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PI/PD Name: Richard Sharp

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☐

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Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.

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PI/PD Name: Emily H Dixon

Gender: ☐ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☐ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

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PI/PD Name: Ana Y Estevez

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☒ Hispanic or Latino ☐ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☒ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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PI/PD Name: Edwin Harcourt

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
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- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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PI/PD Name: Lorraine C Olendzenski

Gender: ☐ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status:
(Select one or more)
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- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Alistair Campbell
Associate Professor of Computer Science
Hamilton College
Clinton, NY 13323
acampbel@hamilton.edu
315-859-4377

Betsey Dexter Dyer
Bojan Jennings Professor of Biology
Wheaton College
Norton, MA 02766
bdyer@wheatoncollege.edu
508-286-3951

Mark D. LeBlanc
Professor of Computer Science
Wheaton College
Norton, MA 02766
mleblanc@wheatoncollege.edu
508-286-3970

REVIEWERS NOT TO INCLUDE:

Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 09-29

NSF 09-561 **08/10/09**

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

CNS - MAJOR RESEARCH INSTRUMENTATION, (continued)

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0959713

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
08/10/2009	**1**	**05050000 CNS**	**1189**	**002255792**	**08/11/2009 12:41pm S**

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

150532239

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

Saint Lawrence University

AWARDEE ORGANIZATION CODE (IF KNOWN)

0028290000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

Saint Lawrence University
23 Romoda Drive
Canton, NY. 136170000

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **179,336**	**36** months	**03/01/10**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____
PHS Animal Welfare Assurance Number _____
☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
_____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
Mathematics, CS, & Statistics

PI/PD FAX NUMBER
315-229-7413

PI/PD POSTAL ADDRESS
23 Romoda Drive
Valentine Hall
Canton, NY 136170000
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Richard Sharp**	**PhD**	**2006**	**315-229-5345**	**rsharp@stlawu.edu**
CO-PI/PD **Emily H Dixon**	**PhD**	**2005**	**315-229-5571**	**edixon@stlawu.edu**
CO-PI/PD **Ana Y Estevez**	**PhD**	**1999**	**315-229-5809**	**aestevez@stlawu.edu**
CO-PI/PD **Edwin Harcourt**	**PhD**	**1994**	**315-229-5444**	**edharcourt@stlawu.edu**
CO-PI/PD **Lorraine C Olendzenski**	**PhD**	**2004**	**315-229-5571**	**lolendzenski@stlawu.edu**

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 09-29). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Susan M Pankey**	**Electronic Signature**	**Aug 10 2009 3:40PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
315-229-5579	**pankey@stlawu.edu**	**315-229-7450**

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

DBI - MAJOR RESEARCH INSTRUMENTATION
MCB - BIOMOLECULAR SYSTEMS

PROJECT SUMMARY

DNA microarrays have revolutionized the field of molecular biology by enabling researchers to observe the behavior of thousands of genes simultaneously under varied environmental conditions, disease states, genetic backgrounds or stages of development. This technology has changed the nature of the field by multiplying single gene expression studies into a massive number of parallel experiments that can concurrently survey the activity of an organism's entire genome in response to particular conditions. In the field of computer science, parallel processing has had a similarly transformative impact. Computational processes that were previously limited to a single processor can often be divided into many parallel parts, thus dramatically reducing computation time. With the recent development of multi-core processors, mid-range high performance parallel computers are now available to leverage the natural parallelism found in many computationally intensive tasks. Naturally, shorter computation time gives faster turnaround and feedback to critical computational experiments. To harness these breakthrough technologies for use within twelve faculty members' research programs, St. Lawrence University (SLU) requests NSF assistance to acquire a high performance computer (HPC) and a microarray scanner.

Intellectual Merit: Computational experiments on the HPC will be executed by the PI and Co-PIs of this proposal to guide experiments using the microarray scanner. Results from the microarray scanner, in turn, will generate questions that can be studied through further computational experiments. This mutually driving and reinforcing relationship will have important implications for more than ten distinct research programs at St. Lawrence, including clarifying the role of DNA structure in gene transcription, understanding microbial communities through the phylogenetic analysis of gene sequences, examining patterns of gene expression during anoxia, and developing statistical methods to test significance in multivariate biological field data. The PI and Co-PIs have been key leaders in establishing interdisciplinary research programs within SLU's science division and are instrumental in providing SLU undergraduates with the research training needed to be competitive in today's advanced scientific settings.

Broader Impact: The research programs supported by this proposal are expected to benefit broader society by identifying potential therapies for minimizing brain damage after a stroke, helping to save threatened bird species in the Amazon, and contributing visually accurate scientific visualizations of human tissue that can aid in the diagnosis and treatment of diseases. Identifying the roles of alternative DNA structures in transcription may allow modulation of gene expression, an important goal given that many diseases result in part from the misregulation of gene expression. At the same time that these research programs advance discovery and understanding in key scientific areas, they also present unique research training opportunities for undergraduates to participate directly in original research and create reliable datasets that will enhance learning in the classroom. To strengthen SLU's undergraduate research culture, it is critical to provide modern facilities and instrumentation. The work outlined in this proposal will contribute to research activities across all four undergraduate years, the production of research-based educational materials – such as unique datasets – useful in teaching, and the research training of undergraduates as full research partners whose experiences culminate in co-authored peer-reviewed papers and presentations at professional meetings and conferences.

At SLU, the CS faculty have active research programs that bring energy to the development of cross-disciplinary research areas, yet their capacity to bolster research in this way has been impaired by the lack of advanced computing resources. With NSF assistance, the PI and Co-PIs will upgrade SLU's computing infrastructure and produce data and results integral to the advancement of knowledge in several cutting-edge areas. Likewise, the new microarray scanner will support the ability of the PI and Co-PIs to contribute to answering challenging scientific questions, and will heighten the possibilities for collaborations with other SLU faculty and faculty from neighboring research institution Clarkson University. Finally, to attract women and students from diverse and disadvantaged backgrounds to the study of science and participation in the research programs supported by this proposal, project personnel will participate in and strengthen their relationships with SLU diversity advancement programs, such as the New York State Collegiate Science and Technology Entry Program and the U.S. Ronald E. McNair Postbaccalaureate Achievement Program and also provide undergraduates with more mentored, hands-on research opportunities with women scientists and faculty from underrepresented backgrounds.

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PROJECT DESCRIPTION

MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

I. INTRODUCTION

The advent of DNA microarrays has enabled researchers in microbiology to observe the behavior of thousands of genes simultaneously under varied environmental conditions, disease states, genetic backgrounds or stages of development. This technology has changed the nature of the field dramatically by multiplying single gene expression studies into a massive number of parallel experiments that can concurrently survey the activity of an organism's entire genome in response to particular conditions. Parallel processing has had a similarly transformative impact on computer science. Computational processes that were previously limited to a single processor can be divided into many parallel parts, thereby reducing computational time dramatically. With the recent development of multi-core processors, high performance parallel computers are now available to leverage the natural parallelism found in many computationally intensive tasks; shorter computation time provides faster turnaround and feedback to critical computational experiments. The advancement of key interdisciplinary research programs at St. Lawrence University (SLU) hinges on harnessing these breakthrough technologies for use within the science division. Thus, SLU requests NSF assistance to acquire both a high performance computer (HPC) and a microarray scanner.

II. INSTRUMENT LOCATION

The microarray scanner sought through this proposal will be housed in a common use room adjacent to faculty research labs for microbiology, biochemistry, genetics and cell biology research and also easily accessible to faculty teaching laboratories in SLU's new Johnson Hall of Science. The HPC will be located in the University's Information Technology (IT) Central Server Facility.

III. ST. LAWRENCE UNIVERSITY NSF-MRI PROJECT GOALS

PI Richard Sharp and his Co-PIs Emily Humphrey-Dixon, Lorraine Olendzenski, Ana Estevez, and Ed Harcourt seek the assistance of an NSF-MRI program grant to purchase a microarray scanner and HPC. The acquisition of these two equipment items will enable them to meet the following project goals: 1) Contribute data and related findings to novel areas of scientific knowledge; 2) Expand the scope of collaborative research and research training across core science programs at SLU; 3) Create well-equipped research laboratories to strengthen the integration of research and education in research-intensive learning environments; 4) Increase the number of firsthand experiences for undergraduates to participate in research; and 5) Increase the number of women and students from underrepresented or disadvantaged backgrounds at SLU who choose to major in computer science, biochemistry, neuroscience, and biology by providing more mentored, hands-on research opportunities with women scientists and faculty from underrepresented backgrounds.

IV. RESEARCH ACTIVITIES

A. Numerical Techniques for Realistic Image Synthesis – *Richard Sharp, Computer Science*

As part of his dissertation research at The Ohio State University, PI Sharp developed a variety of numerical algorithms to simulate the soft lighting effects seen on semi-translucent materials, such as marble and human skin (for example, the red glow seen around the edge of a lit flashlight pressed against the palm). The physical basis for this effect is described with a practically unsolvable integro-differential equation called, simply, the Transport Equation. Although a fast direct solution to this equation is infeasible, reasonable simplifications can be made for semi-translucent materials that yield a simpler equation, the Diffusion Approximation (DA) (Ishimaru 1997). Dr. Sharp's dissertation work focused on developing fast numerical solutions to the DA. These included a real-time algorithm that used a Cholesky factorization, but involved preprocessing overhead (Sharp & Machiraju 2006), and another more complex and more accurate solution using finite elements (Sharp *et al.*, 2007).

Both algorithms can be parallelized and would receive huge performance gains from being run on an HPC. Additionally, the accuracy of these algorithms is related linearly to the amount of memory available on the machine; an order of magnitude more memory would reduce error by an order of magnitude. Unfortunately, SLU has no computers dedicated for any computationally intensive research,

which significantly reduces Dr. Sharp's competitiveness in maintaining a research program in this area. An NSF-MRI award will enable him to purchase an HPC that will support this research program.

The HPC will allow PI Sharp to develop a high-quality adaptive finite element method – an algorithm that would simulate the light scatter in an object, determine the areas most likely to contain error, and then selectively refine those parts without wasting computation or memory on otherwise accurate parts. Dr. Sharp has preliminarily developed the mathematical framework for an *a posteriori* error estimator for the finite element solution to the DA. To continue this work, Dr. Sharp needs to conduct studies in which the simplified finite element numerical model can be directly compared with a more numerically accurate solutions using path tracing; a solution that is impractical with a standard desktop computer, but feasible with an HPC.

As part of his dissertation work, Dr. Sharp collaborated with geneticists, biologists, physicists, and other natural scientists to develop realistic digital images of organic specimens and accurate numerical solutions to physical problems (Wenzel *et al*., 2007; Mosaliganti *et al*., 2008). As PI of this proposal, Dr. Sharp has led a group of young investigators – mentored by senior faculty in the Departments of Biology and Mathematics, Computer Science and Statistics – in the development of the research plans presented in this proposal and that are the result of key interdisciplinary collaborations within SLU's science division. Dr. Sharp has been at the forefront of these collaborations and, as described below, will play a significant role in the advancement of two of the other four primary research projects that will be supported by the HPC and microarray scanner sought through this proposal to the NSF-MRI program. Descriptions of these research programs follow immediately.

B. Comparative Genome Analysis of Yeast Inverted Repeats – *Dr. Emily Humphrey-Dixon, Biology; Dr. Richard Sharp, Computer Science; and Dr. Michael Schuckers, Statistics*

Dr. Emily Humphrey-Dixon has studied the roles of histone acetylation and histone H3 lysine 4 methylation in transcriptional activity in yeast (Bernstein *et al.*, 2002), and the genome-wide location of the yeast histone deacetylase Rpd3p under two nutrient conditions (Humphrey *et al.*, 2004). Currently, her research focuses on inverted repeats and cruciform structures in the *S. cerevisiae* genome and the role they may play in transcription. She has been collaborating with PI Richard Sharp and Faculty Associate Michael Schuckers to identify the conserved inverted repeats in several species of yeast. Thus far, they have generated a list of the inverted repeats in the *S. cerevisiae* genome and used comparative genome analysis to determine which inverted repeats are most likely to form functional cruciform structures and are, therefore, linked to DNA-mediated processes such as transcription. The HPC they seek through this NSF-MRI proposal will enable them to simulate large numbers of synthetic genomes in *S. cerevisiae* to determine statistical significance and to expand the analysis to the genomes of higher eukaryotes. The microarray scanner sought through this proposal will make it possible to test hypotheses generated from this data to identify which classes of inverted repeats actually form cruciform structures in *S. cerevisiae*.

Inverted repeats are sequences of DNA that have the same sequence on both strands with the exception of a spacer consisting of a small number of nucleotides in the exact center (non-palindromic portion). The following DNA sequence illustrates this occurrence:

5'-CGATACCACATATCG-3' (*top DNA strand, read left to right)*
3'-GCTATGGTGTATAGC-5' *(bottom DNA strand, read right to left)*

The underlined part of the top strand, read left to right *(CGATATATCG),* is the same as the underlined part of the bottom strand read right to left. The non-underlined part is the spacer *(CCACA)*, which does not read the same in reverse *(TGTGG)*.

These inverted repeats have been implicated in various processes that take place at the DNA level, including replication, transcription, and genomic instability. At least some of these sequences form an alternative DNA structure, called a cruciform, which may play a role in mediating some or all of these functions. Dr. Sharp has generated for the *S. cerevisiae* genome a list of all the inverted repeats with at least 6 bases in the palindromic portion of the DNA, and a maximum of 10 bases in the non-palindromic spacer, and determined which of them is conserved in *S. paradoxus*, *S. mikatae* and *S. bayanus*. Because conserved genomic elements are more likely to be functional, Dr. Humphrey-Dixon compared the list of inverted repeats found in all four species to lists of genes with high transcriptional activity. She has

identified characteristics of inverted repeats that seem to make the genes with which they are associated more likely to be transcriptionally active.

Drs. Sharp and Schuckers have also generated synthetic *S. cerevisiae* genomes to test whether the pattern of palindromic subsequences can be attributed to randomness in the original genome. Synthetic genomes were generated using a classic second-order Markov chain method whose base pair distributions were sampled from the promoter and coding regions of all genes in the original *S. cererevesiae* genome (see Simons *et al.*, 2005; Lisnić *et al.*, 2005). Currently, they have measured the standard deviation in average inverted repeat lengths of 10, 100, and 1000 synthetic genomes. Preliminary results suggest that the inverted repeats are significantly overrepresented in the yeast genome. The runtime for the generation and inverted repeat detection for 1000 synthetic genomes is ~2 hrs. With an HPC, the investigators will be able to conduct similar analyses of larger, more complex genomes such as rat and mouse species.

In addition to studying more complex genomes, the research team also plans to study the genome-wide locations of cruciform-binding proteins. While it is known that these proteins bind to cruciform structures (Callejo *et al.*, 2002), the genomic locations to which they bind and the functions of this binding are unknown. Previous studies (Ichimura *et al.*, 2004) and preliminary microarray results from Co-PI Humphrey-Dixon suggest that these cruciform-binding proteins are involved in transcription regulation both under standard growth conditions and following rapamycin treatment, a condition that mimics nutrient deprivation. However, since these proteins also play other roles in the cell, the extent to which this effect on transcription is due to cruciform binding is not known. Determining the genome-wide locations of these cruciform-binding proteins will help determine their role in transcription regulation and how they alter gene transcription.

Currently, this project uses microarrays supplied by the Genome Consortium for Active Teaching (GCAT) at Davidson College. While GCAT resources have been critical to the success of the project early phases, using a larger number of microarrays and using commercially available genome-wide yeast microarrays will make it unwieldy to continue to use GCAT scanning resources.

In addition to Dr. Schucker's role in this research program, Dr. Schuckers will utilize the HPC for estimation studies of the performance of biometric authentication systems (e.g., fingerprint or iris systems). The addition of the HPC will allow for extensive exploration of computationally intensive methods (*e.g.*, resampling) on large biometric databases (~4 million comparisons).

C. Phylogenetic Analysis of Microbial Communities and Comparative Analysis of Bacterial Genomes – ***Dr. Lorraine Olendzenski, Biology; Dr. Ed Harcourt, Computer Science***

Molecular data have become essential among the techniques used by microbial ecologists to understand community diversity and function. Sequence data of ribosomal RNAs and amino acid sequences of functional genes are used to elucidate microbial communities composed of organisms that cannot be cultured or identified on the basis of morphology alone. To obtain information on the identity, distribution and evolution of organisms in a particular environment, phylogenetic methods are used to analyze gene sequences from environmental DNA samples. Dr. Olendzenski studies the diversity, ecology and evolution of microbes and their genomes. She and Co-PI Harcourt have created and used software in phylogenetic analyses for research in microbial diversity and ecology. The software ties together existing applications and allows (*e.g.*, BLAST searches against locally held DNA sequence and microbial genome databases) creation of datasets for sequence alignment, and running of computationally intensive Bayesian or maximum likelihood phylogenetic analyses of environmental sequence data.

This work focuses on understanding the ecology of microbial communities in the unusual environment of Fayetteville Green Lake, NY. The water column of Green Lake is permanently stratified with respect to oxygen and other molecules used in microbial respiration; oxygen concentration decreases at 19 meters in the lake and is completely absent at 20.5 meters (Thompson *et al.*, 1990). These conditions support an abundant and metabolically diverse microbial population and are an analog for early Earth ecosystems when atmospheric oxygen concentrations were low. Green Lake has been well studied by geologists and ecologists, but molecular approaches to understanding microbial diversity in this lake have only just begun (J. Macalady, Pennsylvania State University, *private communication*). The lake provides a model system to study the roles of cyanoacteria, sulfate-reducing bacteria, methanogens

and other microorganisms involved in carbon and sulfur biogeochemical cycles. Seasonal whiting events in this environment, where calcium carbonate precipitates out of solution, have been attributed to cyanobacteria (Thompson *et al.*, 1997). Both cyanobacteria and sulfate-reducing bacteria have been implicated in carbonate precipitation in microbial mat environments (Baumgartner *et al*., 2006), which contain similar microbial population as those found in Green Lake. Co-PIs Olendzenski and Harcourt are quantifying the dominant members of the community with depth during whiting and non-whiting periods and exploring hypotheses about interactions of the sulfate-reducing community with other members of the microbial community, such as methanogenic archaea and purple sulfur bacteria. Dr. Olendzenski has sequenced ~1000 clones of rRNA genes from bacteria and eukaryotes from depths at and below the chemocline. Dr. Harcourt and students have supported this work by building the current Linux compute cluster hardware and software infrastructure used in the sequence assembly and phylogenetic analysis of this data. The new HPC will facilitate continuing and expanding the phylogenetic analysis of sequence libraries from lake organisms. To understand the potential metabolic capabilities of the diversity of sulfate-reducing bacteria, the Co-PIs will use the HPC to compare gene content among newly available genomes of sulfate-reducing bacteria sequenced by the DOE Joint Genome Institute and other groups. As part of this study, they will use an oligonucleotide microarray that can detect 16S rRNA genes of known sulfate-reducing bacteria (Loy *et al.*, 2002) to track changes in the sulfate-reducing community across the chemocline at various times of the year, including during carbonate precipitating whiting events.

D. Microarray Analysis of Gene Expression in *C. elegans* during Anoxia – *Dr. Ana Estevez, Biology and Psychology*

Dr. Ana Estevez studies the mechanisms of neurodegeneration after cerebral ischemia or stroke (Estevez and Phillis, 1997). During a stroke, lack of oxygen and glucose due to a decrease in blood flow to the brain can cause severe brain damage (Saver, 2006). This rapid death of neurons occurs because of the onset of a series of biochemical events termed the ischemic cascade, wherein bioenergetic failure leads to excitotoxicity, oxidative stress, inflammation and blood-brain barrier dysfunction (reviewed in Brouns and De Deyn, 2009). Currently, there are no effective neuroprotective drug treatments for ischemic stroke (Green and Shuaib, 2006), and issues of potency, toxicity and pharmacokinetics have hampered developments in this arena. Thus, extensive research efforts are aimed at finding novel therapies to mitigate cell death after an ischemic insult (Wahlgren and Ahmed, 2004).

In an effort to identify novel targets for neuroprotection, Dr. Estevez is conducting whole genome microarray analysis of *C. elegans* nematode worms exposed to various periods of anoxia (very low or zero oxygen) to understand the genes that are up- or down-regulated in neurons under these conditions. *C. elegans* can survive over 24 hrs in an anoxic environment with little loss of viability (Van Voorhies *et al.*, 2000). The animals enter into a state of "suspended animation" during the anoxic state and then resume normal development after oxygen is reintroduced. At the nervous system level, this phenomenon is of great interest due to the lack of neuronal death observed in worms after such long periods of oxygen deprivation. Microarray studies thus have the potential to uncover the signaling pathways inherently activated in worms to achieve such neuroprotection, and, because approximately 40% of *C. elegans* genes share similarities with human genes (Culetto and Sattelle, 2000; Tatusov *et al.*, 2003), it may be possible to identify similar pathways in humans.

Thus far, Dr. Estevez and her team of research students have conducted microarrays[1] on worms exposed to 24 hrs of anoxia. Preliminary analysis of four slides has identified 57 genes with expression changes greater than four-fold, compared with worms maintained under normal oxygen. Of these, 38 genes are up-regulated and 19 are down-regulated. This list includes some genes expected to be important for anoxia survival, such as hypoxia inducible factor 1 (*hif-1*) and stress-response genes such as heat-shock proteins (Table 3). However, there are 23 genes on this list with unknown function that may provide novel insight into the signaling pathways activated during anoxic stress. Also of interest are the genes that have known functions not previously related to anoxic-stress survival. For example, T28C12.4a encodes a carboxylesterase previously shown to be activated only under ethanol stress and not

[1] For the preliminary experiments, Dr. Estevez's slides were scanned at the Genome Consortium for Active Teaching (GCAT).

under heat or salt stress (Kwon *et al.*, 2004). It has 26% sequence similarity to human neuroligin, a protein proposed to be involved in glial-neuronal interactions during embryogenesis. The dramatic up-regulation of this gene under anoxia is a novel finding that may help increase our understanding of the adaptive changes that increase organismal survival in conditions of low oxygen.

Table 1. Representative example of some of the 57 genes identified from microarrays of worms exposed to 24 hr of anoxia (n= 3-4 experiments) * Positive numbers indicate upregulation; negative numbers = downregulation.

Sequence ID	Gene Name	Fold-change*	Proposed Function
Y46H3A.3	hsp-16.2	13.51	Heat Shock Protein
C12C8.1	hsp-70	8.98	Heat Shock Protein
T22B7.3	Unnamed	8.72	Unknown Function
R09B5.9	cnc-4	7.77	Secreted antimicrobial peptide in the innate immune response
T28C12.4a	Unnamed	7.11	Carboxylesterase; Transcription immediately induced by exposure to ethanol, stress
F38A6.3a	hif-1	4.60	Encodes transcription factor required for survival in hypoxic environments
W09C5.6b	rpl-31	-5.38	Encodes a large ribosomal subunit L31 protein
D2023.1	Unnamed	-8.07	Unknown Function
ZK512.7	Unnamed	-8.22	Unknown Function
F40A3.1	Unnamed	-8.51	Unknown Function
W05H7.4b	zfp-3	-8.84	Zince Finger Protein
Y38E10A.12	nspe-3	-9.00	Nematode Specific Peptide Family, Group E

With a microarray scanner, Co-PI Estevez will advance her project by conducting multiple time-points of anoxia exposure (e.g., 1 hr, 4 hr, 12 hr, and 24 hr) to gain a thorough overview of gene expression patterns during anoxia via cluster analysis. The earlier time-points are hypothesized to provide information regarding the pathways necessary to initiate the response to anoxia, whereas the later time-points will help assess the genes necessary to maintain the suspended animation state. Due to the inherent technical variability in such experiments, several replicates (at least 4-6 slides) at each time-point will be conducted to increase statistical power.

E. Foraging Success and Aggressive Interactions in Obligate Army Ant Following Birds – *Dr. Susan Willson, Biology; Dr. Richard Sharp, Computer Science; and Dr. Ivan Ramler, Statistics*

Dr. Willson studies a unique and threatened community of five species of Neotropical birds that feed exclusively at the antswarms of army ants in Amazonian Peru (Willson, 2004). Her project data come from her extensive fieldwork at the Cocha Cashu Biological Station in Manu National Park, Madre de Dios, Peru. All five bird species display a high degree of both inter- and intra-specific aggressive interactions while foraging. This type of interference competition is rare in avian systems, where exploitation competition for a resource is more common. Dr. Willson's hypothesis is that this direct aggression can only be beneficial for a given bird if the aggression translates to a higher rate of foraging success. Dr. Willson has collected observational data to determine if the coexisting bird species differ in foraging success, using hypotheses based on the strong inter-specific dominance hierarchy, differences in body mass, or ephemerality of the food source.

Dr. Willson is collaborating with PI Sharp and Faculty Associate Dr. Ivan Ramler to develop a statistical method to test significance in multivariate data that have randomly varying observation time. They have used this method to show statistically relevant differences between the species of birds that feed off the antswarms. With an HPC, they will be able to test fully the statistical soundness of their time-aggregating technique (Ramler, Willson, & Sharp, 2009). Without a sound statistical technique, it is extremely difficult to determine if birds do in fact follow optimality theory while interacting over a food resource. Table 2 illustrates this challenge.

Table 2. Hypothetical observation data for two species, A and B.

Bird ID	Species	Observation Time	Successful Attempts to Eat
U	A	50	1
V	B	150	1
X	B	300	2
Y	A	100	2
Z	B	75	1

Given these data, it is difficult to argue which species is more successful than the other. For example, consider birds V and Z which are the same species and have the same number of successes, but if V were watched longer than Z it is not clear that one should consider Z less successful. This is the problem that this project attempts to address; specifically, *"How should observation time affect the overall measure of success in a field observation?"* A common approach is to use time as a regression covariate to account for the differing observation times. However, the resulting regression model is very inaccurate due to the small amount of variation in the number of successes. As such, there is a need to approach this problem in a different manner, as outlined next.

The previous question can be simplified by making the following observation: if all observations last exactly the same amount of time, the observation time can be effectively ignored. In practice, it is impossible to observe separate animals in the field for exact amounts of time. Thus, the observations in the project data can be aggregated to create an observation time independent data set. For example, if the data set in Table 2 is converted to 150-second (sec) samples, a possible aggregation of the times might result in the data shown in Table 3.

Table 3. Observations from Table aggregated into 150-sec samples.

Bird ID	Species	Observation Time	Successful Attempts to Eat
U, Y	A	150	3
V	B	150	1
X(150)	B	150	1
X(150)	B	150	1

In practice, aggregating observation times is much more difficult than this example suggests. With many observations, it is not clear which observations can be optimally aggregated into one sample. Indeed, this is a variant of the knapsack problem, a known NP-complete problem (Kellerer *et al.*, 2004). Rather than solve for an optimal aggregation, the problem can be approximated by attempting to aggregate samples randomly. Another difficulty arises from the fact that field data observation times are rarely multiples of the desired aggregate observation time. To compensate, some variation is allowed in the desired aggregate observation time. Not surprisingly, the significance of aggregated observations can be greatly biased by how the samples are combined. Not only the selection of observations to be aggregated *(should A combine with B?)*, but also the desired aggregate observation time *(choose 150 or 500 seconds?)* has a measurable effect on the significance between species. To address the issue of significance, many aggregations are made on the same data set using several different aggregate observation times. Next, significance is tested between species using a *t-test* that has been adjusted by a Tukey's Honest Significant Difference (THSD) adjustment (Neter *et al.*, 1996). It is believed that the result gives an overall sense of significance that is independent of the amount of observation time.

In promising preliminary results, 50,000 samples have been run for each of eight different desired observation times *(150 sec up to 500 sec)*. This analysis is especially computationally intensive, but the results suggest that this technique is effective for removing the observational time dependency in such samples (Ramler, Willson, & Sharp, 2009). To test fully the technique for aggregating time-dependant samples, future plans include generation of synthetic data from both Normal and Poisson distributions and an analysis using the THSD adjusted *t-test* described previously. A dedicated HPC will enable this project to study a variety of synthetic data sets in a realistic time frame, which in turn will allow the researchers to adjust and design appropriate simulations within a reasonable period of time.

In addition to assisting Dr. Willson with the research described in this section, Dr. Ramler will utilize the HPC to run computationally intensive simulation experiments for his research projects such as testing the effectiveness of clustering algorithms for very high-dimensional data. As these algorithms require large amounts of memory as well as computing time, the HPC will be a valuable tool and will greatly benefit his work. Though Dr. Ramler is a Visiting Professor of Statistics, it is a long-range goal of the Mathematics Department to create a permanent faculty position that will be occupied by Dr. Ramler

or another statistician with expertise in developing efficient algorithms in cluster analysis. In the nearer term, the Department intends to fill this need by continuing to retain him as a visiting professor.

F. Impact of this Project on the Research Activities of Faculty at SLU and Clarkson University

Acquiring an HPC and microarray scanner will make a substantial improvement in the capabilities of STEM faculty at SLU to conduct leading-edge research. Table 4 provides a summary of how other faculty users at SLU will employ the equipment sought. Two biologists from Clarkson University, a small R-1 research university, will also benefit from having this technology locally.

Table 4. A description of how other faculty from STEM fields at St. Lawrence will utilize the Sun Fire HPC and GenePix Microarray Scanner to enrich their research activities.

Faculty Member and Research Description
Jessican Chapman, Assistant Professor of Statistics, will use the HPC to perform Markov Chain Monte Carlo (MCMC) analyses of system reliability data and implement search procedures for finding optimal solutions in large-scale resource allocation studies. Studies of this nature currently require substantial processor time and Dr. Chapman is developing methodology to make this type of analysis more computationally efficient.
Robin Lock, Burry Professor of Statistics, will use the HPC to perform computer simulations to assess statistical performance of new estimators and inference procedures. He will also use it to develop computer-intensive statistical methods based on bootstrap, randomization and MCMC procedures.
Alex Schreiber, Assistant Professor of Biology, studies intestinal tissue–tissue interactions during thyroid hormone-mediated frog metamorphosis. One method used by his lab to characterize the roles of individual tissues in gut remodeling is to transgenically inhibit thyroid hormone receptor functioning in different gut tissues. Microarray analysis of differentially inhibited intestinal tissues will allow him to determine which genes are regulated by thyroid hormone in each tissue type.
Lisa Torrey, Assistant Professor of Computer Science, will use the HPC to study reinforcement learning problems, wherein artificial agents are trained using rewards and punishments. Teaching these agents requires running many computationally intensive simulations on large high-dimensional datasets. The HPC is ideal for these simulations, as they are easily parallelized and can utilize the HPC's large memory space.

Table 5. How Clarkson University faculty will use the microarray scanner

Faculty Member and Research Description
Kenneth Wallace, Assistant Professor of Biology. In the *flotte latte (flo)* digestive mutant, neuronal cell bodies do not migrate around the intestine's circumference as they do in wild type zebrafish embryos. There is a specific loss of the majority of the circular smooth muscle, but the longitudinal muscle appears to develop in a normal histological pattern. In this project, Dr. Wallace will isolate RNA from wild type and mutant embryos selected at key time-points during enteric precursor migration, muscle differentiation, and enteric differentiation, and use microarrays to to identify and clone transcripts that are candidates for smooth muscle and enteric neuron differentiation.
Craig Woodworth, Professor of Biology. Dr. Woodworth will use the scanner to study how infection with human papillomavirus (HPV) alters expression of genes that regulate the innate immune response. He has used microarrays previously to demonstrate that expression of HPV-16 E6 and E7 oncogenes disregulates many NF-kB-responsive genes in cultured human cervical epithelial cells (Nees *et al.*, 2001). With the scanner, he will identify specific genes altered by HPV E6 and E7 oncoproteins. Work will focus on genes that contribute to interferon signaling pathways. Dr. Woodworth is also interested in using microarrays to understand how alterations in the epidermal growth factor receptor signal pathway (Woodworth *et al.*, 2005) perturb the host immune response to virus infection.

V. DESCRIPTION OF THE RESEARCH INSTRUMENTATION AND NEEDS

To advance the research described in this proposal, SLU seeks NSF assistance to purchase a GenePix 4000B Microarray Scanner and a Sun Fire HPC for its computer science and biology programs.

A. Technical Description of the Requested Instrumentation

1. GenePix 4000B Microarray Scanner

The GenePix 4000B Microarray Scanner offered by Molecular Devices is a single-slide microarray scanner that accepts standard microscope slides (1" x 3" or 25 mm x 75 mm) and has a maximum 22 x 71.5 mm scan area with user-defined sub-scans. The scanner has integrated GenePix Pro

software, which controls scanner function and allows first pass data analysis. Standard dual laser excitation at 532 nm (17 mW) and 635 nm (10 mW) and accompanying detection filters are optimized for Cy3 and Cy5 fluorophores. Simultaneous scan of both wavelengths allows scanning of a whole array at high resolution to be accomplished in 13 minutes with a user-selected resolution of 5- 100 microns per pixel or with a 40 micron resolution in pre-scan mode. The GenePix 4000B has real-time PMT adjustment, a dynamic range of detection of 4 orders of magnitude, and can accomplish an extra-high signal-to-noise scan mode by averaging**.** The machine comes with one static license for the GenePix Pro software, test slide kits for validating scanner performance, a SCSI cable and interface card and a power supply. The PI, Co-PIs and faculty associates of this proposal are requesting the company-recommended configuration, which includes a preformatted Dell computer interface for storing and analyzing the large computer files generated during full array scans. For more information on the GenePix 4000B Microarray Scanner, see http://www.moleculardevices.com/pages/instruments/gn_genepix4000.html.

2. Sun Fire High Performance Computer (HPC)

The HPC requested is a Sun Fire X4600 M2 Server built by Sun Microsystems. Relevant technical performance specifications include: a) 8 x Quad-Core AMD Opteron Model 8389. 2.9GHz 512 KB processors; b) 448 GB of RAM. (48 x 8 GB DDR2-677 and 16 x 4 GB DDR2-677 DIMMs); c) 2 x 146 GB 10000 RPM SAS Drives and 2 x 300 GB 10000 RPM SAS Drives; d) Operating System: Red Hat Enterprise Linux 5.1; and e) 3-Year Service Contract.

B. Need for the Requested Instrumentation

The GenePix 4000B Microarray Scanner will expand the number and types of microarrays the faculty will implement in their research and eliminate the limitations of shipping slides to another facility. There is no microarray scanner in the North Country Region of New York State (NYS) (north of Syracuse). The GCAT provides microarray scanning services at a discounted rate for faculty conducting research with undergraduate students and has made it possible for Co-PIs Estevez and Humphrey-Dixon to use microarray technology. However, because they and Co-PI Olendzenski plan to expand the number and types of microarrays used in their research, continued use of GCAT for this purpose would present significant limitations. Scanning with GCAT already presents several challenges, such as the need for careful timing and coordination due to the high volume of slides GCAT handles. Degradation of the sensitive fluorophores during shipping adds an experimental variable that will be eliminated with on-site scanning. The dyes used to label cDNA are very sensitive to oxidation and often degrade during the shipping process. The summer months, the busiest time for pursuing research endeavors on liberal arts campuses, are a particularly hazardous time for shipping microarrays due to high ozone levels. An on-site microarray scanner will enable senior personnel and other faculty to conduct experiments with or without student research assistants; will accelerate the pace of research; and will ensure that microarray technology for these projects is available beyond GCAT's funding cycle.

Project personnel have selected a single HPC, as opposed to a cluster of computers, due to the simpler programming model inherent in one machine versus many. There are no HPCs on the SLU campus, nor at SLU's neighboring universities. Most HPC users will employ software tools that are parallel, but not distributed, and hence would not benefit from a cluster. The large memory size in one machine is especially beneficial for those research projects that generate large hash tables, such as the BLAST algorithm, and photon-mapping algorithms used in numerical simulations of light scatter.

VI. IMPACT ON RESEARCH AND TRAINING INFRASTRUCTURE

A. Institutional Context

In recognition of the national need to increase the number of science students studying at the post-graduate level, SLU has implemented a series of strategies to build a research-rich STEM learning environment. Central to these efforts is SLU's Science Facilities Initiative, resulting in the 2007 opening of the new Johnson Hall of Science, which houses the Departments of Biology and Chemistry, a Microscopy Center, and teaching and research labs for Psychology. Next in this Facilities Initiative is a full-scale renovation of Bewkes Hall of Science to provide laboratory, classroom, and office spaces for the Departments of Physics; Geology; and Mathematics, Computer Science and Statistics. In recent years, the faculty have updated and revised curricular and programmatic goals to enhance the research

culture within the institution and have increased student-faculty partnerships for learning/investigation. These goals include: 1) engaging science students with active, hands-on learning through all four years; 2) providing science majors with multiple direct experiences in original research over their academic careers; 3) developing students' appreciation for the interrelationship between science disciplines; 4) providing training on advanced laboratory equipment and instrumentation; and 5) mentoring science majors with a culminating "Senior Year Experience" (SYE).

In recent years, the science departments have also redefined hiring practices to include and support the expectation that all new faculty will contribute to an educational community focused on research and student involvement in collaborative research. Having modern laboratory equipment is a key factor in SLU's ability to attract and hire talented "teaching scholars" who bring both a commitment to undergraduate learning and well-developed, dynamic research programs in which students can participate.

B. Impact of the HPC and Microarray Scanner on Faculty Research Programs at SLU

New scientific research equipment is often prohibitively expensive for SLU and other liberal art colleges, but nonetheless is essential for the advancement of faculty research and faculty careers. The senior personnel of this project will utilize the HPC and microarray scanner to run parallel experiments within distinct research areas on the cutting edge of scientific knowledge. With assistance from the NSF, they will make contributions in key areas, such as performing simulations of visible light scatter in semi-translucent materials, examining patterns of gene expression during anoxia, clarifying the role of DNA structure in gene transcription, understanding microbial communities through the phylogenetic analysis of gene sequences, and developing statistical methods to test significance in multivariate biological field data. The following 'snapshots' illustrate the substantial impact both instruments will have on the interdisciplinary research efforts of the PI , Co-PIs and Faculty Associates of this proposal:

- PI Sharp will use the HPC to run physically based numerical simulations of light scatter in semi-translucent materials. The HPC will be fundamental in developing adaptive solution methods which require studies on simplified numerical models which will be directly compared with numerically accurate solutions. These accurate solutions are computationally infeasible on a standard desktop computer, but practical with an HPC.
- In collaboration with PI Sharp and Faculty Associate Schuckers, Co-PI Humphrey-Dixon will use the microarray scanner and the HPC on comparative genome analyses of yeast DNA. The scanner will enable studies on genome-wide binding of cruciform-binding proteins – a critical next step in her research that is not possible without a microarray scanner. The HPC will be critical in proving statistical significance of inverted repeats in the yeast genome.
- Co-PI Olendzenski will strengthen her phylogenetic analyses of gene sequences from environmental DNA samples as well as comparisons of microbial genomes with support from Co-PI Harcourt, who will also use the HPC in his electronic design automation research, which is based on computationally intensive hardware simulations.
- Dr. Willson will collaborate with Drs. Sharp and Ramler in developing a novel and useful statistical bootstrap technique to aggregate time-dependent observations into time-independent samples for field biology. Because this process is computationally intense, the HPC will be critical in developing and executing this technique.
- With the new microarray scanner, Co-PI Estevez will conduct multiple time-points of anoxia exposure to gain a thorough overview of patterns of gene expression changes during anoxia.

C. Impact of the Requested Equipment on the Research and Research Training Goals at SLU

A primary goal of undergraduate science education at SLU is to train science majors to conduct original research. All faculty participating in this proposal regularly include undergraduates as partners in their research programs and are committed to mentoring them as young scientists. By graduation, most science majors at SLU have participated in original research as full research partners. To achieve this goal, the faculty provide undergraduates with multiple opportunities to participate in original research and gain experience with modern laboratory equipment. The lack of an HPC and microarray scanner has created a gap in the ability of the Senior Personnel and other faculty at SLU to meet critical research and

training needs in computer science (CS), biology, and statistics. The new equipment will allow undergraduates in these disciplines to gain experience with key scientific technologies and relevant methodologies. Having these capabilities on campus is particularly important for training students for graduate study and professional scientific careers. The following examples capture the substantial impact both instruments will have on the research experiences and training of SLU STEM majors:

- Biology and CS students collaborating with PI Sharp and Co-PI Humphrey Dixon will have the opportunity to utilize the HPC and microarray scanner to pursue highly relevant research focused on clarifying the role that DNA structure plays in gene transcription.
- CS students working with Drs. Sharp and Harcourt's will use the HPC in senior research projects and course electives. Example research projects include simulation of light scattering through particles in a dusty room, numerical simulations of partial differential equations, and simulations of computer hardware.
- Co-PIs Olendzenski and Harcourt will include both CS and biology majors in their efforts to shed light on the diversity and metabolic capabilities of sulfate-reducing bacteria.
- The new scanner will also allow Co-PI Estevez's students to conduct scientific experiments in their entirety, more readily troubleshoot issues that evolve during experimentation and become acquainted with bioinformatics through analysis of the data obtained.
- The addition of an HPC will enhance learning/training opportunities for Dr. Willson's students by exposing them to the links between physically challenging Amazonian fieldwork and modern statistical analyses.

D. How the HPC and Microarray Scanner Will Attract Researchers and Students, Particularly Underrepresented Groups and Women Pursuing Advanced Degrees in Science, and Improve the Quality of Research Training

Having up-to-date, research-grade instrumentation and modern facilities, such as the proposed HPC and microarray scanner, is critical for recruiting faculty with active research programs to careers at SLU. A modern scientific infrastructure is also vital for attracting students interested in the sciences to study at SLU. Since the launch of SLU's Science Facilities Initiative and the opening of Johnson Hall of Science, SLU has seen an increase in applications as well as increased enrollment in the sciences. Over the past six years, course enrollments in the natural and physical sciences, mathematics, and CS have increased 18%, and the number of students graduating with majors in those fields increased 25% over the same period. We have also been successful at attracting new faculty members with active research programs to SLU. Those efforts are reflected in this proposal through the leadership of PI Sharp and his colleagues, as they develop their research programs and bring unprecedented energy to creating interdisciplinary research opportunities at SLU.

The equipment sought through this MRI proposal will play a direct role in the fundamental work of the college, where small class sizes, low student-faculty ratios, one-on-one mentoring opportunities, and hands-on research experiences help us achieve particularly positive outcomes for women and students from diverse backgrounds. In every instance, the research programs and coursework that will be supported by the proposed Sun Fire HPC and GenePix microarray scanner will provide precisely these kinds of learning experiences within a nurturing learning environment.

SLU is committed to the ongoing recruitment of faculty and students from underrepresented backgrounds. The number of women faculty on campus rose from 31.9% in fall 1997 to 48.4% in fall 2007, while the number of faculty of color increased from 5.7% to 17.4% during the same time period. The change in our student population has been similar. In fall 1997, 6.4% of SLU's students were students from minority backgrounds; by fall 2007, that percentage had grown to 10.6%. In addition to this campus-wide commitment to diversity, our science faculty are involved in a number of initiatives to attract students from underrepresented backgrounds to the study of science. They collaborate with SLU's campus resource programs for students from disadvantaged and underrepresented backgrounds to engage and support underrepresented students in the sciences. These programs include the Collegiate Science and Technology Entry Program (CSTEP), the U.S. Ronald E. McNair Postbaccalaureate Achievement

Program, and the Higher Education Opportunity Program (HEOP). CSTEP is a NYS program geared toward increasing the number of historically underrepresented and economically disadvantaged undergraduate and graduate students who complete programs of study that lead to careers in mathematics, science, and technology. The McNair Program at SLU provides services, including a funded summer research fellowship, to program participants to prepare them for Ph.D. programs. This summer, Co-PI Estevez mentored a McNair Scholar whose independent summer research project focused on "*Genetic Regulation During Anoxia,"* while she, Dr. Sharp, and Dr. Harcourt each mentored a McNair Scholar the previous summer.

SLU STEM faculty work with HEOP, a partnership between SLU and the NYS Education Department that supports the college experiences of students from disadvantaged backgrounds, by teaching in the summer workshops offered to new HEOP students, and working with HEOP staff to mentor and support students in laboratory and coursework. The PI and Co-PIs will continue to work with these three programs to support students from underrepresented backgrounds in the pursuit of scientific study. They are also involved in several outreach efforts in the local rural schools, where the majority of students come from disadvantaged backgrounds.[2] Co-PI Harcourt has been collaborating with Clarkson faculty on a NYS-funded project to teach robotics institutes for local high school teachers and students. He and Dr. Sharp also teach introductory computer science in SLU's "Talented Juniors" program each fall. Talented Juniors is designed to provide high school juniors from local schools with the opportunity to take enrichment courses on subjects not available in the local high school curricula.

If funded, this proposal will also contribute to the project personnel's efforts to provide undergraduates with more mentored, hands-on research opportunities with women scientists and faculty from underrepresented backgrounds. Each research program supported will include 2 to 4 students annually as student research assistants, with several other undergraduates mentored through independent research (see Table 6).

E. Enhanced Educational Training for Students Involved in Biological and Computational Research and Courses

A fundamental goal of our science division is to teach undergraduates how to conduct research using state-of-the art instrumentation: approximately 20 undergraduates at SLU will participate as research assistants in the research programs directly supported by this proposal on an annual basis. Another 20 will participate in related faculty-mentored research through independent senior-year research projects. In addition to the training on the microarray scanner and HPC that these students will receive, they and other STEM majors (~175 annually) will gain exposure to the new HPC and microarray scanner through classes. The following table, **Table 6**, summarizes the impact the new equipment items will have on the undergraduate science learning environment at SLU through mentored research and coursework.

Table 6.		**# of Students Impacted**	
Researcher/Team	**Course Name (s)**	**Course(s)**	**Mentored Research**
E. Humphrey-Dixon & R. Sharp	1) Genomics; 2) Computational Biology	50	8
L. Olendzenski	Microbial Biology	10	4
A. Estevez	1) Advanced Neuroscience; 2) Drugs & The Brain	8	4
R. Sharp & E. Harcourt	High Performance Computing	20	4
Ivan Ramler	1) Probability; 2) Mathematical Statistics	40-50	4

[2]Approximately 17% of SLU's students come from the surrounding, economically disadvantage "North Country" region, a high proportion of which are first generation college students. St. Lawrence County where SLU is located is the largest NYS county geographically, but one of the lowest in NYS for per capita income ($21,899 compared to $38,264 for NYS). North Country residents attain less education than their NYS and national peers**.** The facts are compelling: more than 1 of every 5 adults (21%) in the target area does not have a high school degree; and 83% of residents have not attained a bachelor's degree, a figure nearly 10% percentage points higher than the national rate of 74%.

Richard Sharp	Computer Graphics	15-20	
Richard Sharp	Numerical Analysis	10-15	
Ed Harcourt	Programming Languages	10-15	2-4
Susan Willson			4
Robin Lock			1-4
Michael Schuckers			4
Lisa Torrey			2-4

VII. MANAGEMENT PLAN

PI Sharp will chair a multidisciplinary Project Steering Committee to oversee use and management of the requested equipment. Specifically, the committee will: (a) evaluate how the equipment is being used; (b) plan how to optimize its future use; (c) monitor purchases and use of equipment supplies; (d) facilitate cooperation among users; and (e) identify potential other opportunities in which the equipment will enhance faculty and faculty-student research, mentoring, and collaborative partnerships. The Steering Committee will meet on a regular basis to ensure the advancement of the research programs described in this proposal and the submission of the required quarterly reports. All of the project team members and equipment users have a solid record of publications relevant to the proposed research. However, a large proportion of the project team are pre-tenure. Active research programs enrich the teaching of SLU faculty and are incorporated directly into the undergraduate curriculum. As a result, it is the practice at SLU to nurture and support the research programs of pre-tenure faculty. To assist in this regard, PI Sharp has recruited onto the steering committee several senior faculty members with extensive experience in grants management, as well as a strong history of mentoring junior faculty and undergraduate researchers. These senior faculty members will help advise the project team as any challenges or questions arise during the grant term. For example, the HPC is a fundamental component of the research programs described in this proposal, but, like most modern computer technology, the HPC will have a limited shelf life (approximately five years). Consequently, another primary role of the Steering Committee will be to coordinate with the senior administrative staff in the University's Academic Affairs and University Finance divisions, as well as the University's grants office, to plan for the eventual replacement of the HPC when needed. Steering Committee members will be: PI Sharp; Co-PIs Dixon, Estevez, Harcourt and Olendzenski; Faculty Associates Schuckers and Willson; Burry Professor of Statistics Robin Lock; Associate Professor of Biology and Department Co-Chair Michael Temkin; and Johnson Professor of Biology and Department Co-Chair Joseph Erlichman.

SLU is committed to the long-term operation and maintenance of the two equipment items sought through this proposal and has permanent, dedicated space as well as experienced faculty who will manage day-to-day use, ongoing operation, and long-term maintenance of both the HPC and the microarray scanner. Following is a summary of how both short- and long-term management of the proposed equipment will be accomplished. (1) The manufacturers will install the equipment and train the PI, Co-PIs and other project senior personnel on its use. (2) PI Sharp and Co-PI Humphrey-Dixon will coordinate with the equipment manufacturers/suppliers to develop a protocol and schedule for maintenance to ensure proper long-term operation of the equipment. (3) On an ongoing basis, PI Sharp and the Co-PIs will teach new users how to operate the equipment. (4) Co-PI Olendzenski will maintain a scheduling system for use of the microarray scanner to ensure adequate access to the instrumentation by all users.

A. Installation and Training/Facility Where Instrument Will Be Housed

The microarray scanner will be housed in a common-use equipment room (Room 217, Johnson Hall) close to faculty microbiology, biochemistry, genetics and cell biology labs – where it will be easily accessible to all biology faculty (see related facilities description below). Also near faculty teaching labs, the 300 sq. ft. space currently houses preparative and ultra centrifuges, -20 and -80°C freezers, a speed vac, a sonifier, a bead beater homogenizer and a five-year old, 8-node Linux compute cluster (used by Dr. Olendzenski's research lab). The scanner and space will be managed by the Department of Biology, but

available for use by faculty and students in all science disciplines, as well as scientists/researchers from the broader region (Clarkson University, SUNY-Potsdam, SUNY-Canton, Paul Smith's College).

The HPC will be housed in the SLU Information Technology (IT) Central Server Facility, a stand-alone building approximately 2,000 sq. ft. It currently houses 60 IBM Intel servers, one IBM z800 mainframe, and two EMC storage systems. The facility includes the following features: 1) Secure physical access; 2) Fire suppression system; 3) Redundant environment control and air-conditioning units; 4) 40 KVA UPS backup power for all systems; 5) Natural gas generator backup power for the entire building; and 6) Environment and access control, monitored by Security and IT staff.

B. SLU Commitment to Housing and Maintaining the HPC and Microarray Scanner

As noted above, the Department of Biology has dedicated, permanent space for the requested microarray scanner, and SLU is committed to maintaining the location and operation of the scanner and covering the long-term service contracts for the equipment. Co-PIs Dixon, Olendzenski, and Estevez will oversee day-to-day operations, training, scheduling of all users, and equipment maintenance (with service contract support from manufacturers). All senior personnel of this proposal will be trained by Molecular Devices (MDS) on the use, care, and maintenance of the scanner, as well as the basic software. The company will provide an applications specialist to conduct one day of on-site installation and training for the project personnel, as well as other faculty users from within the division. Student users will only have access to the scanner under the supervision of a faculty mentor.

The HPC will be housed in IT's Central Server Facility and will be maintained by Drs. Sharp and Harcourt, and IT's server manager, Rhett Thatcher, Red Hat certified engineer. Management tasks conducted by these individuals will include software and server installation, monitoring of server status, and system security policies. User accounts will be maintained, and training will be conducted by Drs. Sharp and Harcourt. Any physical maintenance will be conducted by Mr. Thatcher and IT.

With the new microarray scanner on site, the volume of microarray processing will increase, as will the costs associated with running these experiments. These higher research costs will be covered through research support funds from the Biology Department. The Co-PIs from biology also plan to supplement these funds through proposals to SLU's Faculty Research Fellowship Award program.

C. Instrument Maintenance and Long-Term Operation

The microarray scanner comes with a one-year warranty for parts and labor, after which an annual maintenance service contract is available from Molecluar Devices (MDS). The HPC comes with a three-year warranty, after which an annual maintenance service contract is also available.

1. ***Costs for Long-term Maintenance:*** SLU maintains service contracts for all major science equipment (as available), and these costs are incorporated into the relevant department's annual operating budget. Current service contracts for the Department of Biology total approximately $36,000. Estimated total annual cost to purchase hardware support for the HPC ($1,328/year) and a service contract for the requested microarray scanner ($5,500) total $6,828. SLU is committed to purchasing service contracts for the requested equipment; however, to do so will require the University to increase its service contract budgets by $6,828 for Years 2 and 3 of the project period. To incorporate these ongoing increased annual operating costs into the long-term institutional budget, SLU requests NSF-MRI support to cover the costs for hardware support for the HPC during the 36-month project period and the cost of the microarray scanner service contract during the 24-month period that follows the warrantee coverage. The hardware support and the service contract will cover all repair or replacement costs should either the microarray scanner or HPC malfunction. At the completion of the proposed project period, SLU will assume all costs for the day-to-day operation and long-term maintenance of the equipment, estimated at approximately $6,828 annually. Because the shelf life of an HPC is approximately five years, the Steering Committee will work closely with key administrators (see p. 12 for more information) to pursue funding opportunities that will enable project personnel to acquire updated technology. The PI and his colleagues will use improved data and strong project results to plan strategically for future funding.

2. ***Initial and Ongoing Training of All HPC and Microarray Scanner Users:*** In addition to project personnel, regular users of the requested equipment will include other science faculty, students and

outside users. All users will be trained by project personnel on a one-to-one basis. The HPC will run Red Hat Linux as its operating system, thus many potential HPC users will already be familiar with its use. Drs. Sharp and Harcourt will otherwise provide training as necessary.

3. ***Procedures for Allocating Instrument Time:*** All microarray scanner users will notify Co-PI Olendzenski, who will oversee all scheduling, in writing at least 24 hrs prior to intended use. Priority will be given to SLU faculty and students. In cases when large computation jobs are scheduled on the HPC simultaneously, SLU faculty and students will be given priority. Unless otherwise necessary, short computation jobs will be given priority over long ones to maximize throughput on the HPC.

4. ***Plans for Attracting and Supporting New Users:*** Scientists and researchers (including graduate students from Clarkson University) at other universities will contact Co-PI Olendzenski to schedule use of the microarray scanner. If the proposal is funded, the PI and Co-PIs will communicate with science department chairs at several universities and colleges in Northern New York and will use existing networks, including the Associated Colleges of the St. Lawrence Valley,[3] to inform the science community of the new microarray scanner and HPC. Training/scheduling of new users will be managed through existing training and calendar systems. SLU will not charge fees to outside collaborators/users of the microarray scanner and HPC. Each Co-PI attends small regional meetings in their discipline (including the Northeast [NE] Microbiologists: Physiology, Ecology, and Taxonomy; NE Regional Yeast Meeting; Upstate NY *C. elegans* meeting, and Consortium for Computing Sciences in Colleges Northeastern), where they will present their research. At each venue, they will provide equipment usage and contact information and also explore collaboration with other faculty. The Biology Department website will contain contact information for scanner usage, and each year the PI and Co-PIs will directly contact potential user institutions (Clarkson, SUNY Potsdam & Canton) with instrument/user updates.

VIII. INTELLECTUAL MERIT

At SLU, the faculty are committed equally to maintaining active research programs and undergraduate teaching. The Sun Fire HPC and GenePix microarray scanner sought through the MRI program are critical for helping the PI, the Co-PIs, and the senior personnel of this proposal contribute to important bodies of scientific knowledge and also maintain the critical balance between excellence in teaching and advancing knowledge in their disciplines. Due to the lack of access to sophisticated technological resources, the project personnel have been unable to perform computationally intensive and memory intensive tasks for their research. This disadvantage has meant not pursuing particular research avenues; amending research programs; missing opportunities to train students; and, of course, inefficiency. The proposed equipment will redress these issues. Perhaps, more importantly, the equipment will enable the PI and the other junior faculty members participating in this proposal – all of whom have brought a new level of innovation and cross-disciplinary collaboration to the research programs at SLU – to undertake a more sophisticated approach to research questions, to develop new areas of research, to generate better data, and to become, in turn, more competitive for other grants that will facilitate the growth of their research.

The proposed microarray scanner and HPC will greatly improve possibilities of current studies in computational biology, bioinformatics, microbiology, neuroscience, statistics, artificial intelligence, and graphics. The new HPC will enable CS faculty to pursue their research agendas of physically based rendering and hardware simulation. Currently, the computationally expensive simulations, which are typical of these areas, are essentially infeasible with the hardware currently available. Many typical computational processes associated with realistic image synthesis and hardware simulation can take days of processing time on a stock desktop PC. The long delay between simulations makes it difficult for faculty to get quick feedback on the simulations that they run. Access to an HPC owned by SLU and run by the faculty who will use it will make a dramatic impact on their ability to conduct their own research

[3] The Associated Colleges of the St. Lawrence Valley is an educational consortium between St. Lawrence University and three neighboring universities: Clarkson University, State University of New York, (SUNY) Potsdam, and SUNY Canton. The consortium was created to expand the number and variety of educational opportunities for faculty and students, to share resources, to avoid needless duplication and to innovate through joint action.

and mentor student research – a process that necessarily requires fast turnaround. The HPC will also enable the project personnel and other faculty at SLU to study a variety of bioinformatics statistical simulations and will serve as a critical tool for high performance phylogenetic analysis.

As described earlier in this proposal, SLU has implemented a large-scale science facilities improvement initiative and strategic equipment acquisitions to ensure that faculty and students have the resources they need for practicing science in this era of intense technological innovation. These efforts are closely correlated with SLU's approach to building and sustaining a research-based undergraduate curriculum and to supporting faculty as teacher scholars. The new microarray scanner and HPC will allow biology, statistics, and CS majors to work together on interdisciplinary research questions and to gain experience with a fundamental analytical instrument and relevant scientific methodology, thereby furthering core goals for scientific education at SLU. In summary, this proposal has the capacity to greatly expand and intensify the research and training infrastructure of our science division and achieve important training and educational goals on our campus.

IX. BROADER IMPACTS

The research described in this proposal is expected to benefit broader society by identifying potential therapies for minimizing brain damage after a stroke, helping to save threatened bird species and habitats in the Amazon, and contributing visually accurate scientific visualizations of human tissue that can aid physicians and other researchers in the diagnosis and treatment of diseases. Determining the roles of alternative DNA structures in transcription may allow modulation of gene expression, an important goal given that many diseases, including cancer, result in part from the misregulation of gene expression. Finally, the opportunity for undergraduates to participate in these exciting research programs is absolutely essential for the training of future scientists.

At the same time that these research programs advance discovery and understanding in key scientific areas, they also present unique research training opportunities for undergraduates to participate directly in original research and create reliable datasets that will enrich learning in the classroom. To enhance the infrastructure for research and education within SLU's liberal arts setting, it is critical to provide modern facilities and instrumentation. The work outlined in this proposal will contribute to research activities across all four undergraduate years, the production of research-based educational materials – such as unique datasets – useful in teaching, and the research training of undergraduates as full research partners whose experiences culminate in co-authored peer-reviewed papers and presentations at professional meetings and conferences.

At SLU, the CS faculty have active research programs that bring energy to the development of cross-disciplinary research areas, yet their capacity to bolster research in this way has been impaired by the lack of advanced computing resources. With NSF assistance, the PI and Co-PIs will upgrade SLU's computing infrastructure and create data and results critical for the advancement of knowledge in several cutting-edge areas. Similarly, the new microarray scanner will support the ability of the PI and Co-PIs to contribute to answering challenging scientific questions, and will heighten the possibilities for collaborations with other SLU and Clarkson faculty. Several of the project faculty and members of the Project Steering Committee collaborate with investigators from Clarkson in existing research programs, and this new scientific capability will bolster those activities and foster new areas of cross-institutional collaboration.

By continuing to work with the HEOP, CSTEP, McNair, and Talented Juniors programs, project personnel will strengthen research and education collaborations with students from underrepresented groups and utilize features of the SLU science learning environment – including small class sizes, low student-faculty ratios, and one-on-one mentoring – to cultivate a learning environment that has particularly positive outcomes with women and students from diverse backgrounds.

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Sharp, R., Adams, J., Lee, R., & Crane, R. (2007). Physics-based subsurface visualization of human tissue. *IEEE Transactions on Visualization and Computer Graphics, 13*(3), 620-629.

Sharp, R., & Machiraju, R. (2006). Accelerating Subsurface Scattering Using Cholesky Factorization. *The Visual Computer, 22*(8), 541-549.

Simons, G., Yao, Y., & Morton, G. (2005). Global markov models for eukaryote nucleotide data. *Journal of Statistical Planning and Inference, 130*(1-2), 251-275.

Tatusov, R.L., Fedorova, N.D., Jackson, J.D., Jacobs, A.R., Kiryutin, B., Koonin, E.V., Krylov, D.M., Mazumder, R., Mekhedov, S.L., Nikolskaya, A.N., Rao, B.S., Smirnov, S., Sverdlov, A.V., Vasudevan, S., Wolf, Y.I., Yin, J.J., & Natale, D.A. (2003). The COG Database: an updated version includes eukaryotes. *BMC Bioinformatics* 4:41.

Thompson, P. B. (1997). *Food biotechnology in ethical perspective* (1st ed.). London; New York: Blackie Academic & Professional.

Thompson, J.B., Ferris, F.G., & Smith, D.A. (1990). Geomicrobiology and Sedimentology of the Mixolimnion and Chemocline in Fayetteville Green Lake, NY. *Palaios,* 5: 52-75.

Van Voorhies, W., & Ward, S. (2000) Broad oxygen tolerance in the nematode *Caenorhabditis elegans*. *The Journal of Experimental Biology*, 203: 2467-2478.

Wahlgren, N.G., & Ahmed, N. (2004) Neuroprotection in cerebral ischaemia: facts and fancies – the need for new approaches. *Cerebrovascular Diseases,* 17: 153-166.

Wenzel, P.L., Wu, L., de Bruin, A., Chong, J.L., Chen, W.Y., Dureska, G., Sites, E., Pan, T., Sharma, A., Huang, K., Ridgway, R., Mosaliganti, K., Sharp, R., Machiraju, R., Saltz, J., Yamamoto, H., Cross, J.C., Robinson, M.L., & Leone G. (2007). Rb is critical in a mammalian tissue stem cell population. *Genes and Development,* Jan 1;21(1):85-97.

Willson, S. K. (2004). *Obligate army-ant-following birds : A study of ecology, spatial movement patterns, and behavior in amazonian peru*. Washington, D.C.: American Ornithologists' Union.

Woodworth, C. D., Michael, E., Marker, D., Allen, S., Smith, L., & Nees, M. (2005). Inhibition of the epidermal growth factor receptor increases expression of genes that stimulate inflammation, apoptosis, and cell attachment. *Molecular Cancer Therapeutics, 4*(4), 650-658.

Richard P. Sharp, Jr, Ph.D., Biographical Sketch

(a) Professional Preparation

- University of Utah, Computer Engineering, B.S., 2000.
- The Ohio State University, Computer Science M.S., 2004.
- The Ohio State University (Adviser: Raghu Machiraju), Computer Science Ph.D., 2006.

(b) Appointments

- Assistant Professor, Department of Mathematics, Computer Science and Statistics, St. Lawrence University, 2007 to Present.
- Senior Lecturer, The Ohio State University, 2006-2007.

(c) i. Relevant Publications

1. K. Mosaliganti, L. Cooper, **R. Sharp**, R. Machiraju, G. Leone, K. Huang, and J. Saltz, "Reconstruction of Cellular Biological Structures from Optical Microscopy Data" in *IEEE Transactions on Visualization and Computer Graphics*, 14(4):863-876, July-Aug 2008.
2. **R. Sharp**, R. Ridgway, K. Mosaliganti, P. Wenzel, T. Pan, A. Bruin, R. Machiraju, K. Huang, G. Leone and J. Saltz, "Volume Rendering Phenotype Differences in Mouse Placenta Microscopy Data" in *Special Issue on Anatomic Rendering and Visualization, Journal of Computing in Science and Engineering*, volume 9 (1), pages 38-47, Jan/ Feb 2007.
3. **R. Sharp**, J. Adams, R. Lee, and R. Crane, "Physics-based subsurface visualization of human tissue" in *IEEE Transactions on Visualization and Computer Graphics*, 13(3):620-629, 2007.
4. **R. Sharp** and R. Machiraju, "Accelerating subsurface scattering using cholesky factorization" in *The Visual Computer*, pages 1-9, 2006.
5. **R. Sharp** and R. Machiraju, "A simplified model for inhomogeneous subsurface scattering" in *Volume Graphics*, pages 63-72. EuroGraphics/IEEE Computer Society VGTC, 2005.

(c) ii. Recent publications

1. K. Mosaliganti, T. Pan, R. Ridgway, **R. Sharp**, L. Cooper, A. Gulacy, A. Sharma, O. Irfanoglu, R. Machiraju, T. Kurc, P. Wenzel, A. deBruin, G. Leone, J. Saltz, K. Huang, "An Imaging Workflow for Characterizing Phenotypical Change in Terabyte Sized Mouse Model Datasets" in *Journal of Biomedical Informatics,* 41(6): 863-873, Dec 2008.
2. P. L. Wenzel, L. Wu, A. de Bruin, W. Chen, G. Dureska, E. Sites, T. Pan, A. Sharma, K. Huang, R. Ridgway, K. Mosaliganti, **R. Sharp**, R. Machiraju, J. Saltz, H. Yamamoto, J. C. Cross, M. L. Robinson and G. Leone, "Rb is critical in a mammalian tissue stem cell population" in *Journal of Genetics and Development*, 21(1): 85-97, Jan 2007.
3. K. Mosaliganti, F. Janoos, **R. Sharp**, R. Ridgway, R. Machiraju, K. Huang, P. Wenzel, A. de Bruin, G. Leone and J. Saltz, "Detection and Visualization of Surface-Pockets to enable Phenotyping Studies" in *IEEE Transactions on Medical Imaging*, 26(9):1283-1290, Sep 2007.

4. **R. Sharp**, R. Ridgway, K. Mosaliganti, O. Irfanoglu, P. Wenzel, R. Machiraju, A. deBruin, G. Leone, T. Pan, K. Huang, and J. Saltz, "Examining Phenotype Differences in Mouse Placenta with Volume Rendering and Segmentation" in *Proceedings of the IEEE/NLM Life Science Systems and Applications Workshop*, Bethesda, MD, USA, July 13-14, 2006.
5. **R. Sharp** and N. Rountev "Interactive exploration of uml sequence diagrams" in *Workshop on Visualizing Software for Understanding and Analysis (VISSOFT. 05)*, pages 8-13, September 2005.

(d) Synergistic Activities

1. Teaching "Talented Juniors" program in the Fall of 2009 (and previously in Fall 2008) to introduce local high school students to computer science.
2. Developed studio based introductory programming course for liberal arts students at St. Lawrence University (Fall 2007).
3. Helped establish and write grant proposals for open source based undergraduate computer science laboratory at St. Lawrence University (2007-2009).
4. Gave two talks at Clarkson University's Computer Science Graduate Seminar in the 2007-2008 academic year.
5. Gave SQL tutorial to local Geographic Information Science department at St. Lawrence University (Fall 2007).

(e) i. Recent Collaborators

J. Adams	The Ohio State University	R. Machiraju	The Ohio State University
A. deBruin	University of Utrecht	K. Mosaliganti	The Ohio State University
W. Chen	The Ohio State University	M. Ostrowski	The Ohio State University
L. Cooper	The Ohio State University	T. Pan	The Ohio State University
R. Crane	IRIS Imaging Systems, Inc.	R. Ridgeway	The Ohio State University
J. C. Cross	The Ohio State University	M. L. Robinson	The Ohio State University
G. Dureska	The Ohio State University	N. Rountev	The Ohio State University
A. Gulacy	The Ohio State University	J. Saltz	The Ohio State University
K. Huang	The Ohio State University	A. Sharma	The Ohio State University
O. Irfanoglu	The Ohio State University	E. Sites	The Ohio State University
S. Iyengar	The Ohio State University	P. Wenzel	The Ohio State University
F. Janoos	The Ohio State University	H. Yamamoto	The Ohio State University
R. Lee	The Ohio State University	L. Wu	The Ohio State University
G. Leone	The Ohio State University		

(e) ii. Graduate Advisors

- Raghu Machiraju, Associate Professor, Department of Computer Science and Engineering, The Ohio State University.
- Robert Lee, Professor and Chair, Department of Electrical and Computer Engineering, The Ohio State University.

(e) iii. Thesis Advisor and Postgraduate-Scholar Sponsor (0)

(none)

Emily Humphrey Dixon, Biographical Sketch

(a) Professional Preparation

- Middlebury College, Biochemistry, B.A., 2000.
- Harvard University, Biochemistry Ph.D., 2005.
- Harvard University/Broad Institute of Harvard and MIT, Molecular Biology and Genetics, Postdoctoral Fellow, 2005-2006.

(b) Appointments

- Assistant Professor, Departments of Biology and Chemistry, St. Lawrence University, 2006 to Present.

(c) Publications

1. Bernstein BE, Liu CL, Humphrey EL, Perlstein EO and Schreiber SL. Global nucleosome occupancy in yeast. Genome Biol. 2004; 5(9):R62.

2. Humphrey EL, Shamji AF, Bernstein BE and Schreiber SL. Rpd3p relocation mediates a transcriptional response to rapamycin in yeast. Chem Biol. 2004; 11(3):295-9.

3. Bernstein BE, Humphrey EL, Liu CL and Schreiber SL. The use of chromatin immunoprecipitation assays in genome-wide analyses of histone modifications. Methods Enzymol. 2004; 376:349-60.

4. Bernstein BE, Humphrey EL, Erlich RL, Schneider R, Bouman P, Liu JS, Kouzarides T, Schreiber SL. Methylation of histone H3 Lys 4 in coding regions of active genes. Proc Natl Acad Sci USA. 2002; 99(13):8695-700.

(d) Synergistic Activities

1. Developed hands-on learning modules for Introduction to Biochemistry course
2. Developed a semester-long laboratory component for a course, Research Methods in Molecular Biology, that begins with microarray data and requires students to develop and test hypotheses.
3. Developed a new course, The Science of Food, for non-majors. This course introduces students to current issues in science and gives them the tools to make informed judgements about the portrayal of scientific information in the popular literature.

(e) i. Recent Collaborators

S. Schreiber Harvard University

A. Shamji Broad Institute of Harvard and MIT

B. Bernstein Massachusetts General Hospital

E. Perlstein Princeton University

(e) ii. Graduate Advisors

- Stuart Schreiber, Department of Chemistry, Harvard University

(e) iii. Thesis Advisor and Postgraduate-Scholar Sponsor

- Stuart Schreiber, Department of Chemistry, Harvard University

BIOGRAPHICAL SKETCH - ANA Y. ESTEVEZ

(a) Professional Preparation

Institution	Major	Degree and Year
Binghamton University	Psychobiology	B.S. 1994
Wayne State University	Physiology	Ph.D. 1999
Vanderbilt University	Ion Channel Physiology	1999-2005

(b) Appointments

Position	Institution	Dates
Assistant Professor Biology and Psychology	St. Lawrence University	July 2005-present
Research Assistant Professor	Vanderbilt University	2003-2005
Postdoctoral Fellow	Vanderbilt University	1999-2003

(c) Publications

(i) Publications most closely related to proposed project

Estevez, A.Y., O'Regan, M.H., Song, D. and Phillis, J.W., Hyposmotically-induced amino acid release from the rat cerebral cortex: role of phospholipases and protein kinases. *Brain Res.*, 844: 1-9, 1999.

Phillis, J.W., **Estevez, A.Y.**, Guyot, L.L. and O'Regan, M.H., 5-(N-Ethyl-N-isopropyl)-amiloride, an Na^+/H^+ exhange inhibitor, protects gerbil hippocampal neurons from ischemic injury. *Brain Res*., 839: 199-202, 1999.

Phillis, J.W., **Estevez, A.Y**. and O'Regan, M.H., Protective effects of the free radical scavengers dimethyl sulfoxide and ethanol, in cerebral ischemia in gerbils. *Neurosci. Lett*. 244: 109-111, 1998.

Estevez, A.Y. and Phillis, J.W., Hypercapnia-induced increases in cerebral blood flow: roles of adenosine, nitric oxide and cortical arousal. *Brain Res*., 758: 1-8, 1997

Estevez, A.Y. and Phillis, J.W., The phospholipase A2 inhibitor, quinacrine, reduces infarct size in rats after transient middle cerebral artery occlusion. *Brain Res*. 752: 203-208, 1997.

(ii) Other significant publications

Xing, J., Yan, X., **Estevez, A.Y.** and Strange, K., Highly Ca^{2+}-selective TRPM channels regulate IP_3-dependent oscillatory Ca^{2+} signaling in the *C. elegans* intestine. *J. Gen. Physiol.*, 131: 245-255, 2008.

Yan, X., Xing, J., Lorin-Nebel, C., **Estevez, A.Y**., Nehrke, K., Lamitina, T. and Strange, K., Function of a STIM1 homologue in *C. elegans*: evidence that store-operated Ca^{2+} entry is not essential for oscillatory Ca^{2+} signaling and ER Ca^{2+} homeostasis. *J. Gen. Physiol*., 128: 443-459, 2006.

Estevez, A.Y. and Strange, K., Calcium feedback mechanisms regulate oscillatory activity of a TRP-like Ca^{2+} conductance in *C. elegans* intestinal cells, *J. Physiol.,* 567: 239-251, 2005.

Estevez, A.Y., Roberts, R.K. and Strange, K., Identification of store-independent and store-operated Ca^{2+} conductances in *C. elegans* intestinal epithelial cells, *J. Gen. Physiol*., 122: 207-223, 2003.

Christensen, M., **Estevez, A**., Yin, X., Fox, R., Morrison, R., McDonnell, M., Gleason, C., Miller, D.M. and Strange, K., A primary culture system for functional analysis of *C. elegans* neurons and muscle cells. *Neuron*, 33: 503-514, 2002.

(d) Synergistic Activities

- As part of the laboratory component for the Advanced Neuroscience course, I included students in several of my research projects. Many of these students have gone on to participate in summer research internships in my laboratory or year-long research projects as part of their capstone Senior Year Experience (SYE) curricular component.
- Our science departments strongly encourage students to attend professional conferences with their faculty mentors. One student, Ariel Riezenman ’08, traveled with me to the 2007 International *C. elegans* meeting. In addition, Kadine Hamilton ’08, traveled with me to the 2008 Experimental Biology meeting and won an APS/NIDDK Minority Travel Fellowship award. Liam Delahanty ’09, accompanied me to the 2008 Society for Neuroscience meeting.

(e) Collaborators and Other Affiliations

- Collaborators and Co-Editors

  Joseph Erlichman – Biology Dept., St. Lawrence University
  Larry French – Chemistry Dept., St. Lawrence University

- Graduate and Postdoctoral Advisors

Advisor:	Current Affiliation:
John W. Phillis, Ph.D. (Graduate Advisor)	University of Florida
Kevin Strange, Ph.D (Postdoctoral Advisor)	Vanderbilt University

- Thesis Advisor and Postgraduate-Scholar Sponsor
  N/A

Edwin A. Harcourt, Biographical Sketch

(a) Professional Preparation

State University of New York, Plattsburgh, NY	Computer Science	B.S., 1986
North Carolina State University	Computer Engineering	M.S., 1989
North Carolina State University	Computer Science	Ph.D., 1994
Chalmers University of Technology, Gothenburg, Sweden	Computer Science	Postdoctoral Research Fellow, 1994-1996

(b) Appointments

- Associate Professor, Computer Science, St. Lawrence University 2009-present
- Assistant Professor, Computer Science, St. Lawrence University 2003-2009
- Software Architect, Cadence Design Systems, Chelmsford, MA. 1996-2003

(c) i. Relevant Publications

1. Ed Harcourt. *Simulation, design abstraction, and SystemC*. Computer Science Education, 17(2):87-96, June 2007.
2. Ed Harcourt. *Teaching computer organization and architecture using SystemC*. The Journal of Computing Science in Colleges, 21(2), December 2005.
3. Brian Ladd and Ed Harcourt. *Student competitions and bots in an introductory computer programming course*. The Journal of Computing Science in Colleges, 20(5), May 2005.
4. *Method and System for Simulation of Mixed-Language Circuit Designs,* U.S. Patent 7,424,703. September 9, 2008.
5. *Performance Level Modeling and Simulation of Electronic Systems Having Both Hardware and Software*, U.S. Patent 7,069,204. June 27, 2006. Also published under the Patent Cooperation Treaty, International Publication Number WO 02/027565 A1.

(c) ii. Other Significant Publications

1) Ed Harcourt. *Policies of system level pipeline modeling*. Electronic Notes in Theoretical Computer Science (to appear). Elsevier, 2009.
2) Paolo Giusto, Grant Martin, and Ed Harcourt. *Reliable estimation of the execution time of embedded software*. In Proceedings of the Design Automation and Test Europe (DATE), pages 580-588. IEEE Press, March 2001.
3) Jwahar Bammi, Ed Harcourt, Wido Kruitzer, Luciano Lavagno, and Mihai Lazarescu. *Software performance estimation strategies in a system level design tool*. In Proceedings of the Eighth International Workshop on Hardware/Software Codesign (CODES). IEEE

Press, March 2000.

4) Gérard Berry, Ed Harcourt, Luciano Lavagno, and Ellen Sentovich. ECL: *A Specification Environment for System-Level Design*, pages 205-212. CHDL. Kluwer Academic Publishers, 2001.

5) Mark R. Hartoog, James A. Rowson, Prakash D. Reddy, Soumya Desai, Douglas D. Dunlop, Edwin A. Harcourt, and Neeti Khullar. *Generation of software tools from processor descriptions for hardware/software codesign*. In DAC '97: Proceedings of the 34th annual conference on Design automation, pages 303-306, New York, NY, USA, 1997. ACM.

(d) ii. Synergistic Activities

1. Workshop Instructor for Summer 2008 Advanced Robotics Workshop on Sensors, Data Acquisition, and Analysis and Developing Rigorous and Relevant Lesson Plans. Clarkson University, July 28-August 1, 2008. Funded by the New York State Education Department.
2. Workshop Instructor for Summer 2008 First Tech Challenge Robotics Workshop for high school teachers. Clarkson University, July 2008. Funded by the New York State Education Department.
3. Workshop Instructor for Summer 2008 First Lego League Robotics Workshop for elementary school teachers. Clarkson University, July 2008. Funded by the New York State Education Department.
4. Taught *Talented Juniors* program in Fall 2008 to introduce local high school students to computer science.
5. Interdisciplinary project (with Biology) on constructing a high performance computer cluster for computational biology problems. http://myslu.stlawu.edu/~ehar/projects.html

(e) Recent Collaborators

- Jim Carroll (Electrical & Computer Engineering, Clarkson University)
- Donna Kennedy (Education Department., SUNY Potsdam)
- Glenn Simonelli (Education Department, SUNY Potsdam)
- Brian Ladd (Computer Science, SUNY Potsdam)
- Esmail Bonakdarian (Computer Science, Franklin University)
- Michael Schuckers (Statistics, St. Lawrence University)
- Richard Sharp (Computer Science, St. Lawrence University)

(e) ii. Graduate Advisors

- Graduate advisor: Jon Mauney (deceased) North Carolina State University
- Postdoctoral sponsor: K.V.S. Prasad, Chalmers University

(e) iii. Thesis Advisor and Postgraduate-Scholar Sponsor (None)

Lorraine Olendzenski, Biographical Sketch

(a) Professional Preparation

- Boston University, Biology, B.S., 1989.
- University of Massachusetts, Biology, M.S., 1994.
- University of Connecticut (Adviser: Johan Peter Gogarten), Molecular and Cell Biology Ph.D., 2004.

(b) Appointments

1. Assistant Professor, Biology Department, St. Lawrence University, 2004 to Present.
2. Educational and Public Outreach Lead, NASA Astrobiology Institute, Josephine Bay Paul Center, Marine Biological Laboratory (MBL), Woods Hole, MA, 2002-2004.

(c) i. Relevant Publications

1. **Olendzenski L.** and Gogarten, J.P. 2009. Gene transfer: who benefits? In Gogarten, M. B., Gogarten, J.P. and Olendzenski, L. (eds.). Horizontal Gene Transfer: Genomes in Flux. Methods in Molecular Biology Volume 532. Humana Press, Clifton, NJ.
2. **Olendzenski, L.** and Gogarten, J.P. 2009. Evolution of Genes and Organisms: The Tree/Web of Life in Light of Horizontal Gene Transfer. Annals of the New York Academy of Sciences. Accepted.
3. Perry, R.S., Lynne, B.Y., Mcloughlin, N., Kolb, V.M., Sephton, M., **Olendzenski, L.**, Engel, M.H., Brasier, M., and Staley, J.T., 2005. "How desert varnish forms?", Proc. SPIE Vol. 5906, Astrobiology and Planetary Missions; Hoover, R.B., Levin, G.V., Rozanov, A.Y., Gladstone, G.R., Eds, pp. 276-287.
4. **Olendzenski, L.**, Liu, L., Zhaxybayeva, O., Murphey, R., Shin, D.G., and Gogarten, J.P. 2000. Horizontal Transfer of Archaeal Genes into the Deinococcaceae: Detection by Molecular and Computer Based Approaches. Journal of Molecular Evolution. 51(6):587-599.

ii. Recent publications

1. Gogarten, M. B., Gogarten, J.P. and **Olendzenski, L.** (Eds.). 2009. Horizontal Gene Transfer: Genomes in Flux. Methods in Molecular Biology Volume 532. Humana Press, Clifton, NJ.
2. Zhaxybayeva, O., J.P. Gogarten, and **Olendzenski, L**. 2007. Orthologs, Paralogs and Genome Duplications in Human and Other Genomes. Encyclopedia of the Life Sciences Online version 2.0. John Wiley and Sons, Ltd.
3. . **Olendzenski, L.**, Zhaxybayeva, O., Gogarten, J.P. 2004. A Brief History of Views of Prokaryotic Evolution and Taxonomy. In: Microbial Genomes, Fraser, C.M., Read, T., and Nelson, K.E. (eds.) Humana Press Inc., Totowa, New Jersey. pp. 143-154.

(d) Synergistic Activities

1. Course Director, "Living in the Microbial World", Teacher Enhancement Workshop for middle and high school teachers, MBL, Woods Hole, MA 1995 - present.

2. Development of "What's in a Genome" bioinformatics activity for undergraduates, with Daniel Bond, University of Minnesota, (http://www.bioquest.org/asm2008/resources.php)
3. Contribution of Resources for K-12 Teachers and Students to 'Microbial Life - Educational Resources Digital Library' (http://serc.carleton.edu/microbelife) – 'Bring 'Em Back Alive' and 'Living in the Microbial World' collections
4. Roland, S., Bahr., M., **Olendzenski, L.**, Patterson, D.J. 2005. Switch on micro*scope! The Science Teacher 72:44-46.

(f) i. Recent Collaborators

M.Bahr	MBL, Woods Hole, MA
E. Barthelmess, E.	St. Lawrence University, NY
B. Bebout, B.	NASA Ames Research Center
Sarah Bordenstein	MBL, Woods Hole, MA
D. Bond	University of Minnesota
J. Dodsworth	University of Washington, Seattle
R. Droppo	Indiana University
J.P. Gogarten	University of Connecticut
D. J. Patterson	MBL, Woods Hole, MA
R. S. Perry	Imperial College, University of London
S. Pfiffner	University of Tennessee
M. Sogin	MBL, Woods Hole, MA
J.T. Staley	University of Washington, Seattle
C. Tsairides	NASA Ames Research Center
O. Zhaxybayeva	Dalhousie University

(g) ii. Graduate Advisors

- Lynn Margulis, Distinguished University Professor, Department of Geosciences, University of Massachusetts, Amherst.
- Johan Peter Gogarten, Professor, Department of Molecular And Cell Biology, University of Connecticut, Storrs.
- Mitchell Sogin, Senior Scientist and Director, Josephine Bay Paul Center, MBL, Woods Hole, MA (Post-doctoral sponsor)

(e) iii. Thesis Advisor and Postgraduate-Scholar Sponsor (0)

(none)

Ivan Ramler – NSF Biographical Sketch
Department of Mathematics, Computer Science and Statistics
St. Lawrence University, Canton, NY 13617
Email: iramler@stlawu.edu; Phone: (315) 229-5792

Education

Institution	Major	Degree & Year
University of Minnesota – Morris	Statistics & Mathematics	B. A.; 2002
Iowa State University	Statistics	M. S.; 2004
Iowa State University	Statistics	Ph.D.; 2008

Appointments

2009 – Present	Visiting Assistant Professor, Dept. of Mathematics, Computer Science and Statistics, St. Lawrence University
2009	Adjunct Assistant Professor, Dept. of Mathematics, Computer Science and Statistics, St. Lawrence University
2007 - 2008	Teaching Assistant, Department of Statistics, Iowa State University
2005 - 2007	Research Assistant, Department of Statistics, Iowa State University
2005 - 2007	Statistical Consultant, Agricultural Experiment Station, Iowa State University

Publications

Ramler, I. P. and Maitra, R. (2009). Accounting for noisy observations in clustering directional data. Submitted.

Maitra, R. and **Ramler, I. P.** (2009). A *k*-mean-directions algorithm for fast clustering of data on the sphere. Accepted in the *Journal of Computational and Graphical Statistics*.

Maitra, R., and **Ramler, I. P.** (2009). Clustering in the Presence of Scatter. *Biometrics.* 65, 341 – 352.

Collaborators & Other Affiliations

(1) Collaborators

Ranjan Maitra (Iowa State University); Richard Sharp (St. Lawrence University); Susan Willson (St. Lawrence University)

(2) Graduate Advisors

Ranjan Maitra (Iowa State University); Tapabrata Maiti (Michigan State University)

Michael E. Schuckers, Ph.D.
Biographical Sketch

(a) Professional Preparation

The Pennsylvania State University	Mathematics	B.A., 1992
The University of Michigan	Statistics	A.M., 1994
Iowa State University (Advisor: Hal Stern)	Statistics	Ph.D., 1999

(b) Appointments

Director, Quantitative Resource Center, 2007 to present
Associate Professor, Department of Mathematics, Computer Science and Statistics, St. Lawrence University, 2007 to present
Assistant Professor, Department of Mathematics, Computer Science and Statistics, St. Lawrence University, 2002 to 2007
Assistant Professor of Statistics, West Virginia University, 1999-2002

(c) i. Relevant Publications

1. Schuckers, ME, *Computational Methods in Biometrics: Statistics for Performance Evaluation (*under contract*)* with Springer-Verlag. Expected publication date 2010.
2. Schuckers, ME, "Test Sample and Size" in *Encyclopedia of Biometrics*, Li, SZ and Elliot SJ (eds), (to appear).
3. Schuckers, ME "A parametric correlation framework for the statistical evaluation and estimation of biometric-based classification performance in a single environment," *IEEE Transactions on Information Forensics and Security* 4 (2009), 231-241.
4. Adler, A, Schuckers, ME, "Human versus Automatic Face Recognition," *IEEE Transactions on Systems, Man and Cybernetics – Part B,* 37 *(2007),* 1248-1255.
5. Barthelmess, EL, Phillips, ML, Schuckers, ME, "The value of bioelectrical analysis vs condition indices in predicting body fat stores in North American porcupines (*Erithizon dorsatum*)", *Canadian Journal of Zoology*, 84 (2006), 1712-1720.

(c) ii. Other publications

1. Schuckers, ME, Sheldon, EM, Hartson, HA "When enough is enough: Early stopping of biometrics error rate testing", *Proceedings of the 2007 Auto ID Conference* in Alghero, Italy (2007).
2. Schuckers, ME "Using the Beta-binomial distribution to assess performance of a biometric identification device," *International Journal of Image and Graphics*, 3 (2003), 523-529.
3. Schuckers, ME, Some statistical aspects of biometric identification device performance, Stats Magazine, Winter 2001.
4. Colbert, J., Schuckers, ME, Fekedulegn, D, Rentch, J, MacSiurtain, M, and Gottschalk, K. "Individual-tree based basal area growth parameter estimates for four models," *Ecological Modeling*, 174 (2004), 115-126.

5. Colbert, J.J., Schuckers, ME and Fekedulegn, D. "Comparing models for growth and management of forest tracts." In Amaro, A., D. Reed and P. Soares, eds., *Modelling Forest Systems*. CABI Publishing, Wallingford, UK (2003).

(d) Synergistic Activities

1. Founding member of Center for Identification Technology Research, an NSF I/UCRC
2. Co-developer of PRESS (with CJ Knickbocker), statistical software package for analyzing data from biometric device testing (http://it.stlawu.edu/~msch/biometrics/PRESS.html)
3. Program Co-chair, Biometrics Symposium, 2005-2007
4. Primary author of proposal for Quantitative Resource Center for St. Lawrence University (2006-07)
5. Member, Executive Committee (Secretary), Northeast Consortium on Quantitative Literacy (NECQL), 2009

(e) i. Recent Collaborators

A. Adler	Carleton University, Canada
M. Corwin	Boston University School of Medicine
Z. Dietz	Hamilton College
J. Gabrosek	Grand Valley State University
D. Hou	Clarkson University
C. Knickerbocker	Sensis Corporation
A. Lewicke	Clarkson University
D. Lock	Iowa State University
R. Lock	St. Lawrence University
Y. Minev	Deloitte US, New York City, NY
N. Mramba	University of Maryland - College Park
M. Neumann	Michigan Technical University
S. Schuckers	Clarkson University
C. Wells	St. Lawrence University
X. Xu	National Institute for Occupational Safety and Health

(e) ii. Graduate Advisor

Hal S. Stern, Professor and Founding Chair, Department of Statistics, University of California, Irvine

(e) iii. Thesis Advisor and Postgraduate-Scholar Sponsor

K. Tordoff	M.S. (WVU, 2001)	Battelle Corporation
C. Beighley	M.S. (WVU, 2002)	Rand Corporation
T. Yan	M.S. (WVU, 2002)	National Institute for Occupational Science and Health

Dr. Susan K. Willson
Department of Biology
St. Lawrence University

Biographical Sketch

a) Professional Preparation

Institution	Major	Degree and Year
Skidmore College	Biology	B.A., 1995
University of Missouri, Columbia	Avian Ecology	Ph.D., 2003

b) Appointments

Position	Institution	Dates
Assistant Professor of Conservation Biology	St. Lawrence University	2007-present
Visiting Assistant Professor Dept. of Biology	Earlham College	2005- 2007
Course Coordinator	Organization for Costal Studies, Costa Rica	May-June 2004 and 2005
Visiting Assistant Professor Dept. of Biology	Colgate University	2004-2005
Instructor Div. of Biological Studies	University of Missouri	2003-2004

c) Publications

Willson, S. K. 2004. Obligate army ant following birds: a study of ecology, spatial movement patterns, and behavior in Amazonian Peru. *Ornithological Monographs* 55: 1-67.
Contains the following chapters:

"Background: Some natural history of the birds and army ants"
"Resource use and species coexistence in five obligate ant-following bird species"
"Survival rates and population dynamics in obligate army ant followers"
"Nesting and reproduction in a guild of obligate army ant followers in Amazonian Peru"
"Conclusions and future questions"

(d) Synergistic Activities

- Invited member of Faculty Focus Group, Network of Conservation Educators and Practitioners (based at American Museum of Natural History, NYC). Assess undergraduate teaching modules for Conservation Biology. Jan 2007- Jan 2009.
- Journal article reviewer for the following professional journals:
  - Association of Tropical Biology and Conservation (*Biotropica*)
  - Association of Field Ornithologists (*Journal of Field Ornithology*)
  - Society for Conservation Biology (*Conservation Biology*)
  - Wilson Ornithological Society (*Wilson Bulletin*)

    - Journal of Tropical Ecology
    - Ornitologia Neotropical
    - Journal of Ecological Entomology
- Reviewer of 9 chapters in undergraduate textbook "The Economy of Nature" by R. Ricklefs. 2007-08.

(e) Collaborators & Other Affiliations

* Collaborators and Co-Editors:
-Ivan Ramler, Assistant Professor of Statistics. Dept. of Mathematics, Computer Science and Statistics. St. Lawrence University.
-Richard P. Sharp, Assistant Professor of Computer Science. Dept. of Mathematics, Computer Science and Statistics. St. Lawrence University.

*Graduate Advisors and Postdoctoral Sponsors:
-Dr. John Faaborg, Dept. of Biology, University of Missouri, Columbia.
-Dr. Frank Thompson, Dept. of Natural Resources, University of Columbia.
-Dr. Rex Cocroft, Dept. of Biology, University of Missouri, Columbia.
-Dr. John Terborgh, Research Professor and Director, Center for Tropical Conservation, Duke University.
-Dr. Bette Loiselle, Dept. of Biology, University of Missouri-St. Louis

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Saint Lawrence University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Richard Sharp

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Sharp - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Emily H Dixon - Assistant Professor**	0.00	0.00	0.00	**0**	
3. **Ana Y Estevez - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **Edwin Harcourt - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Lorraine C Olendzenski - Assistant Professor**	0.00	0.00	0.00	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
GenePix 4000B Microarray Scanner & Computer Station $ **48,500**					
Sun Fire X4600M2 Server **113,580**					
TOTAL EQUIPMENT				**162,080**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,600**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,600**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**165,680**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**165,680**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **165,680**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Richard Sharp

ORG. REP. NAME*
Susan Pankey

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Saint Lawrence University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Richard Sharp

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Sharp - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Emily H Dixon - Assistant Professor**	0.00	0.00	0.00	**0**	
3. **Ana Y Estevez - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **Edwin Harcourt - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Lorraine C Olendzenski - Assistant Professor**	0.00	0.00	0.00	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
HPC Server Hardware Support + Scanner Service Contract $ **6,828**					
TOTAL EQUIPMENT				**6,828**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**6,828**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**6,828**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **6,828**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Richard Sharp

ORG. REP. NAME*
Susan Pankey

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Saint Lawrence University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Richard Sharp

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Sharp - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Emily H Dixon - Assistant Professor**	0.00	0.00	0.00	**0**	
3. **Ana Y Estevez - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **Edwin Harcourt - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Lorraine C Olendzenski - Assistant Professor**	0.00	0.00	0.00	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
HPC Server Hardware Support + Scanner Service Contract $ **6,828**					
TOTAL EQUIPMENT				**6,828**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**6,828**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**6,828**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **6,828**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Richard Sharp

ORG. REP. NAME*
Susan Pankey

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Saint Lawrence University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Richard Sharp

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Richard Sharp - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Emily H Dixon - Assistant Professor**	0.00	0.00	0.00	**0**	
3. **Ana Y Estevez - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **Edwin Harcourt - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Lorraine C Olendzenski - Assistant Professor**	0.00	0.00	0.00	**0**	
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **$ 175,736**					
TOTAL EQUIPMENT				**175,736**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,600**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,600**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**179,336**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**179,336**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **179,336**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Richard Sharp

ORG. REP. NAME*
Susan Pankey

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification

A. Senior Personnel: No salary support is requested for senior personnel (listed below)

Principal Investigators and Co-Principal Investigators:
PI Richard Sharp, Assistant Professor of Computer Science
Co-PI Emily Humphrey-Dixon, Assistant Professor of Biology and Chemistry
Co PI Lorraine Olendzenski, Assistant Professor of Biology
Co-PI Ana Estevez, Assistant Professor of Biology
Co-PI Edwin Harcourt, Associate Professor of Computer Science

Other Senior Personnel – Faculty Associates:
Susan Willson, Assistant Professor of Biology
Ivan Ramler, Visiting Assistant Professor of Statistics
Michael Schuckers, Associate Professor of Statistics

B. Other Personnel: Not applicable

C. Fringe Benefits: Not applicable

D. Equipment
St. Lawrence University seeks NSF support to acquire and install a high performance computer (HPC) built by Sun Microsystems and a GenePix 4000B Microarray Scanner. The new HPC and microarray scanner will significantly expand the research programs of our faculty and the classroom and research experiences of our students across the disciplines of computer science, statistics, and biology. These items are described in greater detail below:

a) The **High Performance Computer (HPC)** requested is a Sun Fire X4600 M2 Server built by Sun Microsystems. Relevant technical performance specifications include:

- 8 x Quad-Core AMD Opteron Model 8389. 2.9GHz 512 KB processors.
- 448 GB of RAM. (48 x 8 GB DDR2-677 and 16 x 4 GB DDR2-677 DIMMs)
- 2 x 146 GB 10000 RPM SAS Drives and 2 x 300 GB 10000 RPM SAS Drives.
- Operating System: Red Hat Enterprise Linux 5.1.

Equipment Cost: $113,580*
*This Year 1 cost includes estimated shipping of $154 and hardware support costs of $1,328. Further details on equipment maintenance/support costs in Years 2 and 3 are provided in Section D.c., below.

b) The GenePix 4000B **Microarray Scanner** offered by Molecular Devices is a single-slide microarray scanner that accepts standard microscope slides (1" x 3" or 25 mm x 75 mm) and has a maximum 22 x 71.5 mm scan area with user-defined sub-scans. The scanner has integrated GenePix Pro software which controls scanner function and allows first pass data analysis [http://www.moleculardevices.com/pages/software/gn_genepix_pro.html – details on software to add can be found here]. Standard dual laser excitation at 532 nm (17 mW) and 635 nm (10 mW) and accompanying detection filters are optimized for Cy3 and Cy5 fluorophores. Simultaneous scan of both wavelengths allows scanning of a whole array at high resolution to be accomplished in 13 minutes with a user-selected resolution of 5- 100 microns per pixel or with a 40 micron resolution in pre-scan mode. The GenePix 4000B has a dynamic range of detection of 4 orders

of magnitude, and can accomplish an extra-high signal-to-noise scan mode by averaging**.** The machine comes with one static license for the GenePix Pro software, test slide kits for validating scanner performance, a SCSI cable and interface card and a power supply. We are requesting the company-recommended configuration which includes a preformatted Dell computer interface for storing and analyzing the large computer files generated during full array scans. Also included in our request is a specially configured computer workstation dedicated to the support of the microarray scanner.
Equipment Cost: $48,500

c) **Equipment Maintenance**: The microarray scanner comes with a one-year warranty for parts and labor, after which an annual maintenance service contract is available from Molecular Devices (MDS). Hardware support is available for the HPC for the three-year grant period. SLU maintains service contracts for all major science equipment (as available), and these costs are incorporated into the relevant department's annual operating budget. Current service contracts for the Department of Biology total approximately $36,000. Estimated total annual costs to purchase hardware support for the HPC ($1,328/year) and a service contract ($5,500/year) for the requested microarray scanner is $6,828. SLU is committed to supporting the requested equipment; however, to do so will require the University to increase our equipment maintenance/service contract budgets by $1,328 for Year 1 (HPC hardware support) and $6,828/year for Years 2 and 3 (HPC hardware support @ $1,328 + scanner service contract of $5,500) of the project period. In order for SLU to permanently incorporate these ongoing increased annual operating costs into the long-term institutional budget, we are requesting NSF-MRI support to cover the costs for the HPC hardware support during the three-year grant period and the microarray scanner service contract for the 24-month project period that follows the warranty coverage. At the completion of the proposed NSF-MRI project period, SLU will assume all costs for the day-to-day operation and long-term maintenance of the equipment, including the estimated annual cost of $6,828 for the HPC hardware support ($1,328/year) and the microarray scanner service contract ($5,500/year).

Requested NSF support for equipment support and maintenance for Years 2 and 3 is detailed in the table below.

Description	**Amount**
HPC Hardware Support - $1,328/year x 2 years (Project Years 2 & 3)	$2,656
Microarray Scanner Service Contract - $5,500/year x 2 years (Project Years 2 & 3)	$11,000
Total Equipment Maintenance/Support Request from NSF in Years 2 & 3	**$13,656**

E. Travel: Not applicable

F. Participant Support Costs: Not applicable

G. Other Direct Costs:
Materials and Supplies of **$3,600** requested in Year 1 to support this project include:

- a test kit of calibration slides for the microarray scanner at an estimated cost of $100;
- an equipment rack and power distribution for the HPC at an estimated cost of $3,000; and
- electrical circuitry/installation for the HPC at an estimated cost of $500.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Richard Sharp

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

Source of Support: NSF-MRI-R2

Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13

Location of Project: St. Lawrence University, Canton, NY

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Emily Dixon

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

Source of Support: NSF-MRI-R2

Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13

Location of Project: St. Lawrence University, Canton, NY

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Ana Estevez

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

Source of Support: NSF-MRI-R2

Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13

Location of Project: St. Lawrence University, Canton, NY

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

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Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Edwin Harcourt	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

Source of Support: NSF-MRI-R2

Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13

Location of Project: St. Lawrence University, Canton, NY

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Project: Service Learning in Support of K-12 STEM Outreach Programs Conducted by the Northern New York Robotics Institute

Source of Support: NSF-CCLI

Total Award Amount: $ 58,968 Total Award Period Covered: 01/01/10 - 12/31/11

Location of Project: Canton, NY & Potsdam, NY

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

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Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

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Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Lorraine Olendzenski

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

Source of Support: NSF-MRI-R2

Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13

Location of Project: St. Lawrence University, Canton, NY

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Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

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 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Ivan Ramler

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

Source of Support: NSF-MRI-R2

Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13

Location of Project: St. Lawrence University, Canton, NY

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

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 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Michael Schuckers

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University
Source of Support: NSF-MRI-R2
Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13
Location of Project: St. Lawrence University, Canton, NY
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: ITR Collaborative Research: Biometrics-Performance, Security, and Social Impact
Source of Support: NSF
Total Award Amount: $ 604,519 Total Award Period Covered: 02/15/04 - 01/31/10
Location of Project: St. Lawrence University, Clarkson Univ., & Mich. State Univ.
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 2.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: PRESS Version 2.0
Source of Support: Center for Identification Technology Research
Total Award Amount: $ 53,706 Total Award Period Covered: 05/01/09 - 05/01/10
Location of Project: St. Lawrence University & Clarkson University
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 1.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:
Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Susan Willson

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University

Source of Support: NSF-MRI-R2

Total Award Amount: $ 179,336 Total Award Period Covered: 03/01/10 - 02/28/13

Location of Project: St. Lawrence University, Canton, NY

Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

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Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

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 USE ADDITIONAL SHEETS AS NECESSARY

Facilities and Other Resources

Facilities Available to House Requested Equipment

The **high performance computer (HPC)** will be housed in the St. Lawrence University Information Technology (IT) Central Server Facility, which is a stand-alone building approximately 2,000 square feet in size. It currently houses 60 IBM Intel servers, one IBM z800 mainframe, and two EMC storage systems. The facility includes the following features:

- Limited physical access to facility via central access control system
- FM-200 fire suppression system
- Redundant Liebert environment control and air-conditioning units
- Liebert 40 KVA UPS backup power for all systems
- Natural gas generator backup power for the entire building
- Environment and access control monitored 24x7x365 by Security and IT staff

The requested **microarray scanner** will be housed in a common-use equipment room (Room 217, Johnson Hall) that is in proximity to the microbiology, biochemistry, genetics and cell biology teaching and research laboratories. This 300 square foot space currently houses preparative and ultra centrifuges, -20 and -80°C freezers, a speed vac, a sonifier, a bead beater homogenizer and a five-year old, 8-node Linux computer cluster. An internet drop connection is already in place to accommodate the microarray scanner computer.

Computer Science

Computer Science Facilities**:** St. Lawrence University recently invested $229,000 to renovate and equip three computer science labs, one server room, and three computer science faculty offices. These spaces are located in close proximity to one another in the same wing of the Bewkes Hall of Science. Each lab is a combination of lab and classroom space measuring 736 square feet. This represents a total of 2,208 square feet of new computer science lab space that will be available for faculty and student use during the 2009-2010 academic year.

Introductory Computer Science Lab : One of the lab rooms is dedicated to the introductory course in computer science. This room contains twenty-five computers and workstations, a projector, and an instructor station. Since the introductory class is a mixture of lecture and lab time, the lab space is designed to accommodate active engagement with the course material. Each station has a dual monitor and eight square feet of work space.

Two Upper Level Computer Science Labs: Two of the labs are designed for upper-level computer science classes. These rooms have fifteen computer workstations each, a projector, and an instructor station. The computers are located around the perimeter of the room with seminar tables in the middle. The remaining courses in the computer science curriculum are taught in these two lab spaces. These courses include computer architecture, programming languages, algorithms, networking, database systems, graphics, web programming, artificial intelligence, and various electives.

Server Room: A smaller 400 square foot room contains file servers and networking equipment

to support the labs and faculty offices.

Department of Biology

Faculty members in the Department of Biology have access to the St. Lawrence Microscopy and Imagery Center (SLUMIC). This 2,400 square foot, multidisciplinary facility is located in the new Johnson Hall of Science, a 115,000 square foot, Gold LEED-certified science building which houses our biology and chemistry departments, including our programs in neuroscience and biochemistry, and teaching and research labs for psychology. The SLUMIC is configured with: a 900-square foot preparation/research lab (including a cell culture facility); a meeting/seminar room; a fluorescence microscope alcove; a technician office alcove; a dedicated transmission electron microscope room; a darkroom; a shared room housing the SEM and the laser scanning confocal microscope (with a gallery viewing area); and a storage room. This facility is located on the first floor of the west building wing and was specially designed to prevent vibration from building mechanical systems and adjacent traffic. Major instrumentation in the SLUMIC includes:

- Leica laser scanning confocal microscope - TCS SP2 - acquired in 2001 via an NSF MRI grant (#0116408) awarded to Dr. T. Budd, Professor of Biology)
- Scanning electron microscope - Philips 525R (circa 1985) - equipped with an EDAX Falcon X-Ray analysis system for doing elemental analysis. The EDAX system was acquired in 2001 via the NSF-MRI grant
- Transmission Electron Microscope - Philips 201 (circa 1975) - equipped with a Gatan model 782 Erlangshen ES500W digital camera system acquired in 2007 via Johnson Hall funds
- Olympus B-MAX 50 based florescence microscope
- Four Sorvall ultra-microtomes (2 motorized, 2 manual drive)
- EMS Sputter Coating device to coat SEM specimens with a thin conductive layer of gold

Additional Facilities and Resources Available for Faculty Research:

Drs. Richard Sharp and Edwin Harcourt work in offices of approximately 300 square feet and have adequate space for meeting with students. With a single desktop PC in each office, both Dr. Sharp and Dr. Harcourt will have unlimited network access to the HPC and thus be able to meet their computing needs.

Dr. Emily Humphrey-Dixon

Dr. Humphrey-Dixon's main research laboratory is 600 square feet with: Fume hood, Real-time quantitative PCR machine, PC work station with data analysis software, stationary and rotating incubators for growing yeast and bacteria, analytical balance, microcentrifuges, chemical storage, and student work areas. Dr. Humphrey-Dixon also has unlimited access to two additional 900 square foot laboratories for teaching/research purposes; a 350 square foot shared instrument room that houses preparative and ultra centrifuges, -20 and -80°C freezers, a speed vac, a sonifier, and a bead beater homogenizer; and a cold room.

Dr. Lorraine Olendzenski:

Dr. Olendzenski's microbiology facility has 1800 square feet of teaching and research space, which includes: microbiology/microbial ecology teaching lab, cold room, culture facility and research space. Equipment includes culture hoods, incubators, anaerobic growth chamber, microfuges, PCR machine, Olympus phase fluorescence microscope, phase and brightfield student microscopes, and waterbaths.

Dr. Ana Estevez:

Dr. Estevez's research laboratory is 600 square feet and is equipped with: inverted epifluorescence microscope outfitted with cooled charge-coupled device (CCD) camera, imaging software and electrophysiology set-up; three dissection microscopes one of which has fluorescence capabilities; pipette puller; air table; analytical balance; pH meter; laminar flow hood; three low temperature incubators for worm culture; high temperature incubator for bacterial culture; clinical centrifuge; water bath; hot plate; microcentrifuge; -20 °C freezer, vapor pressure osmometer; chemical store; student work areas.

Dr. Estevez also has unlimited access to the Neuroscience Teaching labs (1,200 square feet) in an adjoining hallway near the main lab. All the Co-PIs have unlimited access to the cell biology/ biochemistry (1000 square feet) and genetics teaching labs (1000 square feet) on the 2nd floor of Johnson Hall.

Dr. Susan Willson:

Dr. Willson's laboratory is 470 square feet with student workbenches, dissection microscopes, laminar flow hoods, two ArcGIS computers that include access to St. Lawrence University statistical software packages, and laser printer and scanner. Dr. Willson also has a second lab for teaching/ research purposes (750 square feet) in an adjoining hallway near the main research lab; research students may access both labs, while students in courses with Dr. Willson use the teaching lab. The teaching lab has student workbenches, two Mac computers, a PC desktop, and an LCD projector.

Dr. Michael Schuckers:

Dr. Schuckers' office is approximately 180 square feet and contains a standard desktop and dual processor Intel® Xeon™ 3.80GHz workstation with 4MB RAM. In addition he has access to 8 Intel Xeon 3.6GHz Blade servers with 1MB RAM each. Both the workstation and the blade servers were purchased in 2005 with NSF support for a different project (Award #0520990). These blade servers are housed in the University's Information Technology Central Server Facility.

Dr. Ivan Ramler:

Dr. Ramler's office in Bewkes Hall is equipped with a Dell Optiplex 755 with 1.9 GB memory and Intel(R) Core2 Duo 2.66 Ghz Processor with the Linux 2.6.27.24-170.2.68 kernel and a Fedora 10 operating system, providing unlimited access to the HPC.

ST. LAWRENCE UNIVERSITY

23 Romoda Drive, Canton, New York 13617

STATEMENT OF PERFORMING ORGANIZATION CLASSIFICATION

August 3, 2009

To Whom It May Concern:

I hereby certify that the performing institution, St. Lawrence University, is a four-year, non-Ph.D. granting institution of higher education that has produced 20 or fewer Ph.D.s or D.Sci.s in all NSF-supported fields of science, mathematics, and engineering during the combined previous two academic years.

Susan M. Pankey
Director of Corporate & Foundation Relations
Sponsored Programs Office

Corporate & Foundation Relations
315-229-5571 • 315-229-7450 (fax) • cfoffice@stlawu.edu • www.stlawu.edu

ST. LAWRENCE UNIVERSITY
Canton, New York 13617

August 5, 2009

Dr. Randy L. Phelps
Major Research Instrumentation Program
National Science Foundation, Room 1270
4201 Wilson Boulevard
Arlington, VA 22230

Dear Dr. Phelps:

On behalf of St. Lawrence University, please accept this letter of full institutional commitment to operate and maintain beyond the project term the equipment requested in the proposed "MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University." The advanced scientific and computing equipment sought through this proposal will enable PI Richard Sharp and his faculty colleagues to conduct collaborative research and formulate new questions in several key areas, including the phylogenetic analysis of gene sequences, identification of novel targets for achieving neuroprotection, and understanding the role of DNA structure in gene transcription. As such, this research is critical to the advancement of the academic careers of these faculty, and St. Lawrence will provide the costs to operate and maintain the acquired equipment – a high performance computer (HPC) and a microarray scanner – beyond the terms of the project, at an estimated cost of $6,828 per year.

Over the past several years, St. Lawrence has hired into tenure-track positions a number of dynamic young scientists who not only arrived here with active research programs, but who also have carved out new areas of collaborative and interdisciplinary research with their new colleagues. PI Sharp and his co-PIs are included among this group of productive and innovative young researchers at our institution. This proposal is an important opportunity for these faculty members to strengthen their ability to generate new data and make significant contributions in their fields. With use of the advanced research equipment, they will be able both to advance their scholarly careers at St. Lawrence and enrich their teaching at our primarily undergraduate college. As envisioned, their collaborative work will foster increased cross- and interdisciplinary research within our science division and greatly broaden the opportunities for our undergraduates to participate in original research, which is a priority within our science curriculum.

In summary, the addition of the requested HPC and microarray scanner will have a significant positive impact on the research activities of our faculty, the research infrastructure of our science division, and the research culture we emphasize within our undergraduate curriculum. As a result, we are fully committed to the long-term operation and maintenance of each instrument; specifically, St. Lawrence University will assume the full costs of hardware support for the HPC and the service contract for the microarray scanner after the grant period, at an estimated annual cost of $6,828. Thank you for the opportunity to submit this proposal for your consideration.

Sincerely,

William L. Fox
President

WLF/kas

Office of the President
315-229-5892 • 315-229-5435 (fax) • www.stlawu.edu

Clarkson UNIVERSITY defy convention

DEPARTMENT OF BIOLOGY

August 4, 2009

Dr. Richard Sharp
Department of Mathematics, Computer Science, and Statistics
St. Lawrence University
23 Romoda Drive
Canton, NY 13617

Dear Dr. Sharp:

By signing below I acknowledge that I am listed as a collaborator and/or instrument user on this MRI proposal entitled "MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University," with Dr. Richard Sharp as the Principal Investigator. I agree to perform the tasks assigned to me, as described in the proposal, and I commit to provide or make available the resources therein designated to me.

Signed:  **Print Name:** Craig Woodworth

Date: August 4, 2009 **Institution:** Clarkson University

Craig Woodworth • Professor of Biology
Clarkson University • PO Box 5805 • Potsdam, NY 13699-5805
Tel: 315-268-2391 • Fax 315-268-7118 • Email: woodworth@clarkson.edu

Clarkson
UNIVERSITY
defy convention

DEPARTMENT OF BIOLOGY

Dr. Richard Sharp
Department of Mathematics, Computer Science, and Statistics
St. Lawrence University
23 Romoda Drive
Canton, NY 13617

Dear Dr. Sharp:

By signing below I acknowledge that I am listed as a collaborator and/or instrument user on this MRI proposal entitled "MRI-R2: Acquisition of High Performance Computer and Microarray Scanner for Interdisciplinary Research in Computer Science and Biology at St. Lawrence University," with Dr. Richard Sharp as the Principal Investigator. I agree to perform the tasks assigned to me, as described in the proposal, and I commit to provide or make available the resources therein designated to me.

Signed: Kenneth Wallace Print Name: Kenneth Wallace

Date: 8/5/09 Institution: Clarkson University

Clarkson University • P.O. Box 5805 • Potsdam, New York 13699-5805
315-268-2342 • Fax 315 268 7118 • www.clarkson.edu

Sales Quotation

Quote Number: T-US-1505556-A

Quote Date: 8/5/09

Customer : RICHARD SHARP
ST LAWRENCE UNIVERSITY
23 ROMODA DR
CANTON NY 13617
Tel / Fax : 3152295444 /

Sun : Michael Irwin
Sun Microsystems, Inc.
500 Eldorado Blvd
Broomfield CO 80021
Tel / Fax : (303) 272-5329/(510) 217-4210

We are pleased to quote as follows:

Validity Period	Credit Terms	Shipping Terms
23 Days	Net 30 Days	Origin

Item	Product Number	Description	Qty	Unit List Price	Disc	Unit Net Price	Extended Net Price
	ORDER PLACEMENT - Please e-mail a formal Purchase Order to EDU-CSR@SUN.COM or FAX to (510) 217-4210. Please also reference the Sun quotation number located at the top of this quote on your PO. **						
	TO CHECK ORDER STATUS PLEASE SEND EMAIL TO: edu-csr@sun.com OR CALL 1 800-786-0404,PROMPT 1, PROMPT 3. OR VIA THE WEB AT: www.sun.com/mysun.						
	THIS SUN QUOTATION AND ANY ORDER YOU SUBMIT FOR PRODUCTS OR SERVICES IS SUBJECT TO THE TERMS AND CONDITIONS OF THE ATTACHED AGREEMENT.						
	Please call 877-786-4623, then select option #2 three times, to schedule installation of your system or software.						
	In order to complete the booking of the service portion of your order, please provide the following information: installation addresses, contact names, phone numbers, and email addresses on your Purchase Order and/or other funding.						
	Leasing offers flexible, affordable options for acquiring Sun technology. For more information, call Sun Microsystems Finance at (800) 735-5786.						
	SUN SALES REP: JEFFREY CHOQUETTE, jeffrey.choquette@sun.com, PHONE 877-357-5293						
1	Config ID 7679420	Configuration: A67-ZZZ8-8H-064LB1	1	$116,082.00	N/A	$116,082.00	$116,082.00

YOU MUST READ THE FOLLOWING: THIS SUN QUOTATION AND ANY ORDER YOU SUBMIT FOR PRODUCTS OR SERVICES IS SUBJECT TO: (1) THE TERMS OF ANY EXISTING SALES AGREEMENT YOU HAVE WITH SUN GOVERNING THAT PRODUCT OR SERVICE, OR,IF NONE, BY SUN'S SALES TERMS FOUND AT http://www.sun.com/sales/salesterms, THE GENERAL TERMS OF WHICH ARE EITHER ATTACHED OR ON THE REVERSE SIDE HEREOF, AND (2) APPLICABLE SUN SERVICE LISTINGS AND STATEMENTS OF WORK FOUND AT http://www.sun.com/service/servicelist [(1) AND (2) COLLECTIVELY BEING CALLED "SUN SALES TERMS."]

ALL ORDERS MUST REFERENCE EITHER YOUR SALES AGREEMENT NUMBER OR THIS SALES QUOTATION AND BE IN CONFORMANCE WTIH SUN SALES TERMS. ORDERS ARE SUBJECT TO ACCEPTANCE BY SUN EITHER THROUGH ISSUANCE OF AN ORDER ACKNOWLEDGEMENT OR DELIVERY OF THE PRODUCTS OR SERVICES. THIS QUOTATION REMAINS FIRM FOR THE PERIOD LISTED ABOVE, EXCEPT THAT SUN MAY MODIFY THIS SALES QUOTATION IF THERE IS A TYPOGRAPHICAL ERROR OR THE AVAILABILITY OF PRODUCTS, SERVICES, OR CREDIT CHANGE. SUN EQUIPMENT, OR PARTS OR COMPONENTS OF SUN EQUPMENT, MAY BE NEW OR USED, REGARDLESS, SUN WARRANTY TERMS APPLY.

Sales Quotation

Quote Number: T-US-1505556-A

Quote Date: 8/5/09

Item	Product Number	Description	Qty	Unit List Price	Disc	Unit Net Price	Extended Net Price
1.1	A67-ZZZ8-8H-064LB1	Sun Fire X4600 M2 Server, 8 Quad-Core AMD Opteron Model 8389, (2.9GHz/512KB), 64GB (16x4GB) DDR2-667 memory, 2x146 GB 10000 rpm SAS drive, DVD-ROM, 4 1133W Power Supply Units, Service Processor, 4x10/100/1000 Ethernet ports, 4 USB 2.0 ports, 2 PCI-X slots, 4 x8-lane PCIe slot, 2 x4-lane PCIe slot, and sliderail kit. No power cord, must order Geo-specific power cord option.RoHS-5. Standard Configuration.	1	$46,595.00	N/A	$46,595.00	$46,595.00
1.2	RH3IL-51RCE99S	Red Hat Enterprise Linux 5.1, 3-year Standard Subscription for x86, AMD64, Intel EM64T. Up to 2 sockets. Includes media, documentation. Multilingual. One subscription required per system. Red Hat provides support.	1	$2,397.00	N/A	$2,397.00	$2,397.00
1.3	X311L	Localized Power Cord Kit North American/Asian This Product is Hazard Class Y, RoHS compliant.	4	N/C	N/A	N/C	N/C
1.4	IWU-A67-8M-22-3H	This part number corresponds to the following 11i Service item: PLAT-HW-SVC X4600 M2 3 year of 7x24 hardware only support with 2 hour response.	1	$3,984.00	N/A	$3,984.00	$3,984.00
1.5	X8356A	X-OPTION 16GB Memory kit DDR2-667 Registered ECC DIMMs (2x8 GB) for Sun Fire X4600 M2 x64 servers. RoHS-6.	24	$2,500.00	N/A	$2,500.00	$60,000.00
1.6	XRA-SS2CD-300G10K	300GB 10K RPM 2.5" SAS hard disk drive with Nemo bracket. (x-option) RoHS-6	2	$689.00	N/A	$689.00	$1,378.00
1.7	EIS-8WAYWGS-E	Installation of one (1) Sun 8-Way Workgroup Server during local business hours.	1	$1,728.00	N/A	$1,728.00	$1,728.00
	Estimated Shipping: $154.00 - Standard Freight						

List Price Total:	$116,082.00

Total:	$116,082.00

Sales Quotation

Quote Number: T-US-1505556-A

Quote Date: 8/5/09

WE CAN HELP YOU SAVE WHEN YOU FINANCE YOUR TECHNOLOGY SOLUTION THROUGH SUN MICROSYSTEMS GLOBAL FINANCIAL SERVICES (SMGFS). CHOOSE FROM A WIDE RANGE OF FLEXIBLE ,LOW RATE FINANCING AND LEASING PLANS. CONTACT US TODAY AT SMGFS_ Quote_ AMER @ sun. com

Sales Quotation

Quote Number: T-US-1505556-A

Quote Date: 8/5/09

THESE ARE THE GENERAL TERMS APPLICABLE TO YOUR ORDER. ADDITIONAL TERMS APPLY TO YOUR ORDER AND CAN BE FOUND AT http://www.sun.com/sales/salesterms/.

1. INTERPRETATION

The purpose of the General Terms is to create a single mechanism under which you and your Affiliated Companies, if any, ("Company") may form purchasing or other Agreements with Sun Microsystems and its Affiliated Companies ("Sun"). In the General Terms:

"Affiliated Company" means, in relation to either party, any entity: (a) which is owned 50% or more by that party; or (b) over which that party exercises management control; or (c) which is under common control with that party; or (d) which owns 50% or more of that party;

"Agreement" means each agreement entered into under the General Terms, comprising the General Terms and an Exhibit executed by Sun and Company referencing the General Terms;

"Confidential Information" means any information disclosed by one party to another under any Agreement which is, prior to or at the time of disclosure, identified in writing as confidential or proprietary;

"Equipment" means the hardware (including components), software media and spare parts listed in the standard product price lists published by Sun from time to time;

"Exhibit" means any exhibit to the General Terms as executed by the parties from time to time;

"IPR" means intellectual property rights, including patents, trademarks, design rights, copyrights, database rights, trade secrets and all rights of an equivalent nature anywhere in the world;

"Products" means Equipment or Software;

"Service Listing" means any offering in Sun's Enterprise Services Service List, which is located at *http://www.sun.com/service/servicelist* (a hard copy of each of which will be made available to

Company on request), together with such other standard service offerings as the parties may agree from time to time;

"Services" means the services described in any Service Listing or SOW;

"Software" means (i) any binary software programs listed in the standard price lists published by Sun from time to time, (ii) any Updates, and (iii) any related user manuals or other documentation;

"SOW" means any statement of work relating to Services;

"Sun Trademarks" means all names, marks, logos, designs, trade dress and other brand designations used by Sun in connection with Products and Services;

"Updates" means subsequent releases and error corrections for Software previously licensed, as listed in the standard price lists published by Sun from time to time.

2. CONFIDENTIAL INFORMATION

2.1 A party receiving Confidential Information ("the Recipient") may use it only for the purposes for which it was provided under the Agreement. Confidential Information may be disclosed only:) to employees or contractors obligated to the Recipient under similar confidentiality restrictions and in each case only for the purposes for which it was provided under the relevant Agreement.

2.2 The obligations set out in section 2.1 do not apply to information which: (a) is rightfully obtained by the Recipient without breach of any obligation to maintain its confidentiality; (b) is or becomes known to the public through no act or omission of the Recipient; (c) the Recipient develops independently without using Confidential Information of the other party; or (d) is disclosed in response to a valid court or governmental order, if the Recipient has given the other party prior written notice and provides reasonable assistance so as to afford it the opportunity to object.

3. RESTRICTED ACTIVITIES

3.1 Export laws. Products, Services and technical data delivered by Sun may be subject to US export controls or the trade laws of other countries. Company will comply with all such laws and obtain all licenses to export, re-export or import as may be required after delivery to Company. Company will not export or re-export to entities on the most current U.S. export exclusion lists or to any country subject to U.S. embargo or terrorist controls as specified in the U.S. export laws. Company will not use or provide Products, Services, or technical data for nuclear, missile, or chemical biological weaponry end uses.

3.2 Nuclear applications. Company acknowledges that Products and Services are not designed or intended for use in the design, construction, operation or maintenance of any nuclear facility.

4. SUN TRADEMARKS

4.1 Company may refer to Products and Services by their associated names, provided that such reference is not misleading and complies with Sun's Trademark and Logo Policies, which are located at *http://www.sun.com/policies/trademarks* (and a hard copy of which will be made available to Company on request).

4.2 Company may not remove or alter any Sun Trademarks, nor may it co-logo Products or Services. Company agrees that any use of Sun Trademarks by Company will inure to the sole benefit of Sun.

4.3 Company agrees not to incorporate any Sun Trademarks into Company's trademarks, service marks, company names, Internet addresses, domain names, or any other similar designations.

5. PUBLICITY

5.1 Sun may use Company's name in promotional materials, including press releases, presentations and customer references regarding the sale of Products or Services. These permissions are free of charge for worldwide use in any medium. Sun will obtain Company's prior approval for publicity that contains claims, quotes, endorsements or attributions by Company, such approval not to be unreasonably withheld.

6. INTELLECTUAL PROPERTY CLAIMS

6.1 Each party ("the Indemnifying Party") will defend or settle, at its option and expense, any legal proceeding brought against the other ("the Indemnified Party") to the extent that it is based on a claim that materials (which term includes Products) developed and provided by the Indemnifying Party infringe a third party's patent, trade secret or copyright. The Indemnifying Party will indemnify the Indemnified Party against all damages and costs attributable exclusively to such claim awarded by the court finally determining the case, provided that the Indemnified Party: (a) gives written notice of the claim promptly to the Indemnifying Party; (b) gives the Indemnifying Party sole control of the defense and settlement of the claim; (c) provides to the Indemnifying Party, at the expense of the Indemnifying Party, all available information and assistance; (d) does not compromise or settle such claim; and (e) is not in material breach of any Agreement.

6.2 If such materials or services are found to infringe, or in the reasonable opinion of the Indemnifying Party are likely to be the subject of a claim, the Indemnifying Party will at its option: (a) obtain for the Indemnified Party the right to use such materials; (b) replace or modify the materials so they become non-infringing; or (c) if neither (a) nor (b) is reasonably achievable, remove such materials and refund their net book value.

6.3 Neither party has any obligation to the extent any claim results from: (a) use of materials in combination with any third party equipment, software or data; (b) compliance by the Indemnifying Party with the designs or specifications of the Indemnified Party; (c) modification of materials other than at the direction of the Indemnifying Party; or (d) use of an allegedly infringing version of the materials, if the alleged infringement could have been avoided by the use of a different version made available to the Indemnified Party.

6.4 This section states the entire liability of each party (as Indemnifying Party) and the exclusive remedies of each party (as Indemnified Party) for claims that materials infringe a third party's IPR.

7. WARRANTY

7.1 Sun warrants Products and Services as provided at http://www.sun.com/service/support/warranty (the "Warranty Web Page") (a hard copy of which is available on request).

7.2 EXCEPT AS SPECIFIED IN THE WARRANTY WEB PAGE, ALL EXPRESS OR IMPLIED CONDITIONS, REPRESENTATIONS AND WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY, SATISFACTORY QUALITY, FITNESS FOR A PARTICULAR PURPOSE AND NON-INFRINGEMENT, ARE HEREBY EXCLUDED TO THE MAXIMUM EXTENT PERMITTED BY LAW.

8. LIMITATION OF LIABILITY

8.1 No limitation on certain categories of liability. Each party acknowledges the full extent of its own liability to the other, arising from: (a) death or personal injury resulting from negligent acts or omissions; (b) breach of any applicable license grant; or (c) claims for non payment; and the non-excludable statutory rights of consumers (for example, under laws providing for strict product liability) are not affected.

8.2 Limitations on other categories of liability. Subject to 7.1 above and to the extent not prohibited by applicable law: (a) each party's maximum aggregate liability for all claims relating to any Agreement, whether for breach of contract, breach of warranty or in tort, including negligence, will be limited to two million US dollars (U.S. $2,000,000); and (b) neither party will be liable for any indirect, punitive, special, incidental or consequential damages in connection with or arising out of the General Terms or any Agreement (including, without limitation, loss of business, revenue, profits, goodwill, use, data, electronically transmitted orders, or other economic advantage), however they arise, whether in breach of contract, breach of warranty or in tort, including negligence, and even if that party has previously been advised of the possibility of such damages.

8.3 Failure of essential purpose. Liability for damages will be limited and excluded, even if any exclusive remedy provided for in the Agreement fails of its essential purpose.

9. TERMINATION AND EXPIRATION

9.1 Termination for cause. Either party may terminate the General Terms or any Exhibit

immediately by written notice: (a) if the other party commits a non-remediable material breach of the General Terms or Exhibit (as the case may be); or (b) if the other party fails to cure any remediable material breach within thirty (30) days of being notified in writing of such breach.

9.2 Termination without cause. (a) Either party may terminate the General Terms immediately by written notice if no Exhibit is in effect. (b) Either party may terminate any Exhibit at any time upon expiration of ninety (90) days' written notice.

9.3 Actions following termination or expiration. On termination or expiration of the General Terms (for whatever reason), all Exhibits shall automatically terminate with immediate effect. Following termination or expiration of an Exhibit (for whatever reason), each party will deliver to the other any property of the other in its possession or control relating to that Exhibit, in good condition, reasonable wear and tear excepted.

9.4 Effect of termination. Neither party will be liable for any damages arising out of the termination or expiration of the General Terms or any Exhibit, provided that such termination or expiration will not affect any right to recover: (a) damages sustained by reason of material breach; or (b) any payments which may be owing in respect of any Agreement.

10. ASSIGNMENT AND SUBCONTRACTING

10.1 Neither party may assign or otherwise transfer any of its rights or obligations under the General Terms or any Exhibit without the prior written consent of the other party, which consent will not be unreasonably withheld, except that: (a) both parties may assign their right to receive payment; and (b) Sun may use subcontractors in the performance of its obligations, in which case Sun will remain responsible for the performance by such sub-contractors.

11. **DISPUTE RESOLUTION.** The parties will use reasonable efforts to resolve any dispute arising out of the General Terms or any Exhibit through a meeting of appropriate managers from each party. If the parties are unable to resolve the dispute, either party may escalate the dispute to its executives. If an executive level meeting fails to resolve the dispute within thirty (30) days after escalation, either party may seek any available legal relief. This provision will not affect either party's right to seek injunctive or other provisional relief at any time.

12. **GENERAL.** All disputes will be governed by the laws of the State of California The venue for litigation will be the appropriate courts located in the County of Santa Clara. Choice of law rules of any jurisdiction and the United Nations Convention on Contracts for the International Sale of Goods will not apply to any dispute under the Agreement. Force majeure. A party is not liable under any Agreement for non-performance caused by events or conditions beyond that party's reasonable control, if the party makes reasonable efforts to perform. This provision does not relieve either party of its obligation to make payments then owing. Notices. All written notices required by the General Terms or any Exhibit must be delivered in person or by means evidenced by a delivery receipt or acknowledgment and will be effective upon receipt. Notices communicated by electronic mail or facsimile will be deemed to be written. Relationship. Neither the General Terms nor any Agreement is intended to create a partnership, franchise, joint venture, agency, or a fiduciary or employment relationship. Neither party may bind the other party or act in a manner which expresses or implies a relationship other than that of independent contractor. Invalidity. If any provision of the General Terms or any Agreement is held invalid by any law or regulation of any government or by any court or arbitrator, such invalidity will not affect the enforceability of other provisions. Survival. Rights and obligations under the General Terms and any Exhibit which by their nature should survive, will remain in effect after termination or expiration of the General Terms or the relevant Exhibit. No waiver. Any express waiver or failure to exercise promptly any right under the General Terms or any Exhibit will not create a continuing waiver or any expectation of non-enforcement. Modification. No modification to the General Terms or any Exhibit will be binding, unless in writing and manually signed by an authorized representative of each party. Entire agreement. Each Agreement constitutes the parties' entire agreement relating to its subject matter. It cancels and supersedes all prior or contemporaneous oral or written communications, proposals, conditions, representations and warranties and prevails over any conflicting or additional terms contained in any quote, purchase order, acknowledgment, or other communication between the parties relating to its subject matter during its term.

MDS Analytical Technologies
Science advancing health

1311 Orleans Drive
Sunnyvale, CA 94089
www.moldev.com

Submitting a Purchase Order
Purchase Orders must be in writing (FAX, Email or Mail).
Visa, American Express & MasterCard Orders are welcome.
FAX Number - 408-548-6439
Email Address - om@moldev.com

Attention: Emily Humphrey Dixon

St. Lawrence University
226 Johnson Hall of Science
Canton, NY
13617
315-229-5671

edixon@stlawu.edu

Quote #: RB70300R2
Date: 5-Aug-09
Expires: 20-Sep-09

Local Sales Rep.: Rich Battaglia
SR Phone: 800-635-5577 X3521
FAX: 408-548-6439
Prepared By: Gina Snider
Phone: 800-635-5577 Opt. 2

Item	Qnty	Catalog Number	Description	Unit Price	Discount	Extended Price
1	1	GENEPIX 4000B	Axon GenePix 4000B Scanner with GenePix Pro. Two laser (532nm and 635nm), simultaneous scanning, nonconfocal, single-slide microarray scanner with real-time PMT adjustment Adjustable laser power (10%, 33%, 100%) 64 micron focal depth User-selectable resolution from 5 microns to 100 microns per pixel One static license GenePix Pro software SCSI cable SCSI interface card Power supply 1 year warranty covering parts & labor.	50,000.00	-5,000.00	45,000.00
2	1	1-6050-0008	Computer, Workstation GenePix	3,500.00		3,500.00
			Total Discount amount for this Quote.		**-5,000.00**	
			This quote is being offered to the institution listed above and is offered as a confidential proposal. Unauthorized distribution of this quote outside of the listed institution is prohibited.			
				Quotation Total - US Dollars		**$48,500.00**

Options

The following Options are presented for your consideration and are **NOT** included in the Quotation Total above. Discounts will only apply when purchased on the same PO as the Items above.

Item	Qnty	Catalog Number	Description	Unit Price	Notes	Extended Price
1	1	1-Test Slide Kit #2	KIT, CALIBRATION SLIDES, GP-7, GP-8	100.00		100.00
2	5	9301-0065	EXTENDED YEAR DEPOT SERVICE CONTRACT GENEPIX 4000B, POS.	5,500.00	-2,750.00	24,750.00

MDS Analytical Technologies Terms of Quote

1. **MDS Analytical Technologies (MDS AT), acceptance of any Purchase Order is subject to the MDS AT "Terms and Conditions " available for viewing or printing @ http://www.moleculardevices.com/pages/terms_window.html?country=USA. All Purchase Orders must be submitted in writing (FAX, Email or Mail) and made out to MDS Analytical Technologies. Fax, Email & Corporate addresses can be found at the top of this Quote. Visa, American Express, and MasterCard Orders are welcome, and are accepted by phone @ 1-800-635-5577 Option # 2.**

2. **All Orders are FOB Shipping Point.**

3. **MDS AT cannot honor "acceptance" terms for transfer of title or risk of loss**

4. **Payment terms are NET 30 from date of shipment, subject to credit approval.**

5. **Shipping and Handling charges will be added to the Invoice and are based on the size and weight of the package. Prices do not include Sales, Excise, Use or other Taxes now in effect or hereafter levied by reason of this transaction.**

6. **Standard shipment is "2-Day Airfreight", unless otherwise specified, or overland truck, depending on shipment weight, packaging and dimensions. To ship "Freight Collect", the Purchase Order must specify carrier and include Customer's Account Number. MDS AT reserves the right to choose alternate carrier should the requested carrier be unavailable at the time of the shipment.**

7. **Pricing on this Quote and/or any discounts given are good only until the "Expires" date specified above and only if the FOB is Shipping Point. Typographical and clerical errors in Quotes are subject to correction. The Quote Number must appear on the Purchase Order.**

8. **The estimated Ship Date, for an instrument Order is 30 calendar days from the time that the Purchase Order is accepted by Cellular Neuroscience instruments may take up to 45 days from the time that the Purchase Order is received at MDS AT. Consumables and reagents are usually shipped within 24 hours of acceptance of Purchase order.**

9. **MDS AT Federal ID Number #94-2914362. D & B DUNS#125123125**

10. **Most MDS Analytical Technologies Instruments are UL & C.S.A. approved.**