Table of Contents

Executive Summary ........................................................................................................................................................................ 3
College Goals and Outcomes .......................................................................................................................................................... 5
  Objectives from last year .......................................................................................................................................................... 5
  Objectives for coming year ...................................................................................................................................................... 5
  Administrative Quality and Improvement (AdQI) .................................................................................................................. 6
The Life of the Mind ..................................................................................................................................................................... 7
Undergraduate Education .............................................................................................................................................................. 7
  Integrated Science Curriculum .................................................................................................................................................. 7
  Forthcoming New Degree Initiatives ...................................................................................................................................... 8
  The Academy of Integrated Science ........................................................................................................................................ 9
  Departmental Efforts ................................................................................................................................................................. 9
  University and College Faculty Awards .................................................................................................................................... 11
  Staff Awards ............................................................................................................................................................................... 11
  Research Experience ................................................................................................................................................................. 13
  Service Learning and Experiential Learning Courses ........................................................................................................ 13
  Study Abroad ............................................................................................................................................................................. 13
  Graduate .................................................................................................................................................................................. 15
Research and Innovation ............................................................................................................................................................... 21
  Discovery .................................................................................................................................................................................. 21
  Engagement ............................................................................................................................................................................. 29
    Industrial partnerships .......................................................................................................................................................... 33
    Patents, Applications and Awards ......................................................................................................................................... 33
Diversity ....................................................................................................................................................................................... 35
  Awards .................................................................................................................................................................................... 37
  Scholarships ............................................................................................................................................................................... 37
  Fellowships .............................................................................................................................................................................. 37
Advancement Team ....................................................................................................................................................................... 39
  Alumni Relations ................................................................................................................................................................. 39
  Development .......................................................................................................................................................................... 39
  Corporate and Foundation Relations ....................................................................................................................................... 40
  Communications ....................................................................................................................................................................... 42
2012-13 College of Science Student Honors and Awards ...................................................................................................... 43
Undergraduate.............................................................................................................................................................................43
2012-13 College of Science Student Honors and Awards.................................................................44
Graduate.................................................................................................................................................................................44
2012-2013 Faculty Honors and Awards..............................................................................................45
2012-2013 Staff Honors and Awards..............................................................................................46
EXECUTIVE SUMMARY

The College of Science is marking its 10th anniversary this year. Much has happened since July 1, 2003, when the College was formed. Substantial parts were for the good, in that they brought recognition to what is possible in a comprehensive land-grant university such as Virginia Tech. Parts didn't quite pan out in ways we had hoped for. On balance, where we are now vindicates the action to create this College from the then College of Arts and Sciences. Clearly, however, much more needs to be accomplished before we can proclaim maturity of the idea. This report will describe the latest chapter in our history, indicate what the immediate future is, and sketch out the broader picture of where the College is headed.

From inception, the aim was to establish an innovative environment for science to flourish, thereby positioning us as a uniquely forward-looking institution for students, scholars, and the country to look to for understanding and, where likely, solutions to some of the critical challenges we confront every day. The strategy that underpins this goal is to exploit the inherent unity in all scientific pursuits, incorporating complementary disciplinary features in the way we train students, the way we do research, and the way we reach out to the community at large.

The following sections detail the attempts that have been made toward this goal, and the progress achieved so far. Chief among these attempts is the institution of a set of Integrated Science programs. It is our answer to the STEM challenge posed by the National Academies a few years ago, wherein they pointed out the dangers in not providing for better education in the basic sciences.¹

As a first step, the College initiated the Integrated Science Curriculum (ISC) as the portal for innovative degree programs in areas that sit at the nexus of different disciplines. ISC was launched two years ago, and has met with substantial enthusiasm among students and faculty. The follow-through is the four degree programs that

¹ Rising Above the Gathering Storm-Revisited (2010), the National Academies.
ISC has been designed to lead to: Computational Modeling and Data Analytics (CMDA), Nanoscience (NANO), Neuroscience (NEURO), and Systems Biology (SYSB), which are now in various stages of going through University governance. The College anticipates eventual approval of all these programs by SCHEV. In the meantime, interest among students is high, with mounting inquiries and waiting-list requests.

The report will also detail the difficulties we face as we attempt to construct a broader framework that encompasses the goals of the land-grant mission, wherein higher education is to be made assessable to all, and those of the liberal arts tradition, wherein higher education should cover a wide spectrum of expertise and knowledge, with its overtones of elitism. All of these are still works in progress.

There are physical and personnel changes taking place at the College that should be mentioned. First, the Dean’s office will be moving from the old triple-wide to the newly finished North End Center in early September, 2013. The trailer has served its purpose as temporary quarters, 17 years in actuality, and cannot continue to do so because of long anticipated structural defects. This move is itself temporary. More permanent quarters are being designed in the renovation of Sandy Hall.

Second, there have been some changes in personnel. After serving as the Associate Dean for Undergraduate Programs, Jill Sible, Professor of Biological Sciences, stepped down last fall, and has taken on the position of the Assistant Provost for Undergraduate Education. Gary Long, Professor of Chemistry, has been appointed to take her place. Nancy Ross agreed to be the next Chair of Geosciences starting last fall. Her position as the Associate Dean for Graduate Programs has been taken over by J. P. Morgan, Professor of Statistics. During the past summer, J. P. also agreed to take on the duties of the Founding Director of the Academy of Integrated Science, the unit charged with nurturing and monitoring the new degree programs already alluded to above. Naya Sou joined us last spring and is the Coordinator for New Undergraduate Programs in the Academy of Integrated Science. Robin Lawson also joined the College as the First Year Experience and Student Development Coordinator after Debbie Wilson, our former Student Services Coordinator, moved to Career Services to assume the position of Program and Event Coordinator. In the ranks of department leaders, we are in the middle of recruiting a new Head for the Economics Department. Among the Advancement Team, Donna Wardell has been appointed to succeed Robin Jackson as the Director of Alumni Affairs, starting last January. Robin took on a similar position with UNC, so as to be close to family. Rosaire Bushey joined us last fall as our new Communications Director, succeeding Catherine Doss, who left over a year ago to assume another assignment. Erin Woodard joined the College in May as the Assistant Director of Development. Amy Fleet left us for personal reasons to take on a new position in North Carolina. The Advancement Team is finally at full strength, the first time in several years.
COLLEGE GOALS AND OUTCOMES

Objectives from last year

There were three objectives listed in last year’s report. In the following, progress in these three objectives will be summarized.

1. Continuance of work on earlier objectives. The crucial elements of these earlier objectives are those in implementing the four new degree programs. Significant progress in all four of the degree programs have been made, as detailed elsewhere in this report. Many of these are now ready to go through governance, with the attendant degree proposals being readied for submission for SCHEV approval. What hasn’t yet happened is expansion into the graduate domain. That will be an objective for the next few years.

2. Formation of the Academy of Integrated Science. The Academy is central to SCHEV approval of the degree programs. We have identified J. P. Morgan as the founding Director, and he has already made notable progress in pulling personnel together to establish the requisite intellectual and physical infrastructure. The details of the organization of faculty in the several tracks within the Academy still remain to be established however. So far, support remains strong across the College.

3. Formation of larger research groups. The College has not been able to gain too much traction in this goal. At least not yet. Our associate dean for research, Tim Long, has been asked to lead this effort. Toward the end of the academic year, he shepherded two projects involving groups at the anticipated larger scales. As detailed elsewhere in the report, such groups and their external support are critical for fulfilling the College’s mission.

Objectives for coming year

1. Continuance on projects from previous year. As listed above, there are several objectives from last year that weren’t completed as yet. These include:
   i. Graduate curricula for the new degree programs.
   ii. Completing solid infrastructure, both intellectual and physical, for faculty within the programs under the auspices under the Academy of Integrated Science.

2. Large research projects on critical Life and Physical Sciences. The two large proposals recently completed are both in the Energy and Environment domain. The College intends to gather and coordinate faculty interested in the Life Sciences to work on large projects, such as neuroscience, cancer, and impact of climate change on health. Tim Long will take on the key role in facilitating this objective. This objective will be pursued in collaboration with the proposed Faculty of Health Sciences, and those faculty involved in the Translational Biology, Medicine and Health degree program (TBMH). The College has an interest in developing the Kimballton Underground Research Facility (KURF) into a national facility. To this end, discussions with the NSF have been initiated to site the Dual Ion Accelerator for Nuclear Astrophysics project (DIANA) at KURF. It is unlikely that the tight funding landscape in the
federal agencies will improve anytime soon, so individual PI grants are going to be difficult to land. It is therefore crucial that such larger projects be pursued and the necessary funding secured through the integrated approach the College is putting forth.

3. **Enrollment management.** The burgeoning enrollment among majors in the programs in Science, resulting from the decision to place students interested in Engineering in their second choice for major, has created an opportunity for the College and the University to grow in many initiatives. These include all of the Integrated Science programs, and existing ones in select departments. To take advantage of this opportunity, the College will need help in new resources to build the requisite faculty. But realizing the limitations imposed by current fiscal constraints, some creative tactical steps will have to be devised and implemented. It is the creativity we bring to the challenges we face, in this and in all arenas, which will allow us to move forward. It is the pace of innovation we will focus on as we enter our second decade as Virginia Tech's purveyor of education and research in science.

**Administrative Quality and Improvement (AdQI)**

Implementation of the courses in the new integrated science curriculum (ISC) has been a success, as clearly evidenced by the number of students enrolled having nearly doubled in each successive year. The one area of constant challenge had been achieving, and maintaining, consistency in the specially designed, and evolving, interdisciplinary labs. The first year and a half found us squeezing into research labs of accommodating faculty, a practice that was as counterproductive as it was unsustainable. With vital support from the provost's office, dedicated ISC laboratories were installed on the fifth floor of Derring, opening in January of this year, in time for the fourth semester of the program. It remained only to achieve consistency of lab operation (ordering of supplies, dispensing of chemicals, availability and upkeep of equipment, etc.), tasks requiring a dedicated lab manager. Craig Tollin has been hired to fill this role, and beginning with the 2013 fall semester is responsible for supplying and coordinating all laboratories not just for ISC, but for nanoscience, neuroscience, and systems biology programs as well. Craig's further charge is to work hand-in-hand with instructors for all of these courses, helping to construct laboratory experiences that illustrate and integrate the theories, ideas, and techniques covered in course lectures. These two vital steps, obtaining permanent lab space and a manager for that space, were the needed responses to weaknesses identified by assessment of the first ISC year.

As explained elsewhere in this report, ISC can serve as a portal not only to many traditional majors within the College of Science, but to the four developing degree programs of CMDA, Nanoscience, Neuroscience, and Systems Biology. Many of the courses developed for these new degrees have passed through governance, and some are now being taught. However, approval for the new degrees did not progress as quickly as expected. Assessment by program leaders, and by College staff, both pointed towards the need for a central figure to facilitate development of degree proposals, to coordinate program-related hiring, and to actively promote the goals of the programs. Realizing also the many challenges that yet lay ahead, these findings led to creation of the Academy of Integrated Science and the appointment of J. P. Morgan as Academy Director. All four programs now have courses being offered, two have degree proposals in governance (with the other two to follow later in fall, 2013), and the Academy has provided an identifiable face to this collection of new initiatives.

Expansion of research efforts, especially as regards large, multi-PI projects, did not gain the traction we had hoped for over the course of the past year. Once again, assessment has indicated the need for a dedicated individual if we are to be effective in pushing ahead. In light of this, the associate dean for research, Tim Long, has accepted the charge. He will be working with our faculty to encourage collaboration with other departments, colleges, and universities, pointing them to the many opportunities for pursuing multi-disciplinary and multi-institution grants.
Undergraduate Education

Changing the Pace of Innovation in Education

Over the past ten years, the pace of innovation in education practices in Science, Technology, Engineering and Math (STEM) education has dramatically increased. This pace is driven by new technologies and pedagogies that facilitated changes in the manner in which information is presented and delivered by teachers and as well shared by students. The College of Science has been an active participant in the use of these new approaches in its undergraduate and graduate classrooms and labs. The College is involved in the creation of courses that integrate STEM material across disciplines, through new offerings and programs. Faculty are using the model of a “flipped” classroom to enhance student involvement and to step away from the “unidirectional” flow of information in the classroom. The establishment of scale-up classrooms in several buildings on campus further heightens student-teacher and student-student interaction. This scale-up concept now extends into several of the College's laboratories.

The pace of innovation is not constrained to students and new faculty. Through the FDI programs, all COS faculty are being exposed to these new methods of teaching, of which many are adapting/adopting them into their classrooms.

A metric that would describe this change in pace is the number of new courses that have been submitted for review to university governance. In this past year, forty-four new courses have been submitted for review. Six new graduate courses are under review. Thirty-eight undergraduate courses have been submitted for review and twenty have been fully approved. Of these thirty-eight courses, twenty-eight are for the proposed degree programs of the College described below.

Several major innovations in the College’s education practices are summarized below. They consist of the Integrated Science Curriculum, and the developing degree programs in Computational Modeling and Data Analytics (CMDA), Nanoscience, Neuroscience and Systems Biology.

Inspiring Creativity, Curiosity and Critical Thinking

Integrated Science Curriculum

In 2011, the College of Science embarked on a bold mission to change the pace of innovation in undergraduate STEM education. The innovation, termed the Integrated Science Curriculum (ISC), was centered on the integration of education in the physical, life, and mathematical sciences into a seamless four-semester lecture and laboratory offering. By merging common content of biology, chemistry, mathematics, physics and statistics, students are presented with a more effective pathway to learn the information, and to not compartmentalize the learned material and theory to one discipline. It is this innovation in STEM education that will train students to integrate disparate scientific information for cohesive action plans. Graduates of the ISC learn how to ask questions, seek interdisciplinary answers, and most important, redefine the definition of failure as part of the pathway to success.
The College believes these students will graduate as problem solvers, team players, community leaders, creative thinkers, global colleagues and spirited entrepreneurs. As the ISC experience is learner-centered, groups are immersed in teamwork exercises. While each of the four semesters of lecture and lab offerings covers the material of the “traditional” science and math offerings, they also introduce the necessary material to bridge the traditional content into the areas of neuroscience, nanoscience, systems biology and computational science. This practice allows the student to experience immersion in areas that are not a part of normal science offerings.

The teamwork aspect of the ISC program is further amplified by the use of “team teaching” in the lectures. This critical concept is carried into labs with the use of guest lectures, as well as ISC faculty and graduate students being directly involved in the laboratories.

Piloted in the fall 2011, eleven students entered the program. A second incoming class of 25 students enrolled in fall 2012. The cohort of 2013 is comprised of 38 students. In the coming five years, we foresee the program growing to 100 students in each class, which would account for 10% of our incoming science majors. These students will primarily be majors in Biological Sciences, Biochemistry, and Chemistry. Other majors include Mathematics, Statistics, and Geosciences. Forthcoming degree programs in CMDA, Systems Biology, Nanoscience, and Neuroscience will be able to use ISC as their foundational portal.

Assessment of the program is proceeding in earnest as the first cohort of students have now completed the program. Both qualitative and quantitative analyses are ongoing. Longitudinal evaluations are beginning in fall 2013. The analysis also includes the graduate students and faculty involved in the lecture and lab sequences.

A New Vision for Undergraduate General Education

Forthcoming New Degree Initiatives

The College is now advancing its planned four new undergraduate degree programs. Two of the degree proposals are under review by university governance, with the others to follow soon. SCHEV proposals are being prepared for submission.

- **Computational Modeling and Data Analytics:** The College has engaged in considerable research and discussion in creating a compelling undergraduate computational modeling and data analytics program at Virginia Tech. The COS departments of Statistics and Mathematics are the primary groups involved in this degree initiative, with Computer Science (COE) also being a substantial contributor. Work to date has resulted in nine courses being submitted to university governance, with six being fully approved. The current degree proposal is under university governance review, and the SCHEV proposal is targeted for submission in November.

- **Nanoscience:** The nanoscience initiative has resulted in eleven courses being developed. Of these courses, 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 current degree proposal is under university governance review, and the SCHEV proposal is being targeted for November.
• **Neuroscience:** The high demand among students for a neuroscience program has prompted the college to develop neuroscience courses supported by the biological sciences and psychology departments. This initiative has resulted in ten courses, of which the introductory courses were taught last year and will be offered in the upcoming academic year.

• **Systems Biology:** The ISC was initially developed as the foundation of the systems biology degree, and several current ISC students are interested in earning this degree. The systems biology initiative has resulted in ten new courses being developed. The introductory courses will be taught beginning fall 2014.

The College has also launched an interdisciplinary minor in Science, Technology and Law (STL). Four newly developed undergraduate courses in support of the minor, as well as the minor itself, have been officially approved. Around 30 students have enrolled over the course of the first year, six of whom graduated in spring 2013. One indicator of the attractiveness of this minor is that Washington and Lee University has begun recruiting STL students for their law degree program. Anna-Marion Bieri, the Director of the STL program, is actively involved in raising awareness of issues surrounding intellectual property (IP) on campus – including teaching guest lectures in various classes across different colleges, helping faculty, graduate and undergraduate students with IP issues, and participating in IP policy related discussions.

**The Academy of Integrated Science**

After considerable planning throughout the year, the Academy of Integrated Science was launched on July 1, 2013. Its charge is to

- Develop and house interdisciplinary, science-based degree programs, curricula, and minors
- Provide a multidisciplinary home for faculty whose teaching and research interests are associated with these programs
- Foster and enhance research opportunities in alignment with its degree programs
- Strengthen inter-departmental collaboration in discovery, learning, and engagement

The Academy currently includes the ISC, the four developing degree programs listed above, and the minor in Science, Technology, and Law. These programs stand at the forefront of science education, leading the movement towards interdisciplinary education at the undergraduate level. It is our goal that the degree programs will further serve to kindle cross-pollination of research among the faculty who are working together to support the degrees. That is, by bringing faculty together from different departments to build and teach in these programs, we are also creating the cross-disciplinary communities that are the fertile ground for new avenues of research. Seen in this light, the Academy is one of our investments in the future of the College, one that aims to jointly change the pace of innovation in education and in research.

**Departmental Efforts**

Faculty in all the departments of the College are involved in changing the pace of innovation in STEM education through new developments in their lectures and laboratory courses. Listed below are highlights from our faculty.

- Richard Walker (BIOL) is leading an effort to reinvent delivery and support for both the introductory biology sequence for science majors (BIOL 1105, 1106) and the math sequence
(MATH 1016, 2015) required by Biological Sciences and other life science majors. The BIOL 1105 and 1106 redesign will create an active, student-centered classroom with both in-class and out-of-class support programs in order to: 1) improve retention of key scientific and biological concepts, 2) improve critical thinking skills, 3) maintain and promote enthusiasm for life science careers, and 4) improve student retention in STEM life science majors.

- Through a partnership between Biological Sciences and Mathematics, the MATH 1016 and 2015 redesign will infuse biological examples into these courses in order to: 1) improve the quantitative skills of Biological Sciences and other life science students, 2) increase student appreciation for the role of mathematics in biology, and 3) improve student performance in math courses taken later in their curricula. Pilot sections of the redesigned BIOL 1105 and 1106 courses will be offered during fall 2013 and spring 2014, respectively. Full implementation is expected for the fall 2014 semester. MATH 1016, 2015 revisions will be completed and implemented in fall 2014. Funding is from the 4-VA program.

- Carla Finkielstein (BIOL) developed COS 2984: Seminar in Nanoscience, offered for the first time in fall 2012. Topics ranged from the use of nanotechnology in drug delivery and disease treatment to applications of new nanomaterials in engineering processes. She also worked on course development for NANO 4314: Nanomedicine, during spring 2013, to be offered for the first time this coming fall. The course will review fundamental concepts underlying nanomedicine that redefine current clinical research including diagnostic imaging agents, nanomaterial-based drug delivery, and its implication for therapeutic treatments of a broad spectrum of diseases.

- Lori Blanc (BIOL) and Debbie Wilson (COS) were awarded a First Year Experience program grant, “Successful Starts in Science: Da Vinci and Curie Living-Learning Communities,” funded in March 2013 through VT’s Office of Undergraduate Education as part of the Pathways to Success initiative.

- Chemistry is now using common-time, common-content tests and final examinations in general chemistry. Dr. Patricia Amateis guided this effort. Anecdotally, students appreciate the “level playing field” in that they find consistent content and assessment throughout the multiple General Chemistry sections.

A readiness examination was administered to general chemistry (CHEM 1035) students for the fall 2013. The online exam tested a student’s ability to do simple algebra, manipulate fractions, rearrange equations involving exponentials, read a graph, solve a word problem and use a calculator. Students scoring 7/20 or below are directed to MATH 1015 or CHEM 2984, a preparatory chemistry class in order to take CHEM 1035 in the spring semester. An assessment of the online exam will begin in fall 2013.

- Prof Webster Santos (CHEM) co-developed a new course, Drugs, Bugs, and Entrepreneurship, offered in the College of Science that deals with the introduction of science students with entrepreneurial activities and was co-taught with Prof. Joseph Falkinham (BIO) and Tim Howland (COS). The course involved lectures and presentations from local and outside industries detailing their entrepreneurial activities. Topics ranged from the importance of
intellectual properties to exit strategies. At the end of the course, the students proposed entrepreneurial activities in the form of a start-up business.

- Barbara Bekken and Madeline Schreiber (GEOS) revised *Geoscience Fundamentals*, which is required by all UG majors in Geosciences, so that it could be taught in the SCALE-UP classroom and include writing intensive assignments. Also using a SCALE-UP setting was John Chermak (GEOS) in his teaching of *Resources and the Environment*.

- John Simonetti (PHYS) taught the first offering of the First Year Experience (FYE) course, PHYS 2325-2326.

- The FYE in Learning from Data (STAT 1004) will be offered for the first time in fall 2013.

- Zip-line to Success, a first-year experience for transfer students in the College of Science has been revised and is being offered to 102 students by Robin Lawson (COS). Of the 18 students from the previous offering, 75% stayed in their major through spring 2013. One transferred to COE, two others to CLAHS. Two students departed from the university.

### University and College Faculty Awards

As evidence of the effort to change the pace of innovation in education, faculty from the College have been recognized as exemplars in the classroom and laboratory. *(See Appendix for more awards.)*

- Patricia Dove (GEOS), University Distinguished Professorship
- Dana M. Hawley (BIOL), College of Science Certificate of Teaching Excellence
- Marlow Lemons (STAT), College of Science Certificate of Teaching Excellence
- Joseph Merola (CHEM), 2013 Wine Award from the Virginia Tech Academy of Teaching Excellence
- Madeline Schreiber (GEOS), College of Science Certificate of Teaching Excellence
- Jeffrey Walters (BIOL), Alumni Award for Excellence in Research

### Staff Awards

The staff of the College play a most valuable role in promoting and sustaining a learning environment for our students. Three of our staff were honored for their contributions to our College.

- Linda Bland (retired) received the 2013 Staff Career Achievement Award. Bland was honored for her exemplary performance and 36 years of university service as the full-time financial officer for Geosciences.
- Lawrence Sewell (MATH) received the 2013 Governor’s Award for Innovation. Sewell was honored for his work in designing and constructing the core service systems at the Math Emporium.
- Diane Walker-Green (PHYS) received the 2013 President’s Award for Excellence. Walker-Green was honored for her tireless efforts of 12 years in which she has been the support...
structure for undergraduate physics majors and for faculty in their teaching and daily interactions with students.

**Undergraduate Student Awards**

The success of our students is an important metric in gauging the education process of our College. Listed below are College of Science students who received awards in 2012-2013. *(See Appendix for more awards.)*

![Image of awardees]

**E-Learning**

A factor that influences the change in the pace of educational innovation is the emergence of online course offerings from our College. In this past year, eight courses were available online. In addition to these courses, other work is emerging to facilitate our students’ immersion in STEM education.

Herve Marand (CHEM) gave an online offering of CHEM 4615, Physical Chemistry for the Life Science for the third consecutive summer. Guided by student comments from the prior year, the content was realigned and optimized. Student comments were very positive on the revised offering. Students achieved a high success rate in this course.

The Math Emporium makes extensive use of technology in support of student learning. It is currently adding short video clips of lectures to the online materials. These video clips will enrich the experiences of students.
on campus as well as enhancing the course materials for distance learning. Emporium courses are offered in distance-learning format during the academic year when there is demand, and they are serving a rapidly increasing population of distance learners during the summers. The successful operation of the Math Emporium continues to draw interests from other institutions of higher learning as a model of instruction and facility management.

**Principal Strategies**

Success in science education is inextricably linked to experiences beyond the classroom. Our principal strategies on this front include research experience, service and experiential learning, and study abroad courses.

**Research Experience**

Research experience is core to the course in the College of Science. In this past year, 56% of the graduating undergraduates participated in a research experience. This amount is double that from two years ago.

External funding continues to be a major driver in the successful offering of research experiences for COS students. The following faculty were able to procure funding for these efforts.

- Prof. Judy Riffle (CHEM) and Co-PI Richey Davis (ChE) were awarded an NSF-REU renewal for “A Summer Undergraduate Research Program (SURP) on Design and Delivery of Polymer-Drug Complexes” for 2013-2015.
- Other Faculty receiving NSF-REU awards were:
  - Biological Sciences: Lisa Belden, Dana Hawley, Ann Stevens, and Dorothea Tholl
  - Physics: Giti Khodaparast

**Service Learning and Experiential Learning Courses**

The number of undergraduate students involved in service learning changed in this past year. There were 143 students in 2013, while there were 365 in service learning courses during 2012.

A larger percentage of COS students participated in Experiential Learning Courses. There were 2,025 COS students in this category. This amount was 22% of the university total and was up from 17% from two years ago.

**Study Abroad**

Of the 1,144 students involved in the study abroad program, 13.9% were from the College of Science. This amount has remained relatively constant for the past two years.

**Enrollment Challenges in STEM**

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). COS may deliver more SCH for the degree than the student’s home college and therefore, COS is impacted by enrollment planning and management practices across campus.

The number of COS entering majors grew in 2013. There were 959 new students selecting the College of Science as their academic home. This number is a 24% increase over the 776 students admitted in 2012, and a 38% increase over the 696 students admitted in 2003. This change in the population of COS majors from 2003, 2012 and 2013 is shown above.
All but one department experienced growth in this past year. Of notice is the increase of 109% for Physics and 78% for Math. While STEM programs continue their decade long growth, a significant factor in the large rises of 2013 may be attributed to an increase in the number of second-choice majors.

As the College has experienced a 38% growth in first year students since 2003, it is not surprising to see the growth in the STEM areas. The second graph displays the difference in the number of enrollees from 2003 to 2013. Much of the decade’s increase of 263 new students is concentrated in Physics, Math, Chemistry, and Biochemistry. In particular, Physics gained an additional 118 enrollees.

The increase in STEM majors is in alignment with the College of Science's goals, as outlined in the University’s Strategic Plan. To promote the changing of the pace of innovation in STEM education, the College continues to explore new approaches to teaching STEM material in the classroom and to provide technically relevant laboratory exercises to its students.

Apart from the AY issues of traditional STEM education, the College has embraced the use of distance and summer school offerings, as articulated in A Plan for a New Horizon, to address enrollment demands with limited classroom and laboratory space. Total summer school enrollment in COS courses remained constant between summers 2012 and 2013. The academic year and summer offerings of off-campus, primarily distance-learning courses, increased significantly by 23% over the prior year. Coupled with the growth in these areas from previous years, the College is setting a trend in the right direction that shows our capacity to grow in both online and summer school offerings.

**Academic Advising**

One of the elements essential for student success and retention is academic advising. As a college, we understand the need to provide developmental opportunities for our academic advisors. To enhance our current success in undergraduate advising, the College initiated workshops and training sessions throughout the year.

In January, the College began the semester with an academic advising kick-off. This session featured the concept of *appreciative advising* by nationally known speaker Dr. Jennifer Bloom. The event was a huge success with 70 advisors in attendance. Comments from the survey included:
“This was so valuable. Keep doing the great work you do!”
“How do we get administrators to appreciate advisors?”
“I was sorry I had signed up for this yesterday afternoon because I am behind in my preparations for this semester, but I am really glad I came. Thank you!”
“I struggled to find the time to do this. I almost said that I don’t have the time. Glad I did attend!”
“This was inspiring presentation that has really made me excited to advise!”

In addition to the kick-off workshop, the College also supported the advising efforts of the university by continuing to support the Advising Matters Workshop. A financial contribution was made to the program, as well as covering the registration fees for a COS advisor in attendance. In addition to monetary contributions, Dr. George Simmons and Susan Haymore presented a workshop titled, “Group Advising: Communicating with Students in a Neutral Environment.” This session was aimed at helping faculty understand different techniques to help students see the importance of advising and to get them engaged in the process, as well as providing faculty ways to improve the efficiency of advising.

Retention Efforts
The College began fostering a program to work with students on academic warning and probation. Students in these categories are required to meet with one of the advisors or the assistant dean in the College office. Before coming to the meeting, they are required to complete an extensive assessment of their prior academic career. The assessment forces students to look at various behaviors or situations that led to their deficit, requires them to become familiar with resources available on campus, and prepares them for discussions on developing an action plan for future success. This also allows the advisor or dean to gauge if additional recommendations are necessary (resignation, counseling, etc.).

Another advising strategy aimed at helping students to become successful is meeting with students who request a course withdrawal. The College adopted this strategy to begin working with students early to help them recognize behaviors that may have hindered their success in one or more classes. This strategy is just one more opportunity for intervention and allows us to work with students that may have underlying issues affecting their academic success (family illness, personal illness, death of close friend or family, etc.). The College is trying to take a proactive, not a reactive, approach on student retention.

Graduate
The achievements of College of Science graduate students continue to bring prestige not only to the departments but to the College and University as a whole. The College of Science’s commitment to graduate education is built on these pillars:

- Developing and supporting interdisciplinary graduate research and training programs
- Recruitment of the highest quality graduate student prospects
- Supporting a steady, realistic 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 for our graduate population is to grow the number of Ph.D. students, within the resources available during this period of relative austerity, with new interdisciplinary tracks at the graduate level. These are emerging from cluster hiring, our deep involvement with IGEPs (discussed later in this report), and the expansion of our Academy of Integrated Science faculty who bridge traditional academic disciplines. The four degree tracks currently under development within the Academy in computational modeling and data analytics, nanoscience, neuroscience, and systems biology, will come online in 2014 and 2015; aside from neuroscience (which falls under the TBMH umbrella at the graduate level), they are all intended for further development as Ph.D. degrees. As with any significant, new endeavor in graduate education, this will take some time. The current expectation for these new doctoral degrees is for them to become available by 2020.

In fall 2012, there were 586 graduate students enrolled in the College of Science. Of these, 489 were Ph.D. students and 97 were M.S. students. While this is a very slight decrease from the preceding three years (our numbers are essentially steady over that time frame), there has been a remarkable growth in the numbers of doctoral students from our 2003 birth, when only 256 Ph.D. students were enrolled in the College of Science. Even more remarkably in light of this rise in student numbers is that the number of full-time faculty in the College has remained virtually unchanged since our birth. The College has far surpassed any reasonable expectation for growth in its graduate programs, and is constrained now only by the need for additional faculty lines. Development of newly integrative doctoral programs will nonetheless allow further growth in doctorates produced. It is one of the important paths by which we are changing the pace of innovation in both research and education.

The College of Science is a leader in developing interdisciplinary graduate degree programs. Such programs span traditional departmental boundaries and allow students 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 advance 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. We expect our new (currently in the approval process) systems biology undergraduate degree to be one feeder for GBCB.
The College of Science is providing primary support from VT’s Blacksburg campus for development of the new doctoral program in Translational Biology, Medicine, and Health (TBMH), an initiative led by Michael Friedlander of VTCRI and the Biological Sciences Department. This campus-wide doctoral degree program has tracks in Neuroscience; Cancer; Health Implementation Science; Metabolism and Cardiovascular Science; Immunity and Infectious Disease; and Development, Aging, and Repair. We expect our new (currently in the approval process) neuroscience undergraduate degree to be one feeder for the Neuroscience doctoral track.

The College of Science has been a leader in developing and taking part in Virginia Tech’s Interdisciplinary Graduate Education Programs (IGEPs). Of the eleven non-degree granting IGEPs formed to date, College of Science faculty play crucial roles in ten: SuN, Translational Plant Science, WATER, MultiSTEPS, Translational Obesity Research, Regenerative Medicine, Remote Sensing, Computational Tissue Engineering, Interfaces of Global Change, and Bio-inspired Buildings.

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. Faculty in the College of Science are leading novel recruitment, teaching, and research efforts to increase the quality, diversity, and reputation of ongoing research programs.

Dana Hawley of the Biological Sciences Department was recognized with a Secretary of Defense Patriot Award. Her nomination was submitted by Army Reserve Captain and doctoral student Camille Harris, who served on a nine-month deployment to South-
west Asia as a veterinarian supporting military working dogs, as well as troops, by providing food inspection services and zoonotic disease risk assessment.

- Assistant Professor Jeffrey Kuhn of the Biological Sciences Department team-taught a new course, GRADS134: Interdisciplinary Research in Bio-transport, for the MultiSTEPS IGEP program, together with SBES faculty member, Rafael Davalos. This course examined the interface between the engineering and biological sciences, with particular emphasis on transport phenomena in biological systems. In addition to the technical content, they also addressed issues such as communication within and across disciplines, ethics in interdisciplinary research, and effective mentoring.

- Biological Sciences faculty maintained leadership in three university-wide graduate recruiting programs: (1) The Interdepartmental Microbiology Graduate Program (IMGP) includes over 50 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 more than 20 participating faculty from seven departments and employs recruiting efforts at regional schools, followed by students rotating through labs before a decision is made on a major advisor; and (3) Faculty in the Cell and Developmental Biology group are heavily involved with the interdisciplinary doctoral program in Genetics, Bioinformatics, and Computational Biology (GBCB) described earlier in this section.

- The College and Departments support up to three four-year ICTAS Graduate Scholarships per year to recruit the best and brightest graduate students to Virginia Tech. There are now eight ICTAS Graduate Scholars in the College of Science including one who will join the cohort in fall 2013.

- The Mathematics Department started a student chapter of the Association for Women in Mathematics. The chapter organized activities and talks for both undergraduate and graduate students. The fall 2013 entering graduate class is expected to be more than 50% female. This is believed to be the first time an entering Mathematics graduate class has exceeded the 50% benchmark, a major accomplishment in a traditionally male-dominant field.

- Departments in the College of Science host “open days” and other such events to showcase the quality of their graduate programs and to help recruit the best students. Biological Sciences, Chemistry, Mathematics, and Physics each run a recruitment weekend, composed of information sessions, social events, and individual meetings, where prospective graduate students are brought together to see their departments and programs up close. Psychology brings in two groups of students, one for their clinical program, and one for their developmental and I/O programs. Economics, Geosciences, and Statistics employ a different recruitment model, bringing in especially desired applicants on an individual basis to meet faculty and learn about the department. This past year the College was able to supplement these efforts with financial support for the first time.
• Assistant Professor Vito Scarola of the Physics Department started a graduate student recruitment effort with the University of Science and Technology of China (USTC), a school akin to Caltech in its focus on math and science. USTC produces very talented physics students. In the first year, he was able to increase the Physics applicant pool, with several of these students enrolling at VT in fall 2012. Dr. Scarola also started a collaboration with Thomas Maier of Oak Ridge National Laboratory to pair his computational methods with Maier’s expertise in Dynamical Mean-Field Theory to study disorder in the Hubbard model. Through this collaboration his research group was awarded a grant of computing time on Oak Ridge supercomputing facilities. Graduate students joining his group will travel to Oak Ridge as part of the collaboration.

• University Distinguished Professor David Kingston was named director of the new Virginia Tech Center for Drug Discovery, whose goal is to accelerate research that could lead to new treatments for cancer, Alzheimer’s disease, cardiovascular disease, atherosclerosis, diseases of the central nervous system, and parasitic diseases such as malaria. With more than $29 million in combined research support, the center includes faculty from six colleges as well as the Bioinformatics Institute, and incorporates both graduate and undergraduate students into its labs.

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.

• Statistics has a very active consulting center with faculty from the entire campus visiting the Laboratory of Interdisciplinary Statistical Research (LISA) throughout the year. This vital service, funded by the Graduate School and six colleges, enhances research and sharpens dissertation work for a wide swath of the VT community. The LISA 2020 project, to train collaborative statisticians in developing countries, has just received a Google seed grant to promote effective statistical practice in parts of the world where it is most desperately needed. All Statistics graduate 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.

• 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. Statistics awards three
endowed prizes each year, totaling $11,000. 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 $11,000 are awarded each year to graduate students who will make a significant difference to the College of Science and the world outside the university.
RESEARCH AND INNOVATION

Discovery

Discovery percolates throughout the strategic objectives for the College of Science; discovery-based learning, interdisciplinary discovery to solve complex global challenges, and discovery-based engagements that nurture a pervasive culture of intellectual entrepreneurship and provide our students with a "hands-on minds-on" experience. Discovery provides an infinite syllabus for our undergraduate researchers and vast career opportunities for our graduate students and postdoctoral fellows. The College boasts many nationally ranked research programs including ones in nanoscience, geosciences, polymeric materials, data analytics, applied mathematics, computational modeling, energy and the environment, and health sciences. We are addressing many of the global grand challenges for the 21st century, including water scarcity and purification, alternative energies and energy storage, nanomedicine, climate change and the environmental impact of emerging science, and computational methods to handle rapidly generated data sets of immense proportions. A steady growth in research expenditures and numbers of scholarly publications during the past decade supports our national rankings. However, federal funding agencies, industries, and society have grown increasingly impatient and now demand discovery at a more accelerated pace. The adage that "change is the only constant" must now be rephrased as "a more rapid pace of change is the only constant."

The national Materials Genome Initiative (MGI) exemplifies the potential impact for accelerated discovery on our domestic imperatives. An inefficient design-test-build model has only further excited impatient industries for technological solutions that are grounded in computational thinking for predictive and efficient experimental design. Thus, the College of Science has focused our discovery strategy on teemed-science to accelerate discovery, including the formation of interdisciplinary teams which will effectively integrate computational thinking and the common languages of mathematics, statistics, and data analytics. Furthermore, teemed-science extends beyond our geographical borders, demanding our faculty to form partnerships with leading institutions around the world and alliances with international industries for more effective translation of fundamental science to societal impact. For example, global demand for functional polymeric membranes for the energy and water sectors exceeded $15B in 2012; the market is expected to rapidly grow to $25B in the next five years. Raw natural gas production, a U.S. strategy for energy independence, increased 10% over the last 5 years; however, new membranes for on-site purification of produced and flow back water must now address environmental hurdles. Interdisciplinary teaming is no longer a new paradigm; interdisciplinary discovery is now an expectation. However, it is important to recognize that as the College focuses on interdisciplinary science, it must also maintain the underlying foundational excellence in the disciplines of our existing eight departments. Laboratory discoveries will define tomorrow’s disciplines. The first decade of research in the College of Science has resulted in a robust portfolio of leading disciplines and emerging strengths, and now we must accelerate our interdisciplinary growth to maintain our leadership.
Research Expenditures and Awards

Research expenditures in FY13 totaled $24.4M, representing an increase from $23.3M in FY12. Figure 1 depicts the historical trend of research expenditures over the lifetime of the College of Science. FY13 value of submitted proposals, $116,900,000, increased from $110,400,000 in FY12, with nearly an equivalent number of proposals with COS faculty as lead investigators (276 in FY13 versus 281 in FY12). Faculty productivity in proposal preparation has remained steady. However, the total amount of FY13 awards, $20.4M, decreased from $25.6M in FY12, but exceeded 2007 values prior to the nation’s economic stimulus package. The College is therefore still experiencing the effects of little hiring in FY09 and no hiring in FY10 due to budget reductions. The current number of tenure track faculty remains at 200, relatively unchanged since the formation of the College in 2003, and significantly less than the average number of faculty for our peer institutions. Moreover, this data suggests the increased competitiveness of federal funding for single-investigator awards and the concurrent criticality of competing for larger center-style, teamed awards whose annual budgets typically exceed $2-3M per year for multiple years. For example, the College of Science recently led (submission in August 2013) the construction of a National Institute of Standards and Technology (NIST) Center of Excellence proposal with a budget of $5M per year for ten years ($50M total award possible). This is one example of how the College is striving to increase its participation in multi-investigator awards, involving the strategic formation of College centers, inter-college partnerships and working relationships, key industrial alliances, and research partnerships with the VT Institutes. Strategic initiatives to accomplish this goal are described in more detail below. The Institute for Advanced Study in the College of Science serves as one conduit for our growth.
It is noteworthy that since the College of Science was formed in 2003, research expenditures have increased by 45%. It is also illustrative to note the source of funding, as summarized in Figure 2.

Figure 2 depicts, as expected for a leading College of Science, a majority of research funding from the National Science Foundation with significant funding also from NIH and the Department of Defense (DOD). The distribution of the funding portfolio has remained constant, as a strong indicator of a broad based approach to fund raising. The only notable exception is funding from commercial sources has significantly decreased, reflecting a struggling global economy and a recent trend for leading industries to form primarily strategic, large-scale, partnerships with specific, technology-aligned universities. Once again, the opportunity to attract individual awards continues to decrease. Thus, the College strives to nurture major industrial alliances, including recent efforts with IBM University and diverse petroleum industries. As one example of potential impact from industrial partnership, the DOE Energy Hub grant (John 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.

Summarized below are notable awards in our eight Departments for FY13:

- National Science Foundation to Prof. Iulia Lazar (Biological Sciences) and collaborators for $781,500 to develop a “Microfluidic platform for accurate sampling of biological signaling events,”

- National Institutes of Health awarded grants to Prof. Jianhua Xing for $148,544 to conduct research “Examining the bacterial flagellar motor switching dynamics,” to Prof. Dana Hawley and colleagues for $2,256,953 to identify “Ecological drivers of virulence evolution in an emerging avian pathogen,” and to Prof. Liwu Li for $1,953,000 to study the “Innate modulation of macrophage homeostasis.” All are faculty in the Department of Biological Sciences.

- Prof. John Hole (Geosciences) renewed a three-year Landmark Graphics Corporation University Grant Program software license, with a commercial value of $60,062,866.

- Prof. Daniel Crawford (Chemistry) was awarded $329,730 from the National Science Foundation for “Collaborative Research: SI2SSI: Sustainable Development of Next-Generation Software in Quantum Chemistry,” with Georgia Tech for the period 06/01/12-05/31/15. He also received $190,000 from the NSF Office of CyberInfrastructure for a collaborative research
project entitled “A Scientific Software Innovation Institute for Computational Chemistry and Materials Modeling

- Prof. Karen Brewer (Chemistry) received a $362,500 two-year award from the NSF for research on “Structurally Diverse Molecular Architectures with Unusual Excited State Dynamics and Reactivity Providing Multifunctional Interactions with DNA.”
- Prof. Eric de Sturler (Mathematics) received an Air Force award entitled “AFOSR-BRI: Co-Design of Hardware/Software for Predicting MAV Aerodynamics,” AFOSR FA9550-12-1-0442 $6,004,922 (total award), $4,004,922 (VT).
- Profs. Seong Ki Mun (Physics) and Kenneth Wong received an award entitled “Rugged Medic Smartphone” from the Department of the Army, totaling $2,115,264 until 2015.
- National Science Foundation, Division of Materials Research, awarded Prof. K. Park (Physics) $300,000 and Prof. M. Pleimling (Physics) $300,000 for a project entitled “Transient and steady-state properties far from equilibrium.”
- The Department of Psychology had 16 faculty with externally-funded research awards with total FY 13 research expenditures for the Department in excess of $1.4M and new awards of more than $1.8M.
- Prof. Judy Riffle (Chemistry) received $320,000 from the NSF to fund: “REU Site: Polymeric Nanostructures for Delivering Drugs and Imaging Agents,” continuing a long-standing tradition with a summer undergraduate research program (SURP).
- Prof. Richard Turner (Chemistry) received a three-year Division of Materials Research NSF grant ($390,000) to explore the synthesis and properties of highly functional alternating copolymers with sterically-congested backbones.
- Prof. Jeffrey Walters (Biological Sciences) received the University’s prestigious 2013 Alumni Award for Excellence in Research, continuing a continued presence of College of Science faculty for this award, including Profs. Long, Riffle, and Crawford in recent years.
- The Department of Statistics boasted 16 new awards in 2013 totaling nearly $2M in new research dollars.

Nurturing the Formation of Interdisciplinary Teams of Researchers: Thriving with Interdisciplinary College of Science Centers

Special attention was devoted to the formation of new interdisciplinary centers in 2013, establishing an assessment mechanism to ensure sustainable success, creating opportunities for faculty to interact in a grassroots fashion, and integrating with mentorship of our recent hires for earlier success. The following section highlights two new centers and three existing centers as an indication of our mission and our continued attention in FY14.

An interdisciplinary Drug Discovery Center (under the directorship of Prof. David Kingston) was formed in 2013 within the College of Science in close partnership with the Fralin Life Science Institute. This College of Science center has rapidly extended its potential impact across the campus and the Commonwealth. The College infused the Center with an initial investment of drug assay instrumentation, and the Center has quickly emerged as an incubator for drug discovery. The vision of the VT Center for Drug Discovery (VTCDD) is to be a major force in drug discovery and delivery in the United States, with the capacity to discover drug candidates and drug delivery methods and to develop them to the point that they will make it to Investigational New Drug (IND) status. This vision is closely aligned with the strength of the ICTAS NanoBio thrust, where drug delivery and theranostic successes have emerged to fundamental understandings of cellular and trans-membrane transport. The VT Center for Drug Discovery represents an interdisciplinary group committed to continuing the growth and advancing the stature of the existing drug discovery and development programs at Virginia
Tech. The Center is committed to fostering a dynamic environment that enthusiastically promotes the recruitment and education of high-quality students; actively initiates and conducts timely research at both the basic and applied levels; and vigorously pursues continuing education and economic growth through outreach activities with industry and government agencies. The Center goals include the following: (1) Foster communication, education, and sharing of facilities among its members, with the aim of promoting high impact collaborative research, (2) Provide a central compound repository and screening resource for use by all members, (3) Provide a visible presence in the Drug Discovery, Development, and Delivery area at Virginia Tech through the use of an integrated organizational structure, coordinated programs, common showcase facilities, and common outreach activities to attract support from industry, foundations, and private donors, (4) Facilitate and strengthen submission of major multi-PI funding applications to federal sponsors, private foundations, the State, and industrial firms or consortia, and (5) Enhance collaborations in the drug discovery and delivery areas with partners, including those at the Virginia Tech-Carillion Research Institute (VTCRI), Georgetown University, and Wake Forest University.

The College of Science also formed the Center for Autism Research (VTCAR) in spring 2013, with the overarching goal to be a leader in promoting state-of-the-art multi-disciplinary research, both basic and applied, related to autism and associated neurodevelopmental conditions (referred to as Autism Spectrum Disorders, ASD). An ancillary aim is to support post-doctoral, graduate and undergraduate student training as they relate to promoting the research mission. In research, VTCAR seeks to become a nationally and internationally recognized autism research center, focused on cutting-edge research that merges multiple disciplines to understand the assessment, etiology, development, treatment, and public health impact of ASD. The Center provides training to graduate students in evidence-based ASD assessment and intervention approaches, as well as brain imaging technology, eye-tracking methodology, genotyping, and other emerging approaches that may advance this field. Post-doctoral trainees and undergraduate students of VT will also have the opportunity to be involved in our training.

The Center for Neutrino Physics was founded in 2010 and remains a vibrant and exemplary center in the Virginia Tech Department of Physics. The center members are all active researchers in the fields of particle and nuclear physics. Neutrinos are a major research direction for the Physics Department. The Center hosted an international session in summer 2012, gathering leaders in the field, and now VT is recognized for the strength of this teamed science. In addition to the various experimental and theoretical research initiatives of the center members, the Center for Neutrino Physics runs the underground lab known as the Kimballton Underground Research Facility, or KURF, as a resource for the wider neutrino and low-background research community. Today KURF is host to experiments and R&D efforts from several research groups, and pending NSF proposals hope to solidify this national resource.

The College also participates with the only two University-wide centers, i.e., 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. 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. 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. 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 hosted the International Union of Pure and Applied Chemistry Macromolecular Congress in the summer of 2012, and its resounding success has solidified the international reputation of VT in polymer science and engineering. A recent hire in Polymer Physics in the Department of Physics will now integrate new scientists to the Center and also serve to strengthen our proposals in the coming year.

Virginia Tech’s Arlington Innovation Center for Health Research (AIC:HR) is a 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). This Center will undergo the first critical assessment as a College center, using new metrics for success. The review will serve to bolster their stature and impact on faculty on the main campus.

Discovery demands the creation of scholarship to disseminate our latest findings, and also contribute to the international reputation of the College of Science. In 2012-2013, the faculty contributed over 750 peer-reviewed publications and nearly 450 invited lectures. Invention disclosures also constitute a critical component of the produced scholarship for the College (23 invention disclosures in 2012-2013, consistent with 26 in the previous year), and this metric is expected to increase in 2014 in alliance with university plans for a new innovation ecosystem at Virginia Tech.

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. All clusters in the College of Science align strongly with Virginia Tech’s strategic plan. Nanoscience and computational modeling and data analytics 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. 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. 2014 will bring new mechanisms to engage faculty involvement in the formation of new clusters.
and the critical assessment of long-standing cluster areas to ensure their continued impact. Moreover, the cluster paradigm now strives to ensure self-identification of faculty with their research cluster, to catalyze teamed science from day one and accelerate the pace of discovery.

The new faculty recruited into the cluster areas and ISC are listed below:

<table>
<thead>
<tr>
<th>DEPT</th>
<th>NAME</th>
<th>LEVEL</th>
<th>EXPECTED START DATE</th>
<th>SCHOLARSHIP AREA</th>
<th>RESEARCH/CLUSTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>James Gray</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>String Theory</td>
<td>Computational/ISC</td>
</tr>
<tr>
<td>Psychology</td>
<td>Michael Braun</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>Industrial/Organizational Psychology</td>
<td>DSI</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>Zachary Nimchuk</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>Plant Molecular Biology</td>
<td>Energy &amp; Environment</td>
</tr>
<tr>
<td>Psychology</td>
<td>Brad White</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>Developmental Psychopathology</td>
<td>FNH/DSI</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Jatinder Josan</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>Drug Design &amp; Synthesis</td>
<td>Infectious Diseases</td>
</tr>
<tr>
<td>Physics</td>
<td>Shengfeng Cheng</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>Polymer Physics</td>
<td>Nanoscience</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Estrella Johnson</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>Math Education</td>
<td>STEM Ed/ISC</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>Silke Hauf</td>
<td>Assistant</td>
<td>25-Dec-13</td>
<td>Molecular &amp; Cell Biology</td>
<td>Neuroscience/VT CR</td>
</tr>
<tr>
<td>Physics</td>
<td>Lara Anderson</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>String Theory</td>
<td>STEM Ed</td>
</tr>
<tr>
<td>Geosciences</td>
<td>Sterling Nesbitt</td>
<td>Assistant</td>
<td>25-Dec-13</td>
<td>Paleontology</td>
<td>Energy &amp; Environment</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Mark Embree</td>
<td>Professor</td>
<td>25-Dec-13</td>
<td>Computational Science</td>
<td>VPR-DA/CMDA</td>
</tr>
<tr>
<td>Statistics</td>
<td>Runlong Tang</td>
<td>Assistant</td>
<td>10-Aug-13</td>
<td>Computational Science</td>
<td>VPR-DA</td>
</tr>
</tbody>
</table>

**Building International Partnerships**

The College of Science Discovery initiatives focus on the 4 I’s, i.e., interdisciplinary, industrial, innovation, and international. During the past year, the College assessed its international presence with the goal of identifying key international partners, assessing the sources of funding for international engagement, and identifying obstacles for faculty to form international teams. Figure 3 illustrates the diversity of international partnerships according to continents, and as expected for science, Europe leads as the most common region for international partnerships. Asia, however, is rapidly changing this distribution with the emergence of China as a scientific leader and our continued strong relationships in South Korea and Japan. Many of these partnerships involve student and faculty exchanges, using funds from existing grants or submitting add-on proposals to complement the theme of the current

---

*Figure 3: College of Science 2013 survey results indicate a broad-based international partnership with Asia and Europe being our largest partners.*
research in our departments. Our goals in 2014 include the construction of proposals from international governmental funding agencies with the NSF; new programs are rapidly emerging for competition. In addition, although the College of Science has examples of long-standing study abroad opportunities for undergraduates and graduate students, our emphasis will shift dramatically in the coming year to accelerate discovery through strategic partnerships.

The College of Science envisions a new paradigm using the recently announced winter session model in 2013. The College will host its first winter session experience for undergraduates and graduate students, entitled “International Perspectives of the Nanoscience of Macromolecules.” This inaugural offering will attempt to address pervasive student concerns for study abroad: (1) economic burden for students and families; and (2) impact on time to degree and course availability. The winter session module will run from December 28 to January 17, including time at Mainz University (Germany, first week) and ESPCI in Paris (second week).
ENGAGEMENT

In *A Plan for a New Horizon*, the university outlines the use of pedagogic models to foster curiosity and creativity in students and faculty, and to facilitate the development of new tools and methods for promoting the exchange of ideas. These models make use of “hands-on, minds-on” approaches to nurture excitement for, and understanding of, issues that confront our citizenry. These outlined approaches resonate with the motto of the university, *That I May Serve*, and speak well to a fundamental mandate of our institution: engagement. The College of Science is actively involved in engagement on many fronts. The College 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, ranging 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. The College participates in the organization of scientific conferences and plays a leadership role in assembling international forums on campus and around the world. Of special note this year was the International Union of Pure and Applied Chemistry Congress on Macromolecules (MACRO2012), the largest conference to be held on the Virginia Tech campus to date with over 1,500 scientists interacting with our faculty, national faculty, and international faculty. The Virginia Tech campus provided a forum for dissemination of our latest scientific findings and to showcase our facilities around the world. These types of engagement will not only help translate our many accomplishments to the community and our institutional peers, but also engagement in this manner will lead to enhanced student recruitment at all levels and the formation of funded programs for discovery. Similarly, ongoing strategic alliances between the College and the Institute for Creativity, Arts, and Technology (ICAT) are expanding avenues of discovery as our faculty and students use new tools to display and better understand complex scientific problems.

Engaging Our Community

Faculty, staff and students in the College continue to be involved in the community, both at the K-12 level and with the general populace. These individuals frequently employed the “hands-on, mind-on” model to share knowledge they had gained in their discipline with inquisitive minds outside of the university. Several of these efforts are described below.

- John Phillips (BIOL) hosted a lab visit by the First Tech Challenge Robotic Team (8th & 9th graders).
- Reinhard Laubenbacher (MATH) was a coordinator of Kids’ Tech University.
- John Simonetti (PHYS) is Coordinator of Public Open Houses at the Prices Fork Observatory and received outreach funding from the Mary Moody Northen Endowment in order to provide programs at the Mountain Lake Hotel for guests, groups from schools in the local counties, private groups, and others. Programs take place at the hotel or Martin Observatory. He is also engaged with the larger community through his website that is devoted to answering Frequently Asked Questions about Astronomy and Physics ([http://www.phys.vt.edu/~jhs/faq](http://www.phys.vt.edu/~jhs/faq)). He provides answers to numerous email questions from the public on specific phenomena, on specific physics – black holes, quasars, pulsars, special relativity, interviews for classes, advice on telescopes, etc. This website is included in
the PSIgate Physical Sciences Information Gateway, and is a very popular website among the national and international department webpages.

The Department of Geosciences continued its strong presence in education and outreach activities through 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 that is open to the public and VT Family Day visitors to support outreach programs. The Museum hosted approximately 7,200 visitors this year.

As reported by the committee on STEM Education National Science and Technology Council in the Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan, “The health and longevity of our Nation’s citizenry, economy, and environmental resources depends in large part on the acceleration of scientific and technological innovations.”² The College of Science has fostered STEM initiatives that support this goal for the past decade.

This year six out of the eight departments participated in providing opportunities for educators and students in K-12, extending some opportunities to the global level. Jeb Barrett, Biological Sciences, and Rosaire Bushey, communications director for the College, developed a blog to engage teachers and students in the happenings of biology in Antarctica. This encouraged students around the world to begin a dialogue with researchers in Antarctica. To build on this concept there is talk of developing Skype opportunities for these students as well. This will not only allow students to get excited about the STEM fields but provide them the opportunity to talk with researchers in the field.

Another great opportunity was joining the College of Engineering in hosting the Virginia Science Olympiad (http://www.virginiaso.com/). This is a program developed for students in grades 6-12 to provide an opportunity for students to learn more about science, technology, engineering, and mathematics (STEM). Students participating in this program competed in teams of 15 students. This year there were 105 teams representing 61 Virginia schools.

In addition to providing guest lectures, participating as science fair judges, and continuing the various outreach programs, many of the departments are beginning to look at the “hands-on, minds-on” approach as a way to bring students and parents to campus for summer camps and tours. As a college, we understand that inspiring students is not enough; if we want to succeed, we must develop programs that also inspire parents and caregivers of these students. We are developing programs and information sessions that speak to the whole family educating them on the many opportunities available in the STEM fields. This past year many of the

²National Science and Technology Council. (2013). Federal science, technology, engineering, and mathematics (STEM) education 5-year strategic plan.
College of Science Engagement FY2013 Annual Report

programs our departments developed fostered the theme, "STEM for the Family" by providing hands-on activities for the entire family.

Service to the Scientific Community
Engagement has a significant component of extra-mural interactions with colleagues. The faculty of the College of Science have a strong presence in the scientific editorial process as editors, associate editors and members of review boards of leading journals. Faculty members in the College hold more than 75 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.

Service to the Community
The faculty of the College are often called on to help educate citizens and to respond to concerns or crises that can benefit from their expertise. Two examples are listed below:

- Robert Weiss (GEOS) and Jennifer Irish (CEE) started the Interdisciplinary Coastal Hazards Research Team, which was initiated on a small scale with the help of a NSF-RAPID grant for Hurricane Sandy. Dr. Yang and Dr. Buckvic from the Department of Urban Affairs and Planning and Dr. Dixit from Political Sciences conduct interviews in the Sandy-affected region to study the economic impacts and long-term impact on environmental and security policy. Dr. Irish, Dr. Lynett (University of Southern California) and Dr. Weiss collected quantitative data on residential and infrastructure damage, coastal change and sedimentological effects of Hurricane Sandy in November 2012. A series of workshops in will be presented this year 2013 to the campus community.

- Robert Bodnar (GEOS) is the leader of a large multi-disciplinary research project on the Coles Hill uranium deposit in Pittsylvania County, Virginia. He is identified as the de facto expert on uranium mining. Over this past year, he gave ~40 briefings related to environmental and public health issues associated with uranium mining to members of the Virginia Executive Branch and General Assembly, local government officials and various NGOs and public interest groups.

Citizenry in a Global Community
The need for international engagement is cited as an imperative for higher education in the university's Plan for a New Horizon. Faculty from the College of Science are actively engaged with colleagues throughout the world. This engagement is most important in the development of new tools and methods for promoting the exchange of ideas. International engagement begins with a thorough assessment of the current state of international partnerships in the College, and our recent survey of all tenure-track faculty indicates a very vibrant research partnership across many continents. The focus on Europe and Asia is obvious in our results, and a majority of the partnerships arise from collaborations with full faculty. The survey also indicates that most faculty utilize funds that are not necessarily exclusive to international
partnerships, thus suggesting the strategic initiative to raise awareness of engagement funding opportunities in FY14. Moreover, there is a strategic initiative to more effectively capture international research partnerships, including student exchanges, and in addition, the College offers a limited number of study abroad programs. Study abroad at the undergraduate and graduate levels represents a strategic initiative for the coming year.

The College is more actively involved in the University international activities, in terms of participation in key meetings and committees. The first winter session course is an inaugural step to foster more education abroad experiences for our undergraduates, utilizing the many research connections across the world. It is clear that the College does not have the expanse of study abroad programs compared to other colleges on campus; however, as the College is now in position after a decade of existence, it is clearly time to enrich our students further with these opportunities.

**Study Abroad and Educational Outreach**

The College continues to look for opportunities to build on global interdisciplinary strengths in education. Two of the leading departments are Biological Sciences and Geosciences. Both of these departments continue to immerse faculty and students in rich, cultural experiences abroad.

Lori Blanc in the Department of Biological Sciences led two programs that focused on cultural aspects as well as complex interdisciplinary topics in sustaining humans and the environment in Australia and Antarctica. The Antarctica program was a collaborative effort between Virginia Tech, State University of New York, American Universities International Programs, University of Canterbury, New Zealand, and Gateway Antarctica: Centre for Antarctic Studies and Research. This course also incorporated an online component for some of the lectures delivered by Antarctic Research Center faculty in Christchurch, New Zealand.

The Department of Geosciences remains committed to making a global impact by participating in programs abroad in Costa Rica, Italy, Saudi Arabia, and China. Esteban Gazel led students on a PGS sponsored field trip to Costa Rica and also sponsored visiting scientists from Costa Rica to Virginia Tech. Robert Bodnar taught a short course in Italy on Fluids in the Earth, and Robert Weiss was an invited speaker at the King Abdullah University of Science and Technology on the processes that cause tsunamis. Ying Zhou worked to establish a dual degree graduate exchange program between Virginia Tech and Peking University with an MOU for a dual degree graduate program.

The Presidential Global Scholars (PGS) program is another avenue through which faculty and students had the opportunity to experience international culture. Robert Bodnar (GEOS) taught a two-week module in Riva San Vitale, Switzerland entitled Volcanoes in Art, History, Mythology, and Cinema, and Lay Nam Chang taught a two-week module structured on how science fits into societal problems. He, along with Anna Marion-Bieri (COS), arranged for the students to visit two labs: (1) Paul Scherrer Institute, the Swiss National Nuclear Laboratory in Lucerne, Switzerland, and (2) CERN, the International High Energy Physics Laboratory in Geneva, Switzerland.

In addition to expanding opportunities abroad, the College is also working to develop initiatives that embrace the “local-global connections that join our resident international students with domestic students” as outlined in the University’s A Plan for a New Horizon. Examples include the Department of Statistics mentoring a student from Rajarta University in Asia; the Department of Mathematics hosting three graduate students in year-long visits from Karlsruhe (Germany) Institute of Technology; and the Department of Physics creating shadowing/mentoring programs for new international students. All of these programs work to enhance Virginia Tech’s global community and foster an atmosphere that is conducive to students, faculty and staff.
Interfacing with Partners

The creation of new tools and methods for promoting the exchange of ideas are often a collaborative effort between industry and/or peer scientists. Partnerships are vital in the fostering of new ideas, which may then result in a new method or tool. Patents are the formal acknowledgement of the utility of the model or tool in our society. Highlights from our college in partnerships and patents are shown below.

Industrial partnerships

- Christopher Lawrence (BIOL): Scientific Advisory Board Member (fungal allergy therapeutics development) and cofounder of Alergenetica SL, allergy therapeutics company, Tenerife, Spain and Manchester, UK.
- Robert Moore (CHEM) received $40,000 from the Virginia Innovation Partnership for a one-year investigation of “Coupling of Nanofibrous Electrodes with Nanostructured Electrolytes for Enhanced Performance in Energy Storage Devices.”
- Seong Mun (PHYS) President and CEO of OSEHRA, a not-for-profit Open Source HER Agent supported by the Department of Veterans Affairs.

Patents, Applications and Awards

- Benny D. Freeman, David Sanders, Claudio R. Ribeiro, Zachary Smith, James E. McGrath, and Ruilan Guo. “Polymer synthesis and thermally rearranged polymers as gas separation membranes,” U.S. Patent 2012 486572, Issued December 27, 2012 (Assignee: The University of Texas, Austin). (This is James McGrath’s 54th patent.)

Institute for Advanced Study

The Institute for Advanced Study (IAS) also provides a visible mechanism for engagement. A visible program in FY13 was about continued integration of artists and scientists, engaging non-traditional partners in the envisioning of science and catalyzing creativity. After our initial forum with Robert Lang with origami art and its relation to molecular folding in FY12, we invited Jim Metzner, an artist devoted to the use of sound in national public radio, in November 2012. This second program resulted in faculty partnerships with Metzner for the creation of interviews for NPR, including Mike Hochella (GEOS) and Carla Finkielstein (BIOL). Both speakers were jointly sponsored with the Institute for Creativity, Arts, and Technology (ICAT). In FY14, we will continue this successful program, inviting an art curator, Gregory Smith, from Indianapolis on the intersection of science and the analysis of historic paintings. In particular, he will focus on the general topic of forgery and preserving art; this forum will also attract and engage the local community. This partnership with COS and ICAT has resulted in a joint NSF Engineering Research Center (ERC) proposal in FY13, with Ben Knapp of ICAT as the Principal Investigator. The connection of art and science also culminated in FY13 with a “Student Images of Science” program, leading to the display of the leading images in the IAS building.

The Institute for Advanced Study has also formed a COS Research Leadership team, a group of leading College faculty to provide guidance and idea generation under the leadership of the Associate Dean for Research.
initial charter in FY13 involved a critical analysis of the cluster hiring model and various means to improve its implementation. Many of the recommendations harkened back to the initial cluster model; however, time has resulted in an oversight of some of the key principles, including mentoring and proposals for forming and dissolving clusters. This new model was termed STRING hiring to also include strategic disciplinary hires that are the seeds of future clusters. The Institute has also planned a University Distinguished Professor Lecture Series, based on the fact that COS has 7 UDPs in our eight departments. This forum will raise the awareness of the UDP leaders, and also provide an opportunity for UDPs to challenge the faculty to become involved with interdisciplinary science. The Institute has also sponsored a number of workshops and research brainstorming events, with the most notable example of the neutrino summer workshop, which served to raise the international awareness of the College Center and our leading research faculty in this popular topic.
DIVERSITY

The College of Science is actively working to achieve a more diverse and inclusive undergraduate and graduate student body, faculty and staff. The College is achieving these goals through active recruitment and retention strategies, which are in alignment with the University’s Diversity Strategic Plan.

Changing the pace of growth in gender and ethnic diversity over the decade

In this first decade of the College of Science, significant growth was seen in the size of the student body. While the number of Full-time tenure and tenure-track Faculty remained essentially constant from 195 in 2003 to 200 in 2012, the number of undergraduate students grew by 29% from 2,862 students to 3,699 students. The graduate population remained somewhat consistent in total numbers, 573 students to 586 students over this decade, but the percentage of Ph.D. students rose from 45% to 84%.

A closer look at this decade of data provides insight into College of Science gender diversity. In 2003, women comprised 22% of the full time faculty of the College; by 2012, this percentage was 29%. The College’s undergraduate student makeup was 60% female in 2003, decreasing to 54% in 2012. This percentage-wise decrease actually corresponds to an increase in the total number of females, albeit a smaller increase than in the number of males. During this period, the female population grew by 294 students, while the male population rose by 541 students. The graduate student ratios for this period are 38% female in 2003 and 41% in 2013.

Further reading of these data also reveals positive trends in the College’s efforts to enhance ethnic diversity. In faculty numbers, 77% of the full-time faculty classified themselves as white in 2012, decreasing from 88% in 2003. The diversity in the undergraduate population grew as 70% of the students reported themselves as white in 2012 and 77% in 2003. A similar change in the graduate student population was 49% reporting themselves as white in 2012 and 55% in 2003.

In this past academic year, the College conducted 12 searches for tenure-track faculty. Eleven hires were made along with one spousal hire. Three of the hires were women and nine were men. Of these hires, one was from Asia and another was from India.

Highlights of Current Diversity Programs

The College’s effort to increase retention and diversity in the physical and quantitative sciences continued with the NSF-funded Summer Bridge Program (SBP). This effort is made possible through a $2M NSF STEP grant awarded to Jill Sible, Debbie Wilson, Gary Long, Bevlee Watford and Kathryne McConnell. The SBP was implemented in collaboration with the College of Engineering's Summer Transition Program. COS hosted its second SBP in summer 2013 with 19 incoming freshman students that had selected majors in the College. All of these students are living in on-campus learning communities this year (Da Vinci, Curie, Honors, or the Corps).

Retention in the COS living-learning communities was quite high. Of the targeted value of 80% retention, the SBP program had an 86% rate for students remaining in COS (one transferred to COE, one transferred out of STEM, and one did not enroll in the spring semester). The Curie community posted an 88% retention rate for students remaining in COS (two transferred to COE, one transferred to another university, and one did not enroll in the spring semester).

In collaboration with the Language and Culture Institute, the COS offered a full-year, pre-baccalaureate experience to 16 Saudi Arabian students sponsored by the King Abdullah University of Science and Technology.
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 is continuing the KAUST program for the 2013-2014 academic year.

The College participated in the Gateway program, held on the second weekend of April. The program coincides with Hokie Focus. The Gateway program targets underrepresented students that were offered admission but have not yet made a decision to attend Virginia Tech. The weekend event is structured around a series of events that identify all services available to the participants. Student hosts talk about their experiences and why they decided to attend Virginia Tech. Of this year’s participants, 28 of the matriculating students listed a major in the College of Science.

**Other Notable Activities**

- Leo Piilonen and John Simonetti, Vicki Soghmonian and Zack Lewis (all from physics) continued their efforts to accommodate a visually impaired physics major in four upper-level courses. Their work involved creating tailored in-class activities, extended hands-on experiences with lecture demonstration equipment, preparation of lecture slides and other course materials in plain-text format. They worked with Assistive Technologies (AT) and Services for Students with Disabilities (SSD) in the production of braille encoding of reading material, tests and quizzes.

- Judy Riffle (CHEM) is focusing on regional universities for recruiting and research collaborations with schools that have high fractions of underrepresented students. Funded programs are in place with St. Paul’s College (HBCU), Lawrenceville, VA.

- Madeline Schreiber (GEOS) served as the AdvanceVT liaison for the College of Science in 2012-13. It should be noted that Schreiber met with 56 candidates for faculty hires over this past year.

- Marlow Lemons (STAT) spearheaded and directed a free Saturday Science Fair Project (SSFP) that was designed to develop high school and Virginia Tech collaborations for mentoring underrepresented high school students (participants) by Virginia Tech faculty, graduate students, and undergraduates (mentors). The program facilitated research projects and preparation for the Blue Ridge Highlands Regional Science Fair held on March 8-9, 2013.

- John Hole (GEOS) was lead scientist on the Idaho-Oregon (IDOR) seismic refraction survey, funded by NSF and the 69-person fieldwork crew consisted mostly of student volunteers from 24 different colleges and universities. Volunteers were solicited from a) undergraduate-only institutions, b) Historically Black Colleges and Universities, and c) Hispanic-Serving Institutions, resulting in a) 10, b) 2, and c) 1 participants. These volunteers interact professionally with professors and graduate students in field research. Such engagement has been shown to excite students towards the pursuit of further studies in STEM-related fields.
Diversity awards and honors

Awards

- Daniel Capelluto (BIOL), 2012 Biophysical Society Minority Travel Award
- Amanda Morris (CHEM), 2013 College of Science Diversity Award
- Marlow Lemons (STAT), 2013 College of Science Diversity Award

Scholarships

- MAOP Scholarships: Camille Harris (BIOL), Regina Wallace (BIOL), Kathleen Craft (GEOS), Kristin Dorfler (GEOS)
- VT-IMSD Scholars: Bianca Baker (BIOL), Crist Cuffee (BIOL), Tristan Hayes (BIOL), Aryana Stukes (BIOL)
- VT-PREP Scholars: Leah Guthrie (BIOL) and Snider Desir (BIOL)

Fellowships

- Esteban Gazel (GEOS) received a Carl Storm Underrepresented Minority (CSURM) Fellowship to support his invited participation in the 2013 Interior of the Earth Gordon Research Seminar and Gordon Research Conference.

College of Science Diversity Committee

The Diversity Committee continued to fulfill its charge to work with new diversity initiatives in the College, to provide COS faculty and other colleges with information on diversity programs, to foster a positive climate of multiculturalism in COS, and support and reward collaborative initiatives and partnerships that promote and recognize the importance of multiculturalism. Highlights of the year’s activity include:

- Programs for increasing sensitivity about different backgrounds and skills. During the last two academic years, the College and Biological Sciences Diversity Committees planned and organized these sessions (“Strategies for Effective Interactions”) and a small grant from the Graduate School and additional funding from the College supported them. In December 2013, a Strategies session (two class periods) tailored to new graduate students was held for the Graduate Orientation class in Biological Sciences.

- Seminars. The COS Diversity Committee co-sponsored with Biological Sciences a 2013 Martin Luther King Week seminar by Dr. Doris Zallen in STS which was entitled “Genomic Medicine: Views from the Mountain Top and the Valley.”

- Interaction with COS Departments. The committee collects annual information on diversity activities across COS and actively works to encourage COS departments to have departmental diversity committees, to collaborate with the College committee and offer events that highlight diversity contributions. Biological Sciences and Psychology have had long-range committees, Geosciences has a newly formed committee.

- Committee Initiatives for 2013-2014. The COS Diversity Committee will sponsor seminars in 2013-2014 that will highlight underrepresented contributors to science. One planned lecture series is to be with Yvonne Reid of the American Type Culture Collection, a major repository of bacterial and tissue cultures located in the DC area. Dr. Reid will present two seminars about HeLa cells, a cancer cell line that has been extensively used for decades.

Future Goals of the College

The College is Science is firmly committed to the goals set forth in the University’s Diversity Strategic Plan.
• In the area of undergraduate students, the College will continue its efforts with the Summer Bridge program to enhance gender and ethnic diversity in the STEM programs.
• The Integrated Science Curriculum will interact with the SBP to engage new STEM students with the unique pathways of our curriculum.
• The KAUST program will continue to engage new international students in STEM education at Virginia Tech.
• The College's efforts through AdvanceVT in promoting our work in diversity and inclusion will continue to be a strong part of our recruiting efforts.
ADVANCEMENT TEAM

Alumni Relations

The Alumni Relations office within the College of Science (COS) continually seeks to serve, steward, and engage our 27,000+ 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 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 Alumni Association (VTAA).

During 2013, the Alumni Relations office orchestrated over 21 events aimed to increase the depth and diversity of our programming in order to make lifelong connections with our alumni. Events included the college homecoming tailgate, spring and fall commencement receptions, college roundtable advisory board meetings, and our third annual “Celebration of Excellence” luncheon, an opportunity to recognize our faculty, students, and generous benefactors.

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 Matthew D. Shoulders (Chemistry, ’04) as our 2012–2013 College of Science Outstanding Recent Alumnus and Kristi D. Graves (Psychology, ’02) as our Outstanding Recent Graduate Alumna.

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, Development Assistant Director, Corporate and Foundation Relations Associate Director, and Communications Director to determine best practices to involve, engage, and communicate with our alumni. During the fall of 2013 we will celebrate the College's 10-year anniversary and the Advancement Team has planned a number of activities to highlight the College in various ways, showcasing the tremendous accomplishments that have occurred over the last 10 years. In addition, we will have our first inductions into the newly formed Hall of Distinction where we will honor individuals who best embody our College goals of enhancing the well-being and development of the local community, the commonwealth, the nation, or the world, and who through their deeds exemplify our University motto, Ut Prosim (That I May Serve).

Development

The College of Science Development Office remains committed to its mission of engaging alumni and friends of the College through personal and professional involvement, forging strong partnerships, and generating critical resources. It is with sincere gratitude that we acknowledge all who supported the College during fiscal year 2012-13. Our continued success would not be possible without the unwavering support and generous
philanthropy of our alumni and friends, as well as our corporate and foundation partners, who share our vision for moving the College forward.

The College completed another solid fundraising year, raising more than $3.2 million in private support, an increase of nearly 70 percent over the previous fiscal year. In addition, we documented more than $3 million in future support that will ultimately benefit the College and its programs. Our fundraising efforts were focused on several key initiatives that support the mission of the College and the University, including the Integrated Science Curriculum, the Institute for Advanced Study, and the College of Science Roundtable Endowed Dean’s Chair. The College sought to increase the number of major gift prospects through networking and research and, as in the past, continued to engage and solicit major gift prospects to support college priorities. Our development team grew over this past fiscal year by adding Erin Woodard as the new assistant director of development.

Several special events were planned and implemented with the dual purpose of stewarding current donors and establishing new relationships. The third annual Celebration of Excellence Luncheon was held in October 2012 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 our Roundtable Advisory Board. The Roundtable members met twice this past fiscal year – once on campus in October 2012 and then in northern Virginia in June 2013. In addition, the College participated in numerous university-wide events, including Ut Prosim Society weekend, Legacy Society breakfast, and various regional receptions, as well as hosting special guests on campus during football season.

**Corporate and Foundation Relations**

Companies continue to aggressively recruit graduate students in Chemistry, Geosciences, and Statistics. Undergraduate alumni (FY2012) reported having firm plans for their future, indicating 36% have jobs and job offers and 46% admitted or plan to attend graduate and professional school. Those seeking employment up to six months after matriculation decreased from 12% to 10%. These resemble the previous year’s trends. In FY12, the College changed its strategy from co-hosting career fairs to hosting dedicated visits for employers providing more feedback and networking opportunities. Job postings through the university’s Hokies4Hire job portal decreased by 37% from FY12 to FY13 for science majors and remained unchanged for all majors. Science students still attended the major career fairs hosted on campus including Engineering Expo and Connections. In addition to recruiting, corporate and private foundation research projects are important for the College of Science. Corporate and foundation research support remained constant. Geosciences received significant contributions of software and datasets to support learning and research. We sincerely appreciate all our alumni and friends who champion these corporate and foundation philanthropy, research, recruiting, and gift matching programs. Our success would not be possible without them.

**Highlights of Corporate and Foundation Activities**

Partnerships with corporations and foundations are becoming more important as sequestration cuts limit government spending. 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. 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. Forums to exchange ideas remain essential to developing joint projects, maintaining high quality standards in curriculum, and debating critical topics. Matching Gifts are barometric investments for many alumni and friends who support efforts closest to them.
Thanks to these corporate and foundation donors for their support:

3M
American Biosystems
American Chemical Society
Anadarko Petroleum Corporation
ARC Abrasives, Inc.
Avon Products Foundation
BD Diagnostics
BP America Production Company
BP Corporation North America, Inc.
Brown Foundation, The Capital One Services
Chevron Global Fund
Chevron-Phillips
ConocoPhillips
CONSOL Energy
E. I. DuPont de Nemours & Company
Eli Lilly & Company
Executive Decisions
International, LLC
ExxonMobil Foundation
GE Research
Google Inc
Hess Corporation
High Energy Accelerator Research Organization
IBM Corporation
Intrexon
KRATON Polymers US, LLC
Merk & Company
Minitab
Nanometrics, Inc.
Newmont Mining Corporation
Norfolk Southern Foundation
Northrop Grumman Corporation
Petroleum GeoServices (PGS)
Pfizer, Inc.
Procter & Gamble
Range Resources Corporation
SAS
Schnabel Engineering
Schweitzer Engineering Laboratories Inc
Society for Industrial and Applied Mathematics
Society of Plastics Engineers
Solvay FA, Inc.
SPLASH! International, Inc.
Susan G Komen for the Cure Virginia Chapters
Toray Industries Inc.
Transformation Systems, Inc.
Virginia Breast Cancer Foundation
Communications

The 2012-2013 year in Communications was busy as we made an official change of the COS Magazine to an annual publication, created a digital library of all back issues of the magazine online, and formulated plans to begin a branding process for the College.

Web/Social Media

Two of the keys to growing awareness of the College are social media and the College web page. The number of unique page views and unique visitors to the web site increased by more than 30% and 38% respectively this year. Social media followers on Twitter increased more than 75% and on Facebook by nearly 40%. A LinkedIn account was secured by the Communications office in conjunction with the Development Team in the spring, offering us an opportunity to reach out to recent alums entering the work force and more established alumni who can provide mentoring and guidance.

In all, social media allowed the College of Science message to be viewed more than 57,000 times. Careful and deliberate development of these approaches will continue to grow our ability to reach out and build brand awareness.

Some 30 stories were written and posted on VTNews to publicize College of Science achievements, achieving more than 20,000 page views.

Traditional Media

Several articles received attention in scientific magazines and websites from coast to coast, most notably Nahum Arav for his team’s discovery of the largest quasar outflow recorded. More than 120 traditional and digital media outlets around the world picked up the story and Arav conducted about a dozen interviews.

Another faculty of note in the media was Patricia Dove, C.P. Miles Professor of Science in Geosciences, who received notoriety for her induction in the National Academy of Science; being selected as a Virginia Scientist of the Year; and her selection as a University Distinguished Professor. Large traditional media outlets, most notably in Florida, California, and Washington state took up her story as well as local and regional outlets. Dove also conducted an extensive array of interviews over the course of the year.

Scott Geller and the Actively Caring for People team received television and print coverage in the Cleveland region as students made several visits to Chadron, Ohio to work with students. The Chadron High School was the scene of a shooting incident in February 2012.

Local and regional coverage was also given to Angela Scarpa and the Virginia Tech Center for Autism Research; the Saturday Science Fair Project which was an initiative of the College Diversity Council; Jeff Walters’ work with the red-cockaded woodpecker; among others.

Branding

The College took several steps forward on the branding path and will enter 2013-2014 ready to begin the survey and focus-group processes. Several measures to promote a more professional image of the College have been completed to include a brochure and templates for informational hand-outs.

Standardizing the web sites for both the College and departments will be a key task in the near future.
2012-13 College of Science Student Honors and Awards

Undergraduate

Dasha Nesterova, Biological Sciences  Virginia Tech Undergraduate Woman of the Year and College of Science Dean's Roundtable Scholar Award

Julia Button, Biological Sciences and Biochemistry  Barry M. Goldwater Scholarship for 2013-2014 and College of Science Dean's Roundtable Scholarship

Jessica Li, Biological Sciences  College of Science Dean's Roundtable Scholarship

Grace Mulholland, Biological Sciences  Outstanding Graduating Senior in the College of Science

Sophia Novitzky, Mathematics and Physics  College of Science Dean's Roundtable Scholarship

Ahmed Roman, Mathematics  College of Science Outstanding Undergraduate Research Award

Christine Tin, Biological Sciences  College of Science Rising Sophomore Dean's Scholarship

Kristin Fread, Biochemistry (BIOL mentor)  2012-13 ACC Fellow in Creativity and Innovation

Cameron Rose, Biological Sciences  2012-13 ACC Fellow in Creativity and Innovation

Douglas Smith, Psychology  2012-13 ACC Fellow in Creativity and Innovation
2012-13 College of Science Student Honors and Awards

Graduate

Nasrin Afzal, Physics
Graduate School Diversity Scholar

Brandon Bear, Physics
Graduate Teaching Assistant Excellence Honorable Mention

Bonnie Fairbanks, Biological Sciences
Graduate Teaching Assistant Excellence Merit Certificate

Sherinta Lee, Genetics, Bioinformatics & Computational Biology
Virginia Tech Graduate Woman of the Year

Shane McCarty, Psychology
Graduate Service Excellence Honorable Mention

Ashley Nelson, Chemistry
American Chemical Society Excellence in Graduate Polymer Research Award and VSGC Graduate Research Fellowship

Roberto Padilla, Chemistry
4-yr traineeship, NIH-funded Initiative for Maximizing Student Development

Ryan C. Smith, Psychology
Virginia Tech Graduate Man of the Year

Matthew Steele-MacInnis, Geosciences
College of Science Outstanding Doctoral Student

Jennifer Wyderko, Biological Sciences
College of Science Outstanding Master’s Student

Shane McCarty, Psychology

Aida Farough, Geosciences

Brenna Maddox, Psychology

Josh Nicholson, Biological Sciences

2013 College of Science Roundtable "Make a Difference" Scholarship for Graduate Study

Madison Brandon, Mathematics

Caleb Magruder, Mathematics

Sahnzi Moyers, Biological Sciences

NSF Graduate Research Fellowship Honorable Mention
2012-2013 Faculty Honors and Awards

Martha Ann Bell, Psychology
Named Senior Fellow, Institute for Society, Culture and Environment

Warren Bickel, Psychology
Appointed to FDA Tobacco Products Scientific Advisory Committee

Tom Burbey, Geosciences
Elected Full Working Member on UNESCO’s Working Group on Land Subsidence

John Burns, Mathematics
Named Fellow, Society for Industrial and Applied Mathematics

Martin Chapman, Geosciences
Elected President, Eastern Section of the Seismological Society of America

Patricia M. Dove, Geosciences
Virginia Outstanding Scientist Award and University Distinguished Professor

Carla Finkielstein, Biological Sciences
College of Science Outreach Award

Roseanne Foti, Psychology
Named Fellow, Society of Industrial and Organizational Psychology

Esteban Gazel, Geosciences
Received a Carl Storm Underrepresented Minority (CSURM) Fellowship

Edward Green, Reinhard Laubenbacher, Frank Quinn III, and Michael Renardy, Mathematics
Named Inaugural Fellows, American Mathematical Society

Tijana Grove, Chemistry
Ralph E. Powe Junior Faculty Enhancement Award

Dana M. Hawley, Biological Sciences
Dr. Carroll B. Shannon Certificate of Teaching Excellence

John Hole, Geosciences
Elected Member, Board of Directors of IRIS (Incorporated Research Institutions for Seismology)

Yili Hong, Statistics
Young Statisticians in Business and Industry Award

Marlow Lebons, Statistics
College of Science Diversity Award and Dr. Carroll B. Shannon Certificate of Teaching Excellence

Jim McGrath, Chemistry
Charles G. Overberger International Prize for Excellence in Polymer Science and Engineering

Joseph Merola, Chemistry
William E. Wine Award for Excellence in Teaching

Amanda Morris, Chemistry
College of Science Diversity Award

Anderson Norton, Mathematics
Association of Mathematics Teacher Educators Early Career Award

Birgit Scharf, Biological Sciences
NSF CAREER Award

Microbiology Outreach Group, Biological Sciences
College of Science Outreach Award

Madeline Schreiber, Geosciences
Dr. Carroll B. Shannon Certificate of Teaching Excellence

Robert Tracy, Geosciences
Elected Fellow, Geological Society of America

Jeffrey Walters, Biological Sciences
Alumni Award for Excellence in Research
2012-2013 Staff Honors and Awards

Linda Bland, Geosciences  
Lawrence Sewell, Mathematics  
Diane Walker-Green, Physics

Staff Career Achievement Award  
Governor’s Award for Innovation  
President’s Award for Excellence
<table>
<thead>
<tr>
<th>University Scorecard Measures</th>
<th>University Target Performance</th>
<th>Weblinks to Data Sources</th>
<th>Performance</th>
<th>3-Year Trend</th>
<th>3-Year Level of Ideal</th>
<th>3-Year Trend</th>
<th>College Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure(s)</td>
<td>Metric Definition and Information Sources</td>
<td></td>
<td></td>
<td>2011</td>
<td>2012</td>
<td>Preliminary 2013</td>
<td></td>
</tr>
<tr>
<td>Number of graduating undergraduates who participated in research experiences.</td>
<td>Degrees extract and course files - linked to credit bearing activities.</td>
<td></td>
<td></td>
<td>75% of graduating undergraduates.</td>
<td>Research Experiences (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of entering students who attended First-Year Experience courses.</td>
<td>First time freshmen and transfer students in fall and spring census files</td>
<td></td>
<td></td>
<td>80% of first-time students by the 2015-16 AY</td>
<td>Percent of Entering in FYE Courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underrepresented students entering the freshman class.</td>
<td>Office of Undergraduate Admissions</td>
<td></td>
<td></td>
<td>Increase the acceptance of offers to underrepresented students; target yield rate for non-underrepresented students</td>
<td>Underrepresented Freshmen Freshman (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degrees awarded to underrepresented students by level.</td>
<td>Degrees extract</td>
<td></td>
<td></td>
<td>Improve on the FY12-13 baseline</td>
<td>Degrees to Underrepresented (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total degrees awarded by level.</td>
<td>Degrees extract</td>
<td></td>
<td></td>
<td>Within 5% of approved projections (SCHEV 2B), per proposed IPS measure #2</td>
<td>Total Degrees Awarded (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate enrollment profile - masters, doctoral, and professional.</td>
<td>Fall Enrollments in Advanced and Direct to PhD per IRPA Ethnrl Report</td>
<td></td>
<td></td>
<td>1,000 graduate students by 2017 18</td>
<td>Graduate Enrollment (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEM-H degrees awarded.</td>
<td>Degrees extract</td>
<td></td>
<td></td>
<td>Within 5% of approved projections (SCHEV 2B), per proposed IPS measure #3</td>
<td>STEM-H Degrees (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTE Enrollment in Special Sessions.</td>
<td>Enrollment Profile from IRPA Ethnrl Report</td>
<td></td>
<td></td>
<td>Meet SCHEV 2B for summer, add winter projections</td>
<td>FTE Enrollment in Special Sessions (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTE Enrollment in virtual and technology assisted learning.</td>
<td>Under development</td>
<td></td>
<td></td>
<td>Under development</td>
<td>Under development</td>
<td></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></td>
<td></td>
<td>$680M in annual research expenditures by 2018</td>
<td>Research Statistics (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count and average value of sponsored awards.</td>
<td>As reported in Sponsored Programs datawarehouse dashboard</td>
<td></td>
<td></td>
<td>Average 3% growth in number of awards and 5% annual growth in average dollar value of awards</td>
<td>Sponsored Awards (IRE)</td>
<td></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></td>
<td></td>
<td>Under development</td>
<td>Faculty Awards (IRE)</td>
<td></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></td>
<td></td>
<td>Under development</td>
<td>Postdoctoral Associates (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Licensing Income.</td>
<td>As Reported in Annual Association of Technology Managers (AUTM) Licensing Survey</td>
<td></td>
<td></td>
<td>33% increase between FY2011-12 and FY2017-18</td>
<td></td>
<td></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 extract and course files</td>
<td></td>
<td></td>
<td>Under development</td>
<td>Study Abroad Foreign Language (IRE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate participation in service learning and experiential programs.</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></td>
<td></td>
<td>Under development</td>
<td>Experiential and Service Learning (IRE)</td>
<td></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></td>
<td></td>
<td>Increased gender and racial ethnic diversity in the faculty.</td>
<td>Faculty and Staff Profiles (IRE)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>