MISSION STATEMENT

The mission of the Virginia Tech College of Science is to provide an internationally recognized environment for a synergistic complement of disciplinary and interdisciplinary training, coupled with a culture of intellectual entrepreneurship for learning through research discovery. This mission supports excellence in recruitment, training, and retention of the brightest scientists at all stages of their careers, from within the Commonwealth, United States, and throughout the world. The mission comprises three core components: (i) to conduct fundamental scientific research on the origins of natural and social phenomena that translate into technologies that address the grand challenges of the state, nation, and world; (ii) to provide innovative education and training with learning outcomes that prepare our future scientific leaders for careers in industry, academia, and national laboratories within a society who must readily adapt to rapid changes in technology, globalization, and increasing demands on the world’s resources; and (iii) to bring scientific discovery and curiosity to the community through collaborative programs and effective transdisciplinary communication targeted toward increasing scientific literacy and connecting varied communities for the advancement of scientific education and appreciation.

EXECUTIVE SUMMARY

The major theme of this annual report is the integration of science disciplines that is essential in addressing significant challenges we all face. The annual report last year indicated that there were shoots from the sowing of programmatic seeds from earlier years of the College. These included innovations in defining pathways to breakthroughs in discovery, in pedagogy that emphasize the unity rather than differences among existing programs of study, the design and implementation of truly interdisciplinary new degree tracks in neuro-science, nano-science, and computational science. The report this year will detail the extraordinary growth of these shoots, under the rubric of the Integrated Science initiative.

The absence of fiscal trauma of the sort in other years has resulted in a calmer environment for the planning of much of what we did during the past year. While no one can predict if this calm will continue, the College believes the plans are sufficiently robust that we can manage any change that may take place in the coming year. The continued support provided by the Provost, the budget office, and other parts of the University is hereby acknowledged, and much appreciated.

The College did record a couple of signal developments in the spring. Dr. Patricia Dove of Geosciences was elected to the National Academy of Sciences. While we have had members in the past, she currently represents the only NAS member among active faculty at Virginia Tech. She also represents another dual triumph in that she is the first woman faculty so honored here, and is a Hokie twice over, having obtained both her Bachelor’s and Master’s degrees at Virginia Tech, before moving over to Princeton for her Ph.D. The second is the success in hosting the World Polymer Congress in June. Attendance was close to 1,500 from all over the world. This event is recognized by polymer scientists globally as the highpoint in their calendar. That we were able to do so demonstrated that Virginia Tech is ready to host other equally significant events on campus. Drs. Tim Long, Robert Moore, and Richard Turner, of Chemistry and the Macromolecules and Interfaces Institute, were responsible for this achievement.
ADMINISTRATIVE QUALITY AND IMPROVEMENT (AdQI)

The assessment practices for 2011-2012 highlighted two of the college’s goals. These are research expenditures and awards, and enrollment management. Both of these goals can be assessed more readily than those of the other goals. The assessment practices for the remainder will be the focus of our action plan for the coming year.

As described in the body of the report, research expenditures present an advance relative to earlier years, in part because of stimulus spending, but are also driven in larger part by the new faculty recruited recently under the cluster rubric. The assessment practices are predicated on direct reports from the Research Division, and so this goal can be tracked straightforwardly.

The assessment practice on enrollment management is also straightforward, by following the trends in SCH, particularly for lower division courses, and the number of seats the college has to provide for surges in matriculating students. Both have shown increases, and the results of these assessments are used in the annual enrollment support requests.

Although the methods of assessment for the highlighted goals are straightforward, they do not capture the full picture of what is happening. For the case of research expenditures, no attempt has been made to examine the correlation of teaching loads of faculty members and the ability to complete and initiate new projects. This correlation touches upon both of these goals. Changes have been looked at in the past few years, but no effective means have been identified yet. These will be studied further in the coming year.

In addition, we will put in place action plans for assessing the remaining goals. These include the outcomes for the Integrated Science initiative. Students enrolled in the pilot will be taking upper division courses with students who have not participated in the Integrated Science Curriculum (ISC), and so a direct comparison of their performance can be carried out. The same is true for students enrolled in the courses of the new degree programs the college is launching.

2012-2013 COLLEGE GOALS AND OUTCOMES

The goals highlighted for these will be described below. They are consonant with the university’s long-range plan, which emphasizes interdisciplinary pedagogy and collaboration. The symbiosis is detailed in the body of the annual report.

OBJECTIVES FROM LAST YEAR

In last year’s report, three objectives were listed. Progress in these has been touched upon below:

1. New Programmatic Tracks Four tracks in nanoscience, neuroscience, computational science, and systems biology have been identified. These are intended to position well the university in meeting the challenge in STEM, and in maintaining leadership in discovery and learning. New faculty members were recruited, all with good records in research and interest in enhancing interdisciplinary programs. The curricula that would lead from freshman year to Ph.D. are now at various levels toward completion, and the entry program in the Integrated Science Curriculum met with good success among students in the first cohort. We anticipate about 24 new students in this year’s cohort.

2. Pathways from Undergraduate to Graduate Studies The new tracks encompass the college’s vision to better integrate undergraduate education and graduate training. Curricula that would
lead from freshman year to Ph.D. are now at various levels toward completion. However, in the formal document to be submitted for approval, it is necessary to split the undergraduate component from the graduate for purposes of going through SCHEV.

3. **New Faculties** This heading covers the role that the college will play in the proposed Faculty of Health Sciences, and others that may be in the offing. COS intends to play a lead role in these faculties, and current hiring strategies are very much predicated on this aim.

**OBJECTIVES FOR COMING YEAR**

1. **Continuance of work on earlier objectives** It is clear that the three objectives listed last year have yet to be reached definitively. One of the objectives for this year is indeed to bring these objectives closer to their goals. The intention to fully integrate undergraduate and graduate offerings requires substantial effort, particularly since existing programs are deficient in upper division and graduate offerings. However, integrating these makes sense both intellectually, given the breadth and depth of knowledge already acquired, and also logistically, since delivery of the material will be more seamless as a result.

2. **Formation of the Academy of Integrated Science** COS will work toward establishing an identity to coordinate efforts in the various elements of this integrated approach, so that students, faculty and staff could better work together toward this common objective. Much of the work is logistical. This Academy will need to fit nicely into the new faculties that the University will be establishing. Of particular importance is the proposed one on computation. Computation is expected to be the basis upon which all future higher education and societal enterprises are founded. It supplies the framework for true integration while maintaining the essence of diversity both intellectually and socially.

3. **Formation of Larger Research Groups** Funding sources for fundamental research are drying up, and if we are to maintain vibrancy in our programs, new revenue sources will have to be identified. These must include the traditional federal sources, but now be extended to agencies other than NSF, DOE, and NIH. We should have more contracts with DOD, DARPA, and others. We must also explore partnerships with industry, many of which are lacking the ability to do R&D work. A notable example is the pharmaceutical industry, many of whose companies have approached us for joint work. And finally, we should seek and establish collaborations with universities and industry elsewhere in the world. All of these require the formation of cohesive research groups, something that other universities are more adept at than Virginia Tech. Tim Long will be leading efforts to form these groups. Collectively, the college will actively seek effective tactical means to achieve this purpose.
INTRODUCTION

The word that best describes the College of Science for the 2011-2012 year was integration. Since its inception in 2003, the College of Science has recognized that solutions to the challenges of the 21st century require an interdisciplinary approach. The paradigm for hiring new faculty members has been to bring in “clusters” of faculty with interests that transcend traditional disciplinary silos. It has become the norm at Virginia Tech for teams of scientists to collaborate in nontraditional ways. Mathematicians, computer scientists and biologists work together to build predictive computational models of cell division that may prove some of our most powerful tools in fighting cancer. Geoscientists and chemists are partnering to address critical issues regarding the availability of key natural resources such as purified water and natural gas. Psychologists and physicists collaborate to elucidate the fundamental nature of decision making through the development and implementation of technologies such as high resolution MRI. These scientists foster a culture of discovery, invention, and entrepreneurship that is unfettered by traditional disciplinary boundaries.

Approaching its 10th anniversary, the College of Science continues to look forward, to inventing the future. Where will we find the next generation of scientists with the imaginations, the skills, and the intestinal fortitude to tackle the world’s most pressing problems concerning hunger, disease, poverty, water, and energy? With this challenge in mind, the college has re-envisioned the learning domain to align with the very best of our discovery domain. New interdisciplinary science programs as well as new approaches to learning in more traditional approaches foster a culture where Virginia Tech students learn science as creators of new knowledge, through interdisciplinary thinking, and as members of a professional community.

The college’s commitment to integration aligns with the university’s Plan for a New Horizon, including the vision to provide “pathways to integrated success.” The vision of the College of Science does not end with the integration of scientific disciplines or the discovery and learning agendas. Integration infuses everything the College of Science does. Engagement, traditionally the third pillar of the land-grant mission, permeates the culture of the College of Science, from K-12 outreach to service learning courses to hosting international research conferences. Indeed, the engagement mission of the college is one of global engagement. The launching of new programs across the learning, discovery and engagement domains has provided the opportunity to weave an explicit attention to diversity into the fabric of the College of Science. This report details a year of reaching forward while holding fast to Ut Prosim, the heart of the Hokie experience.
UNDERGRADUATE

PATHWAYS TO INTEGRATED SUCCESS

In 2011-2012, the College of Science (COS) embarked on a bold mission to transform undergraduate STEM education at Virginia Tech into a more integrated and engaged experience for undergraduates. The Integrated Science Curriculum (ISC; see Appendix A) piloted with 11 students majoring in Biological Sciences, Mathematics, and Physics, completing the first year of the two-year curriculum. Overall, students report that they feel challenged, appreciate the connections made across disciplines, love the lab, and value the close connections made with their professors. The target enrollment for the 2012-2013 cohort for the ISC was 24.

An ISC Shadow Day was launched in February 2012 which gave high school students the opportunity to follow ISC students for the day to learn about the Integrated Science program as well as to get a taste of life on a college campus. There were 11 students from different areas around the state of Virginia participating and three of those students applied and were accepted into the Integrated Science Curriculum for Fall 2012.

In line with the Plan for a New Horizon’s call for an increase in the number of STEM-H postdocs, the COS has developed a new educational postdoctoral fellowship program. This program is supported by the Provost’s Office and the Brown Foundation. Founding fellows Adam Smith and Harumi Shimuda-Beltran helped develop the ISC lab. Shimuda-Beltran also conducted program assessment under the guidance of Kate McConnell from the Office of Academic Assessment. Both Smith and Shimuda-Beltran have left for faculty positions and three new Brown Fellows - Asem Abdulahad, Bradley Carson, and Sarah Stamper - have joined to work on the ISC labs and the neuroscience program. They will be mentored in pedagogy by Jill Sible and Shelli Fowler and will be part of Fowler’s Graduate Education Development Institute learning community. Tim Long and Jill Sible will combine to monitor and advise them on matters of their research fields.

The college is also advancing its planned four new undergraduate degree programs:

**Nanoscience:** The Introduction to Nanoscience I and II sequence was taught during the fall and spring semesters, respectively, and will be offered again next year. The new nanoscience course proposals have been approved by the college and will be submitted for approval, along with the degree proposal, early in the fall semester.

**Systems Biology:** The ISC is the foundation of the systems biology degree, and current ISC students are interested in earning this degree. The systems biology degree proposal is likewise ready for submission to university governance for the beginning of the fall semester.

**Neuroscience:** The high demand among students for a neuroscience program has prompted the college to develop neuroscience majors housed within the biological sciences and psychology degrees. The major will be ready for submission in early fall, and students who entered in 2011 will be able to graduate with this major. A stand-alone degree in neuroscience is still planned and will be developed this year.

**Computational Science:** The College engaged in considerable research and discussion of what should comprise a compelling undergraduate computational science program at Virginia Tech. A faculty team from Statistics,
Mathematics, Computer Science, Biological Sciences, Geosciences, Chemistry, and Physics has been assembled and will be putting forward a proposal that focuses on computational modeling and data analytics. In 2011-2012, the Mathematics Department has paved the way for this degree by piloting Mathematics in a Computational Context, a year-long 10-credit course integrating multivariable calculus, differential equations, and linear algebra with attention to the ways in which computing informs and extends the applicability of these subjects.

In 2011-2012, the college’s Science, Engineering and Law (SEL) minor was approved by university governance. Coordinated by Anna-Marian Bieri and a part of the Howard Hughes Medical Institute-funded “Scienceering” program, the minor is available to any undergraduate. Attentive to the implications of global interdependence described in the university’s Vision for a New Horizon, the SEL program emphasizes international aspects of intellectual property law.

The College of Science is also integrating business with science through its Bringing Science to Market (BS2M) program for undergraduates and its graduate program in Biomedical Technology Development and Management (BTDM) that is housed in Northern Virginia. BS2M offered a new course in entrepreneurship entitled Drugs, Bugs, and Entrepreneurs co-taught by Joe Falkinham (Biological Sciences), Webster Santos (Chemistry), and Tim Howland (Dean’s Office).

**HANDS-ON, MINDS-ON APPROACHES TO LEARNING**

New and established programs in the College of Science are committed to a “hands-on, minds-on” approach to learning in which the learning of science is modeled on the practice of science. During the 2011-2012 academic year, the College of Science continued its commitment to “pedagogical models that spark curiosity, facilitate creative thinking, and develop the tools for effective communication.”

The Derring SCALE-UP classroom was utilized for the second year and housed first-year experience seminars as well as courses in Cell and Molecular Biology, Geosciences Fundamentals, Resources Geology, Integrated Science Curriculum, and Majors Introductory Physics. With the matriculation of the second cohort of ISC students, a successful SCALE-UP faculty study group led by Barbara Bekken, and requests to schedule the classroom from departments across campus, the COS has partnered with University Libraries to build a second, larger SCALE-UP classroom (capacity 72) to be available for Spring 2013 courses. Architectural drawings are nearly finalized and construction is scheduled to begin this fall.

Anderson Norton in Mathematics exemplifies the opportunities to secure federal funding to support research projects in STEM education. He serves as Principal Investigator for an $890,307 Robert Noyce Scholarship grant from NSF, “Virginia Teach: Serving Mathematics Students in Need.” In addition, Norton serves as co-PI on ~$5M sponsored research projects in mathematics education.

Laboratories are an obvious venue for active and engaged learning experiences for undergraduates. The 2011-2012 year marked the pilot of modest laboratory fees assessed for large enrollment, lower division courses. Recognizing that it would take years to accumulate the revenue from lab fees to fund the ambitious plans for introductory labs, the COS dean’s office fronted ~$2M in equipment purchases. The Chemistry Department forged a unique partnership with Agilent Technologies. Both chemistry majors, and the much larger group of non-majors
who enroll in our service classes, have direct, hands-on experience with an array of new instrumentation including GC/MS, NMR, UV/Vis, fluorimeters, atomic absorption spectrometers, a powder X-ray diffractometer, a flash calorimeter, and more. In the non-majors general chemistry laboratory, an entirely new set of experiments has been implemented to take advantage of this new equipment. A fringe benefit of this major investment is that it has reinvigorated the enthusiasm of the faculty, staff, and TAs who are associated with these courses. The Physics department was able to purchase a new telescope for an on-campus observatory and the Geosciences Department Museum now houses the OmniGlobe which is used for not only Geosciences but also Biology labs and K-12 outreach activities.

With funding from the Provost’s office, the Integrated Science laboratories, led by Tim Long and the first Brown Foundation Educational Postdocs, Adam Smith and Harumi Shimuda-Beltran, designed a laboratory experience that focuses on innovation, on inventing the future. Students learn the critical interpersonal communication skills and state-of-the-art laboratory techniques and instrumentation that are vital to solve some of the most challenging issues that face our society today. The laboratory is organized into modules, where experiments are not traditional week-long exercises. In sharp contrast, teams of students tackle some of the most challenging issues that we face today, ranging from delivery of drugs and nucleic acid therapeutics to understanding chemical kinetics and motion. In addition, multi-week modules such as the one on surfactants touch on the ethical issues that scientists face each day: Are we improving the quality and quantities of our lives without sacrificing our earth or human health? Modules such as photosynthesis explore nature’s mechanism for the utilization of light and the mimicry that inspires scientists to create new photovoltaic cells for solar energy. Students experience the excitement of teamed research in an interdisciplinary way, and they accomplish this learning with important everyday issues that we face. The laboratory seeks to expose students to the culture of research and promote students to pursue more research experiences in their undergraduate plan of study. The Fralin Life Sciences Institute has generously housed the ISL for the first year. The program will move to Derring Hall this fall in newly renovated labs that will also house a new molecular biology laboratory course in Biological Sciences.

THE LIFE OF THE MIND: PAVING THE WAY

Visions for a New Horizon highlights the Pathways to Success First Year Experience (FYE) programs as well aligned with the goals of inspiring creativity, curiosity, and critical thinking among all undergraduate students. In 2011-2012, the College of Science housed three FYE programs:

1. The Zip-line to Success Program led by Gary Kinder, which serves >100 transfer students across the college. This program was piloted three years ago by Debbie Wilson. In both the pilot and the last two years as a full-scale FYE, the Zip-line program has resulted in less than half the transfer students going on academic probation and an increase in participation in co-curricular activities (student leadership positions, undergraduate research.)

2. The Physics department launched a Pathways program for all of its incoming majors. Both the Zip-line and Physics FYE seminars are taught in the SCALE-UP classroom to promote engaged and team-based learning.
3. The Psychology department developed an on-line FYE for its freshman majors. The course is co-taught by Kurt Hoffman, Cindy Koziol and Gary Kinder. All three Pathways programs in the COS have received continued funding for 2012-2013.

MEETING ENROLLMENT CHALLENGES

Hands-on, minds-on learning experiences are resource intensive with respect to personnel and classroom/laboratory space. The College of Science upholds its responsibility to providing high-quality, foundational learning in STEM for all undergraduates at Virginia Tech. The “service” load of the college is complex. While non-STEM majors generally earn 12-14 SCH in COS courses to meet CLE area 4 and 5 requirements, the majority of the University’s students are majoring in STEM fields (in COS, COE, CALS and CNRE) in which the COS may deliver more SCH for the degree than the student’s home college. The COS is impacted by enrollment planning and management practices across campus.

The number of COS majors remained relatively constant between 2010 and 2011 census dates with totals of primary and secondary majors at 3,789 and 3,747, respectively. There were modest decreases within Biological Sciences and Psychology. Since these are the two highest enrollment majors on campus with student:faculty ratios of ~45:1, the trend is not unwelcome. On the other hand, STEM programs with capacity to grow (Geosciences, Physics, and Statistics) saw modest increases in enrollment. The university’s recent efforts in enrollment planning seem to be having the desired effect. Paired with retention programs (Zip-line, Summer Bridge), the COS anticipates graduating a breadth of STEM majors in a timely manner.

The 2011-2012 year brought the particular challenge of a second bulge in enrollment of students requiring the first-year engineering curriculum. While the previous year’s bulge were admitted into General Engineering majors, this past year’s pressure came from students who were second-choiced from Engineering to University Studies. For these students, the gateway to admission is demonstrated success in Chemistry, Physics and Mathematics courses, and therefore, they require the same courses as a GE student. The table below shows the trends for these students including the largest enrollments yet for 2012-2013 (pending final census numbers). The number of COS courses taken by engineering students drops after semester three (when they complete Physics) but there is still considerable demand throughout the curriculum, varying somewhat by specific major and student choice of electives. Last year (FY12), $961,000 supplemental funding was provided to cover the cost for the increased demand by COE and US undergraduates. This year, the funding committed to support the past two bulges plus an even larger bulge this year (see table below) was only $571,556. An additional $350,000 that has been requested but not yet committed will be required in order to offer US students the seats they need in the spring.
In this table, 2009 is considered “base” enrollments. In year one, these students take six credits of classroom-based Calculus (MATH 1205, 1206), two credits Emporium-based linear algebra (MATH 1114), four credits Chemistry with lab (CHEM 1035, 1045) and four credits Physics with lab (PHYS 2305). In year two, the students complete the Physics sequence (PHYS 2306) and take additional Math, Statistics, as well as Biological Sciences, Chemistry, Physics, and Geosciences courses depending on their major. Note: every 20-25 students represents a new section of a laboratory. Every 50 students represent an additional GTA who must be funded to teach the laboratories. Personnel costs alone for these labs exceed $200/SCH.

Overall, the total number of SCH delivered by the COS has fluctuated within 1% over the past three years. However, specific departments and types of courses have been disproportionately impacted:

1. In 2011-2012, SCH delivered by Physics and Statistics were up by 15.6% and 7.5%, respectively. The demand in statistics is for upper division undergraduate and graduate courses not typically funded by enrollment support.
2. While enrollment growth in Mathematics has been modest, there has been a drop in some Emporium-based courses and an increase in small instructor-led courses. Thus, the total cost for delivery has increased.
3. The demand for laboratory courses in Chemistry and Physics has increased. As mentioned previously, laboratories are particularly costly to deliver.
4. Decreased enrollments in some departments (Geosciences, Economics) are due to decreased demand for large enrollment CLE courses. The cost savings of such decreases are modest.

As articulated in A Plan for a New Horizon, both distance learning and summer school afford opportunities to address enrollment demands with limited classroom and laboratory space. Total summer school offerings from the COS increased modestly (6.5%) between summers 2010 and 2011. The off-campus offerings, primarily distance-learning courses, increased significantly, by 100%. Additionally, the off-campus offerings increased 35% in the 2011-2012 academic year relative to the previous year. This is a trend in the right direction with capacity to grow in both online and summer school offerings.
GRADUATE

The achievements of the graduate students in the College of Science bring prestige to the departments and thus to the college and university as a whole. The College of Science is committed to:

- Developing and supporting interdisciplinary graduate research and training programs.
- Increasing the successful recruitment of top quality graduate student prospects.
- Supporting a steady growth of M.S. and Ph.D. students.
- Enhancing graduate and professional degree value through national and international partnerships, joint degrees and interdisciplinary programs.
- Enhancing the quality of graduate training and increasing external support for graduate training.

Our goal is to grow the number of Ph.D. students as new interdisciplinary tracks at the graduate level are developed through cluster hiring and the emerging ISC faculty who bridge disciplines. The degree tracks in nanoscience, neuroscience, computational science, and systems biology are intended to end at the Ph.D. In Fall 2011, there were 601 graduate students enrolled in the College of Science. Of these, 501 were Ph.D. students and 100 were M.S. students. There has been a remarkable growth in the number of doctoral students from 2003 when 256 Ph.D. students were enrolled in the College of Science. The college has far surpassed the expectations set by the PhD2010 program to grow the number of Ph.D. students in the college by 120 by 2010, increasing our 2003 enrollment by 57.4%.

The College of Science is a leader in developing interdisciplinary graduate degree programs. Such programs span traditional departmental boundaries and allow students enrolled in a program to study with faculty from many departments and colleges.

- Judy Riffle (Chemistry) is director of the Macromolecular Science and Engineering graduate degree (MACR) which is a university-based degree program spanning multiple departments and colleges to emphasize fundamental and emerging technological areas in the field of macromolecular science and engineering.
- Faculty from Biological Sciences are key members of the interdisciplinary Ph.D. program in Genetics, Bioinformatics, and Computational Biology (GBCB). This exciting program of study encompasses applications of molecular biology, genomics, mathematics, statistics, and computer science to all areas of the life sciences.
• Biological Sciences is also involved in the *Molecular Cell Biology and Biotechnology (MCBB)* option to provide training in broad fundamentals that can then be applied to particular disciplines. On successful completion of the core curriculum in *MCBB*, students will be able to apply concepts of molecular cell biology directly to their own field of interest and research.

• Faculty from the college have also been very successful in developing Integrative Graduate Education and Research Training (IGERT) grants funded by the NSF. The competition for these five-year programs is intense with only a handful of programs selected from several hundred applications.

From this strong tradition of interdisciplinary research, the College of Science is developing a strong IGEP presence. We are also proposing new graduate degrees, including a Ph.D. in Nanoscience which was accepted in 2012. The MACR program, described above, remains as a model IGEP.

Faculty in the College of Science led novel recruitment efforts to increase the quality, diversity, and reputation of research programs.

• With a desire to promote a healthy work-life balance for the next generation as articulated in the *Vision for a New Horizon*, Lisa Belden developed a new course, BIOL 5174 GS: Work/Life Balance in Academia, a graduate seminar designed to give students skills that will help them to define and achieve their personal and professional goals throughout their careers. Nine students were enrolled from COS, COE, CNRE, PCOB and CALS. Topics included goal setting, priorities, university policies relating to work/life balance, dual-career issues, negotiation, leadership skills, and time management with a variety of readings. Presentations included guest speakers and invited panelists. Students kept a journal to help them reflect on the topics over the course of the semester, and an effort was made to give them concrete skill sets.

• Biological Sciences faculty maintained leadership in three university-wide graduate recruiting programs: (1) The Interdepartmental Microbiology Graduate Program (IMGP) includes over 40 faculty participants from across the university. Students who apply and are recruited spend their first semester rotating through laboratories before the decision is made on a major advisor; (2) The Graduate Program in Molecular Plant Sciences (MPS) involves 20 participating faculty from seven departments - this coming year marks the fifth year of an aggressive recruiting effort at regional schools, followed by students rotating through labs before a decision is made on a major advisor; and (3) The Graduate Program in Cell and Developmental Biology (CDB) includes 11 participating faculty. Fifteen students have been recruited, 14 are currently active. Following the model of the Microbiology program, students in the CDB rotate among faculty mentors before being accepted into a particular lab.

• The college and departments support three four-year ICTAS Graduate Scholarships per year to recruit the best and brightest graduate students to Virginia Tech. There are now 10 ICTAS Graduate Scholars in the College of Science and two more will join the cohort in Fall 2012.
• Departments host “open days” and other such events to showcase the quality of their graduate programs and to help recruit the best students. Physics held its annual on-campus Preview Weekend for prospective graduate students in February 2012. The date was chosen to coincide with the Graduate School Preview Weekend and students participate in various activities at the Graduate School and in the department. The departmental sessions include a poster session organized by all research groups and attended by faculty and current graduate students, along with meetings with faculty and lab tours, and a social evening with current students. Fifty percent of the prospective graduate students attending this event accepted offers to join the department this coming fall.

• Departments also target professional meetings to recruit the best and brightest graduate students. Faculty members in the Department of Geosciences, for example, set up special student recruiting and information booths at the following professional meetings: Geological Society of America, Society of Exploration Geophysicists and the American Geophysical Union. Southeast Section of Geological Society of America, Society of Exploration Geophysicists and the American Geophysical Union. In addition, the departmental website continues to use a web-based pre-application form to reach potential applicants and to match their research interests with potential faculty advisors.

Departments in The College of Science are committed to enhancing the quality of graduate training. We are promoting shared instrumentation and core facilities to encourage peer learning and grass roots collaborations. There will be opportunities for graduate students to connect art with science with new partnerships forged with the Institute for Creativity, Arts, and Technology.

• Biological Sciences entered the sixth year of the “preparing the future professoriate” project. Graduate students who wish to build a strong resume in teaching and in preparation for academic careers can participate in a graduate school certificate program that includes a course in pedagogy or teaching at the college level, and an opportunity to teach a lecture course in the department under the mentorship of a faculty member.

• Geosciences continues its new graduate student orientation program in August that includes a presentation of expectations of graduate students, scientific culture and ethics, and career paths for graduate students.

• An important aspect of graduate training is to have students present their research results during “research days” and other such events. Biological Sciences presented their 9th Annual Research Day on February 2012. This program, directed by and for graduate students, is modeled after professional conferences with poster sessions, presentations, and a plenary talk. An abstract book was published on the web, and over 125 people attended the meeting, including several from the Biological Sciences Alumni Advisory Board. Geosciences held its 17th annual Geosciences Student Research Symposium in March 2012. This is a two-day event organized by graduate students where the students present 15-minute talks in a format similar to that found in a professional meeting. An abstract volume is published as well.
• Statistics has a very active consulting center with faculty from the entire campus visiting the Laboratory of Interdisciplinary Statistical Research (LISA) throughout the year. All students are trained in consulting via coursework and practical experience; each M.S. student must work in LISA for at least one semester for a minimum of five hours per week.

Entrepreneurship is of growing importance at the graduate level. In 2011-12, we introduced sessions with VT KnowledgeWorks and these will continue in 2012-13. In addition, connections external to academe will be fostered as they are important in graduate training and build on successes in corporate sponsorships and internships for graduate programs. A few examples are listed below:

• Statistics’ Corporate Partners Program, which includes companies such as BD, Capital One, DuPont, GE, JR Research, Lilly, Minitab, Pratt & Whitney, RJ Reynolds, and SAS, sponsor student recruitment activities and scholarships. The Corporate Partners, and other companies, visit Statistics regularly and the students are among their top choices for recruiting new hires and interns.

• Psychology’s internship component involves strong and abiding relations with institutions such as the Devereux Institute in Pennsylvania. Such internships place students in competitive positions for appointments after graduation.

• There are also opportunities for some graduate students to complete parts of their training at off-campus sites such as Oak Ridge National Laboratories, Georgetown University, the Howard Hughes Institute, and USGS. The National Capital Region (NCR) will provide new opportunities for graduate students by accommodating some of the off-campus training opportunities mentioned above.

Endowments provided by loyal alumni are also providing scholarships that enhance the graduate programs in the college. Geosciences has endowed graduate scholarships totaling $130,000. The College of Science’s alumni advisory group, the Roundtable, established the Make-a-Difference Scholarship for Graduate Study in the College of Science. Four awards totaling $10,000 are awarded each year to graduate students who will make a significant difference to the College of Science and the world outside the university.
Discovery is the foundation of the multifaceted mission of the College of Science; discovery-based learning and discovery-based engagement nurtures a spirit of intellectual entrepreneurship and provides opportunities for more meaningful societal impact. Today’s global grand challenges, including such issues as water scarcity, alternative energies and energy storage, nanomedicine, climate change and environmental impact of science, and computational methods to handle rapidly generated data sets of immense proportions, demand interdisciplinary collaboration among faculty members across our College and the University. Faculty must seamlessly interact to advance research, teaching, and engagement, where interactions with various communities and at different scales are required. Interdisciplinary teaming is no longer a paradigm; interdisciplinary strategies to solve complex problems for global impact are now an expectation. It is important to recognize that in order to excel with interdisciplinary interactions, the College must first maintain excellence in our disciplines, and many grand challenges require the assembly of an interdisciplinary team of researchers from these established disciplines. In parallel, the College strives to foster alliances with the industrial sectors and national laboratories, where external partners catalyze translation and validate the challenges that we strive to address.

**BUILDING INTERDISCIPLINARY TEAMS THROUGH CLUSTER HIRING AND FORMING THE INTEGRATED SCIENCE FACULTY**

Cluster hiring was implemented by the College of Science in 2004 to attract the best scholars, to promote diversity, and to drive the development of interdisciplinary research teams. The initial hires in the college focused on four cluster areas: nanoscience, computational science, infectious diseases, and human development across the lifespan. The selection of the cluster themes was based on criteria that ensure an inclusive paradigm, where research excellence in the interdisciplinary theme would have significant impact beyond the College of Science. Indeed, the initial cluster in nanoscience had COE participation and human development across the lifespan involved participation from CLAHS. These four themes are evident as overarching to many of the subsequent themes that have emerged. In addition, all clusters in the College of Science align strongly with Virginia Tech’s strategic plan. Nanoscience and computational science are critical components of the University’s discovery domain of Innovative Technologies and Complex Systems (ITS) while infectious diseases and human development across the lifespan provide critical components within the discovery domain of Health, Food and Nutrition (HFN) as well as Social and Individual Transformation (SIT). In 2006, the college expanded cluster hiring based on proposals from faculty to include visualization and pattern recognition and data analytics (VPR-DA) which aligns with Innovative Technologies and Complex Systems, and integrated studies of earth systems (ISES) which aligns with Energy, Materials and Environment. VTCRI accelerated growth in the emerging cluster of neuroscience which aligns with Health, Food and Nutrition. These areas build on strengths within the College of Science and help build and sustain a critical mass from which to establish collaborations with other colleges and institutes across campus including the college’s and university’s research institutes – Macromolecular and Interfaces Institute (MII), Interdisciplinary Center for Applied Mathematics (ICAM), Institute for Critical Technologies and Applied Science (ICTAS), Fralin Life Sciences Institute, Virginia Tech Transportation Institute (VTTI), Virginia Tech Carilion Research Institute (VTCRI) and the Virginia Bioinformatics Institute (VBI).
Growing faculty in these areas complement existing programs in biological sciences, chemistry, geosciences, economics, mathematics, psychology, physics, and statistics and will forge strong interactions with the National Capital Region. The selection of research thrusts is also consistent with an emerging faculty of health sciences which truly transcends disciplinary boundaries to ensure success. Although the research thrusts represent grand challenges in science and cluster areas are designed for intellectual inclusivity with longevity, the College continually reassesses these clusters and ensures we continually address the critical issues of our time and the success and relevance of our graduates.

In late 2011 and early 2012, the College of Science embarked on a paradigm of initiating and completing searches for new faculty who signify a commitment to the importance of interdisciplinary science to help solve major societal challenges in nanoscience, neuroscience, computational science, and systems biology. These interdisciplinary programs offer immediate impact on the fundamental issues facing energy, environment, and health sciences. The new faculty members associated with these interdisciplinary programs form an Integrated Science Faculty (ISF) who will not only participate in the College of Science’s recently launched Integrated Science Curriculum but will also collectively serve to build strong research and educational partnerships across sciences and engineering. The ISF members are positioned within our disciplines, serving to advance the mission of the discipline; however, the ISF members are also committed to the integration of their discipline across traditional boundaries of the College and the University. They are positioned to be architects of new interdisciplinary programs, integrated scientific discovery, and an integrated educational gateway for the study of science.

The inaugural ISF search affirmed that these new faculty members sought an interdisciplinary environment, an environment for collaboration for discovery and novel educational pedagogies. Although the ISF search was initiated later in the fall advertisement cycle, the College attracted a new cadre of faculty with an exceptional complement of disciplinary and interdisciplinary excellence. The new faculty recruited into the cluster areas and ISF are listed below:

<table>
<thead>
<tr>
<th>Name</th>
<th>Department</th>
<th>COS Cluster</th>
<th>Discovery Domain</th>
<th>Arriving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cayelan Carey</td>
<td>Biological Sciences</td>
<td>Energy and Environment</td>
<td>EME</td>
<td>Fall 2013</td>
</tr>
<tr>
<td>Joel McGlothlin</td>
<td>Biological Sciences</td>
<td>Energy and Environment</td>
<td>EME</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>Michael Strickland</td>
<td>Biological Sciences</td>
<td>Energy and Environment</td>
<td>EME</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>F. Marc Michel</td>
<td>Geosciences (ISF)</td>
<td>Energy and Environment</td>
<td>EME</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>John Matson</td>
<td>Chemistry</td>
<td>Nanoscience OR E&amp;E</td>
<td>EME</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>Vinh Nguyen</td>
<td>Physics (ISF)</td>
<td>Nanoscience</td>
<td>ITS</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>Kendra Sewall</td>
<td>Biological Sciences (ISF)</td>
<td>Neuroscience</td>
<td>HFN</td>
<td>Spring 2013</td>
</tr>
<tr>
<td>Hongxiao Zhu</td>
<td>Statistics</td>
<td>Neuroscience</td>
<td>HFN</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>Julianne Chung</td>
<td>Mathematics (ISF)</td>
<td>VPR-DA</td>
<td>ITS</td>
<td>Spring 2013</td>
</tr>
<tr>
<td>Matthias Chung</td>
<td>Mathematics (ISF)</td>
<td>VPR-DA</td>
<td>ITS</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>Nathan Glatt-Holtz</td>
<td>Mathematics</td>
<td>VPR-DA</td>
<td>ITS</td>
<td>Fall 2013</td>
</tr>
<tr>
<td>Duncan Farrah</td>
<td>Physics</td>
<td>VPR-DA</td>
<td>ITS</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>William Mather</td>
<td>Physics (ISF)</td>
<td>VPR-DA</td>
<td>ITS</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>Xiaowei Wu</td>
<td>Statistics</td>
<td>VPR-DA</td>
<td>ITS</td>
<td>Fall 2012</td>
</tr>
<tr>
<td>Camillo Mariani</td>
<td>Physics</td>
<td></td>
<td></td>
<td>Fall 2012</td>
</tr>
</tbody>
</table>
**Research Expenditures and Awards**

Research expenditures in FY12 totaled $34.3M, an increase from $32.7M in FY11. The number of awards, 251, decreased from 264 in FY11 and 276 in FY10, suggesting the importance of larger awards of research teams with a concomitant decrease in opportunities for single investigator awards. The total amount of awards, $40.6M, decreased from $42.2M in FY11, and the average value of sponsored awards increased from an average value of $96,111 in FY11 to $105,641 in FY12. The college is therefore still experiencing the effects of little hiring in FY09 and no hiring in FY10 due to budget reductions.

### College of Science Research Awards and Expenditures FY 2007 - FY 2012

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awards</td>
<td>22,210,654</td>
<td>33,492,579</td>
<td>33,486,418</td>
<td>43,374,615</td>
<td>42,189,490</td>
<td>40,627,767</td>
</tr>
<tr>
<td>Expenditures</td>
<td>$23,859,105</td>
<td>$25,264,615</td>
<td>$29,058,522</td>
<td>$31,246,730</td>
<td>$32,678,953</td>
<td>$34,273,204</td>
</tr>
</tbody>
</table>

Given these facts, it is noteworthy that since the College of Science was formed in 2003, the research expenditures have increased 38% and the research awards have increased by 55%. During this period, the average amount per award has grown from $80,330 to $103,485.

Summarized below are notable awards in FY12:

- Scotland Leman (Statistics) is a PI on a $13.4M grant from Intelligence Advanced Research Projects Activity for “EMBERS: Early Model Based Event Detection Using Surrogates”
- Lori Blanc and Jeff Walters (Biological Sciences) are co-PIs on a $2M U.S. Army Corps of Engineers grant on “Endangered Species Management on Eglin Air Force Base, Florida”
- Anderson Norton (Mathematics) and Kirby Deater-Deckard (Psychology) are co-PIs on a $1.99M grant from NSF on “Gateways to Algebraic Motivation, Engagement and Success (GAMES)”
- John Phillips (Biological Sciences) is the PI on a $1.6M grant from DARPA on “Involvement of a Cryptochrome-Based Radical Pair Mechanism in Magnetoreception”
- Lisa Belden (Biological Sciences) is a PI on a $1.2M grant from NSF on “Dimensions: Collaborative Research: Diversity and Symbiosis: Examining the Taxonomic, Genetic, and Functional Diversity of Amphibian Skin Microbiota”
Feng Guo (Statistics) is a PI for an $885K award from the Federal Highway Administration on “Adaptive Lighting”

Ignacio Moore (Biological Sciences) is a PI for a $705K grant from NSF for “Collaborative Research: The Role of Glucocorticoids in Mediating Life History Tradeoffs”

Rachel Diana (Psychology) is the PI on a $746K grant from NIH for “The Dynamics of Item and Context Memory in the Medial Temporal Lobe”

Bruce Vogelaar (Physics) is the lead PI for a $693K grant from NSF on “Solar Neutrinos: Experimental Program”

Robert Weiss (Geosciences) is the PI on a $658K grant from NSF for “NEESR: Tsunami Runup and Withdrawal Dynamics on a Sloping Beach with Discontinuous Macro-Roughness”

Esteban Gazel (Geosciences) is the PI on a $514K grant from NSF on “Collaborative Research: Evolution of the Galapagos Plume”

Paul Carlier (Chemistry) is the PI on a $451K grant from University of Florida on “Voltage-Sensitive Potassium Channel as a New Target for Mosquitocides”

Daniel Crawford (Chemistry) is the PI on a $422K grant from NSF on “Ab Initio Methods for Chiropitical Properties of Molecules in Solution”

Harry Gibson (Chemistry) is the PI on a $420K NSF grant entitled “Entangled Polymers by Design Using Supramolecular Chemistry”

Richard Turner (Chemistry) is the PI on a $390K grant from NSF on “Sterically Congested and Stiffened Alternating Copolymers: Synthesis, Solution and Solid-State Properties”

Judy Riffle (Chemistry) is the PI on a $381K grant from NSF for “Copolymer Nanostructures Containing Polyelectrolyte Blocks and their Complexes with Molecules”

John Tyson (Biological Sciences) is a co-PI on a $2.79M NIH grant, “Integrating Top-Down and Bottom-Up Models in Systems Biology with Application to Cell Cycle Control in Budding Yeast”

Jeffrey Walters and Lori Blanc (Biological Sciences) are co-PIs on a $2M grant from the Department of Defense on “Endangered species management and monitoring on Eglin Air Force Base” Budget: $2,033,269 ($355,520 to Biological Sciences)

Jianhua Xing (Biological Sciences) is the PI on a $149K NIH grant, “Dynamics and Mechanism of Mechanical Regulation of Bacterial Flagellar Motor Switching”

Seong K. Mun and Kenneth H. Wong (Arlington Innovation Center) are PIs on a $1.5M U.S. Army Contract, “Neuroperformance Imaging.” This project is a collaborative effort between Virginia Tech, Washington University in St. Louis, and Gachon University in South Korea.

The following pie charts depict the distribution of funding sources for the College of Science, comparing 2008 versus 2012 sources. As expected, an analysis of the data reveals that a majority of the research funding originates from the leading national agencies, including the NSF, NIH, DOD, and DOE; these funding agencies represent the premiere agencies in the country. Funding from the NSF continues to grow at a modest rate with maintenance in funding levels from the DOD and NIH. It is important to note that funding from industrial sources has decreased (15% to 4%) in the past four years; however, this was expected based on the current economic times during the past four years. This relatively low percentage of the total funding in the portfolio represents a strategic initiative.
for the College in the coming year. Strategic alliances with industrial partners provide research contracts and increase the awareness of our facilities and graduates with industries relevant to our disciplines and interdisciplinary programs. For example of potential impact, the DOE Energy Hub grant (J. Burns and other ICAM members, co-PIs) was awarded to a consortium of 24 partners, including Penn State, United Technologies, Lawrence Livermore National Laboratory, and IBM.

The College participates with two University centers including ICAM and MII, who serve as conduits for the partnership of the College of Science with other colleges and institutes across the campus. The College of Science faculty are some of the visible faculty leaders in both interdisciplinary programs. The Interdisciplinary Center for Applied Mathematics (ICAM) is a University Research Center committed to supporting, promoting, and facilitating interdisciplinary research and education in applied and computational mathematics at Virginia Tech. Applied and computational mathematics plays a central role in all of modern science and advanced technology. The symbiotic relationship between mathematics and its areas of application is ever growing as more areas of engineering and science become dependent on new mathematical tools and mathematically trained scientists. Applied mathematics is therefore becoming the enabling science for the revolutionary changes taking place in all scientific, engineering, and technological fields. These areas are vital to the new industries that will dominate the twenty-first century. The fundamental mission of ICAM is to enhance and expand the historical links among mathematics, computational science, engineering, and the sciences. ICAM is actively engaged in cooperative partnerships with several departments, colleges, and other institutes at Virginia Tech and is closely aligned with a broad range of industrial partners. ICAM is a partner in the Department of Energy's HUB on Energy Efficient Buildings. During the past year, ICAM worked with Purdue University and United Technology Research Center to develop low dimensional mathematical models of the indoor air environment in the Purdue Living Laboratory. ICAM is a member of the Sotera Defense Solutions Team that was awarded a National Institutes of Health indefinite delivery, indefinite quantity (ID IQ) contract in May 2012. Tasks in this ID IQ contract include Scientific Imaging, 3D Visualization and Cyber Security. ICAM will (1) continue interdisciplinary research on existing projects as well as seek additional collaborations and research support, (2) contribute to course and program development for the proposed computational science degree program in the College of Science, and (3) organize the international conference, ICAM: 25 Years of Computational and Applied Mathematics Research.
The Macromolecules and Interfaces Institute (MII) at Virginia Tech is a university-wide interdisciplinary organization of faculty and students committed to continuing the growth and advancing the stature of the existing, highly-ranked macromolecular science and engineering program at Virginia Tech.

- MII’s MACR Ph.D. program received IGEP (Interdisciplinary Graduate Education Program) status from the Graduate School.
- MII’s MACR Ph.D. program accepted nine new students in the fall of 2011 and eight Ph.D. students graduated in AY 2011-2012.
- MII awarded three graduate fellowships during 2011-2012. Each student received a twelve-month appointment.
- Web-based Course: To date, 23 companies have purchased the full course and eighteen companies purchased selected modules. MII faculty also consult the web-based course to assist in their lectures for the Undergraduate Adhesion class, Chem 4654.
- STEM Education via NSF Research Experience for Undergraduates—24 Years of Increasing the Scientific Opportunities in Macromolecular Science and Engineering for Outstanding Undergraduate Students:

For 24 consecutive years the Macromolecules and Interfaces Institute at Virginia Tech has hosted a summer undergraduate research program. Prof. Judy Riffle (Chemistry and MACRO Director), the overall administrator for the program, has led the successful program for the past eight years. Almost 600 students have completed the intense summer program of which 65% were women and 30% were underrepresented minorities. Dr. Maggie Bump (Chemistry) is the technical leader of the program and leads many activities that help make this REU program a special experience for the students. Included in these activities are a mentor training workshop to prepare graduate mentors for working with the undergrads, tutorials for the students, team building and recreational activities, and a final end of summer symposium. Dr. Bump also leads many of the REU students to participate in a program focused on outreach to middle school students from across our region. In this Youth Experiencing Science (YES) workshop, middle school students from southwestern Virginia team with the undergraduate participants who serve as mentors to work in areas at the forefront of scientific research.

Virginia Tech’s Arlington Innovation Center for Health Research (AIC:HR) is a third visible example of the College’s attention to integrated applied research using informatics and systems science in order to address the grand challenges of healthcare in the 21st century. AIC:HR, located within the College of Science, aims to establish a highly competitive combination of biomedical research, education and outreach programs in the National Capital Region. AIC:HR is focused on the multidisciplinary application of advanced technology to address complex problems in neuroscience, human performance, therapeutics, and healthcare delivery (see www.aic.ncr.vt.edu). For example, AIC:HR maintains a $1.5 million cooperative research and development agreement from the U.S. Army for neuroimaging studies of human performance. The agreement also includes an option for approximately $3 million of future work based on availability of funding. Key strategic development activities for 2012-2013 include:

- MedicPhone consortium involving Samsung Electronics of Korea
- Expansion of Neuroscience Activities
- Cyber Security of Biomedical Devices
- Expansion of Graduate Program for Biotechnology
The departure of Georgetown University from the graduate program prompted a complete overhaul of all the courses in the program during 2011-2012, including many new and revised courses through governance during the 2012-2013. The program is piloting a new course in medical imaging and physics, which will also be offered to physics undergraduate and graduate students. The program will also be changing as we are moving away from a weekend-only format in order to make classes more accessible to a wider audience of students. We are also exploring the possibility of tapping into other classes at the university (particularly those taught in Blacksburg) through distance learning technology. We continue to seek recognition from the Professional Science Masters association. We have been closely examining the financial model of the program in conjunction with central finance staff, because the high differential tuition is a disincentive for people to seek us out. The goal is to be able to offer the program at a cost close to standard tuition, with some small added fee to cover costs such as food for long weekend classes. The Arlington Innovation Center remains a central part of Virginia Tech’s strategy to expand in an integrated faction into biomedical research and education.

Discovery demands the creation of scholarship to disseminate our latest findings, and also contribute to the international reputation of the College of Science. In 2012, the faculty contributed nearly 650 peer-reviewed publications and nearly 500 invited lectures. Invention disclosures also constitute a critical component of the produced scholarship for the College (26 invention disclosures in 2012), and this metric is expected to increase in 2012-2013 in partnership with Knowledge Works and the Pamplin College of Business.

BUILDING INTERNATIONAL PARTNERSHIPS

- AIC:HR and Gachon University’s Neuroscience Research Institute cohosted an invitation-only workshop in Incheon, Korea. The workshop examined the potential of macro-connectomics inferred from tractography methods as an aid for the identification of those individuals at greatest risk for deleterious outcomes, for the development of effective treatment strategies and in the evaluation of the efficacy of interventions. Additional discussion focused on the importance of multi-modal neuroimaging and functional imaging in determining the interactions between anatomical connectivity and pathologies, including the role of high resolution MRI, functional MRI (fMRI), high resolution research tomograph (HRRT) positron emission tomography (PET) and electroencephalography (EEG).
- Daniela Cimini (Biological Sciences) collaborates with Juraj Gregan (University of Vienna) and Iva M. Tolic- Norrelykke (Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany) through a Human Frontier Science Program grant to study, “Molecular Architecture and Mechanical Properties of the Kinetochore: A Biophysical Approach.”
- John Tyson (Biological Sciences) maintains an active collaboration with Bela Novak, Professor of Systems Biology at Oxford University in England. Dr. Tyson spends one month per year in Oxford. In 2011, their collaboration resulted in a PNAS article on the molecular basis of irreversibility at the mitotic checkpoint—a mechanism that ensures the accurate segregation of replicated chromosomes to daughter cells at division.
- Adam Dominiak (Economics) has a new project with Juergen Eichenberger (University of Heidelberg) to characterize epistemic conditions in the vein of Aumann and Brandenburger (1995) which are sufficient for players to play strategies generating an “Equilibrium in Beliefs,” a notion of an equilibrium in games which generalizes that of Nash (1950) within the class of Choquet expected utility preferences of Schmeidler (1989).
• Djavad Salehi (Economics) organized and taught a Training Workshop on Measurements of Inequality of Opportunity and Inequality of Outcomes, October 17-20, 2011, in Cairo, Egypt.

• Michael Hochella (Geosciences) was invited as a guest for a week at the Institute for Geochemistry in the Chinese Academy of Sciences, Guiyang, China, April, 2012. He gave a series of lectures on nanogeoscience, and consulted on a number of their projects.

• Nancy Ross (Geosciences) served as a Distinguished Lecturer of the Mineralogical Society of America in 2011-12. During the week of April 15-21, 2012, she visited and presented lectures at the University of Goettingen, Germany, the University of Milan, Italy and the University of Torino, Italy.

• Leo Piilonen (Physics) worked on Belle and Belle II experiments at the KEK laboratory in Tsukuba, Japan (experimental particle physics, to study the properties and behaviors of beauty and charm quarks and tau leptons: 400 collaborators from 15 countries). Piilonen was elected co-spokesperson of the Belle collaboration in April 2012 and was previously chair of the Institutional Boards of both collaborations.

• Michel Pleimling (Physics) collaborates with colleagues at Nancy and Saclay (France), Bremen (Germany), Seoul National University (Korea), and Trieste (Italy).
The College of Science is committed to engaging its intellectual assets to address economic and social needs of communities around the commonwealth, the nation, and the world. Faculty members and students in the College of Science are extensively involved in outreach and service. The involvement ranges from interactions with K-12, to short courses and workshops for students and professionals, to newsletters and media presentations, and to service in professional societies, governmental and non-governmental agencies. Faculty members in the college hold more than 100 editorships or associate editorships on professional journals and many serve on editorial boards. Faculty members also serve on numerous review panels at federal agencies and foundations for grant selection. The College participates in the organization of scientific conferences and plays a leadership role in assembling international forums of science to the campus and around the world. The International Union of Pure and Applied Chemistry Congress on Macromolecules (MACRO2012) was an exquisite example of gathering nearly 1,500 scientists to our campus to provide a forum for dissemination of our latest scientific findings and to showcase our facilities around the world. These types of engagement will not only translate our science to the community and our institutional peers, but also engagement in this manner will lead to increasing recruitment of students at all levels and the formation of funded programs for discovery. Strategic initiatives in 2012 have also involved the alliance of the College with the Institute for Creativity, Arts, and Technology (ICAT). An inaugural event involved the invitation of a world-renowned origami artist to campus to uncover the parallels of molecular folding with artistic folding, and the visit led to novel strategies to include new directions in science for the improved communication of art.

CITIZENS IN A GLOBAL COMMUNITY

The COS and Department of Biological Sciences continue to offer study-abroad opportunities for undergraduates. These courses truly integrate the learning, discovery, and engagement missions in a context that helps to develop the global citizen.

Lori Blanc, research scientist in biological sciences, helped coordinate the study abroad program, BIOL 3954 Hokies Abroad: Australia, for 17 students in summer 2011, which was led by Robert Wright, adjunct instructor in the department. She also once again led the study abroad course, BIOL 3954 Hokies Abroad: Antarctica, for 10 students in fall 2011. These courses focus on the complex interdisciplinary topic of sustaining humans and the environment and are open to all majors. The Antarctica course is a collaborative effort between Virginia Tech, Oregon State University, State University of New York, American Universities International Programs, University of Canterbury, New Zealand, and Gateway Antarctica: Centre for Antarctic Studies and Research.

Ignacio Moore (Biological Sciences) and William Hopkins (FIW) led the study abroad course BIOL/FIW 3954 Tropical Biology and Conservation for nine students in Ecuador during Summer I 2012. This was preceded by a two-credit course in spring 2012 in which students learned about current topics in tropical biology, conservation, indigenous cultures and their customs, the politics of Ecuador and the role of oil in its economy, read current newspapers of Ecuador, and learned some of the major groups of plants and animals.
Jerry Via continues to lead students to study the ecology of the Caribbean, using the University’s campus at Punta Cana in the Dominican Republic. The program has proven to be quite popular among students, giving them the chance not only to learn about the ecology, but also has provided an opportunity to experience the social fabric of that country.

44th IUPAC World Polymer Congress
The Macromolecules and Interfaces Institute (MII) of the College of Science was successful in raising the international profile of Virginia Tech by hosting the 44th IUPAC World Polymer Congress in Blacksburg, USA, June 24-29, 2012. Professors Timothy E. Long, S. Richard Turner, and Robert B. Moore organized the conference that attracted more than 1400 attendees from 52 countries with 60% international attendees. The themes of the conference focused on “Enabling Technologies for a Safe, Sustainable, Healthy World.”
The Congress provided an international forum for scientific discovery, professional networking, research collaboration, interdisciplinary education, and dissemination of the most recent scientific advances. More than 1,200 presentations (766 oral and 475 poster presentations) ensured a diverse technical program, and 12 plenary speakers provided some key focal points.

**STEM Education: Building the Pipeline**

It is never too early to cultivate a hands-on, minds-on approach to learning. With an eye toward building a pipeline of STEM majors at Virginia Tech as well as addressing a broader goal of cultivating an educated citizenry with respect to STEM, the College of Science has engaged in outreach projects for K-12, the community and beyond. COS outreach activities engage undergraduate and graduate students in service learning opportunities.

In August of 2012, the COS hosted its first nanoCAMP for rising 9th-12th graders. Students from as close as Blacksburg and as far as Georgia came with parents and teachers for a hands-on, minds-on introduction to neuroscience. Coordinated by Melanie Matthews and Kaitlin Heenehan, nanoCAMP hosted 65 participants including a large contingent from our partner schools in Richmond. Faculty and staff from the Colleges of Science and Engineering who volunteered their weekend included Tim Long, Harry Dorn, Roop Mahajan, Jerry Via, Susan Haymore, Suvojit Ghosh, Carla Finkielstein, Randy Heflin, Giti Khodaparast, and Chenggang Tao. The Institute for Critical Technology and Applied Science co-sponsored this event.

As part of his NSF CAREER grant, Prof. Lou Madsen continued developing activities to initiate scientific motivations in girls ages 6-11. During summer 2011, his 2nd-year Ph.D. student, Kacey McCreary, continued work on designing “exploration kits” for young girls. Kacey also refined an interactive (forum + resources) website to spread this program and interact with kids and parents ([www.playcreatediscover.vt.edu](http://www.playcreatediscover.vt.edu)). They participated in “Kids Tech University” on February 25, 2012 to test the program with approximately 400 kids ages 7-12 for an afternoon of learning.

Dr. Maggie Bobbitt Bump directed The Youth Experiencing Science (YES) summer program, which involved 27 rising 3rd–7th graders in rural SW Virginia counties who worked in the laboratories at Virginia Tech. This is a highly valued leadership experience for the SURP undergraduates, which also provides a stimulating, enjoyable summer experience for the young scientists. All of the REU students participated in our YES workshop, during which they teamed with children from surrounding districts. This diverse group of young scientists came from public, private, and home schools. The children, mentored by the REU students, worked on four teams, Gascapades (density concepts), Got Green Milk (fluorescent labeling), Acid People (drug encapsulation), and Nylon Noodles (polymers). They presented their demonstrations to the public at Steppin’ Out, the local street fair in Downtown Blacksburg on August 5, 2011.
ENGAGING OUR COMMUNITY

SEEDS (Seek Education, Explore, DiScover) in collaboration with the Town of Blacksburg and the Biological Sciences Outreach Program (SOuP) is now in year three of operating a nature and education center with exhibits in Blacksburg’s Historic Price House. The SEEDS non-profit will operate and manage the center activities. SOuP is a partner in the project and has supplied exhibit materials, a liaison to the VT campus, and undergraduate student volunteers. The program also funds one Biological Sciences Undergraduate Intern for the summer. The Center for Student Engagement and Community Partnerships (CSECP) will highlight this project as a host site for undergraduate and graduate student learners and scholars. Highlights of this partnership include a VT student volunteer who successfully competed for a $500 CSECP grant and the $5,000 Engaged Department Award. As part of this program, Dana Hawley worked with Mike Rosenzweig to incorporate service-learning into the BIOL 4404 Ornithology course. Students worked in groups to design fun educational programs about birds that they implemented on weekends at the Price House Nature Center in downtown Blacksburg. The students then presented their projects to their classmates and wrote papers about their experiences. Overall, the students who participated got a lot out of the experience and enjoyed the opportunity to connect their understanding of science to something in the “real world.” Because of the initial success, this service learning experience is being expanded in 2012. Mike Rosenzweig continues working with Ashleigh Utzinger, 4th grade teacher at Harding Elementary School along with Dr. Phyllis Newbill, outreach coordinator for the VT Center for Performing Arts. They are in the process of producing S.O.L. correlations for the center’s exhibits and permanent programs as well as developing new programs for the pre-K-12 age range.

The Physics department conducted a host of outreach events. The Physics Outreach Team traveled to several regional middle and high schools with their demonstration equipment to convey the excitement of science to their students. John Simonetti and the astronomy-minor students hosted several open houses at the Prices Fork Observatory and at the Martin Observatory at Mountain Lake. The PhysTEC team, led by Teacher-in-Residence Alma Robinson, hosted a Physics Teacher Day for Virginia high school physics teachers. Bruce Vogelaar gave a public lecture at this meeting entitled “Piano Tuning Demonstration by a Physicist using his Laptop, a Microphone, and a Hammer.” Graduate students Brandon Bear and Brian Roper co-hosted a public viewing session outside Hahn North of the transit of Venus across the face of the Sun; almost 500 people came for this two-hour event as reported in the June 6 edition of the Roanoke Times. Read Montague was selected to deliver a talk entitled “Misbehaving Beautifully” at the TEDGlobal “Radical Openness” forum in Edinburgh, Scotland.

StatCom is short for Statistics in the Community. It is a student-run organization that provides pro bono statistical consulting and collaboration for local non-profit organizations and non-Virginia Tech researchers of local interest. StatCom worked with Dr. Carolyn Thomas from Ferrum College, the director of the Smith Mountain Lake Water Quality Monitoring Project and the Claytor Lake Water Quality Monitoring Project. StatCom member Kelly Geyer wrote a report concerning some regression analysis relating various measures of lake health to the distance from the dam at Smith Mountain Lake. StatCom member Elaine Nsoesie has been investigating methods for analyzing bacteria content in Smith Mountain Lake. Matt Williams provided some exploratory plots for spatial analysis of the data collected at Smith Mountain Lake. Since 2010, StatCom has been working with Ann Angert, planning director of New River Community Action. StatCom was asked to help enter data for a census of the homeless in the New River Valley area of Virginia.
The Department of Geosciences education and outreach activities include support for K-12 field science studies and in-class activities, teacher professional development, Education Resource Center (ERC) kit and material loans, and the Museum of Geosciences exhibits, programs, and collections. The Department also has research groups engaged with students and industry. Geosciences Outreach partners with the VT-STEM K-12 Outreach Initiative and the Science Outreach Program (SOuP). The Museum has several new teaching stations including an OmniGlobe spherical projection system that shows NOAA/NASA earth systems data in a striking format. The department also has an EnVision Groundwater Flow Model and an EmRiver Stream Simulation Model, as well as a large collection of high quality minerals, an Allosaurus dinosaur skeleton, a real-time earthquake display, and information about local geology. Each fall, the Museum offers a mineral sale which is open to the public and VT Family Day visitors to support outreach programs.
The College of Science strives to promote greater diversity among faculty, staff, graduate students, and undergraduate students by promoting active recruitment and retention strategies.

**DIVERSITY HIGHLIGHTS**

With the launching of the Integrated Science Curriculum and the first Integrated Science Faculty search as well as a host of pipeline initiatives, the COS had the opportunity to weave diversity goals and initiatives throughout its activities.

Between 2010 and 2011, the undergraduate population within the COS remained relatively constant with respect to gender (57% women) and racial/ethnic (28% non-White). Of the 15 new faculty hires in 2011-12, nine were white males, two were white females, and the remaining four were Asian/Pacific Islander – two male and two female.

A $2M NSF STEP grant awarded to Jill Sible, Debbie Wilson, Gary Long, Bevlee Watford and Kathryne McConnell, has increased diversity as an explicit goal for students majoring in the physical and quantitative sciences, where there is the most room for improvement with respect to diversity. To increase retention and diversity in the physical and quantitative sciences, the COS hosted its first Summer Bridge Program (SBP). The SBP was implemented in collaboration with the College of Engineering’s Summer Transition Program. Twenty-four incoming freshman students majoring in Chemistry, Physics, Mathematics, Geosciences, Statistics, Biochemistry, and Biological Sciences participated in preparatory Chemistry and Mathematics courses. In addition, Yinka Oyewumi, a recent Ph.D. graduate from the Department of Geosciences, prepared students for the rigor and excitement of undergraduate research through a course adapted from the Howard Hughes Medical Institute’s Entering Research program.

In collaboration with the Language and Culture Institute, the COS offered a full-year, pre-baccalaureate experience to 15 Saudi Arabian students sponsored by the King Abdullah University of Science and Technology (KAUST). In the fall, the COS taught a pre-calculus class as well as SAT preparatory classes in Biological Sciences, Chemistry, Physics, and Mathematics. In the spring, the students were integrated into undergraduate classes and labs in the same subject areas. The COS plans to continue the KAUST program for the 2012-2013 academic year.

Melanie Matthews, one of two Multicultural Fellows in the COS, hosted pre-college students from three high schools from Richmond City Public Schools for Robert Lang’s origami presentation as well as underrepresented female students from William Fleming and Patrick Henry High Schools in Roanoke, Virginia in April 2012. She is committed to strong mentoring and pipeline programs with partner schools. Matthews and Susan Haymore visited the An Achievable Dream Academy in Newport News, Virginia, and a career fair was held especially for these students on the campus of Virginia Tech in December 2011.

During the spring semester the Office of Undergraduate Admissions hosts a program that brings underrepresented populations to the university for a weekend event. Melanie Matthews and Susan Haymore represented the dean’s office in this event. Out of the 27 students that attended, 16 accepted the offer of admission.
Other notable activities:

- Victoria Soghomonian (Physics) collaborates with Historically Black Colleges and Universities through collaborative-grant submissions to build ties that will encourage their undergraduates to apply to our graduate program.

- Dr. Aziza Baccouche, a blind African-American female physicist, was invited to give a motivational public lecture entitled “Seeking Vision.”

- Khidir Hilu (Biological Sciences) is a member of the executive committee of NISA, an organization that includes 22 selected Iraqi expatriate scientists who are actively connected with officials in various Iraqi ministries and universities. He contributed materials toward a successful proposal to the UNESCO for the advancement of education in Iraq. Hilu is also a member of the Biology Committee for the Iraqi attaché in Washington D.C. to help improve biological sciences research and teaching in Iraqi universities.

- The Department of Mathematics hosted its 16th Annual Women in Mathematics Career Day.

- Departments in the college are active participants in MAOP, VT PREP, VT-AMP and the McNair Scholars program. Jill Sible (Dean’s Office) serves as Co-Principal Investigator of the VT PREP program.

- Nancy Ross (Dean’s Office) served as College Liaison for AdvanceVT. She met with all candidates for faculty positions during their campus visits and hosted several gatherings for women faculty members.

- Roseanne Foti (Psychology) and Nancy Ross served on the AdvanceVT Leadership Team.

- Two faculty members in Mathematics are active in programs designed to enhance higher education in Africa.

- The Department of Psychology supports a chapter of the Association of Black Psychologists, which has strong undergraduate and graduate participation.

- The “Ladies of Robeson” in the Department of Physics is an active group of female students and faculty who meet for networking, organize alumni events, and invite visiting speakers.

- Several faculty from the college participated in events designed to promote multiculturalism and diversity, including the January Advancing Diversity conference, the Fourth Annual Multicultural Luncheon, and Cranwell Center activities.

- Biological Sciences and Geosciences hosted international luncheons for faculty, staff, and students.
Melanie Matthews (Dean’s Office) is a planning committee member for VT SWAGG (Students Working to Achieve Goals & Graduation); a new initiative to help improve the academic performance and undergraduate experience for African-American males on campus.

2012-2013 DIVERSITY GOALS:

During Fall 2012, with many new members joining, the COS Diversity Committee (“the committee”) will be collecting updated information on diversity activities across COS and will use that information to call attention to significant contributions. The committee will encourage COS departments to have departmental diversity committees and to offer events that highlight diversity contributions.

NEW INITIATIVE:

The committee would like to sponsor 1-2 seminars within the College in 2012-13 that will highlight underrepresented contributors to science. These seminars might be about important scientists who were from underrepresented groups or women, in fields where women are underrepresented (examples of contributions not well covered in historical presentations of science), or they might be seminars by current minority scholars working in the forefronts of science.

CONTINUING WORK:

- The committee will continue to support programs for increasing sensitivity about different backgrounds and improving effective academic interactions. During the last two academic years, the COS and Biological Sciences Diversity Committees planned and organized these sessions (“Strategies for Effective Interactions”). These were supported by a small grant from the Graduate School and additional funding from COS.

- The committee will co-sponsor (with Biological Sciences taking the lead) a special Martin Luther King Week seminar like the one last year that featured Dr. Drew Lanham (Clemson) who spoke about the history of African American land use in the South. Last year’s co-sponsors were COS, CNR, and the Department of Fisheries and Wildlife. The seminar was widely attended.

- The committee will work with MAOP to select undergraduate scholars for the MAOP program. Members of the committee will help mentor those students as needed.

- The committee will review the nominations for the College of Science Diversity Award and select the award recipient(s). The committee would like to better publicize the award and the contributions of those nominated for the award.

- The committee will continue to discuss mechanisms for enhancing diversity amongst the graduate student population in COS.
ALUMNI RELATIONS

The Alumni Relations office within the College of Science (COS) continually seeks to serve, steward, and engage our 26,000+ alumni in lifetime mutually beneficial relationships aimed to strengthen the bond between our alumni, the college, and the university. Our college and departmental programs, alumni events, alumni visits, and participation in numerous alumni and student related activities, serve as a backdrop to generate interest and involve our alumni with the COS faculty, administration, students, friends, and other college alumni. The Alumni Relations office strives to build long lasting connections by interacting with our current undergraduate and graduate students, playing a significant role with the COS student-based Dean’s Leadership Council. The College of Science Alumni Relations office upholds the mission of the university - learning, discovery, and engagement through our college alumni involvement, as well as our representation and involvement with the Virginia Tech (VT) Alumni Association.

During 2012, the Alumni Relations office orchestrated over 25 events aimed to increase the depth and diversity of our programming in order to make lifelong connections with our alumni. In addition to our traditional events such as the college homecoming, football tailgates, commencement receptions, and college advisory board meetings, our office orchestrated or assisted with college lectures featuring world renown individuals; coordinated ‘Fun with Physics,’ a family-oriented outreach program designed to generate interest in the sciences for middle school students; organized our second annual “Celebration of Excellence” luncheon, an opportunity to recognize our faculty, students and generous benefactors; and coordinated and participated in the Virginia Tech Alumni Association’s “Summer Around the Drillfield Series,” highlighting the Department of Physics and observational astrophysics.

Two College of Science alumni received top scientific honors this year. Dr. Patricia M. Dove (Geosciences, ’84) and Dr. Joseph DeSimone (Chemistry, ’90) were elected members of the National Academy of Sciences for their sustained excellence in original scientific research.

Each year the VT Alumni Association honors recent alumni from each academic college who have graduated in the past ten years and made a significant contribution in their profession. The College of Science selected Patrick Gavan O’Shea (Psychology, ’02) as our 2011–2012 College of Science Outstanding Recent Alumnus.

The College of Science Alumni Relations office will continue its mission to increase the visibility of the college by working in conjunction with the College of Science Advancement Team comprised of our Development Director, Corporate and Foundation Relations Associate Director, and Communications Director to determine best practices to involve, engage, and communicate with our alumni. The year 2013 ushers in the college’s 10-year anniversary and the Advancement Team will develop a timetable to highlight the college in various ways, showcasing the tremendous accomplishments that have occurred over the last 10 years.

DEVELOPMENT

The College of Science Development Office remains committed to its mission of engaging alumni and friends of the college and its departments through personal and professional involvement, both on and off campus, and through private and corporate giving. It is with sincere gratitude that we acknowledge all who supported the college this fiscal year. Our continued success would not be possible without the generous philanthropy and unwavering support of our alumni and friends who share our vision for moving the college forward.

During fiscal year 2012, the College of Science focused its fundraising efforts on several key initiatives that support the mission of the college and the university, including the Integrated Life Science Curriculum and the Institute for Advanced Study. The college sought to increase the number of major gift prospects through research and
networking and, as in the past, we continued to engage and solicit leadership and major gift prospects to support college priorities. To date, more than 1,700 major gift prospects have been identified.

This was a challenging but good year for the college, overall. Nearly $4 million in outright gifts and future support were secured. Notable leadership gifts were made to support the Department of Statistics, the Department of Chemistry, and undergraduate scholarships and research in the College of Science.

Several special events were planned and implemented with the dual purpose of stewarding current donors and engaging new prospects. The second annual Celebration of Excellence Luncheon was held in October 2011 to recognize the college’s generous benefactors, as well as our outstanding students and faculty who benefit from their generosity. The college continues to successfully engage members of its Roundtable Advisory Board. Roundtable meetings were held on campus in October 2011 and April 2012. In addition, the college participated in numerous university-wide events, including the Campaign Closing Celebration, Ut Prosim Society weekend, Legacy Society breakfast, and various regional receptions, as well as hosted special guests on campus during football season.

The assistant/associate director of development position was vacant the entire year. A search is currently underway to fill this position.

**CORPORATE AND FOUNDATION RELATIONS**

“Companies are taking a conservative approach,” says Mark Shamley, president of the Association of Corporate Contributions Professionals. “There are a lot of really big, scary things out there like the European debt crisis and whether or not there is going to be demand” according to The Chronicle of Philanthropy Special Report July 22, 2012 article Most Big Companies Expect Flat Giving, Despite 2011 Gains. Conservative approaches were seen across the college and the college adjusted its strategies to these market trends.

In the College of Science, job postings through the university’s Hokies4Hire job portal increased by 58% from FY11 to FY12 for science majors. The college changed its strategy from co-hosting career fairs to hosting dedicated visits for employers providing more feedback and networking opportunities. Networking is the highest success factor in locating jobs according to Virginia Tech Career Services annual surveys. Science students still attended the major career fairs hosted on campus including Engineering Expo and Connections. Recent undergraduate alumni (FY2011) reported having firmer plans for their future indicating a 4% increase in the number employed as compared to the prior year. Most of the other recent graduates indicated they are continuing their education such as graduate school or professional school. Corporate and private foundation research projects for the College of Science dropped by 15% while our major philanthropic gifts and resource loans rose by 38%. Alumni and friends champion these corporate and foundation philanthropy, research, recruiting, and gift matching programs.

**HIGHLIGHTS OF CORPORATE AND FOUNDATION ACTIVITIES**

Partnerships with corporations and foundations are even more important as governments cut budgets. Instruments, software, and gifts in-kind such as high tech analytical instruments and modeling software greatly assist in the college’s discovery and learning missions. Fellowships, scholarships, field trips, and research support provided much needed financial support to attract talented students and provide hands-on experiences in topics of relevant interests. Forums to exchange ideas remain essential to developing joint projects, maintaining high quality standards in curriculum, and debate critical topics. Matching Gifts are barometric investments for many alumni and friends who support efforts closest to them.
Special thanks go to the following:

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INTEGRATED SCIENCE CURRICULUM at Virginia Tech

by Jill Sible

Take a look around campus and you’ll realize groups of scientists are collaborating in nontraditional ways. Mathematicians, computer scientists, and biologists work together to build predictive computational models of cell division that may prove to be some of our most powerful tools in fighting cancer. Geoscientists and chemists are partnering to address critical issues regarding the availability of key natural resources, such as purified water and natural gas. Psychologists and physicists collaborate to elucidate the fundamental nature of decision making through the development and implementation of such technologies as high-resolution MRI. These scientists foster a culture of discovery, invention, and entrepreneurship that is unfettered by traditional disciplinary boundaries.

But where will we find the next generation of scientists with the imaginations, skills, and bravery to tackle the world’s most pressing problems concerning hunger, disease, poverty, water, and energy? Right here in the College of Science.

During the past year, faculty members from across the college have come together to envision new undergraduate programs that meet the demands of our students, industry, and society. They are answering an urgent call from scientists and policymakers. Five years ago, the National Academies published an alarming report, “Rising Above the Gathering Storm,” documenting the United States’ decline as an international leader in science and technology. In 2011, the follow-up report was subtitled “Rapidly Approaching Category 5.” The authors of this report have stated unambiguously: The time for curriculum reform in STEM (science, technology, engineering, and mathematics) is now.

Four faculty teams have designed curricula that will lead to new undergraduate degrees in neuroscience, nanoscience, systems biology, and computational science, programs that don’t fit neatly within a single traditional discipline. Neuroscientists, for example, must draw upon biology, chemistry, psychology, and even physics to investigate one of medicine’s final frontiers, the brain. All of these new programs will require a new pedagogical approach in which the learning of science reflects the contemporary practice of science.

ENTER THE INTEGRATED SCIENCE CURRICULUM

The Integrated Science Curriculum (ISC) began as the brainchild of John Tyson, University Distinguished Professor in Biological Sciences, as he was leading the effort to develop a systems biology degree. Tyson recognized that the cultivation of interdisciplinary thinking and practices had to start early. Tyson says, “I’ve always thought this was the right way to teach introductory science, in an integrated fashion. I just never had the opportunity to put this idea into practice.”

Inspired by the Integrated Science Program at Princeton and with sage advice from David Botstein, director of that program, Tyson and colleagues set about crafting a program that would meet the unique needs of students in the College of Science at Virginia Tech. Those needs included the development of a curriculum that would serve as a gateway not only to the systems biology degree, but also to the other three new programs as well as to the existing degrees in biological sciences, chemistry, geosciences, mathematics, physics, and statistics.

The team spent the better part of the year poring over the syllabi and learning outcomes for foundational courses in biological sciences, chemistry, physics, calculus, linear algebra, statistics, and computer science. They reviewed
accreditation documents within disciplines. They debated which parts of a traditional curriculum were essential and which were not. They identified unifying themes around which to organize the subject matter traditionally covered in three or four different courses and textbooks. They considered a range of pedagogical approaches: lectures, team-based learning, case studies, and problem-based laboratory exercises.

As they wrestled with curricular issues, the team members kept their eye on the prize – the students. What should students be able to do when they completed the ISC? They wanted to matriculate students who could integrate and differentiate. Students who could solve equilibrium problems, titrate, and predict the effect of a specific poison of the electron transport chain on the oxygen output of an oak tree. But they also wanted to graduate students who knew how to ask questions, seek answers, and were not afraid to do so. They wanted problem solvers, team players, and creative thinkers. The team endeavored to build an Integrated Science Curriculum that would attract the very best students to Virginia Tech.

The curriculum that emerged was radically different from anything ever taught before at Virginia Tech, or just about anywhere else. The ISC spans the first four semesters, or two full years, and students enroll in an eight-credit mega-course each semester. The lecture part of the class meets every day, Monday through Friday, for 75 minutes in the SCALE-UP classroom. Each semester is organized around one or two unifying themes. The focus of the first semester is “motion.” How do natural systems change in time? And what language do we use to describe these changes accurately and predictably? Almost everything around us changes in time. Viruses infect our bodies, planets circle the sun, and chemical reactions seek an equilibrium state. The language of change is differential equations, which are used to tie together all the examples of change in biology, physics, and chemistry.

Upon completing the two-year sequence, students will earn the equivalent of one year each of biology, chemistry, and physics, three semesters of mathematics, and one course each in statistics and computer science. But the ISC is about much more than these equivalencies. In the ISC, the whole is truly greater than the sum of its parts. Michel Pleimling, who co-teaches the course, explains that “the divisions between different disciplines are slightly artificial” and there are a lot of top scientists whose research sits between departments. Furthermore, “some of the more interesting and open questions reside at the boundaries separating these fields.”

The laboratory piece of the ISC is radically different as well. Co-developed and taught by Tim Long, Adam Smith, and Harumi Shimada-Beltran, the laboratory focuses on innovation, on inventing the future. Students learn the critical interpersonal communication skills and state-of-the-art laboratory techniques and instrumentation that are vital to solve some of the most challenging issues that face our society today. The laboratory is organized into modules where experiments are not traditional week-long exercises. In sharp contrast, teams of students tackle some of the most challenging issues that we face today, ranging from delivery of drugs and nucleic acid therapeutics to understanding chemical kinetics and motion. In addition, multi-week modules, such as the one on surfactants, touch on the ethical issues that scientists face each day: Are we improving the quality and quantities of our lives without sacrificing the Earth or human health? Modules such as photosynthesis explore nature’s mechanism for the utilization of light and the mimicry that inspires scientists to create new photovoltaic cells for solar energy. Students experience the excitement of teamed research in an interdisciplinary way, and they accomplish this learning with important everyday issues that we face. The laboratory seeks to expose students to the culture of research and promote students to pursue more research experiences in their undergraduate plan of study.

**They built the ISC, but would the students come?**

The pilot of the ISC launched in fall 2011. The inaugural class was selected by an application process designed to identify students with both aptitude and passion for math and science.
From the beginning, the students realized that the ISC would not be “learning as usual.” Walking into the SCALE-UP classroom, the college’s state-of-the-art student-centered learning environment, they faced not one, but two new professors plus a graduate assistant. On the first day of class, they were assigned to teams and asked to estimate:

- The number of obstetricians in Montgomery County, Va.
- The cargo capacity of Noah’s Ark
- The moles of ATP the body produces from a teaspoon of sugar
- How much work is done by the average student climbing a flight of stairs in Derring Hall
- How many flights of stairs must be climbed to burn off that teaspoon of sugar

This was definitely not the typical first day of class and definitely not learning as usual.

Eleven students committed to the pilot program. The ISC is rigorous, but so are the students. Tyson says, “The students are great. They represent a good cross-section of disciplines and interests as well as different types of high school preparation. If this program is going to work, it must be accessible to all of our clientele.” The 11 students who completed year one and are continuing in the program are profiled in this issue (see pages 10-11). Pleimling describes the students as “excellent, motivated, and hardworking.”

CHALLENGES FOR THE FUTURE

Revolutionizing the science curriculum does not come without its challenges. How will students earn credit for the equivalent courses that constitute prerequisites for their majors? The ISC defies categorization by curricular norms. The guardians of the traditional disciplines express concern about coverage of their topics. What topics are being omitted to make room for interdisciplinary themes? What happens if students drop out of the ISC before completing the two-year sequence?

These concerns are valid. The ISC team strives to provide a foundational education with appropriate depth and breadth to prepare students to excel in both traditional and interdisciplinary fields of science. With attention toward what and how students actually learn and retain information rather than what is taught or covered, the ISC philosophy is to create a learning environment that models the way science is practiced. Tyson explains, “We can’t teach everything, even in a traditional setting. And we don’t want to. What is taught is not as important as guiding students in learning how to learn, how to put ideas together, and how to create something new.”

Another challenge is adapting to an active-learning setting like SCALE-UP. This adjustment confronts students and professors alike. Students are accustomed to more passive modes of learning where content is delivered to them by instructors who are equally comfortable with the “stand and deliver” mode of teaching. While lecturing is an important part of the instruction in the ISC, much of the learning is more active and team-based. Students are given problems that are complex and open-ended. As part of his professional development, Pleimling participates in a faculty study group on student-centered learning led by Barbara Bekken. He describes the ISC as “an adventure, a controlled experiment.”

Everyone invested in this experiment – professors, students, and administrators – is committed to its success, and success will generate the greatest of the program’s challenges: garnering the resources (creative teachers, contemporary learning spaces) to meet an increasing demand for this bold approach to science and math education. But if the College of Science is to continue its role in providing innovative solutions to the world’s greatest challenges, it must cultivate the problem-solvers, the leaders, and the dreamers of tomorrow.
APPENDIX B: STUDENT HONORS AND AWARDS

2011-2012 UNDERGRADUATE STUDENT HONORS AND AWARDS

CHARLES BAKER (BIOLOGICAL SCIENCES, MATHEMATICS, AND PHYSICS) was awarded a Barry M. Goldwater Scholarship for 2011-2012 and received the College of Science’s Outstanding Undergraduate Research Award.

Martha V. Blakely, Chemistry and Biochemistry, was named the 2012 College of Science Outstanding Senior. She received an ACC Thacker Scholarship for her graduate studies in Fall 2012 and, for the third consecutive year, was selected to the ACC All-Academic Women’s Tennis Team.

2012 COLLEGE OF SCIENCE DEAN’S ROUNDTABLE SCHOLARS:

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<tr>
<td>Grace Mullholland</td>
<td>Biological Sciences</td>
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<tr>
<td>Julia Button</td>
<td>Biological Sciences and Biochemistry</td>
</tr>
<tr>
<td>Katrina Loncar</td>
<td>Biological Sciences and Psychology</td>
</tr>
<tr>
<td>Aaron Wilson</td>
<td>Biological Sciences and Chemistry</td>
</tr>
<tr>
<td>Trevor Parker</td>
<td>Chemistry, Philosophy, and Medicine &amp; Society</td>
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2011-2012 Graduate Student Honors and Awards

Austin Amaya, Doctoral Student, Mathematics, along with team members Ethan Groves, Christopher Williams, and Jacob Moore, all from the College of Engineering received the 2012 XCaliber Award for excellence as a group involved with technology-assisted teaching.

Bianca Baker and Zhe Bao, both in Biological Sciences, were selected to be 2011-2012 Diversity Scholars by the Graduate School.

Karina Cheung, Geosciences, received a Certificate of Merit for Graduate Teaching Excellence.

Sean Hemp, Chemistry, was recognized by the ACS Polymer Division for “Excellence in Graduate Polymer Research.”


Amanda Rumore, Biological Sciences, was selected to give the student remarks at the graduate commencement ceremony in spring 2012.

Ryan C. Smith, Psychology, received the 2011 William Preston Society Thesis Award in Social Sciences, Business, Education and Humanities category.

Ivan Tavassoly, Biological Sciences, was named the 2012 Outstanding Interdisciplinary Doctoral Student by the Graduate School.

Stephanie Voshell, Biological Sciences, received the 2012 Graduate Teaching Assistant Excellence Award.

2012 College of Science Roundtable "Make a Difference" Scholars for Graduate Study

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<td>Sean Hemp</td>
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<td>Sharmistha Mitra</td>
<td>Biological Sciences</td>
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<td>Martin Rudolph</td>
<td>Physics 2012</td>
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<td>Sharmin Shamsalsadati</td>
<td>Geosciences</td>
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APPENDIX C: 2011-2012 TEACHING AND ADVISING AWARDS

These awards were highlighted in the body of the Annual Report:

Shamindri Arachchige and Karen Brewer, Chemistry, 2012 College of Science Outreach Excellence Award
Lisa Belden, Biological Sciences, COS Certificate of Teaching Excellence
Lee Cooper, Psychology, 2011-12 Diggs Teaching Scholar Award
T. Daniel Crawford, Chemistry, Alumni Award for Excellence in Research
Patricia Dove, Geosciences, Elected Member of National Academy of Science
Julie Dunsmore, Psychology, VT Multicultural Fellow
Preston Durrill, Chemistry, 2012 Sporn Award for Excellence in Engineering Education
Felicia Etzkorn, Chemistry, 2012 College of Science Diversity Award
Susan Haymore, Dean’s Office, President’s Award for Excellence and Governor’s Customer Service Award nominee
Gary L. Long, Chemistry, VT’s Center for Instructional Development and Educational Research 2011-2012 Scholarship of Teaching and Learning Award
Melanie Matthews, Dean’s Office, VT Multicultural Fellow
Vito Scarola, Physics, 2011 DARPA Young Faculty Award
Jack Webster, Biological Sciences, 2012 William E. Wine Award for Excellence in Teaching and a COS Certificate of Teaching Excellence

Additional Honors and Awards:

2012 Excellence in Access and Inclusion Awards from the office of Services for Students with Disabilities and the Office of Diversity and Inclusion were presented to:

Tyler Hassenfeldt, Psychology
Nicole Kreiser, Psychology
Brenna Maddox, Psychology
Kriton Papavasiliou, Physics
Leo Piilonen, Physics
Diane Walker-Green, Physics

Martha Ann Bell, Psychology, was named Fellow, Association for Psychological Science
Lisa Belden, Biological Sciences, was appointed a Research Associate at Smithsonian Tropical Research Institute (Panama)
Fred Benfield, Biological Sciences, received the Distinguished Service Award from the Society for Freshwater Science
Daniel Capelluto received a 2011 Carl Storm Underrepresented Minority Fellowship
Daniel Crawford, Chemistry, was elected Secretary/Treasurer of the Physical Chemistry Division of the American Chemical Society
Kirby Deater-Deckard, Psychology, along with a team of colleagues, received the 2012 XCaliber Certificate of Excellence from the VT Center for Innovation in Learning for their NSF-funded GAMES project to develop digital games to enhance math learning in middle school students.

Carla Finkielstein, Biological Sciences, was recognized with a Karin Decker Doss Scholarship Award for breast cancer advocacy.

Tijana Grove, Chemistry, was invited to present an honorary Young Protein Scientist Talk at the 25th Anniversary Symposium of The Protein Society.

Michael F. Hochella, Jr., University Distinguished Professor, Geosciences, served as President of the Mineralogical Society of America.

Marlow Lemons, Statistics, received the 2012 Pan-Hellenic Community of Virginia Tech Award for Excellence in Teaching and Community Service.

Timothy E. Long, Chemistry, was named an ACS Division of Polymer Chemistry Fellow and received the Pressure Sensitive Tape Council (PSTC) 2011 Carl Dahlquist Award for his research relating to adhesive tape technology.

Amanda Morris, Chemistry, received the 2012 Ralph E. Powe Junior Faculty Enhancement Award from the Oak Ridge Associated Universities.

John Morris, Chemistry, was selected to attend the 2011 Kavli Frontiers of Science symposium hosted by the National Academy of Science.

Thomas Ollendick, Psychology, received an Honorary Ph.D. from the Faculty of Social Sciences at Stockholm University.

Leo Piilonen, Physics, received the 2012 Sally Bohland Award for Leadership in Access and Inclusion.

Nancy Ross, Geosciences, served as a Distinguished Lecturer of the Mineralogical Society of America in 2011-12.

<table>
<thead>
<tr>
<th>Measure</th>
<th>University Scorecard Measures</th>
<th>Final 2011</th>
<th>Preliminary 2012</th>
<th>College Comments on FY12 Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of graduating undergraduates who participated in research experiences.</td>
<td>Graduating undergraduates who received a passing grade in undergraduate research courses. From degrees extract and course files.</td>
<td>75% of graduating undergraduates.</td>
<td>587</td>
<td>Three year trend shows an increase in participation.</td>
</tr>
<tr>
<td>Underrepresented student enrollment</td>
<td>Fall Enrollment Profile from IRPA Ethnrt Report (full student census file)</td>
<td>From Plan - Increase by 50% by 2012.</td>
<td>Underrepresented Student Enrollment (IRE)</td>
<td></td>
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<tr>
<td>Underrepresented students entering the freshman class.</td>
<td>Office of Undergraduate Admissions</td>
<td>Continuous increase tied to plan goal of 50% increase in minority enrollment</td>
<td>Underrepresented Freshmen (IRE)</td>
<td></td>
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<tr>
<td>Advanced degrees awarded to underrepresented students.</td>
<td>Degrees extract</td>
<td>Increase the number of graduate degrees awarded to underrepresented students.</td>
<td>Advanced Degrees to Underrepresented Students (IRE)</td>
<td></td>
</tr>
<tr>
<td>PhD and EdDs Awarded</td>
<td>Degrees extract</td>
<td>From SCHEV 2B Projection - 366 Annually</td>
<td>Doctorate Awarded (IRE)</td>
<td></td>
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<tr>
<td>Graduate enrollment profile - masters, doctoral, and professional</td>
<td>Fall Enrolments in Advanced and Direct to PhD per IRPA Ethnrt Report</td>
<td>From SCHEV 2B Projection</td>
<td>Graduate Enrollment (IRE)</td>
<td></td>
</tr>
<tr>
<td>Total expenditures in grants and contracts by research domain.</td>
<td>As reported by Office of the Vice President for Research</td>
<td>Research Statistics (OVPR)</td>
<td>$27M College of Science</td>
<td>Three year trend shows 3.6% decline in college expenses but a 4.2% growth among all affiliated faculty.</td>
</tr>
<tr>
<td>Count and average value of sponsored awards</td>
<td>As reported in Sponsored Programs database/warehouse dashboard</td>
<td>3% Growth in Number of Awards. 5% Annual Growth in Average Dollar Value of Awards</td>
<td>Sponsored Awards (IRE)</td>
<td></td>
</tr>
<tr>
<td>Faculty arts and humanities awards, fellowships and memberships.</td>
<td>Websites of awards providers; list of awards from AAU</td>
<td>13 Awards from AAU List and other select prestigious awards.</td>
<td>Faculty Awards (IRE)</td>
<td></td>
</tr>
<tr>
<td>Number of post-doctoral appointments reported to National Science Foundation</td>
<td>As reported annually to the National Science Foundation</td>
<td>Increase by 78% to 243 total positions by 2012</td>
<td>Postdoctoral Associates (IRE)</td>
<td></td>
</tr>
<tr>
<td>Annual number of new licenses and start-ups</td>
<td>As Reported in Annual Association of Technology Managers (AUTM) Licensing Survey</td>
<td>Licenses to 31 and Patents to 41 Annually per IPS projections. Start-up to be determined.</td>
<td>Licenses, Patents and Start-up (IRE)</td>
<td></td>
</tr>
<tr>
<td>Number of graduating undergraduates who have participated in a study abroad experience or foreign language course</td>
<td>Degrees extracts and course files</td>
<td>From Plan - Double the 2005 level in Study Abroad. Level participation in foreign language courses.</td>
<td>Study Abroad Foreign Language (IRE)</td>
<td></td>
</tr>
<tr>
<td>Undergraduate participation in service learning and experiential programs. (Also in Learning)</td>
<td>Service learning course list provided by the Service Learning Center with enrollments from course files; experiential programs comes from annual survey by IR</td>
<td>25% Increase from 2005-06 Levels</td>
<td>Experiential and Service Learning (IRE)</td>
<td></td>
</tr>
<tr>
<td>Diversity of the faculty</td>
<td>Gender, racial and ethnic profile of the faculty on the faculty census.</td>
<td>Increased gender and racial diversity in the faculty.</td>
<td>Faculty and Staff Profiles (IRE)</td>
<td></td>
</tr>
</tbody>
</table>