This academic year, 2003 – 2004, has started with some major changes on the Stockton campus. To begin, we have a new president, Dr. Herman Saatkamp, Jr. He succeeds Dr. Vera Farris who served the College for twenty years and led us to become a leading public liberal arts college in the country. This September U.S. News and World Report ranked Stockton fifth among the nation’s public liberal arts colleges.

President Saatkamp was selected as the result of a search process that began the summer before last. Maria Moyer and I were two of the thirteen members who comprised the search committee. After a careful series of meetings and interviews that began with over 100 applications, Dr. Saatkamp was selected and arrived at Stockton in late June 2003 to begin his presidency. Prior to coming to Stockton, he was the Dean of the Humanities at Indiana University – Perdue University at Indiana (IUPUI) where he was also a member of the faculty of Indiana University Medical School. Previously he had been at Texas A&M University as well as the University of Tampa. Dr. Saatkamp is a philosopher, and the world’s leading expert on George Santayana. Since arriving in at Stockton, he has spent many long hours learning about us, as well as the community of southern New Jersey.

Within NAMS, we have been fortunate to appoint six new assistant professors to tenure bearing lines and two individuals as visiting professors. They are:

- **Tait Chirenge** completed his Ph.D. and post-doctoral training at the University of Florida and has joined the Environmental Studies faculty. He brings expertise in the impact of arsenic and related heavy metal pollutants in surface and subsurface water systems.

- **Shanthi Rajaraman** is a new member of the Chemistry program faculty. She is an organic chemist and has recently completed post-doctoral training at Rutgers University where she also obtained her Ph.D.

- **Jeffrey Duguay** was at Stephan E. Austin University in Texas before coming to Stockton. He received his Ph.D. from West Virginia University and is a specialist in wildlife management and conservation. His appointment will allow the Biology program to expand its courses offerings in Conservation Biology.

- **Ekaterina (Kathy) Sedia** was originally appointed two years ago as a visiting Assistant Professor in the Biology program and is now on a tenure line. She received her Ph.D. from Rutgers University and has studied lichen and mosses in former mined terrains of the Pinelands.

- **Fang Liu** completed her Ph.D. in Physics this past summer at the University of Pennsylvania in conjunction with its medical school. She was instrumental in the development of devices to ultimately be used as detectors to aid in neurosurgery.

- **Nada Jevtic** was a faculty member teaching Physics at Rhode Island College while she completed her Ph.D. at the University of Connecticut. Her Ph.D. research involved the analysis of stellar and solar data. This background has enabled me to ask her to begin to oversee the Harold E. Taylor Observatory on the Stockton campus.

- **Peter Rowe** joined the Marine Science program as a visiting faculty member after serving in a similar position at Shippensburg University in Pennsylvania. Following the completion of his Ph.D. from the University of Delaware, he performed post-doctoral research at Rutgers University’s field station in Tuckerton and has now returned to south Jersey.

- **Michael Lague** appointed last Spring as a visiting faculty member in Biology, is continuing on at Stockton for this academic year. Within the ranks of our faculty, Sandy Bierbrauer and Dick Colby were granted the status of Professor Emeritus at the Commencement ceremonies held last January Dick continues as a very active half time faculty member in Biology under his Transition Plan. In addition, Rudy Arndt and Ralph Bean have joined the ranks of Stockton faculty in the Transition Program prior to retirement. We look forward to Rudy’s and Ralph’s continued contributions to Stockton and its students over the coming years. Finally, Rich Hager is on sabbatical for this year and is doing research along the Maine coast.

I am also happy to report that Brian Rogerson of the Chemistry Program was awarded tenure effective this past September and that Monir Sharobeam was promoted to the rank of Professor.
The most recent energy saving project at Stockton is the new Fuel Cell, outside H-wing, that was officially inaugurated on May 22, 2003. The new 200 kW Fuel Cell converts hydrogen into electricity and heat. It generates a significant portion of our electrical use (about 10%) and the heat is utilized by the hot water demand in the cafeteria and other areas. Currently, the hydrogen is extracted from methane (natural gas), so carbon dioxide is formed in the process, but considerably less than the conventional energy sources it replaces. The College will be saving $100,000 a year from this project.

Before the fuel cell project, Stockton reduced its CO₂ emissions by 13% from the base year 1990. During this time the institution grew, so that the reduction is about 25% per enrolled student, a number that will increase with the new fuel cell. As a comparison, the Kyoto Protocol calls for the US to reduce by 7% its CO₂ emissions by the year 2010.

Over the past ten years, with the support of President Farris and the Board of Trustees, and the contribution of key people in the College’s administration, Stockton has pursued the use of combined advanced technologies to reduce energy costs, reduce emissions and demonstrate these new technologies to the public. In the process new educational opportunities were open to our students and the community.

Our closed-loop single well field HVAC system remains the world’s largest system in operation and the first utilizing 1 million cubic meters of saturated ground to seasonally store cold and heat. Combined with the new Housing 4 installation, this system is saving the college approximately $500,000 a year compared to the one replaced.

Several lighting retrofits have reduced electrical costs by about $100,000 a year. And a re-roofing project with upgraded insulation, completed in the 80’s saves at least another equivalent amount. Our photovoltaic array (18kW), located in the A&S building, and 2 kW array recently installed in the Free to Be building is directly converting sunlight to electricity and saves the college approximately $3,500 a year.

It is expected that all projects combined, and some others planned in the near future, will raise operating savings to a total of $1 million per year.

... And What Are They Doing Now?

After the Fall 2002 NAMS Today was issued we received the following messages:

David H. Foos (’80) is Head of Medical Image Science Research at Kodak Research Laboratories in Rochester, NY. He continues to make progress on his research work in digital projection radiography. He presented two papers at the Radiological Society of North America / American Association for Physics in Medicine in Chicago during December 2002.

Will Welisevich (’86) is an Environmental Manager at Empire State Development in Buffalo, NY. He is responsible for delivery of the Clean Air Act Program in Western New York, assisting small businesses in complying with EPA and DEC regulations pertaining to air pollution control.

We love to hear from you, Let us know where you are and what are you doing now. Also please indicate if it is OK to post your e-mail in this section.

Mrs. Zoe C. Stevens, mother of Shari L. Stevens (’83) sent us a note to let us know that her daughter passed away on August 29, 2002. Shari had been Chief of the Hazardous Waste Division of the EPA—Region II.
Chemical Mechanical Polishing
By Dr. Ed Paul, Professor of Chemistry

Ed Paul spent a sabbatical leave during the 1999–2000 academic year working at NIST (the National Institute of Standards and Technology, formerly the US National Bureau of Standards) developing a new research specialty—in Chemical Mechanical Polishing (CMP). CMP is a process used to manufacture computer chips and MEMS (micro-electronic mechanical system) devices. It has been estimated that there are three dozen variables which affect the rate of this process. Ed’s research is focused on being able to describe, qualitatively and quantitatively, how the process works.

CMP is a critical enabling nanotechnology. That means that it is a core process used in practical manufacturing of things from computer chips to sensors and tiny switches that will turn things on and off in cars, homes, offices, and other environments. The computer chip revolution has brought a significant increase in computing power over the past two decades. Moore’s Law, which says that computer chip characteristics (speed and memory) will double every 18 months, has been found to be true over this time frame. Making computer chips is very complicated, with many different component processes. Making better computer chips involves finding ways for applied technology to make steady advances in each of these processes. Within this framework, CMP is one of the critical steps.

Computer chips contain miniaturized versions of electrical circuits, with components connected by tiny “wires” surrounded by insulation. In practice, the manufacturing process first uses a photo-lithography process to cover the surface of a doped silicon wafer with an insulating glass-like material (ILD) that has trenches in it along which the “wires” will run (Fig. 1a). The “wires” are made by a second process called chemical vapor deposition (CVD) which is like raining metal atoms onto the prepared surface. CVD metal atoms fill in all of the trenches and then start to cover the top (Fig. 1b). At this point CMP is used to make the surface smooth and flat (Fig. 1c).

To complete the insulation of the metal wires, another photo-lithography step could be used. In order to allow the wires to pass over each other, this next step could have other trenches built into it, allowing for connections between layers where needed and for separation of layers where appropriate (Fig. 1d).

Early computer chips had only 2 or 3 layers, with relatively large wires and separations between them. As part of the Moore’s Law imperative, more layers and smaller wires are important in reducing the distances over which electrons must travel, and thus decreasing process time and increasing computer speed. Computer chips currently have 6 or 7 layers—moving to 8 layers within a few years, while wire thickness is decreasing— with current targets below 100 nm in width. The implication of these changes is that the lithography, CVD and CMP processes must all be upgraded to permit finer and finer features.

Ed’s project goal is to describe the CMP process clearly enough to enable engineers to understand how it works in detail so that they can improve CMP performance.

The process of removing metal and leaving a smooth, planar surface involves many different components on several different scales. In practice, large polishing machines are used with big, spinning horizontal wheels covered by a polishing pad. The wafer to be polished, containing hundreds of computer chips, is pressed into the moving pad while a polishing slurry containing abrasives and certain chemicals is continuously added from above. Removed material, along with excess slurry, flows off the edge of the pad and is discarded. The CMP process is essentially like wet sanding or liquid polishing compound used on metal surfaces.

CMP was discovered in 1991 and is the way manufacturers like Intel currently make computer chips. It was originally described, qualitatively, in terms of alternating cycles of formation and removal of a film on the wafer surface. Experiments showed that as the amount of either oxidizing chemical or abrasive in the slurry increased, the polishing rate would first increase rapidly and later approach a constant maximum value. When the pressure increased, the polishing rate would increase linearly in some cases and would increase at a decreasing rate in others. Publications from industrial and academic scientists included data showing this behavior, but there was no good explanation for the observed patterns.

Ed’s theory used methods of chemical kinetics as taught in his Physical Chemistry course to derive a relatively simple equation that fit all of the data for the polishing rate R:

(continued on page 7)
Second International Congress on Chelonian Conservation
By Dr. Roz Herlands
Associate Professor of Biology

A trip to Africa had always seemed like a remote possibility. Nevertheless, this past June, I traveled to the West African country of Senegal. Roger Wood and I took three students from last summer’s Coastal Conservation Research Program to an international turtle conservation conference held in Senegal from June 18-22; my husband, Charlie, a mathematician, joined us on this adventure. Roger had been to Senegal a few years ago, but the rest of us had never been to Africa and thus were excited and thrilled about our first visit to this exotic, far-away continent.

The students and I gave presentations on our research on diamondback terrapins (the local salt marsh turtles) and Roger talked about his study of side-necked turtles in northern Kenya.

Senegal turned out to be a good choice for my first visit to Africa. It is definitely a third world country, with subsistence living in the rural areas and no real infrastructure; in this male-dominated society, the women often have five or more children, so about 44% of the population is younger than 14 years old. Yet, it has a stable, democratically elected government and its citizens are proud, tall, good-looking and friendly people. We all felt safe during our visit.

We arrived around midnight at the airport just outside the capital city of Dakar (it seems most of the flights into and out of this airport were in the middle of the night). We had flown Alitalia from Newark via Milan. The airport is relatively small and barren compared to our large airports and going through Senegalese customs was time-consuming and a bit eerie. We eventually got packed into a small van and made the 80 km drive down the coast to the resort town of Saly where the conference was held. We spent our first day getting adjusted to the local time and exploring the nearby village and beach. As seems true for all villages along the coast, the locals fish for seafood (fish and shrimp) in small boats and/or have small shops featuring local crafts (wood carving, jewelry, paintings, colorful clothes), and as obvious tourists, we were accosted persistently by the locals (mostly men) to buy some local product or come visit their shop.

The conference was a small one but everyone was truly dedicated to conserving turtles. These efforts have included such diverse means as academic research projects, national land use programs to protect turtle habitats, and special educational and ecological preserves that frequently showcase endangered species confiscated by customs officials from illegal traders. Many participants came from African countries; we were all impressed by their creative efforts at turtle conservation and by their perseverance in spite of very limited financial support and the fierce tension between economic development and conservation in their countries. Our research group was the only one to report on turtles in North America. Our students gave excellent presentations and received lots of good suggestions for future work. They also received offers for research internships.

Once the conference was over, we had the opportunity to see more of coastal Senegal. We took a one-day trip down to the Parc National du Delta du Saloum near the border with Gambia. This gave us our first opportunity to see rural Senegal. We were there at the end of the dry season, so the landscape was dry ground dotted with a few small shrubs, some mimosa trees, an occasional brilliant flame tree and the large, impressive baobab trees (mostly leafless at this time of the dry season). There is no trash collection system in the country, so we saw trash scattered around the countryside. Skinny goats and cattle roam through it. We stopped by a village compound where the women and children warmly greeted us and showed us how to pound millet. (The men were away working in the cities.) Individual families live in one room mud brick-sided, thatched-roof huts. The villages do not have running water, electricity or plumbing, but the women and children seemed happy and healthy. Our trip took us through a palm forest and then by a troop of monkeys. The highlight of this trip was a boat trip down the Delta to the Atlantic Ocean where we saw mangrove swamps and lots of shore birds—gray herons, white and gray pelicans, black egrets, cormorants, and flamingos.

Another journey took us along the northern border with Mauritania where we took another boat trip down the Senegal River to the Barbary Coast and saw wild camels and many of the same shore birds that we had seen in the Delta. We also briefly visited the quaint, old colonial town of St. Louis. I think we will all remember the fish market and the pungent stench of drying fish. On our way to the Senegal River area, we stopped by the Village des Tortues, which is a national turtle preserve, and Pink Lake, an inland salt water lagoon where people mine for salt. Along the way, we saw mango orchards, agama lizards, several colorful bird species—red-billed hornbills, Abyssinian rollers, scarlet-breasted

(continued on page 5)
sunbirds, bee-eaters—and fruit and insect-eating bats. As far as we could tell, Senegal has no large wild animals along its coast.

Our last day was in Dakar, a busy city with streets crowded with people, cars, and vendors. It was hot and humid, so we escaped to the Ile de Goree, a small island just off the coast of Dakar and easily reached by a short ferry ride. We were joined by hundreds of young school children off to enjoy the clean beach on the Island. Historical lore has Goree Island as the major departure point for Africans sold into slavery for work on plantations in the Americas and Caribbean islands. Today, it is a lovely retreat from the bustle of Dakar, with open-air restaurants, museums and craft vendors. We left Dakar at 1:30 am after a memorable taxi ride to the airport—clearly Senegalese taxi drivers would feel very much at home in New York City!

Joanna Woerner, one of the students on the trip and a recent MARS graduate, summed up our overall impression quite succinctly: “The trip opened my eyes to how different and yet how similar cultures can be. And I want to return to see Senegal in the rainy season!”

Professor Herlands can be contacted at (609) 652-4402 or via e-mail at rherlands@stockton.edu

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**Observatory Dedication**
By Dr. Maria Moyer, Director Academic Laboratories and Field Facilities

On April 15, 2003 the Richard Stockton College of New Jersey Observatory was dedicated in memory of the late Astronomy Professor Dr. Harold Evans Taylor.

The ceremony took place close to Noon on a spectacular, sunny spring day in a tent erected next to the Observatory dome on Pomona Rd.

With Dean Dennis Weiss officiating as master of ceremonies, President Farris and Board Trustee Gerald Weinstein opened the program with brief presentations, followed by Dr. Joe Rubinstein, moderator of the College Faculty Assembly, Mr. Horace Knight, president of the Student Senate, Physics Professors Dr. Yitzhak Sharon and Dr. Lynn Stiles, Mr. Budd Howard, Staff Astronomer and Mrs. Suzanne Day Taylor.

A Kousa dogwood tree was planted outside by the driveway and a commemorative bronze casting plaque was unveiled inside by the president. The plaque reads:

**Harold E. Taylor Observatory**
Dedicated in Memory of
Dr. Harold Evans Taylor
Professor of Astrophysics
September 13, 1939 – December 27, 2001

An astronomer who conceived, built and directed this observatory,
A dedicated teacher who personified passion for science,
A versatile physicist committed to peaceful resolution of conflict and human rights,
A founding member of Stockton’s Applied Physics Program,
And a friend whose vision extended beyond humanity.

April 15, 2003
The capability of NAMS to support genetic research was ratcheted up a notch in September of 2001 with the National Science Foundation's (NSF) award of a major research instrumentation (MRI) grant to fund the “Acquisition of a Core Automated DNA Sequence Facility.” This $102,182 award was made to NAMS faculty members: Dr. Pete Straub, Dr. Brian Rogerson and Dr. Karen York.

The centerpiece of the facility is an automated fluorescent 8-capillary Beckman-Coulter CEQ 8000 Genetic Analyzer. The DNA sequencer is supported by a high-end PC controller workstation, a dedicated PCR thermocycler and Vector NTI bioinformatics software. The three-year award also includes service and research supplies for the grant period through August 2004. The NSF-MRI grant supports research projects that include Dr. Straub’s flounder research, Dr. Rogerson’s work on aging and the immune system and Dr. York’s work on microbial identification.

Work on winter flounder in Dr. Straub’s laboratory began in the winter of 2000 with a series of small exploratory grants (with adjuncts Dr. Bill Phoel and Dr. Stan Hales) from the NJ Sea Grant College program through funds from the National Oceanic and Atmospheric Administration (NOAA). This exploratory work was designed to look for genetic biomarkers of pollution in the winter flounder.

Previous studies by other researchers have detailed cellular, tissue and molecular changes in these bottom dwelling fish exposed to contaminated sediments in urbanized estuaries such as Boston and New York Harbor. Given recent advances in genetic technology including gene amplification and high-throughput DNA sequencing, it looked like a good time to use these technologies to study the problem of chronic pollution in our harbors.

In conjunction with undergraduate research interns from Stockton’s National Science Foundation funded Coastal Conservation Research Program (CCRP), gene libraries were constructed comparing the livers of fish from relatively contaminated waters of the Hudson-Raritan estuary versus the cleaner waters of the NJ shore. DNA sequencing, followed by computer identification of genes using the national genetic database, GenBank, showed different gene expression patterns in the cleaner versus the more pollution affected waters. In general, liver detoxification enzymes and genes involved in the activation of the immune system appeared to be more highly expressed in the polluted waters. Type of genes involved in general metabolism and reproduction appeared to be higher in the fish from cleaner waters compared to fish from more heavily contaminated estuaries.

Results of these studies have been accepted for publication in the scientific journal “Marine Biotechnology” and includes as authors, two undergraduates from the 2002 NSF summer intern program, Mary Higham of Stockton and Theo Thwing of Lehigh.

NAMS in general, through the Academic Laboratories and Field Facilities director Dr. Maria Moyer and Steve Evert manager of the Marine Science and Environmental Field Station, has been essential in providing support for this project in the way of boat time, laboratory space, animal holding and experimental setup.

Other support for the flounder project has come from the Mount Desert Island Biological Laboratory (MDIBL) in Salisbury Cove, Maine which has provided lab space, equipment and grant support to Dr. Straub to carry on gene expression studies. As mentioned above, the flounder project has received critical support from the NSF-CCRP intern program through Dr. Roger Wood and Dr. Stan Hales. The project has also been assisted by B.J Landau, a Rutgers University graduate student, Arnaud Tanguy of Rutgers Haskins Shellfish Research Station and by the Marine Academy of Science & Technology which has provided cruise time on the RV Blue Sea.

Given the excellent progress made on the project to date, the NJ Sea Grant College Program (NOAA) has agreed to provide funding of $109,634 to continue the flounder project for a two year period from March 2004 to February 2006. This funding, and access to equipment at the MDIBL, will allow the flounder project to begin the development of microarray technologies that will be used to simultaneously measure gene expression in a large set of genes and continue to relate these gene expression changes to exposure to chronic pollution. This technology could provide a sensitive barometer with which to judge the efforts to clean up degraded aquatic habitats and to monitor the effects of runoff and pollution entering our marine waters.

Professor Straub can be reached by phone (609) 652-4556 or e-mail at: pete.straub@stockton.edu
where $P$ and $v$ are the polishing pressure and speed, $[C]$ and $[A]$ are the concentrations of oxidizing chemical and abrasive particles in the slurry, $f([A])$ is the fraction of pad surface covered by abrasive particles, and the $a_k$ are kinetics rate constants. Different experimental data were evaluated using this expression to fit the polishing rate to the experimental variables and the $a_k$. Examples of these results are shown in Figures 2 and 3 for tungsten metal CMP. The polishing rate is given as a function of the chemical and abrasive concentrations under different conditions of polishing pressure and speed. The symbols are for experimental data from D. Stein et al. (J. Electrochem. Soc. 146, 376 (1999)) while the lines are the theoretical fit.

Figure 2. Polishing rate as a function of oxidizer concentration at three different $Pv$ conditions for tungsten CMP.

**Figure 3. Polishing rate as a function of abrasive concentration (given in weight % units) at three different $Pv$ conditions for tungsten CMP.**

Ed presented his theory at meetings of the Materials Research Society in San Francisco, where it attracted attention and offers of collaboration. He is currently working with colleagues from the University of Arizona and with an industrial manufacturer who has contracted with Stockton for Ed’s services as a part time consultant. He has been asked to give invited talks to the Japanese Society of Precision Engineering and at other industrial and academic venues.

Ed is continuing his work, extending the model to explain the polishing of copper and the effects of adding inhibitor and etchant molecules to the slurry. He has sponsored a Stockton Chemistry senior thesis on CMP and made research presentations to the CHEM, PHYS and MATH seminars on campus. He enjoys his research and looks forward to continuing it into the future.

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(Dean’s Corner continues from page 1)

Kristen Hallock-Waters has received two grants from NSF. The first is a CCLI equipment/curriculum grant in conjunction with Louise Sowers and Ray Mueller. The second is for research to be done in conjunction with Rutgers University. Stew Farrell has been awarded a major monitoring contract from New Jersey DEP and the Army Corp of Engineers, and Peter Straub has been awarded funding from Sea Grant. They all should be congratulated on their successes.

Within the realm of curriculum development, a proposal for a new program and a 5-year BS/MS degree in Computational Science has been approved by the NAMS faculty. The proposal has been moved forward to the Faculty Assembly for review and approval. Louis DeChiaro, Robert Olsen, and Monir Sharobeam are to be commended for shaping the proposal and leading a large NAMS committee in this effort.

Thanks to the efforts of Ralph Werner, we are exploring the possibility of developing a transfer and dual degree program with the Rutgers School of Pharmacy. This exciting new degree option will meet the ever-increasing number of inquiries about the existence of a pharmacy program at Stockton. In our initial discussions with the administration at Rutgers, we have been guaranteed 10 – 12 seats per year for qualified Stockton students to enter their Doctorate of Pharmacy program.

As I indicated last year, we had embarked in the first phase of a planning process for the expansion and renovation of NAMS’ teaching and research laboratory facilities. With the support of the College’s Administration and the Stockton’s Board of Trustees, an architectural firm, GBQC of Philadelphia was hired to help us develop a program for the renovation of the existing lower F-wing facilities, construction of two additional floors above the F-wing deck, and future expansion into renovated space in the existing F-wing area. Through the hard work of faculty representing Biology, Chemistry, and Physics, and the efforts of Maria Moyer and Nancy Burke, we arrived at a space utilization program and estimated cost. However, the process has also indicated very clearly that a new building is needed to accommodate all programs’ requirements and to maintain the academic quality of the existing facilities during the construction phase. This recommendation has been forwarded to the College’s administration. I look forward to be able to report to you, in 2004, on this new phase of the process.

Wishing you a Happy, Healthy and Prosperous New Year.
**MARS at the Harold E. Taylor Observatory**

As an AstroNews flyer issued in early August by Budd Howard, our Staff Astronomer, indicated: “On August 27 Mars will reach its closest approach to Earth immediately followed on August 28 by Mars closest approach to the Sun. In late August, Mars will be easily found as the brightest star rising on the southeast after 9:00 pm. By mid September and early October Mars will already be above the horizon before sunset.”

But on Thursday, August 28 approximately 600-700 people showed up at the Harold E. Taylor Observatory for a quick glance of Mars through the telescope. Campus Police think it was over 1000 because the line was replenished as quickly as people left, but according to Budd: “After Police closed the road at 11:00 pm it took till 12:30 for the last person to look. On average people took about a 20-second look through the telescope. That's about 3 people per minute or, 9:00 pm -12:30 is 210 minutes, that is 630 people.”

Unfortunately the weather was bad the following day, Friday, August 29, and the scheduled public viewing session had to be cancelled.

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**NATURAL SCIENCES AND MATHEMATICS**

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More on NAMS in our website: [www.stockton.edu/academics/undergraduate/natural_and_math_science](http://www.stockton.edu/academics/undergraduate/natural_and_math_science)