neuron-type specific manner.

7. Research implementation and results under the program

Title of your research plan:

Manipulation of neuronal CaMKIV pathway using a lentivirus vector

Description of the research activities:

I learned the following techniques: how to design and construct vectors and plasmids; how to work develop primary cultures of neurons for use in transfection experiments; how to optimize polymerase chain reaction (PCR) conditions to help in construction of an shRNA-resistant CaMKIV re-expression model; how to work with lentivirus vectors and how to transfect them into primary neurons; how to grow and purify lentivirus vectors; how to purify plasmids from various strains of *E. coli* (DH5α and OneShot® Stbl3); how to do immunocytochemistry; how to do imaging studies of neuronal cultures stained with fluorescent antibodies.

8. Please add your comments (if any):

The research I was able to conduct at the University of Tokyo was very exciting and just what I wanted to do when I came to Japan. I am happy to find out that my research environment was supportive, the resources plentiful, my coworkers' knowledge and past experiences extremely helpful, and my boss very receptive to my ideas. It was a wonderful summer, and I'm very appreciative to have taken part in the program.

9. Advisor's remarks (if any):

Vivek Kalia is clearly a remarkably gifted student/scientist. Despite a total lack of experience in molecular and cellular neurobiological techniques prior to his arrival to Japan, he immediately mastered in my lab all procedures necessary to design, construct and use lentiviral vectors in a neuronal culture context.

His training in Japan is expected to provide him with a tremendous help in order to make an adequate career choice as a physician-scientist in later years of Medical School.

RESEARCH REPORT

1. Name: Ryan Kepler （ID No.: SP07024 ）

2. Current affiliation: Oregon State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences (Biological Sciences)
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Museum of Nature and Science (formerly the National Science)

5. Host researcher: Dr. Tsuyoshi Hosoya

6. Description of your current research

My current research deals with the systematics and population genetics of entomopathogenic fungi of the genus *Cordyceps*, and severally closely related genera. This work expands the relationships previously defined by past workers in my lab by increasing the number of species analyzed. This work takes a molecular approach, using multiple genes to infer evolutionary relationships. In addition to work on the systematics of *Cordyceps* I am also working to analyze the global population structure of the asexually reproducing fungus *Isaria tenuipes*. This species has a known sexual state which is restricted in its distribution to east Asia, however the asexual state can be found on nearly every continent. Understanding of how this pattern of distribution between sexual and asexual states occurs can lead to the development of hypothesis on the evolution of asexuality in fungi in general, a phenomenon that is wide spread.

7. Research implementation and results under the program

Title of your research plan: Systematics of the pathogenic fungus *Cordyceps* and related fungi

Description of the research activities:

My research in Japan consisted of activities in three broad categories: Examination of specimens held in the herbarium of the National Museum of Nature and Science, field collection of new specimens, and establishing a network of collaborators for future research. In the examination of herbarium specimens, I was able to make measurements on five type specimens for species whose placement in a larger phylogeny of these fungi is currently unknown. This examination uncovered systemic errors in several of the measurements of morphological characters reported in the original publications. These errors typically involved misrepresentation of the size of perithecia, as well as length of the ascus. Both of these features are part of the reproductive structures of the fungi and are considered of high importance when determining species boundaries. Unfortunately, the resolution of these discrepancies will have to await future research, since the specimens have been preserved in formalin which degrades DNA, thereby making them unavailable for inclusion in a molecular phylogeny. I also uncovered misidentified specimens in the holdings for species where the type specimen is reported as missing. This is a serious problem, since many of the specimens were deposited by the author of the original description. Material of these specimens will be taken back to my lab in the United States for further work to clarify this issue.

During the course of my field collections I was able to obtain 173 specimens. This includes 34 collections of species in the genus *Isaria* and 30 collections of the species *Cordyceps militaris*. The collections for *Isaria* represent six distinct populations. These will later be subjected to analysis with AFLP techniques to determine the genetic diversity present in each population and compared with populations from other global regions. The collections of *C. militaris* will be used to test for cryptic speciation between Japanese and American collections. Another significant finding from these collecting trips includes the recollection of *C. nelumboides*, a species whose type specimen is currently missing and has not be placed inside a current molecular phylogeny. Similarly, a specimen of *C. pseudoatrovires* was also obtained. This is a rare species that has also not yet been included in the molecular phylogeny for this group. Finally, I was able to obtain specimens of four species that do not have formally recognized Latin names. A thorough review will be undertaken to determine their identity and possibly validate them as new species.

Cultures were successfully obtained for 73 of these specimens collected from the field. These cultures will serve as a long lasting source of DNA for future research. DNA from these cultures will be taken back to the United States for analysis. The cultures themselves have been deposited in the holdings of the National Museum of Science and Nature, but have also been sent to the NITE culture collection. This is a facility that specializes in the long term maintenance of fungal lines, and makes them available for other researchers.

Finally I was able to make several important connections with researchers here in Japan. In addition to the relationship formed with Dr. Hosoya, my host during this stay, I was also able to meet Dr. Hiroki Sato. Dr. Sato is a leading researcher of entomopathogenic (insect loving) fungi in Japan. He is working on an inventory of Japanese *Cordyceps* and has invited me and my lab to join in this very large task. I was also able to develop ties to several researchers at the NITE culture repository, especially Sayaka Ban and Yuko Kurihara. As previously mentioned, this is an important source of fungal cultures. The facility also houses it's own herbarium with many dried specimens of *Cordyceps* species. Connections with researchers at this institution will provide valuable expertise in working with fungal cultures and will be a source of new material. Finally I was able to establish good ties with the Cordyceps Amature Club. This is a group dedicated to the natural history of *Cordyceps* and is a wealth of information in terms of collection localities. Collaboration with this group has allowed for the location of some of the importance collections mentioned above. I applied for and received formal membership in this group, ensuring a connection and making it possible for the acquisition of new material from the personal collections of some of the individuals.

8. Please add your comments (if any):

I feel that my time here in Japan was well spent and was successful at achieving the goals laid out in my proposal. In addition to learning a great deal about the specifics of my field, I also acquired an introduction to the culture of Japan, which is just as valuable.

RESEARCH REPORT

1. Name: George Kikuchi （ID No.: SP07025 ）

2. Current affiliation:

Purdue University (Department of Sociology and Anthropology)

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Research Institute of Police Science (NRIPS)

5. Host researcher: Dr. Yutaka Harada

6. Description of your current research

My general research interest revolves around the spatial and temporal analysis of crime within a city. Both spatial clustering of crimes and temporal correlation of high crime areas were known to early criminologists, and criminologists have long analyzed spatial and temporal distribution of crime using hand drawn maps, multivariate analyses of crime and socio-economic status of neighborhoods could not be fully achieved until recently, due to the difficulty in analyzing spatial and temporal data simultaneously. For example, classical regression models, such as ordinary least squares (OLS), assumes independently distributed residuals. Such an assumption is likely to be violated in spatial data. Thus, my research analyzes multivariate relationships of crime and neighborhood characteristics within a spatio-temporal context by taking advantage of recent development in spatial statistics.

Many criminological theories argue the importance of socio-demographic characteristics of neighborhoods as certain neighborhood characteristics facilitate the creation of criminal motivation (e.g., socio-economic status and employment). Furthermore, certain neighborhoods become attractive targets because of the low level of guardianship (e.g., inability to detect strangers). It has rarely been considered if these socio-demographic characteristics have strong effects on the level of crime in neighborhoods after controlling for the effect of crime rates in neighbors and crime rates in the past. It is possible that crime rates are high in one neighborhood because of the diffusion of crime from surrounding neighborhoods. Based upon the spatial-temporal statistical modeling, my research also re-examines existing criminological theories.

7. Research implementation and results under the program

Title of your research plan:

A Spatial Analysis of the Police Box System and Neighborhood Crime Rates in Japan

Description of the research activities:

In addition to socio-demographic characteristics of neighborhoods, criminological theories argue the importance of social control in explaining the level of crime in neighborhoods. While neighborhood residents' ties can be a source of informal social control (e.g., the ability to detect strangers), law enforcement activities are a typical example of formal social control. By conceptualizing the existence of police boxes in neighborhoods as an indicator of the level of social control, I have analyzed the spatial distribution of crime and neighborhood characteristics in Metropolitan Tokyo.

The police box system can be conceptualized as informal social control for several reasons. First, each police officer is assigned to 100-300 households to conduct visitations, in order to strengthen ties with residents and to communicate crime prevention information. Although the frequency of such visitations varies by types of neighborhoods (e.g., more frequent visitations in residentially mobile neighborhoods), officers' visitations to neighborhood residents is an important element in Japanese policing. Second, police boxes are officers' base camps for foot and bicycle patrols. Although officers most likely target problematic areas for intense patrol, their patrol activities can be sparse as areas get farther from police boxes. Third, the presence of police boxes can be a deterrence factor from the criminal offenders' viewpoint, due to their heightened perceived risk of detection.

Overall, however, the univariate and bivariate analysis showed that high crime areas were located near police boxes. This was not surprising, as the police boxes were located at major intersections, business areas, and some residential areas. Such a relationship between the location of police boxes and the volume of crime held even after controlling for the effects of various neighborhood characteristics, such as socio-economic status, residential mobility, land price, and types of housing. Although crimes tend not to occur right next to a police box, police boxes are in general located in high crime areas.

A few comments need to be made for future research. This research used a crude indicator of formal control. Rather than using the simple distance and the presence of police boxes as an indicator of formal social control, future research can differentiate the size of each police box based upon the frequency of patrols and/or the number of officers stationed in the police box. More officers are likely to be situated in high crime areas. Furthermore, an interaction effect of neighborhood characteristics and the police box can be an important factor in explaining crime rates in neighborhood. If the presence of police boxes and officers' visitations in fact strengthen ties between officers and neighborhood residents, such an effect may be stronger in residentially stable neighborhoods (low residential mobility).

This effect can be tested using regression models and interaction terms (e.g., interaction effect of residential mobility and the presence of police boxes). Finally, future research can also investigate the relationship between perceived fear of crime and the patrol activities. The presence of police boxes in neighborhoods and officers' visible patrol activities may provide a sense of security among residents.

RESEARCH REPORT

1. Name: Gary K. Kilper (ID No.: SP07026)

2. Current affiliation: Rice University, Physics & Astronomy Department

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Astronomical Observatory of Japan (NAOJ)

5. Host researcher: Prof. Saku Tsuneta

6. Description of your current research

My research focuses on taking and analyzing multi-wavelength observations of solar filaments and prominences, which are transient objects composed of partially-ionized plasma suspended in the solar atmosphere by a magnetic field structure. This research is motivated by the coronal mass ejections (CMEs) that are related to eruptions of the filaments and their large and often dangerous effect on the space weather near Earth. The goals are to determine how solar filaments are formed, how the magnetic field supports the neutral atoms, ions, and electrons against gravity, and also what happens during filament eruptions.

The observations are taken in several wavelengths ranging from the near-infrared (IR) up to much higher energy photons in the extreme ultraviolet (EUV) wavelength band. Frequently-taken near IR (e.g. He I 10830 Å) and optical (e.g. H Ic 6563 Å, Ca II H 3968 Å, CH I 4305 Å) observations are used to study the variability and distribution of the filament material via the emission or absorption due to a specific transition line. EUV observations – such as Fe XII 195 Å and Fe IX/X 171 Å – can not be taken as often, but are less temperature-dependent, giving accurate quantitative information about the material via the measurement of the continuum absorption by the neutral atoms.

The coordination of US$1.5 billion worth of spacecraft and ground-based observatories, which are run by agencies in the U.S., Japan, and Europe, takes a lot of time and effort, but the resulting co-temporal observations are producing great science and have greatly advanced our understanding of the physics of filaments and prominences on the Sun.

7. Research implementation and results under the program

Title of your research plan:

Multi-Wavelength Analysis of Solar Filaments

Description of the research activities:

While in Japan working at NAOJ, my focus was to use the space-based observatory *Hinode*, which was recently launched by the Japanese space agency JAXA and was just opened up to outside collaborators this May, to get observations of solar filaments and prominences with unprecedented time cadence and spatial resolution. It was important to write observing plans for the three instruments on *Hinode* that maximized usefulness in the study of filaments, to learn from my co-workers how to prepare and analyze the data, and to collaborate with them in the new physics that has emerged as a result of the improved data from *Hinode*.

These goals were all met within the two month time period for research, and more observations of filaments were made than expected, improving the strength of the research from a case study to one that is more comprehensive. The highlight was the week I spent helping to operate the SOT instrument by preparing and checking the observing programs that were uplinked to the *Hinode* spacecraft, which is in low-Earth orbit.

8. Please add your comments (if any):

I greatly appreciate the opportunity that the JSPS and NSF have afforded me by running the JSPS Summer Program and EAPSI. I have been able to advance my research, gain valuable experience, foster collaboration, make many new friends, live in a country with a very different culture, and have a wonderful time doing so. I plan to encourage others to take advantage of this program in the future.

RESEARCH REPORT

1. Name: Aaron John Kingsbury （ID No.: SP07027 ）

2. Current affiliation:

University of Hawaii, Department of Geography

3. Research fields and specialties:

Social Sciences

4. Host institution: University of Nagoya, Department of Geography

5. Host researcher: Professor Makoto Takahashi

6. Description of your current research

The research conducted this summer focused on opportunities for the distribution in markets of locally produced fruits and vegetables in the Nagoya (sub-) urban periphery outside of the more dominant JA structure. These alternative markets for the distribution of product provide additional and niche income-generating opportunities for many farmers of the region, and incorporate a number of potential multiplier effects to local and community development. As such, the various networks (chains) linking farmers to consumers in these systems were explored through a number of case studies from the perspective of retailers.

More specifically, the details of physical constructions, operations and motivations of markets selling non-JA and locally produced product were collected. Likewise, the financial implications and cultural representations of how this local product was defined, sourced, advertised, and distinguished in the marketplace was gathered as a data set. Conclusions will be based on interpretation of the opinions of informants and relevant statistical data in the near future.

7. Research implementation and results under the program

Title of your research plan:

Selling Locality: Case studies of alternative local fruit and vegetable markets in the Nagoya (sub-) urban periphery.

Description of the research activities:

The research conducted this summer consisted of two interconnected parts. First, the theoretical portion of this project was flushed out through the collection and exploration of the previously unavailable (to me) Japanese language literature. In particular, prior studies on Japanese farmers markets, and the implications of (sub-) urban policy on market development and the suburbanization of the countryside were explored.

Second, and with this framework firmly established, in-depth semi-structured interviews were conducted with key retailers of locally produced but non-JA sourced fruits and vegetables. Normally, this consisted of 1.5 hour in duration interviews with key informants (i.e. directors/managers) of supermarkets, farmers markets, and company owned and operated markets, etc. This interview data is currently being transcribed. Once this lengthy process is completed (likely after my return to the University of Hawaii), it will be analyzed in greater depth and conclusions drawn. Continued close contact between participating members of the project is expected, leading to at least one major conference presentation in the discipline and a likely peer reviewed publication.

8. Please add your comments (if any):

The members of the Department of Geography and in particular my host, Professor Takahashi, was most welcoming and helpful throughout my research experience in Nagoya.

9. Advisor's remarks (if any):

It is very much happy also for us, Department of Geography, to accept Mr. Aaron Kingsbury as a visiting scholar. We are grateful that he really provides our students not only with opportunities for discussion on agricultural geographies and geographical thoughts in USA, but also with academic stimulus especially for field works. Makoto Takahashi (Associate Professor, Nagoya University)

RESEARCH REPORT

1. Name: Kate Labelle Klein （ID No.: SP07028）

2. Current affiliation: University of Tennessee, Knoxville TN

3. Research fields and specialties:

Humanities Social Sciences XMathematical and Physical Sciences
Chemistry XEngineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

(not sure! I'm Materials Science, Nanoscience)

4. Host institution: National Institute for Materials Science, Nanotubes Group

5. Host researcher: Dr. Dmitri Golberg

6. Description of your current research

As carbon forms a large variety of bonding arrangements, an abundance of nanostructured materials (e.g. fullerenes, carbon nanotubes (CNTs), carbon nanofibers (CNFs)) can be formed from carbon. The controlled synthesis of these materials by methods that permit their assembly into functional nanoscale structures lies at the crux of nanoscience and nanotechnology. Carbon nanofibers are currently employed for a wide variety of applications including electron field emitters, gene delivery arrays, synthetic membrane structures, electrochemical probes and scanning probe microscopy tips. In my research group we grow vertically aligned CNFs by a catalytic plasma enhanced chemical vapor deposition (PECVD) process at elevated temperatures (~700˚C) on silicon substrates.

My main research focuses around probing the interaction of the catalyst nanoparticle and the carbon nanofiber in order to elucidate the factors that ultimately determine the properties of each throughout the growth process. This includes studying the evolution of catalyst nanoparticles from thin film metals (Ni, Fe, Co) to encapsulation within carbon nanofiber tips. I have also worked on modeling the nanofiber-catalyst growth interface, looking at the effect of interface curvature on the internal graphitic structure of the CNF. In addition I have investigated the experimental mechanisms of graphitic structure control such as growth conditions, catalyst nanoparticle orientation, and catalyst crystal structure. Lastly, I am involved with exploration of alloy catalysts like the Fe-Co and Fe-Ni systems. More specifically, for any given study I first prepare the catalyst films usually by sputtering or evaporating pure metals or alloys onto silicon wafers. Then I iteratively select the favorable carbon nanofiber PECVD growth conditions for the particular catalyst/substrate material combination and the desired CNF properties. After growing the CNFs I then characterize the samples by methods such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), x-ray diffraction (XRD), and energy dispersive x-ray spectroscopy (EDX). In many cases I work with collaborators to examine additional properties such as field emission, surface chemistry, and magnetism of the CNFs and their catalyst particles.

7. Research implementation and results under the program

Title of your research plan:

The Behavior of Alloys Under Nanoscale Confinement

Description of the research activities:

As the size of materials is reduced and the surface-to-volume ratio increases, the properties of nanomaterials can differ substantially from the bulk material. It is for this reason that basic research and exploration of material properties at the nanoscale are so important. In this collaborative project at NIMS, the goal was to use the CNF-catalyst nanoparticl system to examine an aspect of a metallurgical phase diagram on the nanoscale. In particular we studied bimetallic Fe-Ni alloy nanoparticles encapsulated within carbon nanofibers. This study utilized electron diffraction, dark field imaging, high resolution transmission electron microscopy and chemical spectroscopy to characterize the system and attempt to observe the crystallographic order-disorder phase transition of $FeNi_3$.

We successfully characterized the encapsulated metal alloy nanoparticles and probed their behavior in the confined nanoscale state. More specifically we looked at the morphology, atomic composition and crystal structure of the system as well as the in-situ response of the system to both high electrical bias and thermal heating. In conclusion, we found that $FeNi_3$ catalysts work well for carbon nanofiber synthesis with 5 nm thick initial films yielding ~30 nm particles. The metal remains alloyed (29%Fe, 71%Ni) primarily in the FCC (Fm-3m) phase after CNF synthesis, however sometimes an iron-oxide particle forms at the throat of the fiber at the base of the main catalyst particle. Evidence of superlattice, representative of the ordered phase, was either non-existent (meaning the nanoparticles were unable to crystallographically order at room temperature) or perhaps unobservable by our methods. We also found that the system has metallic electrical properties, and can withstand up to a 7 volt bias before failure. In addition, heating up to 800˚C does not induce melting or significantly change the crystal structure of the $FeNi_3$ nanoparticles.

8. Please add your comments (if any):

Thanks for this very rewarding experience!!!

RESEARCH REPORT

1. Name: Helen Yoon Lee （ID No.: SP07029）

2. Current affiliation: University of Chicago

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Woman's Christian University

5. Host researcher: Mayumi Karasawa

6. Description of your current research

The current study is a part of preliminary work to examine American and Japanese children's socio-emotional development in the context of early childhood education. Specifically, this summer I am examining Japanese children's emotion regulation and teacher behavior in preschools and daycare centers around different parts of Japan. This research consists of four main parts: 1) the literature review of Japanese social and cultural values and attitudes toward child development, 2) interviews with Japanese education experts to understand the changes of early childhood education practices from historical and social perspectives, 3) the ethnographic observation of classroom (teacher-student and peer-peer interactions) and interviews with preschool teachers and directors, and 4) the administration of emotion regulation tasks (laboratory based).

Using ethnographic and experimental methods, my collaborator and I aim to explore the relationship between teacher interaction styles and children's emotion regulation, in the contexts of school characteristics (ex. the belief and attitude of teacher, the organization or curriculum of school, and classroom size). We are also interested in learning about the social and cultural changes that have influenced today's early childhood practices in Japan.

7. Research implementation and results under the program

Title of your research plan:

A Comparative Study of Japanese and American Preschools:
Classroom socialization and Children's Emotion-regulation

Description of the research activities:

This summer I visited 8 preschools and daycare centers in four different areas of Japan: Takamatsu (Shikoku), Kyoto (Chubu), Tokyo (Kanto), and Sapporo (Hokkaido). At each location, I spent about two to five days to observe children's classroom interactions and conducted interviews with teachers and directors. The children from Tokyo area were further examined and participated in a laboratory based emotion regulation experiment at the Tokyo Woman's Christian University. In addition to the data collection, I have interviewed a number of early childhood education experts and developmental psychologists in Japan.

Although much of the research was carried out as planned, there also were some difficulties with research implementation that required changes in the plan. For instance, classroom environment (preschools and daycare classrooms) that was initially planned to be videotaped had to be changed to a few days of ethnographic observation because directors and teachers were uneasy about being videotaped.

Preliminary analyses of qualitative data coupled with early childhood education expert interviews generated some interesting thoughts/findings. For instance, with increasing cultural preference to individualized teacher-student interaction, Japanese classrooms are smaller than before. Early childhood education experts I have talked to explained that that this change has forced teachers to pay more attention to an individual child, forcing teachers to deal with children's everyday conflicts that have been previously taken cared by children themselves. They added that older teachers complained to them that children nowadays are more difficult to deal with. Interestingly, during my classroom observation, different teacher behaviors could be observed. Some teachers chose to ignore most of (minor) children's conflicts in peer socialization, for instance, and talked in interview about how they wanted the children to learn from each other and from their own mistakes. On the other hand, other teachers intervened more frequently, addressing each child with more direct guidance and language. In the former case, children seem to be less dependent on their teacher's reaction to recognize emotional situation and expression, while in the latter case, children were more sensitive to what their teachers were reacting to and how. As my collaborator and I analyze the quantitative data (emotion regulation task), we plan to look into whether there is any difference in how children from different classroom environment recognize and think about emotion and emotional expressiveness.

RESEARCH REPORT

1. Name: Mark Alexander Lever （ID No.: SP07030）

2. Current affiliation: University of North Carolina at Chapel Hill, NC

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Geomicrobiology Group, Kochi Institute for Core Sample Research, Japanese Agency for Marine-Earth Science and Technology (JAMSTEC), Kochi, Japan

5. Host researcher: Dr. Fumio Inagaki

6. Description of your current research

Deep sea sediments are the largest biosphere on Earth, harboring between one tenth to one third of global living biomass (Whitman et al. 1998, Parkes et al. 2000). This huge biomass pool is not astonishing considering that deep sea sediments account for close to 70% of the Earth's surface, average at a thickness of 500m, and are the largest global organic carbon sink (Parkes et al. 2000, Hedges and Keil 1995). A thorough understanding of the factors determining preservation of this organic carbon, and its decomposition, i.e. remineralization, to CO_2, is compulsory to understanding the global carbon cycle, and hence global climate control.

Methane-producing microorganisms, collectively known as methanogens, account for a large fraction of organic carbon decomposition in deep sea sediments. Despite their resulting importance in the global carbon cycle, little is known about the ecology of these methanogens. The aim of my Ph.D. dissertation project is to further the understanding of factors that control the distribution of methanogens in deep sea sediments. Accordingly, I am examining patterns in methanogen community zonation along gradients of three variables known from previous studies to be important determinants of microbial community composition: (1) concentration of growth substrates, (2) temperature, and (3) geology.

I am studying distribution patterns of methanogens at three sites in the Pacific Ocean. Sites are located in the Peru Trench off the continental margin of Peru, the Juan de Fuca Ridge off the margin of Washington state, and the Guaymas Basin, a deep sea basin located in the Sea of Cortez between Baja California and Mexico. The bulk of my Ph.D. work consists of extraction, replication, cloning and sequencing of DNA from sediment to obtain the exact DNA sequences present at the sampling sites. In replicating DNA, I focus on a gene that is unique to and hence diagnostic of methanogens, called coenzyme M methyl reductase A (*mcrA*). Using these sequences it is possible to determine which groups of methanogens are present. I then contrast depth distributions of methanogens at each site with *in situ* substrate types, substrate concentrations, temperature, and geology to infer how environmental conditions shape methanogen community composition.

My results so far suggest that methanogen diversity is positively correlated with substrate concentrations. Diversity is very low under limiting substrate concentrations (Peru Trench), and high when substrate concentrations are non-limiting (Guaymas Basin). Temperature changes of 30°C will result in a completely different methanogen community,

despite similar substrate concentrations and geology (Guaymas Basin). Geological changes, e.g. from one type of sediment to another, appear less important than substrate concentrations and temperature in determining methanogen community composition.

7. Research implementation and results under the program

Title of your research plan:

Vertical distribution of methane-producing Archaea in sediment and underlying basalt of the Juan de Fuca Ridge Flank.

Description of the research activities:

During my stay at the Kochi Institute for Core Research, I examined the community composition of methanogens at IODP Site 1301, on the Juan de Fuca Ridge Flanks, in the Northeast Pacific. I constructed a vertical community profile using a DNA extraction method developed by Dr. Fumio Inagaki's lab, combined with molecular probes that I had designed back home. We had excellent results.

We detected methanogens in 13 out of the 18 core sections examined. Community composition was quite variable: throughout the sulfate reduction zone, where methanogenesis typically plays only a very minor role, and where methanogens are therefore at very low biomass and hardly detectable, we detected methanogen genes. There appeared to be only one methanogen strain throughout the sulfate reduction zone. The same methanogen strain occurred from temperatures of 2-65°C, indicating an extraordinarily wide temperature range. In the methanogenesis zone, diversity increased and we found five additional strains of methanogens. We also detected genes of anaerobic methane oxidizers, close relatives of methanogens, that perform the reverse reaction of methanogenesis, i.e. anaerobic methane oxidation. Our vertical community profile for methanogens is of higher depth resolution than any other such profile ever published. We did not have time to examine basalt for methanogens, but I will attempt this when I return to the US.

In addition to studying methanogens, we added a project in which we probed for genes unique to chemolithoautotrophic microorganisms, i.e. organisms capable of fixing CO_2 using inorganic electron donors and acceptors. We detected two genes that are diagnostic of two different biochemical pathways of chemolithoautotrophy: formyl tetrahydrofolate synthetase (*fthfs*), a key gene of the reductive acetyl CoA cycle, and 2-oxoglutarate:acceptor oxidoreductase (*oor*), a key gene of the reductive tricarboxylic acid cycle. Both genes were widely distributed through the sediment column, suggesting the occurrence of chemolithoautotrophic CO_2 fixation. We also attempted the detection of key genes (*cbbL*, *cbbM*) of the Calvin-Benson-Bassham Cycle, another CO_2 fixation pathway, but without success. I will conclude this study at home, where I will attempt detection of key genes of the 4^{th} CO_2 fixation pathway, the 3-hydroxypropionate pathway. This study was the first in which *fthfs* or genes of

the reductive tricarboxylic acid cycle were detected in the deep biosphere. Our finding has important implication for our understanding of the carbon cycle in the deep subseafloor, where not only decomposition, i.e. organic matter breakdown, but also CO_2-fixation, i.e. production of new organic matter, appear to be occurring.

8. Please add your comments (if any):

I thoroughly enjoyed my stay here at JAMSTEC, and it was a great pleasure and learning experience to work with Dr. Inagaki and his lab group. I learned several new molecular biological techniques, that I hope to apply again in the future, and am very happy about the results generated during my stay. I look forward to continuing my collaboration with Dr. Inagaki in the future, and hopefully throughout a career in science.

9. Advisor's remarks (if any):

Mark Lever has done excellent work here on molecular detection of microbial functional genes in deep subseafloor sediments. He also enjoyed Japanese culture and local food very much. I am very happy to have him and will keep encouraging his work

RESEARCH REPORT

1. Name: Yenny Natali Martinez de Escobar （ID No.: SP07032）

2. Current affiliation: Rice University

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: The University of Tokyo

5. Host researcher: Dr. Hidetoshi Katori

6. Description of your current research

My current research at Rice University is in the field of atomic, molecular and optical physics. Using lasers and tailored magnetic fields, strontium atoms from a vapor are slowed, trapped and cooled down to microKelvin temperatures. Slowing atoms down with lasers is achieved by imparting the momentum of laser photons to oppositely moving atoms. The magnetic fields create a potential well in which atoms can be trapped. Temperatures in the microKelvin range are possible with strontium because its electronic energy structure allows two transitions with drastically different temperature limits to be used for laser cooling. Strontium atoms and atoms with similar atomic structure are very attractive for use as optical frequency standards and fundamental studies of ultracold collisions.

After the atoms are cooled by laser cooling, they are transferred to a far-detuned optical dipole trap formed by a high intensity laser focused to a small diameter. This trap allows the atoms to interact with minimal disturbances from resonant laser light, which is an ideal situation for ultracold collision studies. Future experimental plans include two-photon photoassociation and studying optical feshbach resonances.

7. Research implementation and results under the program

Title of your research plan:

Nondestructive measurement of $^{1}S_{0}$-$^{3}P_{0}$ clock transition in ^{88}Sr

Description of the research activities:

Dr. Katori performs high-resolution spectroscopy on a highly forbidden electronic transition from the $^{1}S_{0}$ ground state to the $^{3}P_{0}$ excited state of two strontium (Sr) isotopes, namely ^{87}Sr and ^{88}Sr. He ingeniously suppresses frequency shifts such as light and collisional shifts by holding these atoms in tailored optical lattices, thereby obtaining fractional uncertainties below 10^{-15} in his frequency measurements. The $^{1}S_{0}$-$^{3}P_{0}$ transition, or "clock" transition for short, found in Sr and atoms with similar atomic structure has proven fruitful as an optical frequency standard for such areas as ultra precision optical clocks and navigation technology.

The frequency of the clock transition is commonly determined by direct excitation of the transition followed by counting the atoms returning to the ground state via another transition, specifically the $^{1}S_{0}$-$^{1}P_{1}$ transition. Unfortunately, this is a destructive process since the cold atom sample held by the shallow optical lattice are easily heated and lost when the $^{1}S_{0}$-$^{1}P_{1}$ transition is probed. A means to reduce the duty cycle of the experiment by multiple probing of the clock transition using a nondestructive method was the motivation behind this summer research project.

One such nondestructive probing method, known as dispersion measurements, has previously been employed when imaging ultracold Bose-Einstein condensates. The idea behind this technique is that when a laser beam interacts with a sample of atoms, it is absorbed and dispersed to different degrees depending on different characteristics of the laser and the atoms. If the properties of the laser and the atoms are arranged such that minimal absorption occurs while a detectable dispersion signal from the probe beam is collected, then the atomic sample can be imaged with little disturbance. A similar approach is pursued in this project with the added detail that a transition allowing excited atoms in the $^{3}P_{0}$ state to decay to the ground state is needed. This transition is possible with an extra 1354 nm laser that was not available at the beginning of the project.

The project began by building a 1354 nm extended cavity diode laser to deexcite atoms from the $^3P_0$ state to the ground state. The available commercial wavemeter cannot be used to measure this laser's wavelength because it is infrared radiation. Therefore a homemade wavemeter was used for this purpose. Good alignment of this wavemeter was crucial and difficult but eventually it was accomplished. The wavelength of the laser was centered near the atomic transition wavelength by "pulling" the wavelength of the laser with the extended cavity grating and by controlling the laser's temperature. This laser was then coupled into a single-mode optical fiber, allowing us to move the 1354 nm light to either of the two different vacuum chambers in which the clock transition measurement was perfomed with either ^{87}Sr or ^{88}Sr.

Another part of the project involved calculating the expected signal size from the dispersion experiment. We considered different probe beam parameters through this calculation in order to determine the optimal experimental signal assuming a given atomic sample. The calculation predicts that the signal from the dispersion measurement is measurable for a range of probe beam detunings and modulation frequencies, two of the variables in the dispersion experiment.

Unfortunately there was insufficient time to perform the dispersion measurement itself using ^{88}Sr. However, the experiment should be possible without delay after aligning the 1354 nm laser onto the atoms. This experimental scheme should allow multiple measurements of the clock transition with minimal perturbations.

RESEARCH REPORT

1. Name: Maura McEwan （ID No.: SP07033 ）

2. Current affiliation:

University of Virginia

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Dr. Yoshinobu Tsujii

6. Description of your current research

My current research involves the study of intermolecular phenomena in colloidal dispersions. Material properties such as strength, hardness and electrical conductivity may be optimized through the dispersion of nanoscale fillers in polymer matrices. This novel class of materials is often referred to as polymer nanocomposites (PNCs). One way prevent aggregation of colloids in such a system is to tether polymer molecules to the particle surface. In order to study these systems, well-controlled, well-characterized polymer grafted nanoparticles in polymer melts must be formulated. Then, the impact of the grafted layer can be detected by comparison to better-understood hard sphere behavior from observation in various flow conditions.

Our aim is to investigate a wide range of grafting densities of PNC systems as the conformation of the grafted polymer chains is sensitive to this parameter. As grafting density increases the polymer chains in the grafted layer stretch into a “polymer brush” conformation. It is expected that there is a dependence on macroscopic flow properties on the relative “softness” or degree of stretching of the polymer brush. In order to access high grafting densities, “grafting from” the surface polymerization techniques such as Atom Transfer Radical Polymerization (ATRP) must be used.

7. Research implementation and results under the program

Title of your research plan:

Polymerization of Methyl Methacrylate from Silica Nanoparticles using ATRP

Description of the research activities:

Well-controlled polymer brushes were synthesized from the surface of silica nanoparticles (SiPs) using Atom Transfer Radical Polymerization (ATRP). Based on previous findings[1] in which high density polymer brushes were synthesized from 130 nm in diameter SiPs, a similar polymerization scheme was developed for SiPs with a diameter of 20 nm. Due to the nature of the smaller particles, conventional gravity based separation and purification techniques were not viable. Therefore, alternative methods, namely, solvent transfer and precipitation were used throughout the synthetic process. Furthermore, initiator catalyst and polymerization solvent and its reaction concentration were selected as appropriate for smaller particles.

The particles were synthesized with an amino acid catalyzed reaction as reported in the literature[2]. They were then purified through dialysis and characterized using Transmission Electron Microscopy (TEM). In order to synthesize polymer from the surface, the initiator, 2-Bromo-2-methyl(propionyloxyhexyltriethoxysilane) (BHE), was fixated to the surface. At high concentrations of catalyst, particle aggregation is observed yet the concentration needed to be sufficient to promote the immobilization of BHE. Therefore, reaction conditions of the catalyst were optimized.

After immobilization of the initiator, polymerization of methyl methacrylate (MMA) was conducted via ATRP. Conversion was quantified by Nuclear Magnetic Resonance (NMR) and molecular weight was confirmed by Gel Permeation Chromatography (GPC). Grafting density was determined by etching the silica cores with HF and performing thermogravimentric analysis (TGA). Furthermore, comparison of the interparticle distance in TEM images before and after grafting confirmed the presence of the grafted layer.

^{1}H NMR analysis yielded a monomer conversion of about 96%. GPC analysis of the grafted polymer indicated that the target number-average molecular weight (M_n) of 11,700 was reached and the polydispersity index (PDI) was 1.35. This data is comparable to that of free polymer, which had a M_n of 12,800 and a PDI of 1.28. From TGA data, it was determined that the graft density was 0.53 chains/nm^2.

In summary, in this work a preliminary synthetic route from particle synthesis to brush characterization, including a series of separation, purification and reaction steps, for the formulation of concentrated polymer brushes from small nanoparticles was developed. Future work will focus on optimization of this process with an emphasis on sample yield in each step.

Reference:

1.Ohno K, Morinaga T, Koh K, Tsujii Y, Fukuda T: **Synthesis of Monodisperse Silica Particles Coated with Well-Defined High-Density Polymer Brushes by Surface-Initiated Atom Transfer Radical Polymerization**. *Macromolecules* 2005, **38**:2137-2142.

2.Yokoi T, Sakamoto, Y, Terasaki O, Kubota Y, Okubo T, Tatsumi T: **Periodic Arrangement of Nanospheres Assisted by Amino Acids.** *J. Am. Chem. Soc.* 2006, **128**:13664-13665.

8. Please add your comments (if any):

This experience has been very educational in terms of both research and Japanese culture. Many thanks to my host scientists!

9. Advisor's remarks (if any):

For these two months, Miss Maura McEwan has been struggling to prepare nanoparticles with well-defined polymer brushes, almost achieving her aim (as she mentioned above). In addition to her good research ability, she has an attractive personality, which facilitated good communication with the members of our group. During her stay in Japan, she actively visited some other research groups to broaden her outlook in a wide research field and to enjoy some Japanese culture. I think that this is the expression of her will. On this occasion, it would be very nice if we could start good collaboration with the research group to which she belongs in University of Virginia.

RESEARCH REPORT

1. Name: Gabrielle Miller-Messner （ID No.: SP07034 ）

2. Current affiliation: University of California, Davis

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo, Misaki Marine Biological Station

5. Host researcher: Dr. Manabu Yoshida

6. Description of your current research

Introduction Introduced populations are often derived from multiple sources. In fact, the union of previously isolated populations may play a role in the capacity of an invasive species to respond to selection and thus successfully colonize new environments[1]. The ascidian *Ciona savignyi* has invaded and continues to invade sites throughout Puget Sound (Washington) and California at an accelerating rate. U.S. Pacific coast populations are thought to have been introduced from Japan, but may represent introductions from multiple sources. A phylogeographic framework for this species is not only necessary for the management of these populations, but also offers an opportunity to investigate how admixture of previously isolated populations can influence invasion success.

Research Objective: To characterize the origin(s) of invasive populations of *Ciona savignyi* and levels of exchange among these populations using a suite of molecular markers to reconstruct their genetic relationships.

Background *C. savignyi* inhabits estuarine environments and is often found attached to docks, ropes, and the boat hulls in harbors and marinas. *C. savignyi* and its congener, *C. intestinalis,* were likely introduced to California from Japan in ballast water or imported shellfish stock. In fact, it has recently been confirmed that *C. intestinalis* populations in Japan share many mitochondrial haplotypes with *C. intestinalis* populations in California [2]. Many believe that the Puget Sound *C. savignyi* populations came directly from Japan as well. However, these northern populations may be derived from introduced California populations or large subtidal populations in British Columbia(BC).

Methods Samples that I have collected from the U.S. and Canada are being processed for sequencing. The portion of this project that was completed during the JSPS program includes collection of samples from potential source populations in Japan. Recent analyses demonstrate significant genetic differentiation among seven populations of *C. intestinalis* in Japan. This evidence is consistent with the idea that species with limited larval dispersal, such as *C. savignyi,* have the potential for fine-scale genetic structure [3]. In order to get a representative sample of the genetic diversity of *Ciona savignyi* in Japan I sampled as much of the geographic range as possible.

I will sequence the mitochondrial gene, cytochrome oxidase-1, along with randomly chosen 500 bp nuclear sequences from throughout the genome. Access to the published *C.savignyi* genome will be invaluable in obtaining sequence data [4]. Relationships between populations will be analyzed using likelihood-based assignment tests

(e.g. STRUCTURE) which assess the probability that a given individual genotype is derived from a putative source population.

Broader Impacts Results from my research could be used to develop predictive models of species range expansion, which are essential for directing management to minimize the impacts of invasive species.

Cited References
1.Rieseberg, L.H., et al., Major ecological transitions in wild sunflowers facilitated by hybridization. Science, 2003. 301(5637): p. 1211-1216.
2.Nydam, M. and R. Harrison, Genealogical relationships within and among the shallow-water members of the Ascidian Genus Ciona. In Review.
3.Kano, S., S. Chiba, and N. Satoh, Genetic relatedness and variability in inbred and wild populations of the solitary ascidian Ciona intestinalis revealed by arbitrarily primed polymerase chain reaction. Marine Biotechnology, 2001. 3(1): p. 58-67.
4.Vinson, J.P., et al., Assembly of polymorphic genomes: Algorithms and application to Ciona savignyi. Genome Research, 2005. 15(8): p. 1127-1135.

7. Research implementation and results under the program

Title of your research plan:

Characterization of genetic relationships among native and introduced populations of the ascidian, *Ciona savignyi*

Description of the research activities:

I collected 30-35 Ciona savignyi specimens from the following locations: Yokohama (Kanagawa prefecture), Onagawa Bay(Miyagi), Otsuchi Bay(Iwate), Asamushi(Aomori), Iwashihama&Murotsu combined site(Hyogo), Kurahashijima(Hiroshima), and Kochi(Ehime). In addition I collected 6 individuals from Nishiura(Aichi). Shallow water samples were collected from the undersides of docks, and from ropes and plastic aquaculture apparatae hanging in the water near shore. Asamushi specimens were collected by Masahiko Washio using SCUBA. On the day of collection, each group of ascidians was dissected and their ovaries were removed and preserved. These samples will be mailed to the University of California, Davis for DNA sequencing and analysis.

After sample preparation was completed I learned how to dissect and fertilize sperm and eggs from Ciona savignyi, as well as assess sperm concentration and fertilization success. These techniques will be useful for assessing reproductive compatibility among populations on the West Coast of the U.S., which may affect patterns of genetic mixture in multiple introductions.

In addition to lab and fieldwork I gave seminars on my research at Misaki Marine Biological Station and Kochi University.

8. Please add your comments (if any): I will analyze my samples at my home university , so I am not sure what my results will be, but whatever the results are, the JSPS program has been a worthwhile experience. Along with my samples I will return to California with knowledge of the unique ways Ciona is studied in Japan. I am especially impressed by the healthy relationship between marine biologists and fishermen, on whom many scientists in Japan often rely for sample collection. Visiting marine laboratories throughout Japan, I have formed relationships that will be invaluable for future scientific collaboration, and gained friends and mentors to whom I can look to for advice.

9. Advisor's remarks (if any):

Her main aim of this program is collection of *Ciona savignyi* samples from many places, thus, I only provided her "base camp", and information about collecting sites for her research. Indeed, she actively collected many *Ciona* samples from many places, and I felt that her purpose of the program is almost completed.

It is a pity that the period of the program was not the best season for *Ciona savignyi*. Usually population of *Ciona* is reduced during Summer because it is too hot, and specimens could not be collected at some places. I wish the period of the program had been able to change to the suitable period for research.

RESEARCH REPORT

1. Name: Michael Mistry (ID No.: SP07035)

2. Current affiliation: University of Southern California

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Advanced Telecommunications Research Institute International

5. Host researcher: Dr. Gordon Cheng

6. Description of your current research

My research focuses on the representation, learning, and control of dexterous motor skills in humans and in humanoid robots. By studying human behavior, we can learn to control artificial robotic systems in a natural human-like manner. Additionally, the implementation processes on humanoid hardware may lead to further insights into the mechanisms used by the brain for motor control. In order to study human behavior, I conduct experiments on human subjects, executing reaching movements within an exoskeleton robot. By perturbing the subjects' natural movements via the exoskeleton, we can examine how the human brain plans motion and deals with the redundancy available in the task. The evidence from human subjects has demonstrated that for tasks such as arm reaching, the brain encodes the task in the lower dimensional operational space (i.e. hand) rather than over the joints of the arm. In a similar manner, we can conduct task control of humanoid robots under the framework of task space control (or operational space control). The dimensionality of the robot is reduced to a small set of operational points, each to be controlled to follow a desired motion trajectory. Various operational points can be assigned different levels of priority, preventing lower level tasks from interfering with higher priority tasks. In addition we use a free-floating, constrained, representation of the robot, which provides a natural way to represent any robot unconfined to a fixed platform and having a continually changing contact state. By implementing inverse dynamics control of a floating base system constrained by external forces, we can achieve human-like compliance during physical interactions.

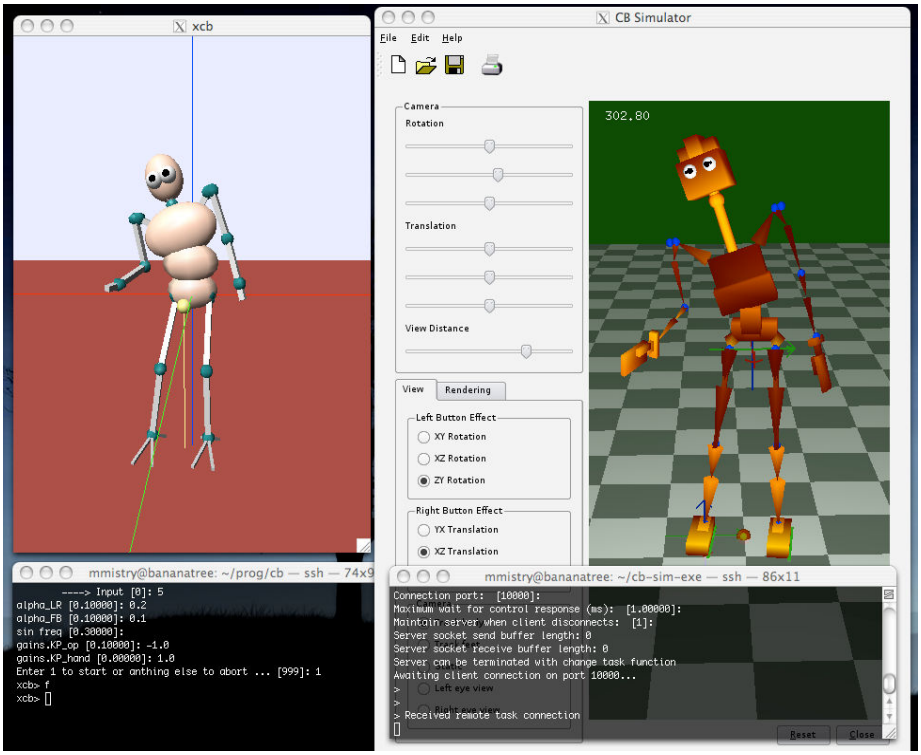
7. Research implementation and results under the program

Title of your research plan:

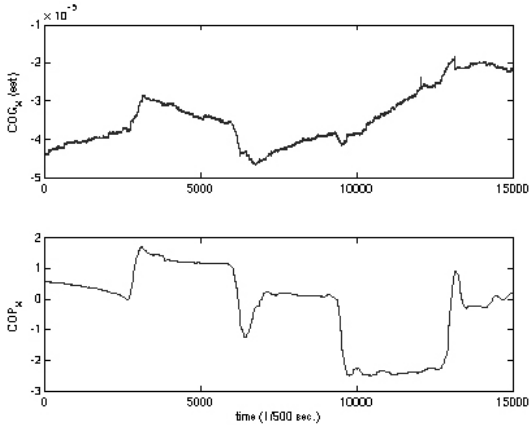
Towards human-like control of humanoid robots

Description of the research activities: My research at ATR during this program involved implementing task-space control on the CBi humanoid robot. In order to do so, my research involved three main parts:

1. Implementation of client-server communication: In order to use existing control software developed at my home laboratory at USC, I first developed a software interface that allowed me to communicate seamlessly with the robots at ATR. Using UDP communication and a protocol provided by ATR, I wrote a software library to send control commands to the robot (from an off-board computer) and receive back sensory signals. Thus I was able to use high-level USC control software, running on an off-board computer, to communicate with the robot running low-level control software onboard. The interface was also able to communicate with the ATR CB robot simulator, which aided in experimental verification and testing. Shown below is a picture of the USC software environment (SL) on the left controlling the ATR CB simulator on the right.

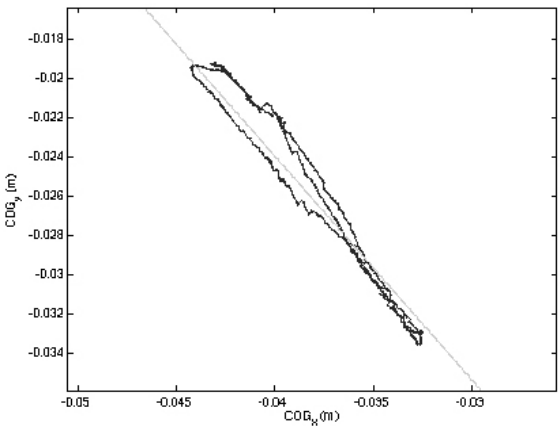


2. Foot Force sensor for balance control: Using the task control framework for static balance control, requires accurate knowledge of center-of-gravity (COG) position. In our approach we estimate the COG position from the forward kinematics of the robot and a model of the individual link masses and COG positions. However, such a method can be unreliable due to inaccuracies of the link mass model as well as whole body movements that may be unaccounted for in forward kinematics (for example, when the robot rolls about its feet). The ATR CBi robot has a six axis force sensor on each foot. From these sensors, I computed and calibrated an estimation of the robot's center-of-pressure (COP). The figure above shows the estimated COG position (using forward kinematics) on top with the computed center of pressure below, during a task where the robot is first pushed backwards, restored, pulled forward, and again restored. We see that the COP computation more accurately represents the actual robot motion, and provides better sensory feedback for balancing.



3. Control Implementation and Experimentation: In the ATR CB simulation environment I was able to implement a variety of robot behaviors, using the framework of task space control with prioritization. Such behaviors include squatting motion while balancing, simultaneous figure-8 COG and hand tracking, single support (one foot) balancing, and simple stepping. Experimentation on the real robot is currently on-going. Shown below is an example of the actual robot's COG position in blue during a task where the COG is to sway side-to-side, following the green line.

8. Please add your comments (if any): It was a great pleasure to work this summer in an outstanding research environment, with state of the art hardware, and with the help of very knowledgeable researches. It is an experience I am grateful for and will not forget.



RESEARCH REPORT

1. Name: Andrew T Myers （ID No.: SP07036）

2. Current affiliation: Stanford University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University

5. Host researcher: Dr. Fumiyoshi Minami

6. Description of your current research:

Significant structural damage to steel buildings was observed after recent earthquakes, such as the 1994 Northridge Earthquake in California and the 1995 Kobe Earthquake in Japan. One commonly observed and well-documented damage mode in these structures is connection fracture. Consequently, the accurate prediction of fracture in structural connections is needed to adequately predict structural performance under large cyclic earthquake loads. Micromechanical fracture models are commonly used to make this prediction. My current research focuses on extending and validating a micromechanical model, the Cyclic Void Growth Model (CVGM), which was created recently at Stanford University.

7. Research implementation and results under the program

Title of your research plan:

A Comparison between Two Micromechanical Models that Characterize Ultra Low Cycle Fatigue in Structural Details

Description of the research activities:

Both Stanford University and Osaka University have independently created two micromechanical models that aim to predict the initiation of ductile fracture in steel structures. Stanford's model is termed the "Cyclic Void Growth Model" while Osaka's model is termed the "Effective Damage Concept." Both models are based on the well-established void growth and coalescence micromechanism, but both models differ significantly in how they capture the effects of damage due to cyclic loading. My work this summer has centered on learning the details of the "Effective Damage Concept" and teaching the details of the "Cyclic Void Growth Model." For the latter half of the summer, an Osaka University graduate student and I have worked on making a formal quantitative comparison between the two models. This work will be continued after I return to Stanford.

RESEARCH REPORT

1. Name: Mai Ng （ID No.: SP07037 ）

2. Current affiliation: University of California, Irvine

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Hokkaido University

5. Host researcher: Professor Junichi Takahashi

6. Description of your current research

As the demand for alternative energy sources increase, fuel cells are considered a highly promising candidate. Although the typical solid oxide fuel cell efficiency relies on multiple components working together, the electrolyte material itself governs much of energy yield. Yttria stabilized zirconia (YSZ) is a commonly used solid electrolyte for O= transport in solid oxide fuel cells (SOFCs), however, great interest lies in reducing the operating temperature and increasing efficiency. Thus, the practical reason for the investigation of alternative oxide materials with higher ionic conductivities.

In my current research, lanthanide silicates are of interest as such an electrolyte material alternative. With the current YSZ electrolyte material, $O^{=}$ (oxygen ion) transport is dictated by an oxygen vacancy mechanism. Where as, in the newly studied lanthanide silicate apatite (LSA) systems, which have high $O^{=}$ conductivity at low temperature, rapid $O^{=}$ transport is via oxygen interstitials at excess oxygen concentrations as well as a less rapid vacancy mechanism as a function of composition. Thus both vacancy and interstitial $O^{=}$ transport mechanisms exist in viable SOFC electrolytes. Understanding atomistic behavior governing these different diffusion mechanisms and the effect of grain boundaries on this behavior will be the underlying goals of my research.

7. Research implementation and results under the program

Title of your research plan:

Lanthanum Silicate Apatite Bicrystal Formation to Study Ionic Conductivity across Grain Boundaries.

Description of the research activities:

The overall goal of my research is to aid in furthering the understanding of the factors governing different diffusion mechanisms, specifically interstitial and oxygen vacancy driven diffusion, as well as the effect of grain boundaries on this behavior. In this particular study, the effect of grain boundaries on the ionic conductivity of apatite-type praseodymium silicate is to be examined. As my current facilities lack the necessary equipment as well as the experience in growing lanthanide silicate single crystals, the goal of my summer research was to fabricate apatite-type praseodymium silicate single crystals. These crystals would then later be used to form bicrystals with controlled orientations and then tested for ionic conductivity as a function of grain boundary misorientation.

The growth of a single crystal of any composition is fairly complex and difficult as a number of factors work against the fabrication of a true single crystal. However, before any crystal growth occurs, a feed rod of accurate stoichiometry must be prepared. First, praseodymium oxide and silica powders of high purity were obtained. These powders were mixed in ethanol with an agate mortar and pestle. The mixture was then dried and pressed under 1000 MPa to form a compact. The compact was the set up in a suspended manner to avoid contact with any other material and calcined at 1550C for 5 hours. After the first calcining, the initially black powder compact changed to a green color. The green compact was then ground to a fine powder with an agate mortar and pestle. The powder was then pressed under 1000 MPa into uniform rods. The rods were then suspended in the same manner as before and sintered at 1650C for 5 hours. After this sintering, feed rods of roughly ¾ cm diameter and 4cm in length were formed.

After the feed rod is formed, a single crystal may be grown using an image furnace. The seed crystal, a small rectangular “stem” that is a single crystal of the material to be grown, was obtained and secured in an appropriate holder. Briefly, an image furnace consists of two or four halogen lamps set within an elliptoid chamber with polished metal surfaces. This polished surface acts as a mirror in focusing all of the produced light to a specific point. During crystal growth, the focused light is used to melt the tip of the seed crystal and feed rod. The two melts are then moved into contact, or “touched.” The crystal growth is initiated with the movement of the seed crystal and feed rod down and away in respect to the light focal point. As the focal point travels up the feed rod, more material is melted and made available for growth. Similarly, as the seed crystal moves away from the focal point, the melt in contact with the seed crystal is allowed to cool slowly and grow atomically identical to that of the single crystal seed. As the single crystal seed travels away, the single crystal region expands and grows. This process of crystal

growth is called the float zone method.

After growth, the crystal was then annealed in the before stated “suspended” manner at 1650C for 5 hours. This annealing step allows for easier handling of the crystal as the initially grown crystal is extremely brittle and would break if cut into small specimens. The annealed crystals were then quality checked with optical microscope and x-ray diffraction methods. Powder x-ray diffraction was used to verify the chemical composition, while the structure was examined with Laue X-ray pattern. A small slice of the crystal was also collected and polished for optical microscope examination. Polarized images were obtained to observe any grains present.

Although straightforward, my single crystal growth work included concerns regarding the quality of raw materials, seed crystal, and heat gradient within the image furnace that resulted in the growth of poor quality crystals. In this report, I will only detail upon the raw material issue. The absorption of water into materials, especially powders, is almost unavoidable. This being so, powders are often tested by the manufacturer for the mass gained due to water absorption. However, this value is very difficult to measure accurately with praseodymium oxide. The first few crystals grown used feed rods batched with amounts following the provided manufacturer specifications. The resulting crystals only produced 1.5 cm of usable crystal, while the remaining portion exhibited bubbles and inclusions. As the silica content of the melt increases, the viscosity also increases ad may inhibit the release of any bubbles. With this in mind, the ratio of silica was decreased. Crystals grown with the new recipe improved with much larger “good” crystal portions.

Overall, my summer research not only provided me with a number of single crystal samples for my research at my home institution, but also invaluable knowledge and experience in the growth of single crystals.

RESEARCH REPORT

1. Name: Edward O'Brien Jr. (ID No.: SP07038)

2. Current affiliation:

University of Maryland College Park and National Institutes of Health

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences

X Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

X Interdisciplinary and Frontier Sciences

4. Host institution: Nagoya University

5. Host researcher: Dr. Yuko Okamoto

6. Description of your current research

Compatible osmolytes are a class of small molecules that stabilize a proteins' native state. Osmolyte induced stabilization of compact protein conformations is referred to as the osmophobic effect, and helps proteins retain their function in the face of environmental stress. The origin of the osmophobic effect is the preferential exclusion of osmolyte molecules from the protein surface. The mechanism by which osmolyte molecules are excluded from the surface has not been determined. Timasheff proposed three possibilities: (1) solvophobic forces, (2) osmolyte induced surface tension changes around the protein, and (3) excluded volume interactions between the osmolyte molecules and protein. Our research tests the hypothesis that excluded volume interactions are the origin of the osmophobic effect. Using all-atom simulations we will test hypothesis by directly computing the free energy contribution of molecular crowding to the osmophobic effect caused by the osmolyte Trimethylamine-N-oxide.

7. Research implementation and results under the program

Title of your research plan:

The contribution of excluded volume interactions to the osmophobic effect of Trimethylamine-N-oxide

Description of the research activities:

Using all-atom molecular dynamics simulations, coupled with advanced sampling techniques, we are directly computing the free-energy contribution of molecular crowding to the osmophobic effect of Trimethylamine-N-oxide. In this way we are testing the hypothesis that the osmophobic effect is caused by excluded volume interactions between the osmolyte molecules and the protein.

To avoid sampling problems in these simulations we have implemented 'Multi-dimensional replica exchange' (MREX), a sampling method first proposed by Dr. Okamoto. The MREX code interfaces with the CHARMM molecular dynamics software package to carry out these simulations. MREX greatly enhances the sampling of thermodynamic properties of the TMAO-peptide systems, including the free-energies we are interested in.

Implementation of the Weighted Histogram Analysis Method (WHAM) was necessary to analyze the results of the MREX simulation. WHAM has allowed us to combine the MREX simulations, run at multiple temperatures, and run under different Hamiltonians, to get an accurate estimate of the free energies.

A large portion of my time in Japan was devoted towards developing the tools (MREX and WHAM code) necessary to test the 'molecular crowding' hypothesis of the origin of the osmophobic effect. Production MREX simulations are currently running, once these are finished, which should be in two weeks, results will come forthwith.

RESEARCH REPORT

1. Name: Stephen Obrochta （ID No.: SP07039）

2. Current affiliation:

Duke University Division of Earth and Ocean Sciences

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Akita University

5. Host researcher: Tokiyuki Sato

6. Description of your current research

Heightened interest in millennial climate variability during the recent geologic past stems from the need to place present and future warming in a better understood, long-term perspective. Accordingly, the climate-related objectives of IODP Exp. 303 focus on extending the millennial-scale stratigraphies of the North Atlantic well beyond the last glacial cycle, in general, and specifically on whether the pacing of millennial climate variability has changed over the past several million years, and if so, why.

During the last glaciation, Greenland ice cores revealed abrupt warmings that occurred every several thousand years. More specifically, these warm periods were approximately spaced in intervals of 1500 years, i.e., intervals of 1500, 3000, and 4500 years. Also during the last glaciation, a 1500-year cycle was discovered in the abundances of certain types of ice-rafted debris (IRD; sediment eroded from land by glaciers, carried to sea by ice bergs, and eventually deposited on the sea floor). Thus, it would appear that millennial climate variability was paced or influenced by a 1500-year forcing during the last glaciation.

It has been widely assumed that this pacing is related to solar insolation forcing and is therefore characteristic of climate variability within the preceeding glaciations as well. However, to date, no complete record of Greenland ice from previous records has been recovered. It is likely that ice persisted in areas of Greenland during the intervening interglaciation, but highly unlikely that a high-quality, complete record of any previous glaciation is currently preserved in Greenland ice. In addition no petrologic studies of the particular types of IRD (hematite-stained quartz and feldspar grains; fresh Icelandic volcanic glass) that exhibit ~ 1500-year cyclicity during the previous glaciation have been conducted within any previous glacial intervals.

My current research is testing the hypothesis that the particular style of millennial climate variability exhibited by the last glaciation is reproducible in previous glaciations.

Evidence from stacked global climate records and high-resolution marine sediments cores from the N. Atlantic Ocean indicate that, during periods of large-scale, global climate reorganizations, millennial climate variability is enhanced.

Therefore, I am conducting similar IRD studies within the two glaciations preceding the

last. Known in paleoceanographic literature as Marine Isotope Stages (MIS) 6 and 8. MIS 6 was remarkably stable, while MIS 8 was highly variable. Results from his study will elucidate the nature of millennial variability beyond the well-studied last glaciation.

7. Research implementation and results under the program

Title of your research plan:

Contrasting millennial climate variability during Pleistocene glaciations

Description of the research activities:

Prepared ~ 600 samples for analysis. Analyzed approximately 400 sediment samples. Analysis consisted of determining the percentage of 1) hematite stained grains, 2) fresh Icelandic volcanic glass, and 3) detrital carbonate.

Ongoing work consists of analyzing the remaining samples, nitrogen isotope analysis from selected intervals, and nanofossil species determination.

While results are preliminary, significant differences exist between the glacial variability between the different glaciations. Both ice-sheet and ocean current dynamics vary in ways not exhibited during the last glaciation.

RESEARCH REPORT

1. Name: Brendan G ODonnell （ID No.: SP07040 ）

2. Current affiliation: University of Washington

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Advanced Industrial Science and Technology

5. Host researcher: Dr. Toshi Ozawa

6. Description of your current research

My research at both AIST in Japan and University of Washington attempts to quantify the environmental impact of products or industrial systems using Design for Environment methodology. Understanding systems themselves using Design for Environment practices, energy materials and technologies research, and energy stewardship are necessary to balance economic development with long-term sustainability.

Life Cycle Assessment (LCA) is a model-based approach to quantify where, and in what form, energy and materials are used (and wasted) throughout the technology life cycle. The "life cycle" refers to the production of raw materials for fuels, infrastructure and energy conversion equipment, use, maintenance, after life options, and relevant health and social factors. This is sometimes referred to as a “cradle to grave” approach with many potential applications. Thus, LCA provides a protocol to understand the potential impact of technological choices on resource depletion, contributions to global warming, manufacturing and infrastructure investment, employment, and human health effects. Products or processes can be selected to reduce net impact and increase sustainable manufacturing if the total system is properly understood to create predictable models.

At the Design for Environment Laboratory, based in the Mechanical Engineering Department at the University of Washington, I’m developing an LCA model of an industrial materials exchange in the city of Seattle. The LCA model aims to increase program efficiency by assessing net impact of commonly traded materials compared to virgin or substituted products. My LCA will include the contribution of hazardous wastes, transportation impacts, toxicological impacts, greenhouse gas emissions, and pollution prevention endpoints. By approaching the exchange of industrial materials using LCA, impacts of trading different materials are be evaluated.

7. Research implementation and results under the program

Title of your research plan: A Life Cycle Assessment (LCA) of Imported American Wheat: Regional Distribution of CO_2 Emissions

Description of the research activities:

While at AIST in Japan, I performed a Life Cycle Assessment (LCA) on wheat imported from the United States. This included CO_2 emissions from planting, fertilizer application and production, field operations, domestic transport, and cargo transportation to point of use (POU) in Japan. The function unit was 1 kg of dry wheat for four species: Hard Red Winter, Hard Red Spring, Soft Red Winter, Soft White.

Japan produces very little domestic wheat in the Hokkaido prefecture, but there is a strong connection between wheat grow in the U.S. and wheat consumed in Japan. Wheat for noodles, bread, and pastries, are a staple of Japanese food production and consumption systems (KOGA, 2006). Japan imports almost six millions tons of wheat, with the United States being the primarily source. Conversely, Japan is the largest destination for wheat exported from America (WWC, 2006).

For the LCA, I gathered inventory data for chemical application, fuel consumption, and energy use for farms in the top three production states for each species of wheat. Transportation distances were calculated using the United States Department of Agriculture's grain storage database. Preliminary results show two-fold range of CO_2 emissions both between wheat species and in different states producing the same species. For example, Hard red wheat at POU in Japan imported from Oklahoma produced 439 g CO_2 per kg wheat, while hard winter wheat imported from Montana produces 246 g CO_2 per kg wheat. Results have also been displayed using Geographic Information Systems (GIS) software.

Results indicate that the species and location of wheat production can have significant variability of CO_2 emissions. As Japan's Food Study Group develops it's sustainable consumption policy, our final results will suggest which species and location of U.S. wheat have lower emissions and should be recommended.

Nobuhisa KOGA, Takuji SAWAMOTO, Haruo TSURUTA (2006) “Life cycle inventory-based analysis of greenhouse gas emissions from arable land farming systems in Hokkaido, northern Japan.” Soil Science & Plant Nutrition 52 (4), 564–574.

“Washington Wheat Facts 2006.” (2006) Washington Wheat Commission (WWC). Spokane, WA, United States

8. Please add your comments (if any):

This is a fantastic experience. I was not expecting such a well run and organized program -- support received from JSPS and my host institution was remarkable. Thank you to all who were a part of it, especially Dr. Ozawa and Akiko Chiba. Please do not hesitate to contact me with questions, comments, etc.

RESEARCH REPORT

1. Name: Brian Phillips （ID No.: SP07041）

2. Current affiliation: University of Illinois at Urbana Champaign

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Institute of Technology

5. Host researcher: Dr. Kazuhiko Kawashima

6. Description of your current research

In bridge design, support and approach conditions sometimes call for a parallelogram shaped deck rather than a typical rectangular one. These skewed bridges have their own unique behavior resulting from asymmetry, as seen in Figure 1. When subject to earthquake loads, the decks may collide with the abutments or adjacent decks if displacements exceed the gap of the expansion joints. Due to the skew angle, the collision will result in a rotation of the decks. Problems resulting from deck rotation include unseating of the deck whereby the deck will fall from the support, as well as excessive torsional force on the pier supporting the deck. Large forces and displacements may also lead to the damage and subsequent locking of the bearings between deck and pier, significantly amplifying the torsional force in the pier. Mitigation of this damage can be accomplished through proper use of restrainers, dampers, and bearings to prevent excessive displacements with adequate seat length to prevent unseating.

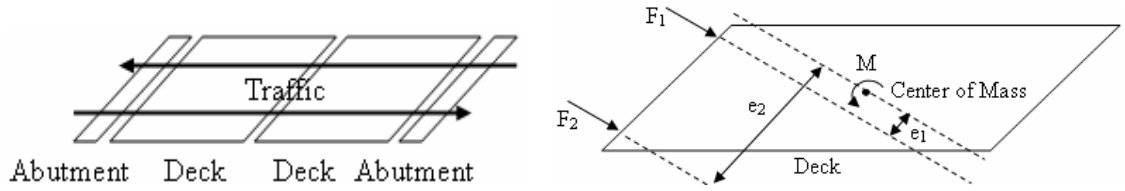


Figure 2. Example Skewed Bridge (a) Overhead View (b) Eccentric Forces on Deck

The complex nature of skewed bridges leads to limited understanding of their behavior when compared to normal bridges. Thus, only partial guidance is provided in design codes. An accurate and reliable analytical model would be a valuable tool to help assess the interaction of the variety of contributing factors and predict the resulting forces.

7. Research implementation and results under the program

Title of your research plan: Seismic Performance of Skewed Bridges

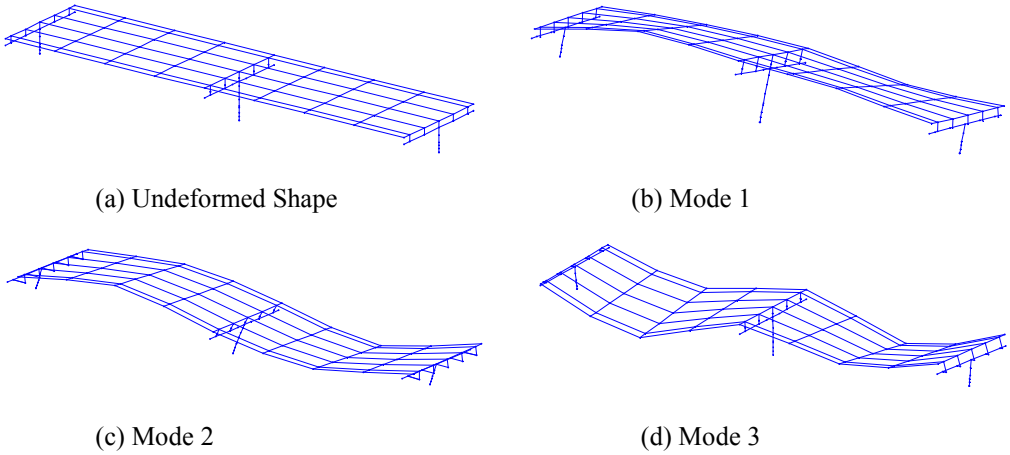
Description of the research activities:

Research began with a literature review conducted at the Kawashima Laboratory of the Tokyo Institute of Technology using the master's theses and PhD dissertations on file. A focus was placed on those related to skewed bridges, pounding, and combined flexural and torsional loads on bridge piers. This was coupled with a review of papers produced by Dr. Kawashima, his students, and collaborators. Dr. Kawashima is an expert in the area of the seismic performance of bridge structures and he and his group have completed extensive research in this area.

With knowledge of the mechanisms that are required to accurately replicate the performance of skewed bridges under dynamic loads, focus turned to analytical modeling. In order to get acquainted with analytical modeling of bridge structures, a simple one pier bridge model proposed by one of the students at the Kawashima Laboratory was replicated using the program OpenSees. This program is a simulation framework in development by the Pacific Earthquake Engineering Research Center (PEER) of the National Science Foundation (NSF) to simulate the seismic response of structures. A fiber element model was used to model the reinforced concrete (RC) pier and capture its nonlinear behavior. Earthquake records in three translational directions were applied to the model at both design and ultimate levels. The results compared very well to the student's proposed model.

After success was achieved in this endeavor, a more complicated model was considered. A proposed skewed bridge was analyzed and translated into an OpenSees model. This model was complete with elements to simulate the interaction between soil and structure, bearings between deck and support, and pounding between deck and abutment. Currently the model parameters are being honed to get a good quality response and thus reasonable prediction of the pounding forces between deck and abutment and the torsional force on the pier. After establishing confidence in the model, performance improving alterations will be added to achieve and assess reductions in displacement and force. Similarly, the model can be easily altered to match that of an existing skewed bridge, which would provide a useful tool in future

studies on skewed bridge design. The current dynamic response is illustrated in Figure 2 with displacement mode shapes shown.



(a) Undeformed Shape (b) Mode 1

(c) Mode 2 (d) Mode 3

Figure 3. Skewed Bridge Model

This research may be extended into the realm of hybrid testing using the facilities at the University of Illinois at Urbana Champaign. A critical component of the structure, such as the pier, would be created and tested experimentally. The rest of the structure, and thus the force imparted to the experimental pier, would be computed analytically. This method saves time and money and can be readily applied to scaled experimental models. Such experiments could capture behavior, especially in damaged components, that the analytical model may not.

8. Please add your comments (if any):

I would like to thank Dr. Kawashima and his research group for welcoming me to their laboratory and assisting my in my research. I would also like to thank NSF and JSPS for jointly funding and organizing this summer project.

RESEARCH REPORT

1. Name: Moire Prescott （ID No.: SP07042 ）

2. Current affiliation: University of Arizona

3. Research fields and specialties: Astrophysics

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Astronomical Observatory of Japan

5. Host researcher: Dr. Nobunari Kashikawa

6. Description of your current research

In recent years, imaging surveys have uncovered gigantic nebulous structures in the distant Universe that may in fact be the sites of massive galaxy formation. Seen as large, diffuse cloud of gas emitting strongly in the Lyman-alpha (Lya) line of hydrogen, astronomers have dubbed these objects “Lya nebulae.” The question of how and where galaxies form is fundamental to understanding the inner workings of the Universe, but while it is probable that these Lya nebulae are galaxy factories located in crowded regions of the Cosmos, this has not been proven unequivocally. It is also not yet clear what process causes them to glow brightly in Lya nor what defines their enormous extent, sometimes as large as 300,000 lightyears across. Recent work has suggested that photoionization of hydrogen gas by massive stars or supermassive blank holes, gravitational cooling radiation from the accretion process, shock heating in starburst-driven galactic superwinds, or resonant scattering may all play a role. As part of my thesis research, I have begun investigating the question of Lya nebulae from a variety of different angles, looking at the detailed characteristics of one particular Lya nebula as well as developing a systematic search for these objects in order to better understand how frequently they arise in the Universe.

The goal of the research this summer was to test the association between Lya nebulae and overdense regions of the Universe. Most known large Lya nebulae are located in crowded regions, surrounded by a greater than average number of galaxies. Several authors have suggested that Lya nebulae will only be found in overdense regions, as might be expected for sites where the most massive galaxies are in the process of forming. However, in the past Lya nebulae have typically been discovered by specifically targeting crowded regions of the Universe, thus the observed association is difficult to interpret. In contrast, one of the largest known Lya nebulae found recently was discovered somewhat by accident because of its very strong mid-infrared emission and without any a priori knowledge of its environment. It therefore provides a unique and unbiased test of the suspected association between Lya nebulae and overdensities. Prior to the summer, we submitted a proposal to use the Subaru Telescope to obtain deep intermediate-band imaging of the environment of this large Lya nebulae located at a redshift of 2.7 in the Bootes field. These data provide a means for discovering Lya-emitting galaxies, which can be used as tracers of the underlying galaxy density in a given region of the Universe. Our goal therefore is to determine quantitatively whether or not this Lya nebulae is in fact sitting in a local galaxy

overdensity as predicted. The answer to this question will be an important contribution to our understanding of the Lya nebulae phenomenon and consequently the role these objects play in the formation of massive galaxies.

7. Research implementation and results under the program

Title of your research plan: Exploring Sites of Galaxy Formation: Large Lyman-alpha Nebulae in the Bootes Field

Description of the research activities:

During the period of the JSPS summer program, I successfully completed the primary goals of our project, in close collaboration with my host researcher Dr. Nobunari Kashikawa (NAOJ) and Dr. Yuichi Matsuda (Kyoto University). In June we traveled to Mauna Kea in Hawaii in order to use the Subaru Telescope, a state-of-the-art telescope run by NAOJ, and its wide-field imaging camera SuprimeCam. Luckily the skies were stable and clear, so we obtained very high quality images through a custom intermediate-band filter of the environment around a large Lyman-alpha nebula.

During the remainder of the summer, I used NAOJ facilities to complete the data reduction, with the assistance of my host and other local SuprimeCam experts. From these data we uncovered a sample of several thousand Lya-emitting galaxies, which can be used as tracers of the underlying galaxy density in this region. We can therefore investigate whether the large Lya-nebula is located in an overdense region of the Universe, as has been predicted by several authors. Our preliminary analysis suggests that the Lya nebula is indeed located in an area of higher galaxy density relative to surrounding areas and that we may see evidence for large scale structure within the Lya-emitting galaxy sample. We are preparing a short paper on these initial results, to be submitted to the Astrophysical Journal Letters by the end of the summer. Building on this work, we will be submitting a follow-up Subaru telescope proposal in September with the goal of expanding our survey in order to better understand the environment of this Lya nebula.

In addition to providing a test of the density of this region, our galaxy sample also gives us a unique opportunity to study the properties and spatial distribution of the

Lya-emitting galaxies themselves in detail. Extensive multi-wavelength observations are available for this field, and our galaxy sample is a much closer sample of Lya-emitting galaxies than has been studied up to this point. This analysis will therefore inform studies of Lya-emitting galaxies at higher redshifts. We plan to continue this work into the Fall and will be preparing a full length paper on the results to be submitted in the Astrophysical Journal.

Participating in the JSPS summer program also gave me the opportunity to give a number of research talks at Japanese institutes. I presented my ongoing thesis research at a Galaxy Workshop at NAOJ and gave Astronomy Department colloquia at Tokyo University and Kyoto University. These were valuable experiences for me in terms of gaining practice giving research presentations as well as networking within the international astronomical community.

8. Please add your comments (if any):

The JSPS summer program has been an enormously positive experience for me both scientifically and personally. The Subaru Telescope facility was very impressive and allowed us to obtain high quality data for our research, the environment at NAOJ was conducive to scientific productivity, interactions with my host and other NAOJ students/postdocs were extremely helpful and enjoyable, and living in Japan for a summer was an amazing cultural experience. I am delighted that my host and I are planning to continue to collaborate on this research; new proposals for additional telescope time are already in the planning stages. I will also recommend this experience to my fellow graduate students and will be looking for opportunities to improve my Japanese and to return to Japan in the near future.

9. Advisor's remarks (if any):

Ms. Moire Prescott is very hard working and dedicated for our collaborative work using the Subaru telescope. Her intensive work during her stay in Japan has made a great progress on our work. It usually takes two months to reduce a Subaru observational data, though she reduced it only within two weeks. Now we have obtained a visible symptom of new discovery in our work, and I 'm looking forward to our extensive works with Subaru and other telescopes.

RESEARCH REPORT

1. Name: Arturo Ramirez （ID No.: SP07043）

2. Current affiliation: Fred Hutchinson Cancer Research Center/University of Washington

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kazusa DNA Research Institute

5. Host researcher: Dr. Hisashi Koga

6. Description of your current research

My current research involves the search for human blood protein biomarkers for the detection of ovarian cancer. The early detection of ovarian cancer could greatly decrease morbidity and mortality due to the high survival rates if the disease is diagnosed when it has not spread outside of the ovarian tissue.

The approach I am using is to fabricate antibody microarrays that are hybridized with fluorescently labeled blood to determine which antibodies recognize proteins that are more abundant in blood of women with ovarian cancer with respect to blood of women without ovarian cancer. I am using two kinds of antibodies: first, a library of single chain antibodies expressed in bacteria which have been selected for binding to proteins in the blood of ovarian cancer patients, and second, full length commercially available antibodies which are specific for cancer-specific proteins.

I have compiled a list of antibodies which can differentiate cancer serum from normal serum using our array technology. I want to test these antibodies in other techniques in order to select a few high confidence antibodies to characterize the protein they bind and then elucidate the role this protein plays in ovarian cancer and validate is as a biomarker for the detection of this disease.

7. Research implementation and results under the program

Title of your research plan:

Measurement of Antibody-Antigen Interactions for Cancer Biomarker Discovery

Description of the research activities:

My project will utilize recombinant antibody fragments known as single chain variable fragment antibodies (scFv), to perform a proteomic analysis of cell lysates in order to validate biomarkers for the detection of ovarian cancer.

In order to validate these antibodies as tools for biomarker discovery I will perform Surface Plasmon Resonance (SPR) experiments. SPR is a technique based on immobilizing a target protein on a gold-coated chip. A biological sample is loaded onto the chip and the interaction between the target protein and the proteins in the sample is measured as a change in the angle of reflected light that is shone onto the chip. The relative amounts of a protein in different samples can be inferred by comparing the magnitude of the angle change for a particular target in each of the samples.

I printed ovarian cancer-specific single chain antibodies on a SPR chip. I compared relative protein abundance between cultured cell lines. My hypothesis was that the antibodies that interact with ovarian cancer specific proteins will show increased angle changes when ovarian cancer cell lines are loaded onto the SPR chip with respect to non-ovarian cancer cell lines.

In order to perform the objectives of my project it was necessary for me to learn how to use a microarray printer. This machine is a robotic spotter that takes the antibody samples I purify and prints nanoliter spots of them on a gold coated SPR chip. The chip must be activated so that the antibodies will covalently bind to it when they are spotted. After the spotting process, the arrays are blocked and used in SPR.

Before I could use my antibodies for SPR I had to master the use of the machine and the construction of the microarrays. For this, I used previously characterized antibodies which have been used in my host lab and printed arrays which were then challenged with their cognate antigens.

I had to establish the optimal antibody printing conditions and determine the limit of detection of this technique. My advisor and I decided that we would like to achieve a limit of detection of 100 ng/ml of analyte in SPR running buffer. This level is comparable to reports in the literature about this technique.

I was able to achieve this limit of detection with the antibodies produced in my host

lab. I determined the optimal conditions for spotting of arrays and for the SPR technique with these antibodies and then could use the same conditions for my single chain antibodies and full length antibodies.

I used cell lysates prepared from different ovarian cancer cell lines and also breast cancer cell lines as a control.

My results show that the different antibodies I used for SPR have distinctive signal intensities and have a high signal to background ratio. The antibodies also have distinctive signal intensities from one cell lysate to another. These results lead me to believe the signals observed are specific for antibody-antigen binding and not just background signals.

I performed several replicates using similar arrays on the same cell lysates and I had very reproducible results, showing that signal intensity differences between antibodies and between cell lines is not just random variation.

I was also able to show that ovarian specific antibodies had higher signal intensities when used with ovarian cell lysates than those of colon or breast cancer specific antibodies. This demonstrates that the antibodies detect antigens specific for ovarian cancer.

Overall, the objectives of my project were achieved in full and the results obtained while on this program will be very valuable for my thesis project.

We will continue to collaborate with my host lab in Japan in order to identify the ovarian cancer specific antigens studied during this program.

8. Please add your comments (if any):

This has been a wonderful experience, both scientifically and culturally. I am very glad I could participate in this program and I am sure what I learned over this summer will be very useful for me in the years to come. I would like to thank JSPS for their support.

9. Advisor's remarks (if any):

Mr. Arturo Ramirez has been working hard during this short program and he has learned many new technologies such as multiplex SPR, SAMs (Self-Assembled Monolayers), Hydrogel among others. He has been active not only with his research but also with human communication. He made strong friendships with Japanese scientists. I believe these kinds of relationships will advance their future scientific collaborations. During this program, he to attended a small meeting in Kyushu (DBELS workshop) together with another of my students. He builds up people's interest with appropriate questions and comments. If he could stay longer, it is promising that he could produce scientifically important findings and possibly publish in an international journal.

RESEARCH REPORT

1. Name: Kristin D. Rule （ID No.: SP07044 ）

2. Current affiliation: Division of Chemistry and Chemical Engineering, California Institute of Technology

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

X Chemistry Engineering Sciences **X** Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Physiological Sciences

5. Host researcher: Dr Yoshihiro Kubo

6. Description of your current research

As a graduate student in the Dougherty lab at Caltech, I employ range of techniques used in modern chemical biology, including organic synthesis, conventional and unnatural amino acid mutagenesis, electrophysiology, and computer modeling. In our lab these techniques are applied to obtain a chemical-scale understanding of ion channels and neuroreceptors. Specifically, our research focuses on the cys-loop superfamily of ligand-gated ion channels. My current research involves understanding the conformational changes that connect agonist binding and channel gating in the nicotinic acetylcholine receptor.

Thus, while I was already familiar with the study of membrane proteins, as well as with some of the techniques (i.e. mutagenesis, electrophysiology) that are used to study prestin in the Kubo lab, the FRET component represented a new technique for me. In addition to learning new techniques, I was able to share some of my research by giving a seminar on the work we do in the Dougherty lab.

7. Research implementation and results under the program

Title of your research plan:

Monitoring the Conformational Changes of Prestin by TIRF/FRET Analysis

Description of the research activities:

The mammalian hearing organ is unique in its exquisite sensitivity and frequency resolving capacity. These features, which have enabled sophisticated speech and music in humans, are imparted in large part by the outer hair cells (OHC) in the cochlea. Cochlear amplification, or the process which enables mammals to efficiently detect high frequency, low intensity sounds, occurs in part through a process called electromotility, whereby the OHC changes its length in response to a change in membrane potential. Recently, a transmembrane protein (prestin) has been identified which is integral to the molecular mechanism by which OHC electromotility occurs. Currently, the nature of the voltage-dependent conformational changes that confer motility are unknown. The aim of my summer research was to use Fluorescence Resonance Energy Transfer (FRET) in combination with TIRF microscopy to gain a better understanding of the voltage-dependent structural changes of Prestin.

FRET is a powerful technique for studying the conformational changes of proteins. FRET describes a distance-dependent energy transfer mechanism of excited state energy from a donor fluorophore to an acceptor fluorophore. To monitor protein conformational changes, a FRET donor and acceptor are attached to different sites on a protein. When these sites move or rotate relative to one another a change in FRET can be observed. Due to the nature of prestin, FRET provides an attractive approach to gain a better understanding of the structural changes that accompany electromotility in this transmembrane protein. By using the TIRF/FRET combination we were able to monitor the conformational changes of only the prestin molecules that were being expressed in the cell membrane.

In order to study conformational changes of prestin by FRET, it was necessary to attach a fluorescent moiety to prestin. This was initially approached by attaching fluorescent proteins to the N- and C- termini. The incorporation of fluorescent proteins at the N-terminus of prestin led to improper membrane targeting. Thus, a less disruptive strategy of incorporating tetracoordinate arsenic group binding motif and subsequent labeling by small fluorescent molecules (FlAsH and ReAsH) was employed. As prestin is currently thought to function as a tetramer, both intra- and inter- prestin conformational changes were studied.

Prestin undergoes conformational changes in response to changes in membrane potential. We chose to control membrane potential by varying extracellular

potassium concentration. Application of 140 mM potassium chloride solution results in a membrane potential of about 0 mV, thus depolarizing the membrane. A decrease in FRET efficiency was detected upon application of high potassium concentration between the C-termini and the C- and N- termini of separate prestin molecules.

To confirm that the changes in FRET were due to prestin and not global changes in cell morphology, FRET changes of the metabotropic Glutamate receptor (mGluR) were monitored upon high potassium concentration application. For mGluR transfected cells, the FRET intensity increased upon application of activating concentrations of glutamate, but no change was observed upon change in extracellular potassium concentration. To determine whether the conformational changes were related to non-linear capacitance (NLC), the electrophysiological signature of prestin, a mutation was made that has been shown to eliminate the NLC of prestin. No FRET changes were observed upon application of high potassium concentration for this mutation. In addition, FRET efficiency changes were reversibly diminished in the presence of 10 mM sodium salicylate, which is known to block electromotility in OHCs. These results strongly suggesting that the conformational changes we observe are related to NLC. Furthermore, electrophysiological measurements of NLC at 140 mM potassium chloride confirm that the NLC of prestin is unaffected by high extracellular potassium concentration.

8. Please add your comments (if any):

This summer research program was an amazing experience for me. The pace of research in the Kubo lab was exhilarating, if at times exhausting. The casual scientific conversations that happened on an almost daily basis and the supportive and collaborative environment of the Kubo lab contributed to my being able to learn a remarkable amount of new information and techniques in a very short period of time. In addition to being an extremely productive time for me, my research experience this summer served as a much needed reminder of why I chose to pursue a PhD in science in the first place.

9. Advisor’s remarks (if any):

Ms. Rule's research activity during her short stay was truly exceptional. She not only learned techniques of our expertise, but also played very important roles of our "Prestin-FRET project" which propelled it strongly. I would like to thank her for her contribution, and also thank JSPS and NSF for providing us this precious opportunity.

RESEARCH REPORT

1. Name: Joshua Mark Schendel （ID No.: SP07045）

2. Current affiliation: Ohio University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Japan Advanced Institute of Science and Technology

5. Host researcher: Dr. Koichiro Ochimizu, Dr. Kazuhiro Fujieda

6. Description of your current research

The incapacity for efficient communication is one of the most significant factors that hinder progress, particularly in multi-site or even global software engineering projects. Adding additional team members often only serves to aggravate the problem by incurring increased communications and training overhead. While attempts have been made to incorporate collaboration mechanisms into common software development tools, few have been regarded as having substantially ameliorated the communications problem. What would the results be if, instead of building collaboration mechanisms into existing software tools, these software tools were built atop a rich multi-user communications platform? My research explores an approach that aims to leverage this unique perspective to heighten the potential for effective collaboration amongst software developers and management, particularly those which operate in highly-decentralized environments. Specifically, it introduces participation in virtual environments as an integral piece of the development workflow to facilitate opportunities for collaboration and communication.

7. Research implementation and results under the program

Title of your research plan:

Facilitating Communication in Software Engineering by Incorporating Version Control Systems into Immersive, Collaborative Virtual Environments

Description of the research activities

As the client source code for Second Life (the virtual environment used in this project) was recently open-sourced, I first pursued successful compiling and using my own custom viewer. I then compiled Subversion, the version control system I would be interfacing with Second Life, into a command line program so I could invoke VCS operations programmatically from the client code via calls to operating system command interpreter. I set up a test repository with sample files on a test server, after which I created virtual objects in the Second Life world with a simple interface for supplying information where the host server repository is located. Finally, I created a virtual software engineering lab to house the virtual artifacts that interface with the repository, as well as implemented the in-world interface for common version control operations such as checking files in and out. Finally, I discussed ideas for future expansion of the project.

8. Please add your comments (if any):

During my stay I was introduced to the "Future Version Control System" (FVCS), a project that builds on existing version control workflows by incorporating mechanisms for change approval. My interest in this project is so great that I am already working on future partnerships (most notably the Fulbright award) of which FVCS is of central importance in the research project. Without EAPSI, I would have never been exposed to FVCS, so thank you EAPSI!

RESEARCH REPORT

1. Name: Stephen Schmitt Jr. (ID No.: SP07046)

2. Current affiliation: University of Illinois at Urbana-Champaign
Department of Civil & Environmental Engineering

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: International Institute of Seismology and Earthquake Engineering
Building Research Institute

5. Host researcher: Dr. Taiki Saito, Chief Researcher

6. Description of your current research

Earthquake engineering is important in mitigating earthquake risk to building infrastructure, such as schools, hospitals, and government buildings. In a forensic manner, structural behavior and performance can be readily assessed after a seismic event from collected strong motion data of instrumented buildings. The complexity of building systems and their seismic failure modes prevents full behavioral understanding from white box models constructed solely based on first principles. An alternative is the black box model which relates input and output motions without delving into internal mechanisms. Dynamical building models are constructed from the observed data using mathematical tools and algorithms, referred to as system identification. System identification plays the role of verifying and calibrating structural buildings models which could not otherwise be validated through experimentation. These models can be used to understand the performance of the as built structure and determine residual seismic safety after earthquakes.

7. Research implementation and results under the program

Title of your research plan: Structure Observation and Identification Considering Soil Structure Interaction

Description of the research activities:

The research investigates system identification techniques to identify key structural parameters, natural frequency and damping ratio, for an instrumented steel encased reinforced concrete (SRC) building considering the effects of soil-structure interaction on input ground motion. The target building is the 8-story Urban Disaster Prevention Research Center (UDPRC) at the Building Research Institute in Tsukuba, Japan. The stages of the system identification process utilized include: experimental design and data acquisition, data analysis and preprocessing, model estimation, and post-processing.

A 30-min ambient vibration observation was performed on UDPRC at a sampling frequency of 100 Hz. A total of twelve servo velocity sensors were placed at the floors, basement, and outside the building. Two benefits of utilizing microtremor signals are their length and stationary nature. Unfortunately, their noisiness owing to small measurement amplitude necessitates signal processing prior to identification. Morita (2007) showed the modal analysis to be performed is concentrated in the low-frequency range; therefore, the signals were conditioned by applying a low-pass filter with cut-off frequency at 5 Hz.

System identification is application specific and depends greatly on the quality and characteristics of the collected input-output signal pair. Accordingly, non-parametric estimates computed by the power spectral density and transfer function methods provide a means of comparison to parametric identification estimates. The importance of structural identification in the time-domain was described by Saito et al. (1996). The Autoregressive Moving Average with eXogenous input (ARMAX) method was utilized to identify the natural frequency and damping ratio for the first mode of the structure. In this study, the single input single output (SISO) system is assumed. The responses at the floors are taken as outputs and the inputs include ground level and basement floor motions. The averaged results of the first natural frequency estimates are shown in Table I. The natural frequency estimates match well between the methods. The damping ratio estimates were in agreement with Morita (2007) but are markedly scattered for meaningful comparison.

Table II. 1st F_N Estimates

Input	Non-Parametric	Parametric	% Difference
1	1.474	1.481	0.474
2	1.450	1.468	1.234
3	1.428	1.430	0.140

The magnitude 6.6 Niigata earthquake which struck on July 16th, 2007 provided a unique opportunity to explore system identification methods under forced excitation. The UDPRC is fortunately equipped with permanent strong motion accelerometers which captured the dynamic motions of the structure and ground. The benefits of forced vibration signals are opposite those of ambient vibration. The non-stationary nature of the signal, however, poses a more difficult problem as the dynamics evolve with time, i.e. the structural parameters are a function of excitation amplitude.

Initial estimates of the first natural frequency were computed by non-parametric and parametric methods using the basement floor acceleration as input and fifth and eighth floor motions as output. The input-output data was broken into segments to simulate a stationary signal over a small time range. The result of natural frequency estimates at 8-sec intervals is shown in Figure I. The first natural frequency is plotted versus absolute input acceleration. A two standard deviation confidence interval is drawn from the eighth floor non-parametric estimates. The fifth floor non-parametric and eighth floor parametric estimates fall within this region. There appears to be a correlation between first natural frequency and dynamic response or input acceleration. Notice there is more than one parametric estimate per interval. This is a result of high order ARMAX models which overestimate the number of natural frequencies to accurately fit time-domain data.

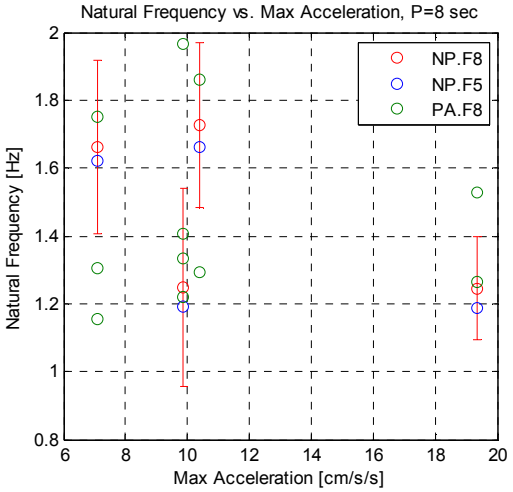


Figure IV. 1st F_N vs. Acceleration

8. Please add your comments (if any)

Continued collaboration with BRI to complete this research is expected. The results explained regarding first mode estimates of natural frequency and damping ratio are preliminary. Additional tasks include: (i) improving criteria for choosing model orders, (ii) providing a method to eliminate superfluous modes, (iii) calculating a meaningful damping estimate, (iv) performing non-parametric and parametric estimates for all inputs under investigation, and (v) comparing forced and ambient vibration estimates.

RESEARCH REPORT

1. Name: Tyler M. Sharp （ID No.: SP07047 ）

2. Current affiliation: Baylor College of Medicine

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences **Biological Sciences**
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Infectious Diseases

5. Host researcher: Dr. Kazuhiko Katayama

6. Description of your current research

Noroviruses are the causative agent of up to ~96% of non-bacterial outbreaks of gastroenteritis, and Norwalk virus (NV) is the prototype norovirus. The NV genome has three open reading frames (ORFs), with ORF1 coding for six nonstructural proteins and ORFs 2 and 3 coding for structural proteins. There are currently no published data on nonstructural protein p22. Although it has been denoted as the 3A-like protein due to its locational homology in the NV genome when compared to the poliovirus genome, p22 shares no amino acid homology with poliovirus 3A. GFP-tagged p22, transiently expressed in 293T cells harboring replicating NV RNA, co-localizes with several non-structural proteins, suggesting its presence in a viral replication complex. When expressed alone, GFP-tagged p22 localizes to both the *cis* and *trans* Golgi apparatus at 6 hours post-transfection (hpt), however by 24 hpt p22 localizes solely to the *trans* Golgi. Interestingly, p22 is also able to mediate the phenotypic disruption of both the *cis* and *trans* Golgi by 24 hpt. Analysis of deletion mutants has shown the predicted transmembrane (TM) domain of p22, amino acids (aa) 110-128, as well as aa 50-102 are both necessary but not sufficient for Golgi localization. Sequence comparison of genogroup I and II noroviruses has revealed a fully conserved ESDG motif 40 aa N terminal to the predicted TM domain. Mutation of this sequence leads to complete localization of NV p22 to the endoplasmic reticulum (ER), indicating that the ESDG motif is an ER exit signal that is required for proper trafficking of p22. NV p22 also localizes to and phenotypically sequesters COPII vesicles, thus yielding a mechanism by which the Golgi apparatus is disrupted. Although aa 50-148 are sufficient to mediate COPII localization, they are unable to sequester COPII vesicles, indicating that the region of p22 responsible for COPII sequestration lies beyond these residues. These results suggest that NV p22 functions to mediate Golgi disruption by binding COPII vesicles, and accomplishes this by utilizing a TM domain in concert with a unique and previously uncharacterized viral ER exit signal.

7. Research implementation and results under the program

Title of your research plan:

Comparative Study Upon Genogroup I and Genogroup II Norovirus 3A-Like Proteins

Description of the research activities:

Using deconvolution microscopy, I have imaged 293T cells expressing the 3A-like (3AL) protein of the genogroup II U201 norovirus and determined its sub-cellular localization. Much like that of Norwalk virus p22, the homologue of 3AL, U201 3AL localizes to the Golgi apparatus late in expression, and mediates it's phenotypic disruption. Interestingly, it appears that the U201 3AL protein forms punctae both more frequently in cells expressing the protein (43.2% ± 6.2% vs. 72.7% ± 7.1%, respectively), and forms more punctae per cell than p22 (mode of 2 vs. 3, respectively). Moreover, the ESDG motif that was found to be critical to p22's localization appears to be similarly critical for the localization of U201 3AL, as mutating this sequence to all alanines leads to complete ER localization. Live cell imaging of cells expressing the U201 3AL protein showed the gradual accumulation of punctae in Cos7 cells. Initially, cells expressed many small punctae at remote locations of the cell, resembling Golgi localization, and later many of the punctae accumulated into just a few, large, peri-nuclear punctae. This confirms previous time-course experiments showing that the 3AL protein localizes in a manner indicative of gradual COPII sequestration near the ER, potentially at ER exit sites. Attempts to perform live-cell imaging of cells with COPII or ER exit site fluorescently labeled cells were unsuccessful primarily due to extreme tardiness in acquiring the required plasmids from a collaborating laboratory in the United Kingdom.

RESEARCH REPORT

1. Name: Alexander Shkolnik （ID No.: SP07048 ）

2. Current affiliation: MIT

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Advanced Industrial Science and Technology (AIST), Tsukuba

5. Host researcher: Dr. Shuuji Kajita

6. Description of your current research

At MIT I work with Russ Tedrake in the Robot Locomotion Group. I study locomotion, mostly of quadruped robots over rough terrain. The research uses a 20 Degree of Freedom robot, LittleDog, developed by Boston Dynamics, Inc. A controller for walking statically over rough terrain was developed by our group. However, walking with static stability does not guarantee stability when the robot actually moves, and furthermore is not acceptable for more difficult terrain, for example if the robot is require to jump over part of the terrain. My current research has been focusing on getting the LittleDog robot to stand up on its hind legs in order to place its front legs on a very tall obstacle. This is especially challenging because the robot has no ankles, and instead has “point feet” (like stilts) – so when standing on two legs, there is no actuation between the leg and the ground. All control must be done by moving the body mass. The research I did in Japan is very similar from a mathematical point of view; even though the robot is different – the control problem is similar.

7. Research implementation and results under the program

Title of your research plan:

Towards achieving foot roll in the HRP-2m biped robot

Description of the research activities:

In this project I worked with Choromet, HRP-2m, from General Robotix. This is a small, 35cm / 1.5kg, biped humanoid robot which has 20 actuated degrees of freedom (motors), and 26 total DOF, taking into account body pose. A simplified planar model with 7 degrees of freedom was constructed using Matlab – which included actuation of the ankles, knees, and hips, and one unactuated joint at the toe. To attempt to utilize optimal control techniques including value iteration, the model was further simplified so that four of the joints were servoed as functions of the toe angle, leaving only two joints to control: the stance ankle, and the swing hip. A feedback controller was developed in simulation which allowed the robot to walk using a very aggressive step with toe-roll.

This controller from simulation required precise knowledge of the angle between the ground and the stance foot – this is an angle which is difficult to measure or even to estimate from the available sensors on the actual robot. Because the robot has narrow but long feet, a side-to-side sway motion would be required for stepping forward. To try to keep things planar, we focused instead on stepping sideways, which is mathematically an equivalent problem. An openloop trajectory was found to produce the desired step, and feedback was added to minimize impact forces at the touchdown. This feedback included retracting the leg when collision was detected, and using force compliance on the foot to adapt to the ground (and to adapt to kinematic model inconsistencies, which turned out to be a big problem).

8. Please add your comments (if any):

This was an excellent program that allowed me to explore Japan while also getting some work done. I am grateful I had this opportunity to get to know many Japanese people, the Japanese culture, and to see the history which is so rich.

RESEARCH REPORT

1. Name: Elizabeth Ann Simpson （ID No.: SP07049）

2. Current affiliation: University of Georgia

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Neuroscience

5. Host researcher: Dr. Katsuki Nakamura

6. Description of your current research

My research at the University of Georgia has focused on the processing of emotional faces and voices in humans and monkeys. I have used event-related potentials to measure humans' brain responses to unattended emotional voices. However, we have not yet been able to apply this method to the study of emotional voice processing in monkeys. We need a different measure of emotional arousal to compare across species. In a related line of work, I am examining how humans and capuchin monkeys (*Cebus apella*) perceive and respond to emotional facial expressions of monkeys and humans. For this cross-species comparison, I am relying on behavioral measures, such as differences in response speed, as indices of emotional arousal. However, again we need additional measures to determine the degree to which an emotional expression influences the emotional state of the viewer. To this end, I carried out a project at the National Institute of Neuroscience, examining physiological responses of monkeys and humans in response to socioemotional expressions. Our goal was to test the application of a new and noninvasive measure of autonomic arousal: an infrared thermographic (IRT) system.

7. Research implementation and results under the program

Title of your research plan:

How to measure emotional arousal in nonverbal moving individuals? An infrared thermographic system can detect emotion-related temperature changes in humans and monkeys viewing digital stimuli

Description of the research activities:

Our goal was to test the IRT system in three ways: (1) determine whether we can measure emotion-related temperature changes in response to digital stimuli, (2) determine whether we can apply this method to moving individuals, and (3) test whether this method can detect temperature changes in human participants.

Using the IRT system, we measured temperature changes in a restrained rhesus monkey's (*Macaca mulatta*) nose. We used temperature change as an index of emotional arousal in response to digital social stimuli (i.e. 1-second video clips of coo, threat, and scream vocalizations made by 3 different monkeys; stimuli used in Kuraoka & Nakamura, 2006). Previous research (Nakayama, Goto, Kuraoka, & Nakamura, 2005) has indicated we can use the IRT system to measure monkeys' change in emotional state from neutral to negative, in response to *real* stimuli (e.g. threatening human with capture net). However, no researchers have used this method to measure emotional arousal to *digital* stimuli, which allow experimental control and direct comparisons within and across individuals and species.

To this end, we measured temperature changes to threat and scream vocalizations, considered negative, and coo vocalizations, considered more neutral (Hinde & Rowell, 1962; Van Hooff, 1962). We noted that the monkey's baseline temperature varied considerably from day to day (mean range: 7.27°C), indicating that prior to stimulus presentation the monkey often had a low nasal temperature. We excluded days in which average baseline nasal temperature was below 33°C, to ensure the monkey was not already in a negative emotional state prior to starting the trial. Once we did this, we found our predicted differences: scream and threat elicited greater temperature decreases than coo (-1.16, -1.15, and -0.76°C, respectively). Unfortunately, after the exclusion there were only a small number of trials, so we are currently conducting further tests using 10 second monkey threat video clips.

To confirm that the digital stimuli elicited an emotional reaction in the monkey we examined skin conductance responses (SCR), heart rate, and respiration. The SCR amplitudes for threat, scream, and coo were 0.19±0.08μV (mean±SEM), .15±0.06μV, and .07±0.02μV, respectively, indicating there was a greater emotional response to the negative expressions. While heart rate did not increase for scream and threat, relative to coo, there was increased respiration for the negative expressions. The change in respiration was significantly greater for scream (2±0.93), compared to coo (-0.17±0.87). We also measured the influence of movement on nasal temperature, and found a positive correlation ($r=0.70$, $p=0.01$), which should be explored further.

Our second goal was to determine whether we could apply this method—the IRT system—to a moving target. To this end, we measured temperature changes in unrestrained human participants (n=9) viewing emotionally arousing photographs (International Affective Pictures System; Lang, Bradley, Cuthbert, 2005). We placed markers on the participants' faces, which allowed us to track and correct for movements. Photos rated as emotionally arousing and negative did not elicit decreases in average nose temperature in all participants, as we predicted. There are a couple of possible reasons. The photos may not have been arousing enough, or the nasal bone may be thicker in adult humans and therefore temperature changes in this region

cannot be detected. Although we can employ this method to measure temperature in moving targets, we should confirm that humans show decreases in nasal temperature with more arousing stimuli (e.g. movie clips, or photos with emotional sounds), that elicit larger and more consistent temperature decreases. Additionally we tested our ability to employ this method on a moving nonhuman participant. We measured nasal temperature in a monkey, whose head was unrestrained, therefore confirming that we can apply this technique to moving nonhuman individuals as well.

Never before have we been able to measure autonomic arousal in a completely non-invasive and nonverbal way. Once further tests confirm our present findings, we can apply this method to the study more challenging nonverbal populations, such as infants and animals. This method also expands the contexts in which we can study emotional reactivity. Future research can examine emotional reactions of infants interacting with caregivers and nonhuman primates interacting with social partners. Thus, we can use the IRT system as a tool for unraveling the ontogenetic and phylogenetic development of socioemotional processing.

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RESEARCH REPORT

1. Name: Daniel J. Sindhikara （ID No.: SP07050 ）

2. Current affiliation: University of Florida

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Nagoya University

5. Host researcher: Professor Yuko Okamoto

6. Description of your current research

My current research with NSF/JSPS is the implementation, application and optimization of multicanonical algorithm replica exchange method (MUCAREM). The protein-folding problem has remained difficult to solve for decades. The inherent rugged energetic landscapes of proteins inhibit sampling rates during computer simulations thus prolonging simulation times to unreasonable lengths. My project is to implement into AMBER, MUCAREM, a highly efficient algorithm for solving systems with a rough energy landscape such as proteins. MUCAREM is a combination of two generalized-ensemble algorithms that take advantage of random walks in energy space to overcome potential barriers and hence alleviate kinetic trapping. MUCAREM can efficiently sample a molecules potential energy space while gathering entropic data in order to map continuous temperature ensemble space. These data will allow elucidation of such phenomena as first order phase transitions. AMBER is a worldwide-distributed molecular simulation suite. After the initial implementation, novel optimizations will be tested and implemented. The implementation of MUCAREM into AMBER would allow scientists worldwide to solve molecular systems such as proteins with high detail and speed.

7. Research implementation and results under the program

Title of your research plan:

Implementation of Multicanonical Algorithm Replica Exchange Method into AMBER

Description of the research activities:

Initially original references were consulted for MUCAREM and its predecessors. Discussions with Professor Okamoto solidified the logistics and specific goals of the project. Then, analysis software (custom WHAM) was written. This software is required to gather important parameters to run MUCAREM (these parameters allow the flattening of the energy landscape). Once this software was working properly, modifications were added the AMBER source code to initially run MUCA (the simplified version of MUCAREM). Through, Professor Okamoto other scientists were contacted to help understand the optimal manner of implementation.

In order to graduate the code from MUCA to MUCAREM, knowledge of parallel programming is necessary, thus many references were consulted. Finally, MUCAREM was implemented and tested in AMBER. It is currently working and will be included in the next release (AMBER10). Unfortunately, certain logistical problems with various supercomputer clusters have delayed the optimization research and application. But work can and will be continued in the US.

8. Please add your comments (if any):

Though the project has not been completely finished, I believe it has been a success since the majority of the work has been completed. Some simple testing can be done easily in the US. In addition to learning much information from Professor Okamoto, he has helped me meet some important contacts in Japan. I hope and plan on having further collaborations.

RESEARCH REPORT

1. Name: Jackson Sparks （ID No.SP07051 ）

2. Current affiliation: University of South Carolina Graduate School

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo, Graduate School of Frontier Sciences, Dept. of Integrated Biosciences

5. Host researcher: Kazushige Touhara

6. Description of your current research:

My laboratory (Vogt and Rogers) identified and characterized an antennal specific protein that is abundantly expressed in the receptor membranes of olfactory neurons of moths called Sensory Neuron Membrane Protein (SNMP). This work initiated as follow up of our previous specific labeling of a sensory membrane protein using a photoaffinity analog of the sex pheromone. SNMP is related to the CD36 class of receptor proteins, may of which interact with other proteins. We are exploring the function of SNMP, which we believe may interact with other proteins of the olfactory sensilla.

These studies are revealing molecular landscapes that have evolved to support olfactory based behaviors in an extremely large and diverse group of animals. The situation of these molecules at the literal interface between animal and environment makes these molecules particularly useful in understanding the molecular-genetic evolution of olfactory based behaviors.

7. Research implementation and results under the program

Title of your research plan:

Characterization of *Bombyx mori* Sensory Neuron Membrane Protein using Xenopus oocyte expression system

Description of the research activities:

Proposed functions of SNMP range from direct interactions with odorant binding proteins resulting in efficient shuttling or offloading of odorants to functional associations with traditional odor receptors. Xenopus oocytes provide a convenient way to probe for molecular associations and indirect effects of SNMP in a cellular context. Two-electrode voltage clamp recordings have already shown a voltage response specifically to Bombykol in oocytes expressing Bm-OR1 and BmOR2 (odor receptor complex). However, coexpression of SNMP with BmOR-1 and BmOR-2 in oocytes showed no noticeable change in response in oocytes to bombykol stimulation. Dose dependency and response amplitude and latency were examined. This suggests that SNMP does not directly interact with odor receptors in this context, or at least requires the presence of one or more mediators to do so. Further analysis of oocytes is required to ensure SNMP was actually localized in the membrane in these studies. Based on these results, the next step is to probe for interactions between SNMP and other members of the molecular cast in odor sensory neurons such as pheromone binding proteins. Identifying at least one specific binding partner or ligand for SNMP is tantamount for proper characterization. SNMP knockout insect are also being researched.

RESEARCH REPORT

1. Name: Ceren Susut （ID No.: SP07052 ）

2. Current affiliation: Georgetown University, Washington DC, USA

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
XChemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Hokkaido University

5. Host researcher: Dr. Masatoshi Osawa

6. Description of your current research

I am investigating the catalytic properties of platinum (Pt) nanoparticles of different size and shape for methanol electro-oxidation reaction.

In the quest for alternative energy sources, methanol is one of the most promising candidates thanks to its safety and the convenience of its storage. A direct-methanol fuel cell (DMFC) is an electrochemical cell in which electricity is generated from methanol. A simple DMFC consists of an anode at which methanol is electro-oxidized to carbon dioxide and a cathode at which oxygen is reduced to water.

Electrocatalysis of methanol oxidation is one of the main areas where serious improvements should be done in order to be able to advertise methanol fuel cell as a real commercial possibility . Few electrode materials are capable of adsorbing methanol and in acid solution Pt and Pt-based catalysts display the best catalytic behavior for methanol oxidation in terms of activity and stability. However, Pt anode is deactivated by even trace levels of carbon monoxide (CO). On the other hand, all studies in the literature indicate the CO as the dominant adsorbed species in the methanol electro-oxidation on Pt. Thus, the main challenge is to be able to make modifications on the Pt anode to maximize the adsorption of methanol while facilitating the oxidation of the poisonous CO to free more active sites.

It is well known that the catalytic activity of a single crystal surface depends critically on its surface orientation and the real world electrocatalysts used in fuel cells are dominantly made of transition/noble metal nanoparticles. Accordingly, the primary focus of my project is the controlled synthesis of Pt nanoparticles of different shapes so as to expose different orientations of the surface and the detailed study of methanol electro-oxidation on these particles. Recently, I further extended my investigation to Pt nanoparticles of controlled size as well as shape.

These investigations led to very surprising and intriguing observations which could give new insights about the mechanism of methanol electro-oxidation on Pt nanoparticles. The best way to study this mechanism is through monitoring the adsorbed species on my particles during methanol electro-oxidation by using an in-situ spectroscopic tool. Infra-red spectroscopy is well suited for this task and different techniques using external mode have been proposed for in-situ infra-red monitoring of electrochemical interfaces. Alternately, surface-enhanced infra-red absorption spectroscopy (SEIRAS), developed by Dr. Osawa, overcomes most of the drawbacks that arise as a result of using external mode

for examining electrochemical reactions. The interfacial spectroscopy laboratory led by Dr. Osawa in Hokkaido University is equipped with the latest technology for in-situ characterization of the adsorbed electrochemical species and that is why I wanted to work in his laboratory this summer.

7. Research implementation and results under the program

Title of your research plan:

Investigation of Methanol Electro-Oxidation Mechanism on Platinum Nanoparticles of Controlled Size and Shape by Surface-Enhanced Infra-Red Absorption Spectroscopy

Description of the research activities: I spent the first one and half week in Hokkaido by attending a very important conference in my field; International Conference on Electrified Interfaces (ICEI 2007) and its pre-symposium that took place in Hokkaido University. Dr. Osawa was one of the organizers of the conference and I got to have a poster presentation. This was an incredible opportunity for me because this conference takes place only every 4 years. After the conference I immediately started my training on SEIRAS. I quickly learned how to set up the electrochemical cell and how to operate the IR instrument. The concept of SEIRAS is not hard to grasp and the strength and practicality of the technique lies on its simplicity.

During this research I had the hardest time preparing the gold film required to enhance the signal coming from surface. In Dr. Osawa's laboratory, the gold thin films are prepared by electroless deposition. Although the procedure is very straightforward, one needs a lot of practice in order to get the films of the right thickness. Unfortunately, to this day, I am not capable of making good films by myself but the post-doctoral associates and graduate students working in Dr. Osawa's research group have been very helpful to me in preparing those films. With their help,

I was able to study the particles that were the most important to me, namely; mixed, cubic and octahedral/tetrahedral shaped Pt particles of 9-10 nm as well as Pt catalyst commercially available. These preliminary results indicate that the polymer that encapsulates the particles alters their surface properties although this observation needs to be corroborated by a lot more experiments.

On the other hand, the main purpose of my participation to summer program was to assess the feasibility of constructing, in our laboratory at Georgetown University, a set-up similar to the one in Dr. Osawa's laboratory. I gathered a lot of information regarding this issue and with Dr. Osawa's permission I took pictures of their set-up and sent them back to my advisor in USA.

8. Please add your comments (if any): JSPS summer program has been a great experience in every way. Not only I got to do research in a completely different environment but I also I got to meet other researchers from different countries including Japan, Germany, UK and France. I found Japanese people very polite and helpful and I'm grateful to everybody at Hokkaido University who helped me so much. I hope this experience will help me build scientific collaborations as well as strong friendships with some of the people I met.

9. Advisor's remarks (if any):

Two months were not enough to carry out all the experiments planed. However, she learned everything of surface-enhanced infrared spectroscopy (principle, optical setup, and procedures), so she can continue the experiments after going back to Georgetown University.

RESEARCH REPORT

1. Name: Dane Swango （ID No.: SP07053 ）

2. Current affiliation: University of California, Los Angeles

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Aoyama Gakuin University

5. Host researcher: Professor Yoshinobu Yamamoto

6. Description of your current research

My dissertation examines state participation and behavior in the nuclear proliferation control regime embodied by the Nuclear Nonproliferation Treaty (NPT). The inability of technical measures to detect noncompliance with NPT obligations, and the fact that some states are known to have violated their NPT obligations while members of the regime, calls into question the utility of the control regime as a device to promote cooperation through detection and punishment of states that violate their commitments. Furthermore, participation in the control regime is voluntary; states that do not wish to be constrained can leave the NPT. These facts raise three questions. The first is whether and how the NPT control regime, or alternative control regimes, can constrain states that are highly motivated to pursue a nuclear weapons option. The second is how states intent on cooperating assure other states they are complying with their regime obligations, given imperfect monitoring. The third is why participation in the control regime has varied over time, focusing particularly on the incentives built into the regime when it was being negotiated to encourage states to participate. My dissertation answers these questions using statistical, game theoretic, and historical methods. It also provides new evidence on states' nonproliferation behavior gathered through interviews conducted and documents collected during field research, as well as new evidence on the origins of the NPT control regime collected from archival sources.

7. Research implementation and results under the program

Title of your research plan:

Japan's Participation and Behavior in the Nuclear Proliferation Control Regime

Description of the research activities:

Principally, my research focused on arranging and conducting interviews with members of the national security community in Japan knowledgeable about the politics of Japanese nuclear proliferation policy and behavior. Interviews were conducted over a period of two months with five classes of individuals: reporters, academics, researchers in foreign affairs oriented public policy research organizations, current government officials, and former and current members of Japan's nuclear industry. Specific issue areas investigated during interviews depended on the background, interests, and willingness of subjects to answer questions, but generally fell along three dimensions. The first was the factors that caused delay in the ratification of the NPT by Japan. The second was the perceived utility of Japan's participation in the NPT as a device to assure other states of Japan's intent to refrain from developing nuclear weapons. The third regarded the application of nuclear safeguards in Japan, particularly concerning the Rokkasho plutonium reprocessing facility.

RESEARCH REPORT

1. Name: Elizabeth Dawn Swanner （ID No.: SP07054）

2. Current affiliation: University of Colorado-Boulder

3. Research fields and specialties:

Humanities Social Sciences XMathematical and Physical Sciences
Chemistry Engineering Sciences XBiological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: JAMSTEC

5. Host researcher: Dr. Ken Takai

6. Description of your current research

My research this summer consisted of identifying and quantifying the methanogenic inhabitants of hydrothermal chimneys in the Central Indian Ridge. I primarily used molecular methods to detect the *mcrA* gene, a genetic signature of a methanogen, from chimney fractions. I also performed high-pressure cultivation experiments in an attempt to culture native methanogens using a novel, high-pressure incubation system.

Previous JAMSTEC research led to the isolation from CIR of *Methanopyrus kandleri* strain 116, which produces isotopically "not-light" methane (i.e. more enriched in ^{13}C than what is generally ascribed to methanogens) under high-pressure or high H_2 concentrations. Because this "not light" methane signature is also observed in the CIR hydrothermal system, we wonder if the community of methanogens in CIR might also produce "not light" methane similar to strain 116. If so, it may fundamentally change common interpretations of "not light" methane in the deep-sea as having an abiotic, magmatic origin. As the CO_2 assimilated into strain 116 biomass also carries a "not light" signature, determining the ^{13}C signature of deep-sea biomass will inform the question of whether ancient hydrothermal systems, whose abundant geochemical energy may have nursed the cradle of life, carry a similar isotopic signature in residual organics. Gathering this evidence will help geochemists to better align the chronologic sequence of life's development on this planet.

7. Research implementation and results under the program

From quantitative PCR (qPCR) experiments, we discovered that methanogens make up to 10% of the microbes present in CIR hydrothermal chimneys, but in some chimneys account for much less than 1% of all microbes. Most of the sequences belong to *Methanococcales*, which is a thermophilic, methanogenic phylum of archaea. About 20% of Monju chimney *mcrA* clones were identified as *Methanopyrus*, which correspond to the isolate implicated in "not light" methane production under high-pressure or high H_2 cultivation. Greater diversity was found in Nura Nura chimney, located in an adjacent hydrothermal field from the three other chimneys. Nura Nura

additionally contained *mcrA* sequences from *Methanosarcina* and *Methanobacteriales*, as well as several anaerobic methanotrophs. Our high-pressure experiments indicated that methanogens were enriched only at 50°C and 70°C. These temperature regimes are within the range comfortable to *Methanococcales*, but are too low to be hospitable to *Methanopyrales*. Thus, future experiments to determine the isotopic fractionation of ^{13}C in biologically produced methane using the high pressure cultivation system will likely need to target *Methanococcales*, which from clone libraries appears to be the dominant phylum in CIR chimneys.

Title of your research plan:

Quantification and identification of methanogens in the Central Indian Ridge using quantitative PCR and high-pressure cultivation.

Description of the research activities:

Chimney samples were collected in February 2006 from hydrothermal fields in the Central Indian Ridge. The samples included lower temperature surface samples exposed to ambient seawater, and high temperature inside samples as well as those collected in an In situ Coloniztion System (ISCS) inserted into the chimney for several days. After extracting DNA from 10 different samples, I amplified the 16S rRNA gene from both the archaeal community and the entire microbial community, as well as the *mcrA* gene using qPCR. This was accomplished with newly designed *mcrA* primers, which were more sensitive to environmental *mcrA* sequences than anticipated, and will be a useful molecular tool in future studies. I subsequently sequenced the *mcrA* genes present in each chimney sample and constructed clone libraries. The distinctive clones were aligned in a phylogenetic tree to illustrate their relatedness to other *mcrA* sequences detected in deep-sea methanogenic communities from other hydrothermal sites.

Additionally, we began cultivation experiments with chimney fractions to identify the numbers of viable methanogens present in the original samples, as well as to determine at which temperatures CIR methanogens grow. We used a novel cultivation system capable of incubating methanogenic enrichments at high pressure and H_2 concentration, as well as at a range of temperatures (30°C, 50°C, 70°C, 85°C, 100°C). We incubated dilutions of one chimney sample at these various temperatures, and then checked for methanogenic enrichment using optical microscopy and the autofluorescence of F_{420}, a methanogenic co-factor, under UV light.

8. Please add your comments (if any):

I was happy to work on such a fascinating project and I hope my summer work will contribute to the study of the methanogenic communities in hydrothermal systems, and a greater understanding of some of the early inhabitants of our planet.

9. Advisor's remarks (if any):

She has worked hard during her stay in JAMSTEC. She has also experienced the deep-sea research expedition which was a very novel opportunity even for Japanese students. She has tried to learn the Japanese words, custom, ways of things and cultures. I hope that she is one of the most successful students among many students the JSPS summer program. I guess that she has enjoyed her summer in Japan and I also enjoyed this summer together with her.

Ken Takai, a program director, SUGAR Program, JAMSTEC

RESEARCH REPORT

1. Name: Carla Ann C Takaki Richardson （ID No.: SP07055）

2. Current affiliation: University of California, Santa Cruz

3. Research fields and specialties:

Humanities XSocial Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University, Osaka School of International Public Policy

5. Host researcher: Dr. Naoto Yamauchi

6. Description of your current research

My research focuses on emerging philanthropic activities in Japan among non-profit and non-governmental organizations and Japanese donors. Civil society activity has grown tremendously in Japan since the time of the Great Hanshin Awaji Earthquake of 1995. The quake, which left thousands dead and an infrastructure in ruins, provoked an outpouring of private donations and prompted public discussions on the need for social welfare and other services outside of government support. Since then, Japan has experienced a growth in non-profit organizations (NPOs) that aim to provide aid or advocacy both within Japan and in international arenas. The proliferation of these organizations raises a central question: how do these groups finance and promote their work? For many of these NPOs, charitable gifts are a modest but important source of revenue. At the same time, however, Japan is often dismissed as not having a philanthropic tradition and a weak or nonexistent civil society. Moreover, Japanese tax laws are such that charitable giving is not encouraged among individual citizens. My project aims to reconcile these two views by researching philanthropy and civic activity as an emerging social phenomenon.

This predissertation research therefore seeks to understand how Japanese NPOs continue and promote their work within a particular cultural and legal context. This summer, my research revolves around gaining a strong foundational understanding of philanthropy in Japan, including the mechanisms by which organizations solicit support, the laws and regulations they must follow, and the extent to which they rely on charitable gifts.

7. Research implementation and results under the program

Title of your research plan: Transformative Gifts: Charity and NPOs in Japan

Description of the research activities:

My research involved three primary activities: 1) Identifying and interviewing domestic and international NPOs within the Kansai and Tokyo areas; 2) Understanding the general climate of civil society activity in Japan; and 3) Preparing for long-term dissertation fieldwork by establishing a network of contacts.

1) Identifying and non-profit organizations with the Kansai and Tokyo areas

I conducted formal interviews in Japanese with 12 NPOs that covered a range of services including health, international aid, voluntarism, and environmentalism. These interviews lasted between 40 minutes to 1.5 hours in length, and involved speaking with staff members and, in some cases, volunteers of NPOs. The discussions covered programs, revenue, fundraising, voluntarism, the opportunities and challenges of NPOs in Japan, and motivations for donors and volunteers. I also had informal discussions with staff members and volunteers at approximately ten additional organizations, and conducted brief observations of fundraising practices among two organizations in Tokyo. The results of my interviews often agreed with existing non-anthropological work on philanthropy completed by Japanese researchers, particularly my own host professor, Dr. Naoto Yamauchi.

Most of the organizations I interviewed were small, with 1-4 paid staff, and most relied on volunteer labor. Many of the groups supplemented donations and membership fees with revenue from international study tours that combine tourism with volunteer work. While dependence on charitable gifts varied depending on the organization, even groups that relied on contributions did not have staff members dedicated to fundraising. Staff members instead juggle fundraising with all the other aspects of running an NPO. They also deal with infrastructural obstacles such as government regulations, and several noted that many people do not understand tax laws well enough for tax deductibility to be a motivation for giving (as it is in the US) because tax returns are often prepared by individuals' employers.

2) Understanding the general climate of civil society activity in Japan

In addition to discussions with individual nonprofits, I visited a number of resource centers, including piaNPO in Osaka, the Nagoya NGO Center, and the Hyogo NGO Support Office. These organizations are sometimes public/private hybrids and serve as outreach centers for people interested in donating to, working for, or volunteering at an NPO. They may also serve as resource centers for NPOs (providing office

space, for example, at low rates) and as outlets for the organizations to promote themselves through colorful pamphlets, glossy posters, and flyers. Over the course of my research I was struck by the sheer volume of information that organizations make available to the public, and the care with which this information is packaged and produced. This area has become a secondary research interest for me.

The resources offered by Prof. Yamauchi's NPO research center was also central to my gaining a better understanding of civil society in Japan. The Japanese written materials there exposed me to the depth and breadth of research (much of it unavailable in the US) conducted by Japanese researchers. It allowed me to better envision how an anthropological study might complement this existing work.

3) Preparing for long-term anthropological dissertation fieldwork

Anthropologists often refer to "finding one's feet" at a fieldsite, and the importance of becoming familiar with professional and social networks is crucial to this process. Prof. Yamauchi was extremely generous in introducing me to potential contacts, inviting me to seminars, and allowing me to sit in on meetings. I certainly hope to remain in contact with Prof. Yamauchi, and I will remain in touch with several of the organizations and individuals I interviewed for my dissertation-length fieldwork.

8. Please add your comments (if any): This has been a wonderful experience for me, both professionally and personally. I give my deepest thanks to Prof. Yamauchi for generously sharing his time and resources with me. I would not have been able to do much of my research without his hospitality. I also thank Takako Minami in Prof. Yamauchi's lab for her assistance and good humor.

9. Advisor's remarks (if any): While this is my first experience for hosting a graduate student from overseas, I am very happy to learn that Carla spent fruitful weeks in Japan. Indeed she has been very active in visiting various organizations and interviewing their staff members. I hope that her experience in this summer has real value-added as an initial investment for her dissertation research. As a comment for future improvement of a summer program, if the program started a few weeks earlier, participants could have enjoyed attending classes and meeting with more professors and graduate students at a host university in Japan.

RESEARCH REPORT

1. Name: Elena Tenenbaum （ID No.: SP07056 ）

2. Current affiliation: Brown University

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo University

5. Host researcher: Dr. Kazuo Hiraki

6. Description of your current research

Language learning occurs primarily in face-to-face interactions. Information available in facial expressions has been shown to facilitate language processing in both adults and infants. At Brown, we have been examining how English-learning infants, who are just beginning to speak, look at talking faces. American infants at this age tend to divide their attention equally between the eyes and mouth. The goal of my research this summer has been to run a parallel experiment with Japanese infants.

Some believe that Japanese and American adults maintain different patterns of eye gaze when conversing with others; it is argued that Americans engage in more eye-to-eye contact. If true, it is interesting to determine how early in development such patterns emerge. Within the first year of life, infants display knowledge of some of the essentials of conversation: sharing attention and taking turns. They are also becoming attuned to aspects of their native languages. This summer, I have been investigating whether or not infants at this age also show signs of becoming acculturated listeners.

An alternative hypothesis to this would be that eye gaze patterns among infants are universal. If these patterns are consistent across such distant languages and cultures, it would be possible to establish a baseline pattern for eye gaze at this age. Given available data on aberrant patterns of fixation among autistic children, this could provide a detection mechanism for autism significantly earlier than available methods.

7. Research implementation and results under the program

Title of your research plan:

Cross Cultural Infant Face Processing: An Eye Tracking Study

Description of the research activities:

I have spent my time in Japan creating stimuli, recruiting subjects, running and analyzing data. For my experiment, 14-month-olds visited Dr. Hiraki's Baby Lab at Tokyo University, and watched video clips of a Japanese woman speaking in infant directed speech. Throughout the video presentations, the infants' eye movements were tracked using a Tobii eye tracking system. I compared the fixation points of eye gaze from the Japanese infants to the data we had collected from the American infants.

Though there are a few potentially confounding factors yet to be resolved, preliminary data suggests that there may in fact be cultural differences in eye gaze patterns between the American and Japanese infants. Due to external constraints however, the Japanese and American infants tested thus far differed slightly in age, making it impossible to determine whether this effect was due to cultural or developmental differences. The current results suggest that American infants at 10-months divide their attention between the eyes and mouth approximately equally while 14-month-old Japanese infants focus predominantly on the mouth. Upon returning to Brown, I plan to redo the American study with 14-month-old infants to resolve the question of developmental versus cultural differences. It will also be necessary to run the Japanese infants through the American version of the study and vice-versa to establish that these patterns are not a function of the stimuli themselves. To address the unresolved concerns about the stimuli used thus far, it is my hope to collaborate with one of the graduate students in Dr. Hiraki's lab. With her help, I plan to continue investigating the validity of these preliminary findings.

8. Please add your comments (if any):

Thanks to the generous efforts of JSPS, NSF and Dr. Kazuo Hiraki at Tokyo University, I have had the opportunity to join an extraordinary lab this summer. Dr. Hiraki's guidance, as well as the input of lab members from a variety of fields has greatly enhanced the caliber of my research. The experience I have gained in conducting research and living in Japan these last two months has solidified my desire to pursue international collaboration in the future. The experience and future opportunities made possible by this program have been tremendous.

9. Advisor's remarks (if any):

Elena Tenenbaum has accomplished very good work in our lab.
She conducted an eye-tracking study on 14-month-old infants to
reveal preferences to facial parts on dynamic video clips and found very
interesting results. I hope the results will be combined with her future
study in the U.S. and will blossom into a cross cultural study.

Kazuo Hiraki

RESEARCH REPORT

1. Name: Andrew Tiedt (ID No.: SP07057)

2. Current affiliation: Fordham University, Department of Sociology and Anthropology

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Nihon University Population Research Institute/Advanced Research Institute for the Sciences and Humanities

5. Host researcher: Yasuhiko Saito

6. Description of your current research:

The demographic concerns of the 20th Century centered on limiting rapid population growth through the spread of information and policies concerning fertility control. In the early 21st Century the more developed world has been forced to shift its attention toward addressing a new concern—lowered fertility and mortality. The post-industrial world has seen its elderly population balloon in recent years, raising concerns over the ability of current healthcare and retirement programs to remain flexible in the face of the graying of society.

There has been considerable attention paid to the issue of population aging in Japan. Fertility has declined to 1.29 births per woman—well below the 2.1 births per woman necessary to maintain the current population size of 127 million (National Institute of Population and Social Security Research, Japan 2006). At the same time, improvements in health care and medical technology have resulted in longer life spans. Between 1970 and 1996, the proportion of citizens over the age of 65 doubled (Population Reference Bureau 2007). Today Japan has the world's highest life expectancy at close to 79 years for men and almost 86 years for women (Ministry of Health, Labor and Welfare, Japan 2007). The aging of the Japanese population (currently 20% over the age of 65) and subsequent rising dependency of the elderly on the working age population has raised concerns over the cost and availability of medical care, old-age dependency and overall changes in lifestyle (IPSS 2006; UN Bulletin: World Population Ageing 2003).

As has been the case in the past, families are expected to shoulder much of the burden for elderly caretaking. The Japanese family is ideologically centered in a Confucian, patriarchal tradition. This implies that sons and daughters-in-law are expected to take responsibility for aging parents. Many households consist of three to four generations, with the eldest son inheriting both property and the financial responsibility of supporting the parents. It is important to keep in mind that spouses are the most-likely caretakers of the infirm elderly. According to data provided by the International Longevity Center of Japan, wives, daughters and daughters-in-law currently provide approximately 80% of elderly care in Japan (ILC, Japan 2007).

The working age population is shrinking in relation to the elderly. Since, in the modern era, both men and women can be expected to work outside of the household, there is a need to identify who provides informal family care. This research project addresses recent concerns over lowered fertility and mortality in Japan and the subsequent growth of the nation's elderly population. The experience of family caregivers and the gendered division of labor was examined as central to the problem. The project utilized a survey questionnaire to record the experiences of 35 Japanese citizens who either cohabit with family over the age of 65 or are 65 and older themselves. This study has focused on understanding the role of gender in determining who performs care-related tasks. I also examined the relationship of the caregiver to the recipient, attitudes towards household activities and levels of depression experienced by family caregivers.

7. Research implementation and results under the program:

The instrument of data collection for this research was a survey questionnaire. This questionnaire was created for Japanese respondents under the supervision of the faculty and staff of Nihon University. The questionnaire was based on both the International Social Survey Program's Family and Changing Gender Roles Survey (ISSP 2004) and Nihon University's Japanese Longitudinal Study on Aging (NUJLSA 2007).

A total of 35 surveys were collected for this research project from 21 women and 14 men. Although 45 to 50 questionnaires were distributed and returned, several could not be added to the data set due to incorrect, inconsistent and missing information or a withdrawal of participation on the part of the respondent. 20 to 70 additional surveys will be added to the dataset by the end of September, 2007. The Survey Questionnaire consisted of 30 questions, which were subdivided into 91 items, or variables, for data analysis. The first set of questions was designed to collect demographic data and included items on kin relationships. Another set of questions collected information on the division of household labor, including the amount of care provided for family members. Respondents were asked to indicate whether housework and care were provided by themselves, divided equally in the household or provided entirely by another person. Those answering "another person" were then asked to specify whether the work was done by a household member, non-household kin or a care service.

Further questions measured the respondents' attitudes about gender roles on a five point, Likert scale. For example, item 12.1 of the questionnaire states "When a woman works full time, family life suffers." Respondents then circled the answer that matched their attitude on a scale from strongly agree to strongly disagree.

Another set of 20 statements designed to measure depression was based on the Center for Epidemiological Studies' Depression scale. This questionnaire used a translation that had been previously tested in the field by Shima, Shikano, Kitamura and Asai (1985). Finally, the survey questionnaire contained items concerning the relationships between caregiver and care receiver, the caregiver's sense of well being and the accessibility of transportation, hospitals and care centers in the respondents' neighborhood.

Although data analyses can not be completed until all surveys have been collected and the information they contain coded, some descriptive statistics follow. Women and men were equally likely to cohabit with family members (71% of both men and women). All who did not cohabit with family members were over the age of 65. The male sample was older than the female sample (Men averaged 64 years, while women averaged 57). 50% of men and 67.2% of women cohabited with a family member over the age of 65. Although women reported coresiding equally with fathers (19%), both parents (19%) and spouses (19%), men most frequently reported living with spouses alone (35.7%). In addition, no men resided with their in-laws, while 9.5% of women responded that they did. This information is not surprising in light of the fact that women live longer than men and make up over 80% of informal family caregivers (ILC 2007).

There was a very slight difference between men and women on the depression scale, with men scoring an average of 12.38 and women 13.52, with higher scores indicating greater levels of depression. Women on average reported more combined hours of housework and care per day than men (2.92 hours versus 1.35 hours) and more hours of overall care (1.09 hours versus 0.28 hours). Men reported working, on average, 3.92 more salaried hours per week than women. It is important to keep in mind that 62.9% of the sample was 65 years of age or older. Among respondents living with spouses 65 years old and older, men averaged a higher score on the depression scale than women (10.66 versus 6.50).

It is critical to note that many men and women over the age of 65 lived alone (40.9% of respondents over 65). This may be a phenomenon associated with Tokyo residents and may also reflect socio-economic status. Several respondents expressed a preference for living independently, even if it meant living alone, while filling out the questionnaire. These attitudes contradict assumptions concerning cohabitation among generations in Japanese families. About a fifth of survey respondents have actively provided care in the past year (21.4% men, 23.8% women), although many over the age of 65 expressed that they have at some point in their lives. Most respondents, although aware of caregiving services provided by the state and neighborhood care centers, conveyed a reluctance to use such care unless absolutely necessary.

Title of Research Plan: Elderly Caregiving in Japan: Dependency, Gender and Intergenerational Exchange in an Aging Society

8. Please add your comments (if any):

A full data analysis will be performed upon receipt of the remaining surveys. This investigation has been limited by the time available for data collection. However, it is apparent that greater attention needs to be given to respondents' socio-economic status, when considering the choices available for residency. The survey would benefit from further questions regarding income, including access to retirement benefits, and property ownership. In addition to an obvious correlation between the amount of care provided to family members and gender, there appear to be correlations among depression, socio-economic status, caregiving and gender.

9. Advisor's Remarks (if any): N/A

0RESEARCH REPORT

1. Name: Alison Ting （ID No.: SP07058 ）

2. Current affiliation:

Department of Molecular and Integrative Physiology
University of Kansas Medical Center
Kansas City, KS, U.S.A.

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:

Tokyo University of Agriculture and Technology
Fuchu City, Tokyo, Japan

5. Host researcher:

Dr. Taya Kazuyoshi

6. Description of your current research

Breast and ovarian cancer affect over 1.3 million women worldwide each year. Women at increased risk for breast cancer are also at increased risk for ovarian cancer, and vice versa, reflecting common risk factors and intertwined etiology of the two diseases. These common risk factors include age, genetic predisposition (BRCA1/2 mutation), personal or family reproductive history, lifetime exposure to estrogen and diet. Our laboratory has developed a preclinical model of simultaneous breast and ovarian cancer that resembles the human condition more closely than separate models of the two diseases to investigate common pathways and potentially common prevention strategies of the two diseases.

Inhibins are member of the transforming growth factor beta (TGFß) superfamily that are central to the regulation of reproductive endocrinology and are involved in the etiology of cancers in women. Like other members of the TGFß superfamily, inhibin interacts with cell surface receptors and regulates cell proliferation, differentiation and neoplastic transformation. Alteration in these regulatory molecules may lead to the development of cancer. In this project, the role of inhibin in 2 cancers of the reproductive organ in women, breast and ovarian neoplasia, is examined. Indeed, inhibin has bee shown to be present in breast epithelia and the ovary; however, the correlation between inhibin expression and breast and ovarian cancer has been controversial. **Our central hypothesis is that inhibin subunits have a direct role in breast and ovarian cancer progression and suppression and that the levels of inhibin will correlate with the disease state in the rat.** In addition to local inhibin subunit expression examined by immunohistochemistry, serum levels of inhibin, and other reproductive hormones/peptides including FSH, LH, progesterone, and prolactin will be measured using radio immunoassay technique. The result of this project will provide important insight to the combined etiology of breast and ovarian cancer as well as an additional biomarker for cancer assessment of the breast and ovary.

7. Research implementation and results under the program

Title of your research plan:

The Role of Inhibin Subunits and Other Reproductive Hormones in Breast and Ovarian Cancer in a Preclinical Model.

Description of the research activities:

1. Radioimmunoassay (RIA)

Concentrations of inhibin, LH, FSH, and prolactin were measured using homologous double-antibody equine RIA method. Hormones for iodination were rat LH-I-7, rat FSH-I7 and rat prolactin-I-5. Plasma concentrations of progesterone were determined by double-antibody RIA systems using ^{125}I-labeled radioligands. Plasma inhibin concentrations were measured using a rabbit antiserum against purified bovine inhibin (TNDH 1) and ^{125}I-labeled 32-kDa bovine inhibin. Each RIA was performed with triplicate standards and duplicate samples.

2. Immunohistochemistry

Six-micron sections of mammary glands and ovaries were deparaffinized, rehydrated, and prepared for immunostaining by antigen retrieval (121°C, 10mM citrate buffer) and incubation with 3% hydrogen peroxide. Non-immune serum or primary antibody against inhibin subunit βB (1:1000; rabbit monoclonal antibody, Clayton Foundation for Peptide Biology, Salk Institute for Biology Studies, La Jolla, CA) was applied and visualized with diaminobenzidine (DAB, Sigma) and biotinylated secondary antibodies (Vector Laboratory).

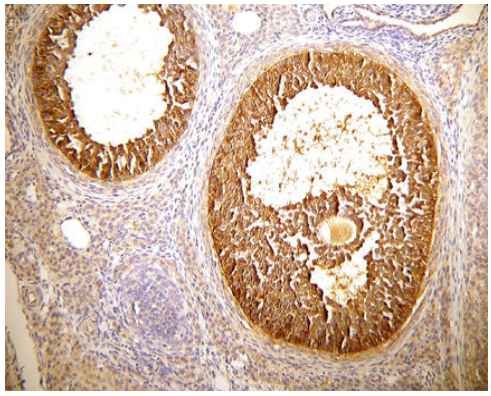
Research results:

1. Serum levels of LH (ng/ml), FSH (ng/ml), inhibin (pg/ml), progesterone (ng/ml) and prolactin (ng/ml) for controls (CONT), tamoxifen-treated (TAM), estradiol-alone treated (EC), carcinogen-treated (CARC), and CARC+TAM rats:

	CONT	TAM	EC	CARC	CARC+TAM
LH	3.14±2.24	5.41±5.26	0.038±0.0084	0.043±0.004	0.112±0.080
FSH	5.58±1.30	4.40±1.78	1.84±0.11	2.27±0.12	2.07±0.23
Inhibin	2.90±0.468	2.37±0.26	1.99±0.43	1.17±0.191	1.53±0.28
Progesterone	30.1±6.74	26.6±9.84	13.3±4.74	9.89±1.75	18.6±3.65
Prolactin	136.9±56.9	109.07±55.4	259.3±13.3	3613.2±1540.3	431.3±60.44

- LH and FSH levels were abolished in estradiol-alone, carcinogen- and carcinogen+tamoxifen-treated rats when compared to controls and tamoxifen-alone-treated rats. Inhibin serum concentration was decresed in carcinogen-treated rats when compared to controls. Progesterone serum levels were decreased in estradiol-alone, and carcinogen-treated groups when compared to controls. Prolactin levels were markedly elevated in carcinogen-treated animals when compared to controls.

2. Immunohistochemistry:



Inhibin subunit βB antibody was used to investigate the protein expression of this subunit by immunohistochemistry. Inhibin βB is localized in the cytoplasm (see figure) and is found in late antral follicles (strong immunoreactivity), some small size follicles (medium to strong immnunoreactivity) and some corpra lutea (weak immunoreactivity). The correlation between inhibin βB immunoreactivity and different treatment groups has not been determined. However, based on the initial observation, inhibin βB expression may be decreased in the mammary gland corresponding to the progression to mammary cancer. In this ovary, since the organization of ovary varies among different treatment groups, it is difficult to summarize the result before detailed quantitation which will be done in the United States along with the final quantitation of the mammary gland.

RESEARCH REPORT

1. Name: Conrad S. Tucker （ID No.: SP07059）

2. Current affiliation: University of Illinois, Urbana-Champaign

3. Research fields and specialties: Multidisciplinary Design Optimization, Product Family design, Data Mining

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kanazawa Institute of Technology

5. Host researcher: Professor Kazuyoshi Ishii

6. Description of your current research:

My current research involves the design and development of a *product family* based on a set of reconfigurable *product architectures*. My research can be partitioned into two separate research domains; The first is the development of a predictive data mining methodology in the context of new product development. This design paradigm involves the accurate analysis and characterization of customer attributes based on extremely large customer databases that in many instances cannot be analyzed in a timely and efficient manner by personnel. Consequently, predictive data mining algorithms based on machine learning theories are presented that can achieve this goal. Novel, previously unknown patterns can therefore be extracted from these large data bases and serve as a guide in the new product development process.

The second research domain involves the research of product families in the product portfolio design process. A *product family* can be defined as a set of product variants that evolve from an existing product architecture. A *product architecture* can be thought of as the amalgamation of components necessary for the establishment of product design functionalities demanded by customers. My research addresses this product design challenge from a multidisciplinary design standpoint by creating a synergy between multiple facets of the product design process; I.e., Marketing, enterprise decision makers, engineering design team, manufacturing and supply chain management, etc. The resulting product design solution therefore satisfies the design constraints of each product design team.

Customer predictive information acquired by the data mining approach are set as targets at the engineering design level and subsequent product design solutions are achieved by attempting to satisfy the predictive customer functionality requirements. The overall product design phase is modeled as a multi-level optimization problem and an optimal solution is that which maximizes enterprise profit while concurrently satisfying customer wants.

7. Research implementation and results under the program

The research conducted at Kanazawa Institute of Technology (KIT) was divided into two stages. The first stage involved the expansion of the predictive data mining methodology to include multi-class predictions. In the product development process, the product performance evaluation process is in many instances made on multiple degrees of product functionality. Consequently, a major focus of the summer research was to expand the current predictive data mining methodology to include predictions across multiple dimensions. The application case study for such an approach included a reconfigurable vehicle prototype currently being developed by the aerospace /mechanical engineering departments at KIT. A major source of interest in this case study is the level of customer performance requirements for such a design. The reconfigurable vehicle prototype is evaluated based on multiple levels of performance, both on the road and in the air. The multi-class data mining approach therefore would allow customer attribute predictions that would provide the needed product design functionality criteria for the hybrid land-air vehicle. Although at its infancy implementation stage, the hybrid reconfigurable land-air vehicle has great potential to be a tangible product design in the future that could benefit from the incorporation of multi-class data mining predictive techniques.

The second stage of the summer research included a series of company visits to investigate the current product development strategies being utilized by leading Japanese companies. The major benefit of the company visits was the ability to personally interact with high level members of the research and development teams. Since my current research primarily focuses on product family formulation, data was acquired from several Japanese companies that presented their overall product development methodology. It was interesting to realize some of the differences that exist between actual industry/company practices, and the assumptions made by the academic research community in the product development process.

Eizo Company specializes in the design and manufacture of high end LCD displays for medical, personal and industrial consumer markets. After meeting with the CEO and Manager of R&D operations, several potential applications were identified that would be beneficial to both the industry and academic fields.

A technical visit was also paid to Kanazawa Murata company to investigate their current product *commonality methodology*; an academic research domain that is gaining much attention in the research community. Kanazawa Murata company is unique in that they are not a final product assembler, but rather a component manufacturer and supplier. This allowed us to further understand the different approaches needed for catering to highly specialized customers such as a final product assembler (Kanazawa Murata's primary customer base and major source of annual sales).

Ishikawa Seisakusho LTD is a company that specializes in the design and manufacturing of mechanical sewing machines and other industrialized machinery. During our technical visit, we were able to understand the effect of product commonality decisions and the changes in customer performance requirements. Although this company serves a highly specialized and diversified customer base, they are able to achieve up to 50% product component commonality across product families

which made their manufacturing process more efficient and allowed for added cost savings and increased revenue. Further efforts are being made to increase the product component commonality abilities in the future.

Title of your research plan:

Multi-Class Data Mining Methodology in Product Family Development

Description of the research activities:

Research activities at Kanazawa Institute of Technology took a multidisciplinary design approach to solving the product family design problem. The Ishii research laboratory collaborated with researchers in the aerospace and mechanical engineering departments in applying the multi-class data mining methodology to the hybrid vehicle prototype. The expansion of our proposed product family methodology hopes to utilize multi-class data mining predictions to serve as customer predicted targets and allow for the design of a more profitable (based on an increased customer satisfaction level due to a closer match between engineering design and customer needs) product portfolio.

The Ishii lab conducted five technical company visits with the aim of understanding the product family design methodologies currently being utilized by several Japanese companies in the consumer electronics and manufacturing machinery industries. The company visits, spread out through the course of the 8 week summer research project allowed us to meet with high level R&D managers and in some instances the CEO of these multi-billion dollar companies. The results of these interviews will help strengthen the understanding of real life company practices in the academic research domain.

8. Please add your comments (if any):

The EAPSI program, funded by the NSF and JSPS is one of the greatest experiences of my life. It allowed me the opportunity to collaborate with researchers in one of the worlds leading technological nations, while at the same time enabling me to understand many of the cultural aspects of Japan that make it such a unique and interesting place. My only complaint is that the weeks seemed to fly by too fast and before I realized, it was time to say farewell. The experiences that I gained will last a lifetime and the friendships, just as long.

RESEARCH REPORT

1. Name: Tannen S. VanZwieten （ID No.: SP07060 ）

2. Current affiliation: University of Wyoming
Department of Electrical and Computer Engineering

3. Research fields and specialties:
Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Japan Aerospace eXploration Agency (JAXA), Sagamihara Campus

5. Host researcher: Dr. Shinsuke Takeuchi

6. Description of your current research

The Japan Aerospace eXploration Agency (JAXA), NASA and other agencies have recently been looking beyond conventional propulsion methods for a low cost, light, efficient means of traveling through the solar system. The use of Solar Sail technology appears to be a viable option. Solar Sails are made up of a large mirror-like surface that reflects sunlight to create free acceleration, thereby providing propellantless thrust.

JAXA has focused their development efforts on the spinning-type Solar Sail that uses the centrifugal force to maintain tension in the membrane. While this is advantageous for weight reduction, the sail's rotation coupled with its large size and membrane-like dynamics creates a challenging control problem. This may be further complicated by excitation from a variety of disturbances, including gravity, magnetic field interaction, thermal gradients, slew maneuvers, and even the control actuators themselves. My research at JAXA was focused on designing a control algorithm to mitigate unwanted vibrations in a spinning-type Solar Sail.

7. Research implementation and results under the program

Title of your research plan: Solar Sail Control for Vibration Suppression

Description of the research activities:

Repeated testing and tuning of a controller on an actual Solar Sail in space is not feasible, making the use of simulations as a development tool absolutely essential. Thus, the first component of my summer research focused on modeling and simulating a spinning-type Solar Sail. A nonlinear, lumped mass Solar Sail model was supplied by the JAXA. This model includes the forces due to membrane stiffness and damping as well as the spin-induced angular acceleration, centrifugal, and Coriolis forces. Solar radiation pressure on each element was also considered.

While working at JAXA, this simulation was linearized, simplified, and put into state space form to facilitate control design and analysis. Assuming the angular velocity was constant eliminated the angular acceleration term, and allowed the centrifugal and Coriolis forces to be put into a linear matrix form without any further simplifications. The linear spring forces were found via the Jacobian matrix for each connection. The in-plane component of the spring force was linearized about the initial, unstretched, flat sail position. However, the use of this initial condition for the out-of-plane component resulted in a complete loss of the force in this direction, including its coupling with the two in-plane components. Therefore, this particular initial value was perturbed slightly such that transverse vibration frequency of the model was close to what would be expected for the actual Solar Sail. Damping forces are hard to accurately model and they have the effect of increasing the system stability, so these were removed from the simulation to give a "worst case scenario" from a control perspective. This change has the added benefit of increasing the computation speed. Linearization of the solar radiation pressure to form the input matrix forced its directional component to be static. Thus the photonic pressure was assumed to act perpendicular to the initial, flat surface of the sail, which gives a close match to the original, nonlinear force for small amplitude vibrations.

The linearized equations of motion contained an unwanted offset that was removed by defining new system states via a linear coordinate transformation of the physical coordinates. The resulting linear, simplified state space model was validated by comparing it to its nonlinear counterpart using both numerical simulation results and a comparison of the magnitude of the spring forces connecting an arbitrary set of nodes. All simulations were performed in Simulink and Matlab with a total of 48 nodes, corresponding to 144 elements and 288 states.

Two control approaches were considered: (i) Reduced Order Model (ROM) based control, augmented with a Residual Mode Filter (RMF) and (ii) adaptive control. Because of adaptive control's distinct ability to self-tune to accomplish the vibration suppression goals, it is a good fit for the Solar Sail. Parameter errors due to variations

in design fabrication and modeling inaccuracies, fluctuations caused by changing rotation speeds, disturbances, and possible partial failures in deployment make the extra layer of robustness that adaptive control offers particularly appealing for this application.

A Model Reference Adaptive Control architecture was designed such that the actual system mimics the behavior of a reference system. The was achieved by designing the adaptive control command so the Solar Sail output converges to the reference model output, while the reference output itself converges to the desired output (which is zero in this case). The reference system was designed based on a set of second order oscillators and used to provide smoother convergence to the desired output. The coefficients were tuned so the natural frequency of the oscillator matched that of the Solar Sail's first mode of vibration. The reference system damping can be modified to adjust the rate of convergence.

Simulation results for the aforementioned MRAC were obtained for a velocity output at a node on the outer edge of the sail. The control input was applied to the surrounding elements by modifying their reflectivity. The controller successfully reduced the transverse vibration for the node under consideration. Given enough time, the vibration at other locations on the sail would also be attenuated. However, a more practical vibration suppression solution would be to simply control the reflectivity for a larger number of elements. The simulation and controller can be easily modified to control a larger number of elements and nodes, but memory allocation errors are likely to become an issue for simulations on a normal desktop or laptop computer.

8. Please add your comments (if any):

This was a great opportunity for me to perform Solar Sail research with the first and only aerospace agency to have deployed one in space. I enjoyed working within this agency, learning about the research that other Japanese agencies and universities have done in this area, and also familiarizing myself with the Japanese science infrastructure. Many wonderful Japanese people who I met warmly welcomed me into their country and even their homes, giving me a taste Japanese culture and hospitality. Many thanks to the people who have worked behind the scenes at JSPS and NSF to make this opportunity possible.

9. Advisor's remarks (if any):

I think the result is challenging and interesting in the view of realization of Solar-Sail spacecraft. In the current state of research, that is just start point, the result is not perfectly sufficient one, however it shows some capability for future application in Solar-Sail. I hope this research is continued in the future.

RESEARCH REPORT

1. Name: Nicholas L. Venti （ID No.: SP07061）

2. Current affiliation:

University of Delaware, Ph.D student

3. Research fields and specialties: paleoceanography, geochemistry, micropaleontology

Humanities Social Sciences x_Mathematical and Physical Sciences

Chemistry Engineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Hokkaido University, Sapporo

5. Host researcher: Dr. Hiroshi Nishi

6. Description of your current research

Dramatic fluctuations in global ice volume during the Pliocene onset and intensification of Northern Hemisphere Glaciation (NHG) relate to Earth's 41,000-year obliquity cycles. The exact causes of this link are unknown, but the details of the relationship between ice volume and obliquity might reveal important insights into the conditions necessary for the formation and retreat of large continental ice sheets. We do know, however, that some combination of cool summers and snow are required to form glaciers. One theory speculates that a warm North Pacific Ocean provided a moisture source for the snow that became the Northern Hemisphere glaciers.

In order to test whether Northern Hemisphere Glaciation was linked to changes in the intensity of the North Pacific subtropical gyre, I am investigating orbital-scale changes in subtropical surface ocean temperatures in the North Pacific during the onset and intensification of NHG (~5-2 million years ago). Using the foraminifers preserved in the deep-sea sediment on Shatsky Rise I will reconstruct relative surface temperature changes on obliquity timescales. Specifically, my multi proxy approach includes three $\delta^{18}O$ records in planktic foraminifers (a summer and a winter record to quantify seasonal temperature changes, a thermocline $\delta^{18}O$ record to constrain relative mixed layer depth) and, in support of the link between $\delta^{18}O$ and temperature changes, a planktic foraminiferal diversity record and census data. In order to test that changes in surface temperatures are related to ice volume fluctuations, as implied by obliquity-scale cyclical changes in mineral composition of the North Pacific sediments, I am also constructing an obliquity-scale benthic foraminiferal (*Cibicidoides*) $\delta^{18}O$ record.

7. Research implementation and results under the program

Title of your research plan:

Comparing Cenozoic Foraminifer Taxonomy in the United States and Japan

Description of the research activities:

Age control for many marine sections relies heavily on planktic foraminifer biostratigraphy. The accuracy of these biostratigraphies depends in turn on agreement among workers to identify foraminifers according to well-defined taxonomies. In order to test consistent application of these taxonomies, I proposed to compare taxonomic concepts of Cenozoic planktic foraminifers with a Japanese micropaleontologist.

According to the taxonomic concepts described and illustrated by Bolli et. al., (1985), Pearson et. al., (2006), and Leckie et al., (1993), Dr. Hiroshi Nishi and I identified over 100 species of planktic foraminifers from the Paleogene section recovered from ODP (Ocean Drilling Program) Site 1260 on Demerara Rise in the western tropical Atlantic. Before working with any of this material, however, I spent approximately one month familiarizing myself with Paleogene planktic foraminiferal species using the type specimens of Dr. Nishi's previous advisor, Dr. Tsunemasa Saito, and the assemblage slides from neighboring sections on Demera Rise (ODP Sites 1258 and 1259) prepared by Yasutaka Ose, a recently graduated masters student of Dr. Nishi.

Planktic foraminifer specimens were identified in the >125μm fraction of four 2-cm interval samples from Site 1260, Hole A: Core 2-1, 100; Core 2-2, 100; Core 6-1, 100, and Core 27-5, 100. Over 50 species of planktic foraminifera were identified in Section 1260A, 2-1, 100, which consisted of reworked middle and early Miocene material in the Oligocene section. In Section 1260A, 2-2, 100, an Oligocene sample, some 25 species were identified. Some 30 species of planktic foraminfera were identified in Section 1260A, 6-1, 100, a middle Eocene sample. And in the lower Eocene sample, 1260A, 27-5, 100, some 25 species of planktic foraminifera were identified. Foraminifers are well-preserved in all four samples, although in 1260A, 6-1, 100 radiolaria dominated foraminifers in abundance and in 1260A, 27-5, 100,

calcite cement inhibited identification. I did not work with any upper Eocene material because most of the upper Eocene was missing from Site 1260.

References:

Bolli, H. M., Saunders, J. B., and Perch-Nielsen, K., (*Eds*.), 1985. Plankton stratigraphy, Cambridge University Press, Cambridge, Great Britain.

Leckie, R. M., Farnham, C., and Schmidt, M. G., 1993. Oligocene planktonic foraminifer biostratigraphy of Hole 803D (Ontong Java Plateau) and Hole 628A (Little Bahama Bank), and comparison with the southern high latitudes. *In* Berger, W. H., Kroenke, L. W., Mayer, L. A., et. al., *Proceedings of the Ocean Drilling Program, Scientific Resuslts*, College Station TX, 130:113-136.

Pearson, P. N., Olsson, R. K., Huber, B. T., Hemleben, C., Berggren, W. A., (*Eds*.) 2006. Atlas of Eocene planktonic foraminifera, Cushman Foundation Special Publication No. 41.

8. Please add your comments (if any):

In coming to Japan I wondered whether an American and Japanese micropaleontologist could agree as to the identity of foraminiferal specimens. I was pleasantly surprised when Nishi-san referred me to western atlases as taxonomic guides, though Nishi-san's teaching methods differed from Mark's. At UMass, Mark let me learn by trial and error, instructing me to pick through material and group like specimens together. Later we sat down together and assigned names to them. On the other hand, Nishi-san collected type specimens of his teacher, Dr. Saito, his masters student's picked assemblage slides, and referred me to the Eocene atlas of Pearson et. al. (2006). I spent a full month making a poster and studying the already identified specimens before identifying specimens in new material. Though my tenure in America and Japan provides only an anecdote, in general, Nishi-san and I (and probably my previous advisor, Dr. Mark Leckie) agree in our application of foraminifer taxonomy.

RESEARCH REPORT

1. Name: Aaron Wech (ID No.: SP07062)

2. Current affiliation: University of Washington

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Research Institute for Earth Science and Disaster Prevention

5. Host researcher: Dr. Kazushige Obara

6. Description of your current research

I am investigating a unique earthquake phenomenon known as episodic tremor and slip (ETS) which is characterized by deep low-frequency tremors that last for days or weeks and are coincident with the observation of approximately 2 cm of anomalous retrograde plate motion. These periodic ETS events have been best observed in the northern Cascadia subduction zone of the Pacific Northwest, and beneath Shikoku, in southwest Japan. Given the low signal to noise ratio of tremor energy, difficulties arise in the application of standard seismological tools to elucidate the nature of the tremor source. By studying the amount and direction of ground motion directly above tremor sources, I am exploring the connection between seismically observed tremor and geodetically observed slow slip. Previous results from the northern Cascadia subduction zone indicate that the direction of ground motion measured at seismographs directly above tremors is aligned with the direction of plate convergence between the descending oceanic plate and the stable continental plate. This directional alignment can be explained by characterizing the tremor source process as fault slip on the interface of the two converging plates. The dense Hi-Net seismograph network provides a perfect opportunity to further test this hypothesis in Japan by comparing the observed ground motion direction at many stations above or near the tremor with predictions from a fault slip model.

7. Research implementation and results under the program

Title of your research plan:

Polarization investigation of Japanese tremor source mechanism.

Description of the research activities:

I examined the March 2007 Episodic Tremor and Slip (ETS) event that occurred beneath Shikoku, Japan. The event began on March 13 in western Shikoku and migrated towards eastern Shikoku over the next 9 days. Due to the nature of this migration, it was possible to analyze the event in its entirety in addition to making a direct comparison of the tremor polarization characteristics between the eastern and western parts of Shikoku. This comparison yielded unexpected differences between the two regions.

I examined 9 days of continuous data from 11 3-component Hi-net stations, 5 in western Shikoku and 6 in eastern Shikoku. I analyzed the data in 4 different frequency bands and used two different time-window lengths. I first bandpass-filtered the data into the tremor frequency band of 2—8 Hz. I then removed the mean and computed the covariance matrix. The dominant eigenvector of this resulting covariance matrix is the polarization direction. Furthermore, the amount of energy exciting this dominant direction can be quantified by computing the linearity using a ratio of the dominant eigenvalue to the remaining eigenvalues. At all stations I observed the linearity, polarization azimuth, and polarization dip. There didn't seem to be any strong correlation among tremor occurrence and polarization linearity or azimuth. However, for both regions and in all frequency bands the polarization dip angle was observed to decrease to near zero during periods of high tremor activity. Despite a lack of high linearity, the shallow dip angles implied stronger horizontal ground motion than vertical.

This process was applied to 2—8 Hz, 4—10, 1—6 Hz, and 2—4 Hz frequency bands. The latter of which revealed the most stable results. This frequency band dependence is likely related to large amounts of wave scattering at higher frequencies due to crustal heterogeneities.

In eastern Shikoku daily histograms of polarization azimuths associated with dip angles less than 30 degrees revealed a strong peak at an azimuth of 300^{o} east of north coincident with high tremor activity. Predictions for near-vertical ray paths emanating slip on the plate interface are aligned with the direction of plate motion 305^{o} east of north. This indicates that tremor in eastern Shikoku is a direct result of slip on the plate interface. As a result of stronger inhomogeneity in western Shikoku, however, daily histograms of polarizations azimuths associated with dip angles less than 30 degrees shows a significant amount scatter in the data.

Despite the low linearity of Japan tremor sources, eastern Shikoku tremor polarizations match expected polarizations of plate interface slip, implying that Japan tremor is the result of slow slip on the plate interface.

RESEARCH REPORT

1. Name: Corin Williams （ID No.: SP07063 ）

2. Current affiliation: Boston University, Department of Biomedical Engineering

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Women's Medical University

5. Host researcher: Teruo Okano

6. Description of your current research

A major goal of vascular tissue engineering is the creation of a tissue-based vascular graft *in vitro*. One major challenge is the control of vascular smooth muscle cell (VSMC) behavior. In the healthy artery, VSMCs are spindle-shaped and circumferentially aligned within the medial layer where their main function is to regulate vascular tone. However, during disease (eg, atherosclerosis), VSMCs switch from this contractile phenotype to a synthetic phenotype. Synthetic VSMCs become migratory and proliferative and are major contributors to neointimal thickening and arterial occlusion. VSMCs also undergo phenotypic modulation when placed in culture; furthermore, they lose their spindle-like morphology and become disorganized.

Recently, there has been growing interest in patterning cells to control their shape, function, and organization. My research at BU applies micropatterning techniques to recapitulate native VSMC morphology and organization in culture. I investigated whether controlling cell shape and organization could modulate VSMCs to a more contractile phenotype. Cell-resistant comb polymer barriers were patterned onto tissue culture polystyrene (TCPS) substrates via micro-contact printing, allowing VSMCs to attach and spread on exposed TCPS lanes. Micropatterned VSMCs regained elongated morphology and aligned parallel to lanes. Micropatterned VSMCs had highly aligned actin fibers and preliminary results showed an increase in smooth muscle myosin heavy chain, a protein marker for the contractile phenotype. I was next interested in expanding my studies from 2D to 3D by creating confluent aligned VSMC sheets that could be rolled into tubular constructs. Therefore, my proposed EAPSI project aimed to combine my micropatterning techniques with the cell sheet engineering approach used by the Okano lab.

7. Research implementation and results under the program

Title of your research plan:

Development and Characterization of Micropatterned Vascular Smooth Muscle Cell Sheets for Vascular Tissue Engineering

Description of the research activities:

Cell sheet engineering using thermo-responsive substrates allows for non-invasive harvest of confluent cell layers and their underlying extracellular matrix (ECM). This method is promising for vascular tissue engineering as the *tunica media* of the artery has alternating VSMC-dense and elastin-rich layers. In order to mimic the native organization of the media, the main aim of this project was to develop and characterize micropatterned thermo-responsive surfaces that would result in aligned VSMC sheets.

The thermo-responsive polymer poly(*N*-isopropylacrylamide) (PIPAAm) was grafted onto TCPS as previously described [1]. Micropatterned cell cultures were achieved using micro-contact printing. Briefly, polydimethylsiloxane (PDMS) stamps with 50µm/50µm groove/ridge dimensions were made by soft lithography. Flat PDMS stamps were used as controls. Stamps were incubated with fibronectin (FN) solution for 10 minutes. The stamps were dried and then brought into conformal contact with the PIPAAm substrate. After stamps were peeled away, substrates were rinsed with sterile PBS. Substrates were then covered with serum-free media until cell seeding. Human aortic smooth muscle cells (HAoSMCs) were seeded onto FN-printed PIPAAm in serum-free media and allowed to attach and spread overnight. Cells were then given media with serum to promote growth.

We confirmed the presence of printed FN on PIPAAm by immunofluorescence microscopy, demonstrating that our method resulted in a biochemical pattern to guide cells. When HAoSMCs were seeded without serum onto these substrates, the cells preferred to attach to FN-printed areas. HAoSMCs aligned parallel in lanes on micropatterned substrates, but were randomly oriented on substrates that had been printed using flat stamps. After serum was added, HAoSMCs began to proliferate and filled in non-FN-printed areas. Cells on micropatterned FN maintained alignment at confluency and produced organized FN matrix. Cells on non-patterned FN were overall randomly oriented and produced disorganized FN matrix. Several days after confluent cultures were formed, we confirmed that we were able to harvest intact sheets by lowering the culture temperature to 20ºC.

In summary, we were able to create aligned VSMC sheets using micro-contact printed FN on PIPAAm surfaces. Furthermore, we were able to harvest intact sheets

by lowering the culture temperature. We are planning to submit a manuscript on this method in the near future. I plan to continue my work with patterned PIPAAm substrates upon returning to BU; future experiments will include further characterization of cell sheet properties and development of tubular constructs.

[1] Okano, T., et al. **Biomaterials**, 1995. 16: p. 297-303

8. Please add your comments (if any):

I would like to thank NSF and JSPS for the wonderful opportunity to do research in Japan. My experience at TWMU has helped me mature as a scientist and was invaluable to furthering my future PhD research. I now have a greater appreciation for international collaboration. I am very grateful to Dr. Okano, Dr. Shimizu, and Dr. Yamato for allowing me to come to the lab. I thank my advisor, Dr. Joyce Wong, for all her support. I look forward to future opportunities to return to Japan and a continued collaboration with the Okano lab.

RESEARCH REPORT

1. Name: Laurel Wucherer （ID No.: SP07064）

2. Current affiliation: University of Florida

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Yamanashi

5. Host researcher: Dr. Satoshi Wada

6. Description of your current research

This research is conducted to improve the dielectric properties of $BaTiO_3$-$SrTiO_3$ superlattice structures for capacitors and other electronic applications by creating a high, uniform dielectric constant. The traditional $BaTiO_3$-$SrTiO_3$ superlattice structure contains horizontal layers of alternating material which demonstrate a very high dielectric constant along the horizontal plane (30,000-40,000) and a very low dielectric constant along the vertical plane (300-400). This difference limits the use of this material system. It is proposed that this variation in dielectric constant can be prevented by changing the morphology of the superlattice from a flat, epitaxial structure to a sphere. Therefore, all tangents will be horizontal to the surface, thus maintaining a high dielectric constant at every point in the structure.

The structure consists of a 10-15 nm $BaTiO_3$ core and four additional layers of alternating $SrTiO_3$ and $BaTiO_3$ that are a few angstroms thick. The dielectric constant is indirectly correlated to size; therefore higher dielectric constants are achieved by creating a nano-structure.

The material is synthesized using solvothermal method. Characterization techniques include scanning electron microscopy (SEM), transmission electron microscopy (TEM), x-ray diffraction (XRD) and dielectric measurements using an impedance analyzer. Each layer is characterized to ensure accurate synthesis.

7. Research implementation and results under the program

Title of your research plan:

Synthesis and characterization of $BaTiO_3$-$SrTiO_3$ superlattice nanospheres

Description of the research activities:

The research activities included literature research, material synthesis and material characterization. $BaTiO_3$ was synthesized using $Ba(OH)_2$ and TiO_2 precursors and $SrTiO_3$ was synthesized using $Sr(OH)_2$ and TiO_2. All layers maintained a 1:1 Ba/Sr to Ti ratio. The parameters for solvothermal synthesis included:

- Solvent: 250 mL of ethanol
- Temperature: 240°C
- Stirring: 200 rpm
- Soaking time: 18 hours
- Concentration: 0.01 mol for core/0.001 mol for layers

The resulting powder was washed, filtered and dried for 24 hours before characterization. XRD results showed successful synthesis of a layered structure and crystal growth since it did not indicate additional nuclei. SEM, TEM and dielectric measurement results are pending.

8. Please add your comments (if any):

This research will be continued when I return to my university in America.

RESEARCH REPORT

1. Name: Kamal A. Ali **(ID No.: SP07066)**

2. Current affiliation: Department of Geosciences, The University of Texas at Dallas, Richardson, TX, USA

3. Research fields and specialties:

□ Humanities □ Social sciences **X Mathematical and Physical Sciences**

□ Chemistry □ Engineering Sciences □ Biological Sciences

□ Agricultural Sciences □ Medical, Dental and Pharmaceutical Sciences

□ Interdisciplinary and Frontier Sciences

4. **Host institution: Shimane University, Matsue City, Matsue 690-804**

5. **Host researcher: Prof. Jun-Ichi Kimura**

6. Description of your current research

The snowball Earth Hypothesis describes and explains wild climate change during Neoproterozoic time (1000-544 million years ago (Ma)). This is an important focus of international and interdisciplinary geoscientific research (Allen, 2006). Research in the Arabian-Nubian Shield (ANS) on this hypothesis has been sparse, in spite of the fact that sediments of Neoproterozoic age are abundant (Stern et al., 2006). ANS formation began at ~ 870 Ma following the breakup of Rodinia and concluded ~ 620 Ma when convergence between fragments of east and west Gondwana closed the Mozambique Ocean along the East African Orogen (Stern, 1994). The ANS consists of deformed and metamorphosed ophiolite suites, volcano-sedimentary sequences and calc-alkaline intrusions (Moghazi, 2002; Stern et al., 2004). The proposed project will stimulate this line of research, by studying volcanic rocks and diamictite associated with banded iron formations (BIFs) in Egypt and Arabia. BIF provides important information about the Snowball Earth hypothesis, as it is suggested that BIF formed when the ocean was cut off from the atmosphere by a global ice sheet and the hydrothermal flux from the mid-ocean ridge became the main source for Fe+2. When the ice melted it is thought that the ocean became oxygenated and the BIF precipitated as Fe+3 (Kump et al. 2005). Another possibility is that BIF precipitated in restricted basins (Young, 2002) while Yeo (1981) suggested deposition in a rift setting during a glacial period. Stern et al. (2006) proposed a model for the tectonic evolution of the ANS suggesting that the Neoproterozoic BIF might have precipitated about the time of Sturtian glaciation (~720 Ma). This project addresses the controversy by focusing on the significance of volcanic rocks, which provides critical context for understanding these BIF and their significance for understanding the Neoproterozoic Snowball Earth hypothesis.

The proposed research involves detailed geochemical analyses of 93 samples of volcanic rocks that I collected from the younger metavolcanics in Wadi Kareim and Wadi El- Dabbah in the Eastern Desert of Egypt and from the Gawjah Formation of NW Arabia. These volcanic rocks stratigraphically underlie Neoproterozoic BIF and contain important information on the age and tectonic setting of BIF formation.

7. Research implementation and results under the program

Title of your research plan:

Determination of major and trace element concentrations of volcanic rocks by XRF fluorescence analyses and inductively coupled plasma mass-spectrometry (ICP-MS)

Description of the research activities:

Seven weeks were spent in the Geochemical laboratory of Dr. Jun-Ichi Kimura at Shimane University in Matsue City. Powders from 93 rocks samples collected in Egypt and Saudi Arabia has been analyzed by XRF fluorescence spectrometry for major and trace element. All analyses were obtained from glass beads made from a mixed flux and sample. More trace and rare earth elements were done by ICP-MS. Sample was dissolved in Pt crucibles using HF and HCLO4 acids and desiccated on a hot plate. The residues were mixed with an alkali flux and fused in a muffle furnace. The fusion cakes were dissolved in HNO3 and HCl and diluted. An internal standard was added to each sample solution for monitoring analytical precision. The final solutions were analyzed for elemental concentrations by inductively couple plasma mass spectrometry (ICP-MS) on a VG PlasmaQuad 54 instrument. Elements analyzed include the Rare Earth Elements (REE; La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu), the High Field Strength Elements (HFSE; Zr, Hf, Nb, Ta), as well as Ba, Li, Pb, Rb, Sr, Th, U, and Y.

The elements above typically occur in trace (<1% by weight) amounts within most igneous rocks (i.e. those derived from magmas) and they are particularly useful for discriminating between the types of mechanisms that caused melting in the mantle and the geologic environment in which melting occurred.

The data have only been reviewed cursorily, and a more thorough investigation will be conducted in the coming weeks. However, the data have already revealed important insights into the origin of the magmatic components of the ANS and the geochemical evolution of the magmatic systems. On diagrams that plot the above elements in order of increasing compatibility in the mantle (rare earth element and spider diagrams), the normalized patterns of most of the samples are typical of those expected for arc magmas. However, there is indication that some of the magmas may have been derived from the subduction and subsequent partial melting of young, hot oceanic lithosphere.