Institute for Applied and Interdisciplinary Mathematics
Proposal: University of Toronto Academic Initiatives Fund, January 2005

1. Vision and Priorities 'I-AIM' for excellence!

Our understanding of the world is built by blending information induced on the one hand from empirical observations, and deduced on the other from conceptual models. But while experimental and inductive techniques vary widely from discipline to discipline, the models and modes of scientific deduction are almost universally couched in the language and methods of mathematics. Thus mathematics plays a central and unifying role, at least among those sciences which aspire to progress beyond the descriptive phase to make rigorous quantitative predictions. Augmenting these two traditional sources of knowledge, a powerful third methodology of computational modelling has emerged, closely allied with applied mathematics. It provides a new tool for probing regimes accessible neither to experiment nor to direct analysis; its impact can hardly be overstated.

University of Toronto hosts the strongest collection of mathematical scientists in Canada. Apart from those appointed to the mathematics department, many others are dispersed across three campuses — in engineering, statistics, physics, chemistry, computer science and the biomedical and social sciences. These scientists are often renowned in their fields. However, as long as they remain insulated from one another within departmental units — which provide little coordination of research and teaching efforts — the transformative impact these scholars could have on science, the university, its students, and the broader community, is not fully achieved. There is also great potential for synergies involving the many researchers whose work stands to benefit from a closer relationship to mathematics. To date connections between such researchers have been formed mainly by serendipity, and few resources have been dedicated to nurturing these essential links, or to orienting students towards the challenges and opportunities emerging at the junction between mathematics, computation and the sciences.

We therefore propose a dynamic research institute (I-AIM) to function as an umbrella organization to coordinate and benefit the common interests of these scholars and students. Our aim is to create an intellectual environment of such excitement that it energizes and inspires the activities of all of its members — from the freshest undergraduate to the most seasoned faculty member. It will lead to the discovery of fundamental mathematics, new science, and transformative technology, from the crucible of their mutual interaction. At the same time, it will help counteract disciplinary balkanization, whose success in producing intense focus often comes at the expense of hampering innovation and change in the broader scientific and learning endeavours. The institute will be staffed primarily by cross-appointments between existing faculty, with a revolving cohort of postdoctoral fellows and senior visitors to supply a continuous infusion of new ideas and expertise. Together, they will engage in the training of students from participating departments who are as well-versed in mathematics as in some area of application. This will be done through a new interdisciplinary program of graduate studies and undergraduate internships designed to facilitate joint mentoring by researchers, mathematicians, and computational scientists working in different disciplines.

The time is ripe for such an initiative. While results of pure mathematics laid the groundwork for many of triumphs of the last century — including general relativity, quantum mechanics, game theory, and computing machines — many of the hard challenges facing the modern technological world now have such scope and complexity that they require mathematicians working in concert with experts from other domains to make significant progress. A sustained effort is necessary. The richness of datasets now available — genomic, geophysical, computational, astronomical, biochemical, financial — coupled with the imperative to complement observation- and technology-driven programs with hypothesis-driven research, demand new conceptual models, organizing principles, computational and data mining approaches. Moreover, the National Research Council is considering establishing a national laboratory in mathematical and computational science, which we hope that I-AIM will attract to Toronto. In prioritized order, the key resources required for this endeavour to flourish will be new 1) infrastructure and space; 2) fellowship funding for interdisciplinary graduate students, postdoctoral fellows, and distinguished visitors; and 3) faculty lines.

2. Intellectual Scope

I-AIM brings together top researchers and students from the University and around the world to attack big problems with complementary methodologies: scientific experiment, mathematical modelling and proof, computer simulation. Faculty enthusiasm for the institute has been enormous: the proposal is supported by some 85 teaching faculty from more than a dozen departments in the Faculties of Arts and Science (54), Medicine (10), and Applied Science & Engineering (20). The scientific imperatives facing us are almost as diverse: they range from fundamental questions about the building blocks of life and the universe, to conceptual and computational modelling possibilities in the nanoscale and biosphere, the design of molecules, aeroplanes, and telescopes, nonlinear wave and material dynamics, to the quantitative management of uncertainty, complexity, and security. We remain bound together by a common reliance on mathematical approaches and computational techniques, and the dramatic opportunities for impact rewarding the successful employment and invention of these. Many of the faculty listed in Appendix A classify loosely into seven groups:

(A) Communications and Control: *(Blake, Brumer, Broucke, Colliander, Francis, Feuerverger, Jurdjevic, Kschischang, Lidar, Lo, Maggiore, Mann, Murty, Nachman, Penn, Sargent, Tall, Valaee).*

(B) Nonlinear Dynamics: *(Brumer, Colliander, Dhirani, Fraser, Ivrii, Jerrard, Kapral, Khesin, Kofman, Matzner, McCann, Mitrovica, Morris, Murray, Peltier, Pugh, Sargent, Schofield, Shepherd, Sulem, Shub, Wu).*

(C) String Theory, Gravitation and Cosmology: *(Bond, Hori, Kofman, Peet, Pen, Poppitz, Khesin, Thompson).*

(D) Discrete Math: Algorithms, Complexity, Geometry, Graph Theory, Statistical Mechanics. *(Borodin, Fraser, Molloy, Rackoff, Shub, Virag, Whittington, Wodak).*

(E) Probability, Statistics, Data Mining: (*Almgren, Bond, Carlberg, Christara, Feuerverger, Fraser, Hogg, Jackson, Jaimungal, Kramer, Knight, Quastel, Rosenthal, Seco).*

(F) Scientific Computation and Modelling: *(Almgren, Bailey, Bond, Buchweitz, Bussman, Carlberg, Christara, Enright, Ethier, Groth, Hansen, Jackson, Lavers, Martin, Martins, Matzner, Mitrovica, Nachman, Peltier, Pen, Pugh, Repka, Sargent, Sarris, Schofield, Sulem, Whittington, Zingg).*

(G) Biochemistry, Biology, Genetics, and Biomedical Research: *(Abrams, Emili, Ethier, Feuerverger, Friesen, Hogg, Joy, Lewis, Nachman, Pugh, Repka, Schofield, Skinner, Shub, Steipe, Tall, Tillier, Tropak, Wodak, Yip).*

Some specific agendas for each of these groups are sketched in I-AIM's April 30 submission to the Arts and Science Stepping Up process (www.math.toronto.edu/iaim/public/plan-doc.html).

3. I-AIM and *Stepping Up*

As stated in the Executive Summary on page one of the Arts and Science Plan, the foundation of an Institute for Interdisciplinary and Applied Mathematics ranks among that Faculty's highest priorities, and addresses many crucial needs. It also satisfies each of the five criteria desired for AIF proposals:

• **Enhancing the student experience.** Current programs and courses in applied mathematics are offered by the mathematics department, but these are not always well-integrated with faculty expertise and program offerings in the many departments which provide natural areas of applications. At the same time, many student researchers in life sciences and medicine are hampered by limitations in quantitative expertise. Scientific computing has been taught in an ad hoc and as needed manner by various departments — computer science, mathematics, statistics, astronomy, chemistry, electrical and aerospace engineering. I-AIM addresses the student experience by bringing graduate students, postdoctoral fellows, undergraduate students and research assistants from different backgrounds under a single roof, where they may profit from each other's experiences, discovering new skills and challenging problems looking over each other's shoulders. Our agenda includes revamping existing programs in applied mathematics, and developing a *computational science* designation as an additional certification to various existing degrees. Coordination of course

offerings in areas of overlap — scientific computation, numerical analysis, mathematical modelling, dynamical systems, control theory, general relativity, quantum mechanics, statistical mechanics, fluid mechanics, complexity — promises increased relevancy and reduced cost of delivery, but its main purpose is to bring students from different application areas together and position them to communicate with and learn from each other. There is a need to create courses in bridge areas, such as mathematical biology. The proposed postdoctoral teaching resources make this possible; they also combine with the breadth of its faculty to give I-AIM a unique potential to arrange team taught courses and sequences by members of different disciplines.

• **Enhancing interdisciplinary, interdepartmental, interdivisional and cross-campus collaborations.** I-AIM is interdisciplinary by nature, involving some 85 teaching faculty spread over three Faculties and a dozen departments. Research partnerships, joint teaching ventures, and co-sponsored I-AIM fellows (from undergraduate interns to senior visitors) will stimulate collaborations, while a physical home, where these faculty and their students encounter each other regularly, in seminars and courses, sharing high-performance computing resources, and in discussions with I-AIM fellows and visitors is the key to ensuring sustained and meaningful interactions. This space, which will house the I-AIM fellows, administrative offices, a classroom, computer lab, and communal areas, would ideally adjoin either the Fields Institute, or the new home of the mathematics department (in 215 Huron and the 6th floor of Bahen), to draw in participation from the many nearby departments and take advantage of close proximity to core scholars, resources, and activities of mutual interest.

• **Bringing together undergraduate and graduate activities with research opportunities.** I-AIM brings undergraduate and graduate students into contact with interdisciplinary research opportunities, through interactions with I-AIM faculty and fellows at its physical location, novel classroom and seminar offerings, research collaborations, joint-supervision arrangements, and summer undergraduate NSERC and industrial internship placements. The development of such programs will be overseen by a Graduate and Undergraduate coordinator (the Associate Directors of I-AIM), who will also be available to guide students to appropriate projects and mentors, and to catalyze summer research internships. I-AIM will hold an annual weekend retreat, at which a selection of faculty and fellows showcase research programs developing in the Institute, with a view to apprising undergrads and graduate students of research opportunities and mentoring possibilities. The same occasion will serve as a scientific networking event for the broader I-AIM community, and will include working lunches to establish a dialogue between the graduate and undergraduate program coordinators of participating departments, hosted by I-AIM's Associate Directors.

• **Connecting the University with the broader community through terms of public policy and outreach.** Our annual retreat will include a public lecture by a distinguished scientist, with enough drawing power to capture the imaginations and bring a broad swath of the public together with the I-AIM community. Attendants may also learn about other I-AIM activities from the juxtaposed presentations. I-AIM Fellows will form a living bridge linking University of Toronto students and researchers to the international scene, while joint activities and proximity will network I-AIM's participants to the local, regional, and international mathematics communities through the Fields Institute. Student industrial internships will establish a dialogue between I-AIM, commercial interests, and prospective employers. I-AIM's space and human capital will allow it to function as an incubator for spinoff companies founded by our members; precedents include Khartika, RiskLab, and Sigma, in the data security and financial analysis sectors. Such industrial partnerships stimulate research of societal relevance through cross-fertilization and generation of novel perspectives and ideas. They also contribute significantly to the training and placement of students, and can play a pivotal role in securing governmental support for I-AIM.

• **Improving equity and diversity.** As documented in Surowiecki's "The Wisdom of Crowds," a group featuring a diversity of backgrounds, opinions, skills, and approaches will often outperform a homogeneous group of superior talent at learning and problem solving. I-AIM, through its disciplinary breadth, brings together exactly the diverse groups of scholars and students necessary to achieve break-through innovations in education and scientific research. I-AIM also addresses the

gender gap and hard science phobia, by establishing partnerships between hard sciences and the life sciences, where underrepresentation of women has tended to be less extreme. Finally, I-AIM's fellowships and recruitment enhance cultural diversity, since mathematics has an unusually international tradition, which was nurtured and flourished in many cultures and countries (India, China, Eastern Europe, the Middle East) where other sciences developed more slowly due to a combination of history, outlook, and financial/technological constraints.

4. I-AIM and the Fields Institute:

I-AIM anticipates close collaboration and a beneficial partnership with the **Fields Institute for Research in the Mathematical Sciences**. The latter is a seven-university consortium located on the St. George campus, with no permanent faculty or degree programs, whose main activity is to host revolving one-year (and shorter) programs of a topical nature, selected to balance the needs of the regional, national, and international communities in pure and applied mathematics. Fields also engages in some longer term network-building invaluable to the local community, but its mandate leaves little room for sustained support to research and teaching activities (interdisciplinary or otherwise) internal to the University of Toronto. That role will be filled by I-AIM, which is interdisciplinary in its conception, and will focus on the long-term support and development of resident scientific programs. A close relationship with Fields will enhance the missions and activities of both Institutes, by connecting students and researchers throughout the University to Fields' activities, and by providing interdisciplinary graduate and postdoctoral programs in applied math as a long term complement to these rotating programs. We have already begun planning a monthly joint seminar series and weekly teas with the Fields Institute, which has graciously offered to provide meeting space for the I-AIM annual retreat.

5. Specific Initiatives

The members of I-AIM will work closely to foster interdisciplinary collaboration between the Departments of Mathematics and Aerospace Studies (UTIAS), Astronomy, CITA, Computer Science, Chemistry, Electrical & Computer Engineering, Mechanical & Industrial Engineering, Statistics, Physics, and the Faculty of Medicine, and students in such programs as Financial Mathematics, Proteomics & Bioinformatics, and the IBBME. Core activities include cultivating and strengthening partnerships through research collaborations, fundraising, the organization of interdisciplinary seminars, team taught courses, and the recruitment and training of jointly supervised graduate students, postdoctoral fellows, and undergraduate summer interns. A successful partnership with I-AIM will be an asset for all departments, producing great science and at the same time acting as a drawing card enhancing efforts to attract students and faculty with theoretical and computational talent. Specific initiatives include:

- high profile weekly interdisciplinary seminar series and annual weekend retreat;

- reworking the applied mathematics graduate program, with special attention to recruitment, course offerings, and program requirements, to promote cross-disciplinary opportunities and interactions.

- coordinating a unified approach to course offerings of different units, adapting these offerings for accessibility and relevance to cognate disciplines while reducing redundancies;

- introducing new course offerings which bridge disciplines; many of these will be team taught, and geared towards orienting graduate and undergraduate students towards research opportunities;

- coordinating a unified approach to the sharing, acquisition, and development of high-performance computing resources at Toronto, and to educating students and researchers in their use;

- acting as a clearing house for catalyzing and placement of undergraduates into summer NSERC and industrial research internships;

- development of *applied math* and *computational science* designations, as additional certifications to various existing degrees.

- the *I-AIM Fellows* program.

6. The I-AIM Fellows.

The lifeblood of any research institute is a constant infusion of new ideas. For I-AIM, this means having a steady stream of top-quality student and postdoctoral talent, distinguished long-term sabbatical visitors, and dynamic interdisciplinary speakers passing through the institute. These Fellows not only contribute directly to I-AIM's research and teaching missions, but disperse into the world when their fellowships end to spread the word about University of Toronto and the scientific research programs here; (thus enhancing our future recruitment efforts). We propose to implement a system of graduate student and postdoctoral fellowships, which will rely on matching AIF funds with individual faculty contributions to catalyze interdisciplinary graduate student and postdoctoral offers. Three of each would be appointed per year, with the fellowship duration of roughly two years. The fellowships would be awarded by a rotating committees, established periodically by I-AIM's Advisory Board. These committees will preference fellowship nominations submitted jointly by faculty members from two or more separate units, and distributed equitably among the different research directions comprising I-AIM. Many of these may be cross-appointments between mathematics and one of the (a) physical sciences; (b) biological sciences; (c) computational sciences or engineering. The competitive nature of these fellowships will help ensure quality. Funding to support residencies by distinguished faculty visitors would be allocated similarly. Interdisciplinary appointments of this nature simply do not happen in the absence of a program to nurture them.

7. Structure and Leadership:

I-AIM will consist of a core of Organizing Members, together with a larger group of Affiliated Faculty. Its Directorate will be advised by an Advisory Board, consisting of representatives of the Affiliated Faculty approved by their units each year, who will also serve as liaisons between their home departments and I-AIM. Members of Planning and Advisory Committees listed in Appendix A are natural candidates for this Board. As the institute grows, an External Board may also be appointed to maintain global standards of excellence.

As with other interdisciplinary activities at the University, administrative affiliation will be determined jointly between the participating faculties and departments. A natural lead in this process will be taken the Department of Mathematics, since I-AIM's mandate and graduate program concern it closely. While we do not anticipate that the Director of I-AIM would necessarily be a mathematician, the administrative costs involved in starting up a new institute can be partly ameliorated by building on existing departmental infrastructure, such as the APM program and course designation. ¿From the outset, tenure-stream appointments and graduate student admissions to I-AIM would flow through participating departments, but with I-AIM playing a key role e.g. in providing interdisciplinary representation on hiring committees. Resources such as the I-AIM Fellowship program would be administered directly through I-AIM.

The I-AIM directorate will include a Director (to implement the recommendations of the internal and external advisory boards, report to the University, petition funding agencies such as CIAR, MITACS, NCE, NSERC, the NRC and industry, and to coordinate the institute activities and postdoctoral program with I-AIM's members and their various departments and units); an Associate Director / Graduate Coordinator (to oversee and actualize the revision of the curriculum in applied mathematics, to coordinate with the graduate directors of the cognate departments, and to provide academic advice to cross-appointed graduate students from the departments which choose to participate); and an Associate Director / Undergraduate Coordinator (to play an analogous role with respect to the undergraduate program, and to catalyze summer NSERC and industrial research internships for students, and coordinate placements). A manager or administrator will support the Directorate, assist Fellows, and provide all feasible aid to Affiliated Faculty with their initiatives in applied mathematics.

To achieve a position of global leadership in interdisciplinary mathematics, new appointments are necessary to fill in critical gaps in our base of expertise, bind together existing strengths and open new directions on our research agenda. Six key areas for such hires were identified in our planning process: 1. solid and fluid dynamics; 2. geometric analysis and general relativity; 3. discrete math,

probability, and statistical mechanics; 4. scientific computation; 5. mathematical modelling; 6. data mining, bioinformatics, and harmonic analysis. As a first step toward this goal, we propose to take advantage of the opportunity afforded by creation of the new institute to lure a leading scientist in one of these areas to Toronto to assume the Directorship of I-AIM as a Senior CRC Chair in Applied Mathematics.

Appendix A:

The scope and shape of I-AIM continue to evolve, but the intellectual relevance of applied mathematics across the university is reflected by the widespread interest and broad support which this proposal has garnered. The following 85 faculty members have expressed strong support for the concept and their interest in affiliation with I-AIM. They include 19 members of the Department of Mathematics, 28 additional faculty from Arts and Science, 20 members of the Faculty of Applied Science, 10 members of the Faculty of Medicine, 7 from the School of Graduate Studies, plus the Director and Deputy Director of the Fields Institute. This document was prepared by a Planning committee consisting of twelve representatives,* in consultation with an Advisory committee consisting of 20 additional faculty.†

*Peter Abrams, Zoology
†Robert Almgren, Computer Science and Mathematics; Mathematical Finance Program
Richard Bailey, Geology and Physics
Ian Blake, Electrical and Computer Engineering
†Richard Bond, Canadian Institute of Theoretical Astrophysics
Allan Borodin, Computer Science
Mireille Broucke, Electrical and Computer Engineering
Paul Brumer, Chemistry
Ragnar Buchweitz, Mathematics
Markus Bussman, Mechanical and Industrial Engineering
Ray Carlberg, Astronomy and Astrophysics
†Christina Christara, Computer Science
James Colliander, Mathematics
Al-Amin Dhirani, Chemistry
Andrew Emili, Medical Research, Medical Genetics & Microbiology; Proteomics & Bioinformatics
*Wayne Enright, Computer Science
Ross Ethier, Mechanical and Industrial Engineering
Andrey Feuerverger, Statistics
Bruce Francis, Electrical and Computer Engineering
Simon Fraser, Chemistry
Jim Friesen, Banting and Best Department of Medical Research
†Clinton Groth, Institute for Aerospace Studies
Jorn Hansen, Institute for Aerospace Studies
David Hogg, Medicine and Medical Biophysics
Kentaro Hori, Mathematics and Physics
Victor Ivrii, Mathematics
Ken Jackson, Computer Science
Sebastian Jaimungal, Statistics
*Robert Jerrard, Mathematics
Mike Joy, Institute of Biomaterials and Biomedical Engineering
Velimir Jurdjevic, Mathematics
†Raymond Kapral, Chemistry
†Barbara Keyfitz, Fields Institute
Boris Khesin, Mathematics
*Keith Knight, Statistics
Lev Kofman, Canadian Institute for Theoretical Astrophysics
Lisa Kramer, Rotman School of Management
†Frank Kschischang, Electrical and Computer Engineering
J. Douglas Lavers, Electrical and Computer Engineering
†Peter Lewis, Biochemistry and Medicine
Daniel Lidar, Chemistry
†Hoi-Kwong Lo, Electrical and Computer Engineering and Physics
†Manfredi Maggiore, Electrical and Computer Engineering

Steve Mann, Electrical and Computer Engineering
†Peter Martin, Astronomy and Canadian Institute for Theoretical Astrophysics
Joaquim Martins, Institute for Aerospace Studies
Christopher Matzner, Astronomy
*Robert McCann, Mathematics
Jerry Mitrovica, Physics
Michael Molloy, Computer Science
Stephen Morris, Physics
Norman Murray, Canadian Institute of Theoretical Astrophysics
†Kumar Murty, Mathematics
*Adrian Nachman, Electrical and Computer Engineering and Mathematics
†Amanda Peet, Physics
*Richard Peltier, Physics
Gerald Penn, Computer Science
*Ue-Li Pen, Canadian Institute for Theoretical Astrophysics
Erich Poppitz, Physics
*Mary Pugh, Mathematics
Jeremy Quastel, Mathematics and Statistics
†Charles Rackoff, Computer Science
Joe Repka, Mathematics
Jeffrey Rosenthal, Statistics
†Tom Salisbury, Fields Institute
†Ted Sargent, Electrical and Computer Engineering
Costas Sarris, Electrical and Computer Engineering
*Jeremy Schofield, Chemistry
†Luis Seco, Mathematics
†Theodore Shepherd, Physics
†Michael Shub, Mathematics
Francis Skinner, Medicine - Neurology, Physiology, Biomaterials and Biomedical Engineering
*Boris Steipe, Biochemistry, Molecular & Medical Genetics; Proteomics & Bioinformatics
Catherine Sulem, Mathematics
Frank Tall, Mathematics
Christopher Thompson, Canadian Institute for Theoretical Astrophysics
Elisabeth Tillier, Medical Biophysics
Michael Tropak, Hospital for Sick Kids
Shahrokh Valaee, Electrical and Computer Engineering
Balint Virag, Mathematics and Statistics
Stuart Whittington, Chemistry
†Shoshana Wodak, Biochemistry, Structural Biology, and Medical Genetics
Yanqin Wu, Astronomy and Astrophysics
Christopher Yip, Biomaterials, Biomedical & Chemical Engineering, Applied & Biochemistry
*David Zingg, Institute for Aerospace Studies

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Appenix B: Time frame and benchmarks

2004-05:

- April 22, 2004; full day I-AIM planning retreat attended by more than 30 faculty members;
- Fall 2004: weekly interdisciplinary seminar series and tea commence;
- Begin forging collaborations and partnerships;
- April 2005: Acting Directorate and Advisory Board to be appointed upon AIF approval;
- Consolidation of reporting structure within the university;
- Solicit nominations of first I-AIM fellows from supporting faculty;
- Begin planning interdisciplinary graduate program;
- Hire manager and halftime systems administrator;
- Begin website development.

2005-06:

- Welcome first I-AIM Fellows (half complement: 3 PDFs, 3 graduate fellows, 1 senior fellow)
- September: First Annual I-AIM Weekend Retreat;
- October: graduate curriculum recommendations completed in time for next academic year;
- Clearinghouse in place for undergraduate summer research placements
- Weekly interdisciplinary seminar including high profile external speakers;
- Regular teas held in partner departments;
- Joint weekly teas with the Fields Institute;
- Joint monthly colloquium series with the Fields Institute
- Locate space and renovate as necessary
- Search for Senior CRC Chair in Applied Mathematics to direct I-AIM;
- Develop fundraising strategy for long term support of the Institute and computational resources, including granting councils, NRC, OFI, CIAR, and private donors.

2006-07:

- Official opening of the Institute and welcome of new Director
- Welcome full complement of Fellows and Directorate to new space;
- Interdisciplinary graduate program in place, with lectures and seminars taking place in new space;
- Review undergraduate curriculum in applied mathematics and computational science;
- Unified webpage listing for Toronto area seminars of related interest;
- Submit applications to granting councils and continue fundraising efforts;
- Daily teas in new space;
- Continue other activities as above.

2007-08:

- Undergraduate curriculum recommendation completed in time for next academic year;
- Continue fundraising efforts and other activities as above.

2008-09:

- Undergraduate certifications in computational science and in applied mathematics in place;
- Continue all major program activities.

2009-10:

- Continue all major program activities;
- Review and assess I-AIM development.

Appenix C: Projected Budget

BUDGET (in thousands; OTO except as noted)	05-06	06-07	07-08	08-09	09-10
*Director (Senior CRC Chair)	-	150	155	160	165
*Manager	60	60	60	60	60
*Systems Administrator (halftime)	30	30	30	30	30
Associate Directors (stipend or teaching release)	20	20	20	20	20
Graduate Fellowships (6 @ 20K)	60	120	120	120	120
Postdoctoral matching funds (6 @ 60% of 50K)	90	180	180	180	180
Fellowships for Senior Visiting Scholars (2 @ 50K)	50	100	100	100	100
Seminar Series	25	25	25	25	25
Annual Retreat	12	12	12	12	12
†270 NASM (12 offices, classroom, computer lab, lounge)	135	135	135	135	135
†Renovation and reconfiguration costs (if necessary)	405	-	-	-	-
TOTAL = $ 4,665,000	887	832	837	842	847

* Base budget: includes salary and 20% for benefits

† Capital costs.