SMU Research, Volume 1

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SMU RESEARCH magazine has been created to provide a window on research that is being conducted at Southern Methodist University. It fulfills a long-felt need, and SMU plans to make it a regular publication in the future.

Research at a university can be categorized in many ways. The nature of research depends on the discipline as well as the individual. Research can be sponsored or unsponsored, theoretical or experimental, campus-based or field-work dependent, product-based or performance-based, carried out by faculty or students. In a brief magazine it is impossible to do justice to all the varieties every time. Therefore, in each volume we will present examples so that eventually we will have covered most of SMU's research and offered a view of its vitality, diversity, and depth.

This volume of SMU Research includes four feature articles showcasing some of our distinguished researchers in history, chemistry, psychology, and electrical engineering. Departments that offer doctoral degree programs are profiled through the research interests of their faculty. These departments and programs represent nearly one-third of the SMU faculty. A sampling of research carried out university-wide is provided in selected faculty publications. Faculty recognitions further highlight their diversities and strength.

SMU received 136 awards for sponsored research in 1992-93. A list of faculty members who received $50,000 or more in awards from external sources provides information on projects and sources of funding. A brief summary of sponsored research activities at SMU completes the picture.

Research support for faculty and students comes from many sources and sponsors -- they may be federal or state agencies, private foundations, corporations, businesses, or individuals. On behalf of faculty, students, and the University, I would like to extend our appreciation for this support.

U. Narayan Bhat

Dean, Research and Graduate Studies

On the cover: An illustration shows Pedro Menéndez de Avilés striking a regal pose. His chaplain said Menéndez was guided by the "Holy Spirit" in defeating the French and taking possession of Florida in 1565, in the name of his king. From the collections of the St. Augustine Historical Society. Published in The Spanish Frontier in North America, 1992.
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The Doctor of Philosophy degree is offered by the departments of Anthropology, Biological Sciences, Economics, Geological Sciences, Mathematics, Physics, Psychology, and Statistical Science in Dedman College of Humanities and Sciences; Computer Science and Engineering, Electrical Engineering, and Mechanical Engineering in the School of Engineering and Applied Science; and the graduate program of Religious Studies.

During 1992-93, the Engineering (Engineering Management) degrees in Mathematics, Economics, Geological Sciences, Psychology, Engineering, and Statistical Science were conferred in the School of Engineering and Applied Science; and the graduate program of Religious Studies.

Forty-three graduate students received Doctor of Philosophy degrees and five received Doctor of Engineering (Engineering Management) degrees during 1992-93. The Ph.D.s were conferred in Anthropology (4), Biological Sciences (3), Economics (2), Geological Sciences (1), Mathematics (2), Psychology (4), Religious Studies (2), Statistical Science (4), Civil Engineering (3), Mechanical Engineering (2), Computer Science (4), and Electrical Engineering (12).

**DEDMAN COLLEGE OF HUMANITIES AND SCIENCES**

**Anthropology**

The Department of Anthropology offers a Ph.D. degree in anthropology and an M.A. in medical anthropology. During the past year, faculty and students engaged in research projects around the world and continued to report the results in significant publications.

Among the social-cultural anthropologists, Professors Caroline Brettell and Carolyn Sargent edited a volume on *Gender in Cross-Cultural Perspective*. Victoria Lockwood published a monograph on *Tahitian Transformation: Gender and Capitalist Development in a Rural Society* and co-edited with Ben Wallace and Thomas Harding *Contemporary Pacific Societies Studies in Development and Change*. Professor Mark Sargent also co-edited a special issue – “Caribbean Medical Systems” – for *Social Science and Medicine*. In addition, Ben Wallace (with support from Cal-Tex Philippines Inc.) continued his five-year applied research project on the ecology of northern Luzon; Robert Van Kemper continued long-term studies in Mexico with support from the Foster Fund.

Among the archaeologists, several are supported by the National Science Foundation: Fred Wendelaar and Angela Close continued their long-term investigations in the eastern Sahara (Egypt); Anthony Marks is concluding a five-year project in Portugal and starting exploration in Croatia; and C. Garth Sampson is completing his work on ethnoarchaeology in South Africa. David Wilson continued his multiyear project (with support from the J.M. Kaplan Fund) in the Casma Valley, Peru. David Freidel (with major support from National Endowment for the Humanities and the Sclafani Foundation, and various private donors) continued research at Yaxuna in Yucatan, Mexico; Michael Adler continued the department's long-term research at Fort Burgwin, New Mexico; David Malotz published *The Archaeology of William Henry Holmes* (Smithsonian Institution Press); and Lewis Binford, featured in a BBC television program, is preparing to publish a volume on hunter-gatherers in comparable perspective. In addition, Angela Close and Fred Wendelaar edited *Prehistory: The Journal of World Prehistory*.

A final noteworthy accomplishment for the department: Nine Ph.D.s graduated in 1992, tying SMU with Harvard University for the most Ph.D.s granted by an anthropology department at a U.S. private university.

**Biological Sciences**

The Department of Biological Sciences offers Master of Arts, Master of Science, and Doctor of Philosophy degrees. The Ph.D. degree was created in 1977 with support from the Department of Pathology at Baylor University Medical Center. The department includes faculty members with international reputations whose interests reflect a diversity within the discipline.

Researchers are working on a variety of topics: development and aging (Venita Allison, Richard Jones, Liz Orr, and Raj and Barbara Sohel) with projects that include tracking changes in the epithelial basement membranes of animals associated with aging and steroid hormones; gene regulation during *Drosophilia* development and investigations of oxidative stress induced by free radicals in the aging process; developmental and biochemical endocrinology (John McCarthy and Timothy Siler) which includes the biosynthesis of steroid hormones in mammals and invertebrates; structure and function of proteins (Christine Buchanan, Larry Ruben, and Steven Visk) involving the identification and analysis of proteins and the genes that code for them; and parasitology and infectious diseases (Frank Sagdares-Bernal and John Ubelaker) involving the pathology and treatment of parasitic infections and other infectious diseases, including the use of lasers and photoactive reagents to cleanse human blood and studies on the mechanisms of pathogenicity of *Acanthamoeba* spp., and *Angiostrongylius* spp.

**Economics**

The Department of Economics offers the oldest Ph.D. program at SMU. The department also offers a Master's degree in economics and a Master's in Applied Economics for corporate decision makers. The Richard B. Johnson Center for Economic Studies provides the setting for faculty and student researchers.

Faculty members specialize in a broad area of topics: economics of risk and uncertainty (Josef Hadar, William Russell, Eoe Kon See); macroeconomics and business cycle behavior (Nathan Balke, Greg Huffman); econometrics (Hermon Bierens, Tom Fomby, Joseph Hirschberg, Esfandiar Maasoumi); game theory (Shimento Weber); applied microeconomics (Kathy Hayes, Joseph Hirschberg, Ping Lin, D.J. Stettje); international trade and finance (Ravi Bhat); and general theory (Raj Deo, Jim Dolmas).

Research also extends to the undergraduate program. The department arranges internships for undergraduates with companies such as Mary Kay Cosmetics, Federal Reserve Bank of Dallas, Gardere and Wynne, Price Waterhouse Inc., and Merrill.
I try to provide opportunities to develop research papers for departmental distinction.

**Geological Sciences**

The department of Geological Sciences offers a Master of Science in geology, geophysics, and applied geophysics; and Ph.D. degrees in geology and geophysics. Since the establishment of the Ph.D. program in 1964, 50 degrees have been granted. The department has been a leader in sponsored research funding in Dedman College of Humanities and Sciences. During the past five years Geological Sciences faculty have received more than $250,000 in externally funded research grants.

Research interests encompass a wide area: geothermal exploration (David Blackwell) of temperature in the lithosphere and of regional plate tectonic processes as they relate to, and are affected by, the thermal field of the Earth; sedimentology (Robert Laury, Peter Scholle) at Mammoth Site; Hot Springs, South Dakota, and Permian carbonate work conducted in Greenland, Poland, Texas, and Wyoming; structural geology (Vicki Home) on the structural and tectonic analysis of Verne; metamorphic petrology (Mike Holdaway, John Addoches) on pelitic rocks to determine pressure-temperature evolution and the tectonic evolution of Precambrian basement terrains exposed in the central Transantarctic Mountains; paleontology (Louis Jacobs, Lee McEacher) focusing on the Early Cretaceous of Africa and Texas, and on Neogene small mammal evolution; and geochemistry (Robert Gregory) with studies of various problems in stable isotope geology including the isotopic evolution of seawater and the role of fluids during denudation and metamorphism; and seismology (Geri Herrin, Brian Stump) on seismic data acquisition systems and array data processing techniques sponsored by the United Nations Conference on Disarmament, and on the development of experimental techniques characterizing earthquakes and explosions and stratigraphy (James Brooks) in Egypt, including the deterioration and preservation of Egyptian monuments such as the Sphinx and pyramids at Giza.

**Mathematics**

The department of Mathematics offers M.A. and Ph.D. degrees in mathematics and an M.S. degree in applied mathematics. Faculty research is divided into broad, overlapping areas: the modeling and analysis of physical problems and the numerical solution of equations arising from the modeling process. Physical modeling develops and analyzes equations of fluid flow for special circumstances, particularly for problems in turbulence and foam rheology (Douglas Reimelt, Mogens Melander, Lawrence Marland). An area of particular analytic and numerical strength is bifurcation analysis for nonlinear dynamic phenomena (Richard Haberman, George Reddien Jr.). The strongest area of computational activity is in the numerical analysis of differential equations (Lawrence Shampine, Warren Ferguson, Mogens Melander). Associated with this activity is the preparation of mathematical software for ordinary differential equations (Lawrence Shampine and Ian Gladwell are associated with some of the world's most heavily used software). The solution of large-scale scientific problems on novel (parallel) computer architecture is a new research focus (Ian Gladwell, Warren Ferguson, Jim Nagy).

**Physics**

A new Ph.D. program began in fall 1992 to take advantage of the growing strength of the department and the proximity of the Superconducting Super Collider (SSC). In the past three years, the department has hired four faculty members with specialties in high-energy physics.

Professors Fred Olness and Tom Skwarnicki were made SSC Fellows. SSC Fellows were given each year to 24 promising high-energy physicists - 12 experimentalists and 12 theorists. Six are postdoctoral associates and six are junior faculty. Only one other institution (Fermilab) received two Fellowship awards. Skwarnicki works in experimental high-energy physics, along with Ryssard Stroynowski, who heads the high-energy experimental group at SMU. They work on the CLEO collaboration at the Cornell Electron-Positron Storage Ring, one of the two major U.S. sources of accelerator data. Skwarnicki and Stroynowski also were members of the GEM collaboration at the SSC, which was building one of the two largest SSC detectors. Olness is a theoretical particle physicist who works on issues at the border between the subfields of theory and the complexities of experiment. He is part of a national collaboration of theorists and experimentalists mounting an "all-source" concentrated attack questioning the structure of the proton.

Other research interests of the faculty include study of the propagation of wave packets (Jeff Chalk); elementary particle physics and quantum field theory (Gary McCarto, Kent Hornbostel); and elementary particle physics and astrophysics (Boris Rosenbaum, Vigdar Tapline). The Physics Department was awarded an infrastructure grant of $120,000 by the Texas National Research Laboratory Commission.

**Psychology**

The Psychology Department offers M.A. and Ph.D. degrees in general psychology and an M.A. in clinical and Counseling Psychology. The department has moved into national prominence with respect to its research productivity. The new Ph.D. program entered its second year in 1992-93. Faculty research productivity included 72 articles, 55 convention papers, and 10 invited talks. Among present undergraduate and graduate students, 25 were coauthors on published articles and paper presentations.

Faculty members in the department cover a broad area of research in memory and cognition (Alan Brown, David Mitchell); clinical health psychology (Ephrem Fernandez, Robert Hampson, Laura King, James Pennebaker); developmental psychology (Stanley Kuczaj II, Curtis McIntyre, Kenneth Springer); animal learning (W. Robert Batsell, Michael Best); perception (Diane Berry, Curtis McIntyre, William Todd Jr.); and social psychology (Diane Berry, Mary Alice Gordon, Laura King).

In 1990, the national journal Professional Psychology ranked SMU's Department of Psychology as one of the three most productive departments in the country among those with a terminal Master's degree program. A more recent study published in Personality and Social Psychology Bulletin examined the impact of individual social psychologists' contributions to their field by tracking the number of times a particular scholar was cited in works by his or her colleagues. The report included two of the Department's faculty members, James Pennebaker and David Watson, among the eminent scholars in the field of social psychology based on references to their works in journals and textbooks.

**Religious Studies**

The Religious Studies graduate program includes M.A. and Ph.D. degrees. The research interests of the faculty fall broadly into four areas: biblical studies, the history of the Christian religious and theological tradition, philosophical and theological studies, and religious ethics. Representative examples of the work the faculty is doing in each of these areas include the following:

Professors Donna Fellows and W.J.A. Power pursue the literary-critical interpretation of the writings of the Hebrew Bible, while Professor James Ward has concentrated on the theology of the prophets. In relation to the New Testament, Professors Victor P. Furnish and Jouette Bassler have concentrated on the writings, theology, and ethics of Paul; Professor Joseph Tyson has worked several years (Department Profiles continued on page 14).

SMU Research • 3
Our Hispanic Past

Retelling U.S. history to include a long-ignored heritage

By David J. Weber

As the story has been told conventionally in many high school and college texts, American history begins with Columbus (who never set foot on the shores of what is today the United States). He is followed in the 1530s and 1540s by colorful but cruel and gold-crazed Spanish explorers—Coronado and De Soto. Then the English colonists arrive, eclipsing the conquistadors in our historical imagination so that the real American history, the Anglo-American variety, can begin.

In recent times, the American story usually includes parts played by Native Americans and Blacks. Nonetheless, the national pageant typically moves forward from Massachusetts and Virginia without any Hispanics in sight, until they suddenly resurface as obstacles in the path of westering Anglo Americans, whose Manifest Destiny would have them wrest the fine harbors of California from Mexico in the Mexican-American War.

From the 1540s to the 1840s, Hispanics had not, of course, disappeared from the American landscape. At the height of its influence in the late 18th century, Spain claimed most of the American South and the entire West. Across what is today the Sun Belt, from California to Florida, the sons and daughters of Iberia, their blood mingled with that of Native Americans, established towns, missions, and fortifications.

As they did throughout their New World empire, Hispanics in North America set into motion profound human and environmental transformations. Spaniards introduced an astonishing array of life forms to the continent, ranging from cattle, sheep, and horses to the grasses those animals ate. They also unwittingly introduced alien diseases that ended the lives of countless Native Americans. On the other hand, the horses and firearms introduced by the Spaniards strengthened the ability of the Comanches, Apaches, and other native survivors to resist Hispanics and Anglo Americans alike.

Although Spanish place names have survived, America's Spanish past has slipped from historical memory. That Spain once supported missionaries, soldiers, and settlers

(Above) A familiar symbol of the church's mission in the New World was St. Francis of Assisi, depicted in a missal (1731) apparently used by Franciscans in colonial New Mexico. From the collections of the Museum of New Mexico. Published in The Spanish Frontier in North America, 1992.
In many parts of the United States, the history of the region is often overshadowed by the history of the nation as a whole. In recalling the dawn of European settlement in Virginia, we readily think of the English colonies at Roanoke in 1584 and Jamestown in 1607, but not of the earlier mission that Spanish Jesuits established in 1587 near what would become Jamestown.

Who is aware that Spaniards in the late 1500s established a military post on Vancouver Island, some 350 miles from today's Seattle? Even in California, with its visible reminders of the Spanish era, one college student proclaimed his astonishment to me upon learning that Spaniards, rather than Anglo-Americans, had built the 21 picturesque missions that attract tourists today from San Diego to Sonoma.

These gaps in historical understanding may seem myopic, but they are consistent with our construction of the nation's past. The Spanish colonial origins of the United States have yet to be woven into the fabric of American history. Although the United States has always been a multiethnic society, in American popular culture and in most general histories, the American past has been understood as the story of English America rather than as the stories of the diverse cultures that make up our national heritage.

Mistaking regional history for national history most historians have continued to see the nation's "formative years" as a phenomenon of the Eastern seaboard. In doing so, they have slighted Hispanic influences on art, architecture, literature, music, language, laws, running, and cuisine in the United States.

The energy and funds released by the Columbus Quincentennial revitalized the study of Spain's colonial empire in North America.

On site and in archives, archaeologists and historians re-examined the routes of Francisco Vázquez de Coronado, Hernando De Soto, and other 16th-century explorers. In symposia organized in communities from St. Augustine to Los Angeles, scholars discussed the reciprocal influences between Spaniards and Native Americans, and the formation of Hispanic communities. And in Spain and the United States, publishers seized the moment to reissue older works and to publish new titles on Hispanic North America.

Like previous scholarship on Hispanic North America, much of this new work will stand the test of time. Whether it will filter into classrooms, textbooks, and our national consciousness, however, remains to be seen. The shift of political and economic power toward the Sun Belt and the growth of America's Latino population suggests that a fuller retelling of our nation's story should be imminent. If so, university historians seem unprepared to take the lead. In research universities, historians of North America's old Spanish borderlands have become marginalized. Historians of the United States generally regard "borderlands historians" as Latin Americanists, and Latin Americanists regard them as historians of the United States. The consequences are clear: Only a few doctorate-granting history departments employ historians who specialize in Hispanic North America. The field is in danger of dying.

More than a century ago, Walt Whitman lamented Americans' impoverished understanding of their rich past, what he called the "splendor and sterling value" of Hispanic culture. "Impressed by New England writers and schoolmasters," Whitman wrote in a letter to community leaders in Santa Fe, New Mexico, in 1883, "we tacitly abandon ourselves to the notion that our United States have been fashioned from the British Islands only ... which is a very great mistake."

We still make this "very great mistake." We continue to overlook those Hispanics who came in Columbus' wake and who, together with other Europeans, changed America indelibly.

David J. Weber is the Robert and Nancy Dedman Professor of History at SMU. His most recent book is The Spanish Frontier in North America (Yale University Press, 1992). This article represents an abridged version of one that appeared March 10, 1993, in The Chronicle of Higher Education.

* SMU has initiated a fund-raising campaign to establish a doctoral program in history with an emphasis on history of the Southwest.
Write It Down, Work It Out

By Jeff Hampton

"Go ahead - get it out of your system. You'll feel much better."

The age-old prescription for working through and getting over an upsetting experience is being studied in SMU's Department of Psychology in Dedman College of Humanities and Sciences. But the prescription for improved psychological and physical health has an added ingredient: "Write it down."

"We are looking at traumatic, upsetting experiences and how they are linked to health problems," says James W. Pennebaker, professor of psychology. "More specifically, our research studies show that writing about upsetting experiences can affect short-term psychological well-being and long-term health."

Begun in 1986 and funded by the National Science Foundation, Pennebaker's research comprises a series of studies. In each project, participants are asked to write about emotional or non-emotional topics, including a personal experience that was upsetting or difficult, such as going to college or losing a job. "We ask them to put down their deepest thoughts and feelings about those experiences," Pennebaker says.

Other participants are given control topics of a superficial nature - discussing their plans for the day or describing a specific object. Writing sessions last 15 to 20 minutes a day for three to five consecutive days. All participants are told to write continuously and not to worry about spelling, grammar, sentence structure, and other writing conventions.

SMU students who volunteer as subjects have written about a range of experiences, including going to college, moving to a new town, situations that caused public embarrassment, family violence, drug and alcohol problems, their parents' divorce, sexual abuse, incest, rape, and a family member's suicide.

Other studies have involved groups of participants who share common traumatic experiences: Holocaust survivors, individuals with personal recollections about the assassination of President John F. Kennedy, employees from the same company who were terminated, among others.

Although the types of people and the experiences they relate are different in each study, the results have been the same, Pennebaker says. "We have found that individuals who are randomly assigned to write about deeply personal topics for three to five consecutive days are subsequently healthier than 'controls' who write about relatively superficial topics."

After their participation in a study, for example, students made fewer trips to the health center; and University staff went to a doctor less frequently and took fewer sick-leave days than did their control-group counterparts. In a study of recently unemployed professionals, Pennebaker found that 53 percent of the experimental subjects had accepted full-time jobs eight months after completion of the study, while only 24 percent of the control subjects had found employment.

Pennebaker emphasizes that effective, health-promoting writing should not be confused with diary or journal writing, which
typically relates the trivial events of life. Instead, writing for health must explore deeper cognitive or emotional states. The writer must "let go" and release all of his or her inhibitions.

Although Pennebaker’s results have been significant, he and his undergraduate and graduate assistant researchers also have sought to learn why writing can have such a healthy impact.

"Most recently, our research has asked: What are the dimensions of language that make a difference?" Pennebaker says. "Should people unload all their negative feelings or should they be upbeat and cheerful?"

To find the answer, Pennebaker and his research assistants designed two special studies. One used a computer program that analyzed written text; the program was developed by researcher Martha Francis as part of her dissertation for SMU’s new Ph.D. program in psychology. She learned that individuals who experienced better overall health had used significantly more negative-emotion words. The objects also evolved in their writing, increasing their use of cognitive words such as "understand," "realize," "because," and "reason" during the course of their exercises.

With the help of another Ph.D. graduate, Chee Hughes, a second study used a machine called the CARMEN (Computerized Automatic Retrieval of Morphemes and Even Neologisms). A morpheme is the smallest meaningful form in a language (such as car), and a neologism is a new word or new meaning of an established word. The CARMEN machine measures skin conductivity level and heart rate as subjects type into a computer keyboard. The study revealed that the suppression of negative emotions creates heightened short-term physiological responses that can be associated with improved long-term health.

The implication is that keeping traumatic experiences bottled up can be physiologically taxing. High blood pressure, faster heart and breathing rates, and high skin-conductance levels all are signs of an autonomous nervous system that is working overtime, Pennebaker says. On the other hand, writing about upsetting experiences results in lowered nervous-system activity and causes the immune system to work more efficiently. The result is an improved ability to combat illness and maintain better health.

These results reinforce the connection between mind and body, Pennebaker says. "You can’t really separate them. Thoughts, by their definition, are biochemical experiences."

Pennebaker’s research has spawned similar studies at colleges and universities in North and South America, Europe, and New Zealand. Researchers worldwide have employed what has become known as the "Pennebaker method" with similar positive results. In addition, some researchers are exploring the benefits of oral communication of upsetting experiences, while others are comparing written with oral expression.

"Both [writing and talking] are good," Pennebaker says. "My view is that the important dimension is simply putting those upsetting experiences into words."

Pennebaker’s findings are being applied in the professional community. The writing techniques and styles shown to benefit health are being used by institutions as varied as hospices, prisons, and universities — all places where large groups of people are dealing with upsetting events or dramatic changes in their lives.

The SMU psychologist’s research has become widely known partly because of his own prolific writing on the subject. He has written two books, Opening Up: The Healing Power of Confiding in Others and The Psychology of Physical Symptoms, and has co-edited three others, among them Mass Psychogenic Illness. Pennebaker also has written more than 100 articles and papers.

In addition to conducting research, Pennebaker teaches introductory courses in psychology as well as courses relating to his specialization in health, stress, and psychosomatics.

Pennebaker, who received a Ph.D. in psychology from the University of Texas at Austin in 1977, taught at the University of Virginia for six years before joining SMU in 1983. In 1989 he was a Hilgard Visiting Professor at Stanford University. In March 1993 he received an honorary doctorate from the Catholic University of Louvain in Belgium, which praised his "innovative research on immediate and long-term effects of expressing and inhibiting memories of traumatic emotions."
WHEN SMALLER MEANS MORE

By Kathleen Tibbetts

The scientific partnership of Gary Evans and Jerome Butler has lasted through several research projects and nearly 50 joint publications. Now the two engineers are teaming up at SMU to continue their investigations into the properties of semiconductor lasers—research that could change the way we compute and communicate in years to come.

Semiconductor lasers are manufactured commercially at a rate of two million to four million a month. A single laser consists of a semiconductor chip the size of a grain of salt attached to a copper wire, which rests on a copper heat sink (used to disperse the heat of the laser). These devices are found in compact disc players. Laser light reflected from microscopic patterns of holes in the CD's surface digitally reconstructs the original music. Many telephone users communicate over fiber-optic lines that use semiconductor lasers.

A market that may be even larger is optical memory for computers. To make the technology competitive, researchers are working to cut the already minuscule wavelength of a semiconductor laser in half. A shorter wavelength means a tighter beam and a tinier reading area, making it possible to store more and more information in a smaller and smaller space.

“One of the problems with the integrated circuits in computers is that they keep getting bigger, and you have to get more information into and out of them,” says Evans, who in 1992 became a professor of electrical engineering in the School of Engineering and Applied Science, where Butler has been teaching since 1965. “An optical interconnection can carry a lot more information and takes up a lot less room while using less power.”

Conventional types of lasers (called edge-emitting lasers because the light comes out of one edge of the semiconductor device) create integration problems for scientists. These devices require unobstructed interaction with air to generate the feedback necessary to create laser light—a fact of physics that makes it infeasible to integrate them on a single, monolithic foundation.

Evans and his fellow scientists solved the problem by creating surface-emitting lasers. These devices use gratings to provide feedback and couple light out of the surface, rather than the edge of the device. (Gratings are very fine lines etched into a semiconductor. Approximately 75 lines will fit into one-thousandth of an inch.) Surface-emitting lasers are important because monolithic integration allows the construction of coherent, two-dimensional arrays of lasers. This process is called phase-locking and is an important step in generating very high power suitable for applications ranging from deep-space communication to assembly-line welding.

If you took the lasers from 10 different CD players, lined them up, and turned them all on at once, you'd simply create 10 different laser beams. Because each device would be creating its own operating frequency, none of the lasers would be coherent with respect to any of the others. But when the same 10 lasers are phase-locked, they work at the same frequency and as a single beam and increase their coherent power exponentially—giving a peak power not 10 times that of a single laser, but 100 times.

Evans and Butler have demonstrated phase-locking of more than 1,000 surface-emitting lasers, and they say there is no reason why up to one million integrated lasers cannot be operated coherently. "We now can make the same step with lasers that has been made with microprocessors, from individual transistors in the late 1950s to the large, monolithic integrated circuits of the '90s, which contain over one million components," says Evans. The result is that production and test-
Lasing levels are reduced by orders of magnitude when reliability increases. Surface-emitting lasers also are significant because they can be combined with conventional integrated circuits and other optical components to form optoelectronic integrated circuits (OEIC). These OEIC chips are expected to have numerous applications, not only in optical interconnects but in such areas as optical processing and neural networks.

Evans relied upon his expertise in this field in collaboration (with Jacob M. Hammer) of Surface-Emitting Semiconductor Lasers and Arrays, published in September by Academic Press at SMU; he is continuing his longtime association with University Distinguished Professor Jerome Butler, a pioneer in semiconductor lasers. Since 1984, he has devoted much of his work to the characterization and theory of optical gratings—researching questions "how, when, and where gratings should be inserted into the laser structure and which gratings shapes provide the best results. Gratings also are being used with semiconductor lasers to make wavelength-tunable lasers that can be important in telecommunication systems that use fiber optics. "By having lasers that generate light at different wavelengths, you can dramatically increase the amount of information [that can be transmitted on a fiber]," Evans says.

Wavelength-tunable lasers also hold great potential for optical computer applications. By building a system that combines the wavelength-tunable lasers with outcoupling gratings, Evans says, the user could change the direction of the beam by changing its wavelength. Steerable beams would allow radical computer architectures by eliminating some of the internal cable or hardwiring—interconnections would be made through writeable beams of light.

To fully explore the possibilities of these ideas, SMU scientists will collaborate with researchers at other leading universities and laboratories, including the David Sarnoff Research Center, Xerox Palo Alto Research Center, and the Massachusetts Institute of Technology's Lincoln Laboratories.

"We really count on working with a lot of other places," Evans says, citing the prohibitive cost of performing all the necessary work at one location. "Even if you have all that expensive equipment, you have to be very knowledgeable to make it work to its best advantage," he says. "And if you're going to spend hundreds of hours processing, you might as well do it with the best material you can get. So we hope to be able to collaborate with people who are very good in other areas and bring our grating expertise to that."

Even as SEAS' laser scientists look to the expertise of other institutions, SMU should be the recognized leader in grating research, Butler says. "I would like us to build an international reputation on that topic. It may be only five percent of the entire process ... but if people are interested in making lasers, they'll think of us, because they'll know that we specialize in the one thing required to make sophisticated lasers work."

SEAS research into grating theory already has brought real-world benefits. Butler and his associates, using knowledge gained from over 20 years of experimentation, have developed software to analyze optical devices such as lasers, detectors, and wave guides. "If a small company wants to manufacture lasers, they can offer software packages for use in designing them," Butler says. "A university itself can't build VCRs or electronic components. So it should find something it can do that will fit in with industry."

Butler predicts that in the next 10 years, "there will be a move in manufacturing from large companies and large electronic facilities to small companies that have 100 people or less. Most of the innovation in manufacturing is going to come from small companies, not big ones," he says. He cites the Clinton administration's emphasis on small businesses as the engines of economic growth. "Where small businesses are blooming, they're going to need resources—in research, in software, in expertise. And SMU is going to supply those resources."

Even as SEAS' laser scientists look to the expertise of other institutions, SMU should be the recognized leader in grating research. "I would like us to build an international reputation on that topic."

• Jerome Butler
By Timothy Palmer

Patty Wisian-Neilson looks back on 1984-85 as "crazy and extraordinary years. Crazy, because her life was divided into thirds: she had a visiting professorship in Boston, a nascent research program in Dallas, and a family in Fort Worth. Miraculous, because her work that year produced important breakthroughs that have advanced her research and her career. "And everything has taken a whole turn since then," she says.

To understand where her research was heading in 1984, it is necessary to know where it had been. As a research scientist at Texas Christian University, Wisian-Neilson had synthesized a new kind of polyphosphazene, or phosphorus-nitrogen polymer. Polymers are large molecules characterized by repeating structural units. Organic polymers, composed of repeating units of carbon, are the building blocks of polystyrene and other plastics. Polyphosphazenes are inorganic polymers composed of repeating units of phosphorus and nitrogen.

Wisian-Neilson's achievement was notable because polyphosphazenes were emerging as a promising new field of research. Polyphosphazenes eventually might be used to develop new synthetic materials, similar to plastics but with different chemical properties. For example, phosphazenes are known to have flame-retardant properties, so polyphosphazenes potentially could be used to make plastics and synthetic fabrics that don't burn.

By 1984, Wisian-Neilson's achievements had positioned her at the leading edge of polyphosphazene research. That spring, she received a grant from the National Science Foundation's Visiting Professorships for Women in Science and Engineering program, which would fund her research at MIT for the coming academic year. At about the same time, SMU hired her for a faculty position in Chemistry, to begin after her year at MIT.

Supported by a grant from the U.S. Army Research Office, Wisian-Neilson established a research program in Dallas. She trained a postdoctoral research associate to continue the polyphosphazene studies under her direction. In September, she moved to Boston to begin work at MIT on a separate aspect of the polyphosphazene research. During the next nine months, Wisian-Neilson also made trips to Fort Worth to visit her husband, a professor of chemistry at TCU.

At the MIT lab, Wisian-Neilson created one of the first of a new class of small inorganic molecules, using a low-coordinate phosphorus to connect two iron atoms. "No one had ever used that compound to bridge across two iron atoms," she says.

When Wisian-Neilson joined the SMU faculty, she continued her work with the iron compounds for the next few years. Wisian-Neilson obtained funding from the American Chemical Society's Petroleum Research Fund, which supported undergraduate students who continued to explore the small-molecule phosphorus-iron compounds. But it is her work with the polyphosphazenes that eventually consumed more time and has enhanced her reputation as a chemist.

While Wisian-Neilson was at MIT, her research associate in Dallas developed a new way to make the polyphosphazenes. Since then, Wisian-Neilson's research has continued to yield new methods of preparing different types of polymers. She has developed the
forced corporations to curtail spending on basic research.

Because it is often easier to secure funding for medical applications, Wisian-Neilson believes the biomedical industry may offer the strongest potential for commercializing her research. Start-up companies, which often are more willing to invest in basic research, represent another area of opportunity.

Wisian-Neilson’s work has established SMU as a leading research center for this emerging area of inorganic chemistry. She has attracted funding from the U.S. Army Research Office, Welch Foundation, American Chemical Society, and the Texas Higher Education Board Advanced Technology Program, as well as the SMU Research Fund.

And although commercial applications may be years away, academic interest continues to grow. Wisian-Neilson co-chaired the second international symposium on inorganic polymers during the annual convention of the American Chemistry Society in Denver. She had hoped that 30 to 40 scientists would participate; to her surprise, she received papers from more than 80.

"The problem we face is getting across this barrier of what we can make and what someone else can use them for."

Patty Wisian-Neilson
Selected Faculty Publications

With nearly 500 SMU faculty members who publish more than 600 articles and 50 books a year, it would be impossible to list them all. Following is a sample of publications from various faculty members to indicate the publishing level at SMU.


Alessandro Comini, Art History, essay in catalog on Kathe Kollwitz for the exhibition at the National Gallery in Washington, D.C. (Yale University Press).


Debra Hunter, Art, exhibited photographs at the Art Institute of Chicago through January 3, 1993, in the exhibition, “Sitting Pretty: Photographs by Debra Hunter and Sue Packer” at the Amon Carter Museum of Fort Worth and Houston Museum of Art recently acquired Hunter’s work.


Jack Myers, English, Blindsight (David R. Godine), his fifth book of poetry.


Ryszard Stroynowski, Physics, co-authored articles in Physics Letters and Physics Review Letters reporting results of his research from the CLEO collaboration.


Fred Wendorf and Angela E. Close, Anthropology, Egypt During the Last Interglacial: The Middle Paleolithic of Bir Tarfawi and Bir Sabana East, Plenum Press.


DOCTORAL DEPARTMENT PROFILES

(Continued from page 3)

especially on Luke-Act; and Professor C. Clifton Black has studied the Gospels of Mark and John. In the area of Christian tradition, Professor William S. Babcock has concentrated on the early period and on Augustine of Hippo, in particular; Professor Edwin Sylvest deals especially with Hispanic Christianity; Professor Richard Cogley with the figure of John Eliot and the interaction between Native Americans and colonists in colonial New England; and Professor Klaus Penzel with the relation between German and American Protestantism in the 19th century and, most recently, with the historian and theologian Philip Schaff. In philosophical and theological studies, Professor William J. Abraham has interests in religious epistemology; Professor Charles M. Wood in questions relating to the way in which systematic theology is properly to be understood; and Professor Ellen T. Chary in the issue of how religious doctrine bears on the formation of the religious literacy and religious character. And in the sphere of religious ethics, Professor Joseph L. Allen concentrates on the issues of justice and the political order; Professor Charles E. Curran works on recent and contemporary Roman Catholic ethics; and Professor William F. May on professional and medical ethics.

Statistical Science

The Department of Statistical Science was established more than 25 years ago to take advantage of the faculty strength in this discipline. Since then, it has awarded approximately 100 Ph.D. degrees and 100 M.S. degrees. The graduate program was rated as the 12th best graduate program in statistics in the United States by the latest "Gourman Report." The rating was the best of any statistics graduate program in the Southwest.

Three broad areas of research strengths within the department are time series analysis and stochastic processes, regression analysis and experimental design, and nonparametrics. In time series analysis, Henry L. (Buddy) Gray and Wayne Woodward are researching ARMA and long-memory time series modeling. Sabyasachi Basu's interests are multivariate time series and spatial modeling. Narayan Bhat's research is in applied probability.

In regression and experimental design, Richard Gunst is studying the development of regression methods and error-in-variables models. C.H. Kapadia works in linear models and the theory of sampling. Rudy Guerra is conducting research in variance component modeling with applications to statistical genetics. Campbell Read's interests are goodness-of-fit testing and contingency table analysis.

William Schucany's research involves nonparametric regression and kernel density estimation. Georgia Thompson has published theoretical work on rank tests and high-dimensional graphical display of ranked data. Tuly Koshevnik has studied the theoretical foundations of semiparametrics. Rudy Guerra and William Schucany are collaborating on extensions of the bootstrap resampling theory and methodology. In addition, four members (Narayan Bhat, Buddy Gray, Richard Gunst, William Schucany) were named as Fellows of the American Statistical Association.

School of Engineering and Applied Science Computer Science and Engineering

The Department of Computer Science and Engineering has offered graduate level programs in computer science and operations research since the 1960s. A graduate program in computer engineering was added in 1989. The department offers M.S. degree programs in computer science, operations research, computer engineering, and engineering management. Ph.D. programs are offered in computer science, computer engineering, and operations research. In addition, the Doctor of Engineering degree is offered in engineering management.

Faculty research specializations in computer science and operations research include computer architecture (Paraskevas Evrifidou, Dan Moldovan, Sukumaran Nair); knowledge engineering (John Sullins, Murat Tanik); software engineering (Murat Tanik); design and analysis of algorithms (Richard Barr, Jose Dula, Richard Helgason, Jeffrey Kennington, David Matula, Yanjun Zhang); parallel processing (Richard Barr, Paraskevas Evrifidou, Richard Helgason, Jeffrey Kennington, Dan Moldovan, Yanjun Zhang); database and information systems (Weidong Chen, Margaret Eich); computer arithmetic (David Matula); and mathematical programming (Richard Barr, Jose Dula, Richard Helgason, Jeffrey Kennington).

Departmental research has been funded by numerous government and institutional groups including the National Science Foundation (NSF), National Space and Aeronautics Administration (NASA), Air Force Office of Scientific Administration, the state of Texas, Texas Instruments Inc., and NEC America Inc.

Electrical Engineering

The Department of Electrical Engineering offers M.S. and Ph.D. degrees in electrical engineering and an M.S. in telecommunications. The department is conducting pioneering research in microwave applications of high-transition temperature superconducting (HTSC) devices. In 1992, the solid-state research group led by Donald Butler and Zeynep Celik-Butler fabricated a HTSC heterodyne mixer that exhibited the lowest conversion loss and noise ever reported in the 20 GHz range. The work was performed in collaboration with Superconducting Technologies Inc.

In addition, infrared detectors are the focus of a research project in which the performance of pin junction and MIP infrared detectors is improved for better night vision. These devices are manufactured by Texas Instruments and Hughes Santa Barbara Research Center and purchased by the U.S. Army for use in surveillance and warfare. These projects are sponsored by the National Science Foundation and Texas Advanced Technology Program. Zeynep Celik-Butler is the principal investigator.

Someshwar Gupta and four Ph.D. students are studying problems associated with personal con-
FACULTY RECOGNITION

Herman J. Bierens, Economics, was listed as No. 1 in a 1993 ranking of Dutch economists by the periodical Intermediarium.

Ann Early, English, was awarded the Doctor of Humane Letters (honoris causa) by Clark University, Massachusetts, for her contribution to women's studies. The Women's Studies Council is establishing a scholarship, the Ann Early Award for an Outstanding Student Minorin in Women's Studies. For more information on how to support the scholarship or to receive the Women's Studies newsletter, write: Caroline Brettell, Women's Studies Coordinator, Southern Methodist University, P.O. Box 750172, Dallas, TX 75275-0172.

Jack Holman, Mechanical Engineering, received the 1993 McGlyn R. Lohman medal from his alma mater, Oklahoma State University, for his contributions to the engineering profession and education.

Mechanical Engineering

The graduate programs in mechanical engineering include Master of Science and Doctor of Philosophy in Mechanical Engineering and Master of Science in Manufacturing Systems Management. The department emphasizes the following areas of specialization: thermal and fluid sciences (Jack Holman, David Johnson, Jose Lage, Peter Read), dynamics and control (Yildirim Hurmuzlu, David Johnson, Hal Watson), mechanics, materials and design (Charles Lovas, Bijan Mohraz, Paul Packman, Cecil Smith, Hal Watson Jr.), and environmental engineering (Cecil Smith, Edward Smith).

Some specific samples of research and specialization are: Jack Holman, thermodynamics, heat transfer, cooling of electronic equipment; Yildirim Hurmuzlu, control systems and dynamics, stability of robotic and human locomotion; David Johnson, dynamics, free surface fluid flow; Jose Lage, thermal and fluid sciences, instability of natural convection flows, porous media, transition to turbulence, indoor pollutant transport; Charles Lovas, mechanical and thermal systems design; Bijan Mohraz, engineering mechanics, structural dynamics, earthquake engineering; Paul Packman, fracture mechanics, non-destructive evaluation and testing; Peter Read, computational fluid dynamics, solids interface in magnetic recording, incompressible free surface fluid flow, pin fin air cooling; Cecil Smith, photomechanical engineering, rock mechanics; Edward Smith, environmental engineering, water and wastewater treatment; and Hal Watson, vibrations, noise control.

Thomas J. Knock, History; Schubert M. Ogden, Religious Studies; and David Weber, History, were honored for their outstanding research, publications, and teaching at the annual Authors' Award Luncheon of the Dedman College University Lecture Series (April 1993). Knock's book, To End All Wars: Woodrow Wilson and the Quest for a New World Order, was nominated for the Pulitzer Prize and received the Warren E. Kuehl Prize from the Society of Historians for American Foreign Relations. Schubert M. Ogden has written six books, all of which are in print. He was honored for his most recent book, Is There Only One True Religion or Are There Many?, published in 1991. David Weber has several prize-winning books on the American Southwest. His latest book, The Spanish Frontier in North America, was published in October 1992 by Yale University Press, which also nominated it for the Pulitzer Prize. It has been recognized by the Texas Institute of Letters with the Carr P. Collins Award for the best nonfiction book, the Caughey Western History Association Award, and the Western Heritage Award from the National Cowboy Hall of Fame for the best nonfiction book.

Stephen McNally, Rhetoric, has won the prestigious Juniper Prize, sponsored by the University of Massachusetts Press for first books of poetry for Child of Amber, 1993.

John W. Peavy III, Financial Investments, is serving as research director of the Research Foundation of the Institute of Chartered Financial Analysts (ICFA) until May 31, 1994, when he will return to SMU.

James Pennebaker, Psychology, was awarded a Doctorate honoris causa from the Catholic University of Louvain in Belgium for research on immediate and long-term effects of expressing and inhibiting memories of traumatic emotions.

Dennis M. Simon, Political Science, received the Pi Sigma Alpha Award from the Southern Political Science Association for the best paper presented at the Association's 1991 annual meeting.

John Slocum, Organizational Behavior and Business Policy, received the 1993 Distinguished Service Award from the Academy of Management.

Ryszard Stroynowski, Physics, served as chair of the 700 Ph.D. GEM collaboration's magnet subgroup in the development of the Superconducting Super Collider.

Marshall Terry, English, received the first annual Golden Pen Award for his novel My Father's Hands from the Dallas-Fort Worth Chapter of PEN, the international writers' organization.

Joseph Tyson, Religious Studies, received the John G. Gammie Senior Lectureship Award from the Southwest Commission on Religious Studies.
During academic year 1992-93, 114 SMU faculty members (25 percent) directed research and sponsored projects and wrote proposals for new projects. External sponsors awarded $7,308,128 to SMU for direct and indirect costs of research and sponsored projects directed by 76 faculty and staff members. Although the dollar value of awards decreased slightly from the $7,416,292 received in 1991-92, the number of awards increased from 119 to 136. Awards include grants, contracts, and extensions and modifications of existing grants and contracts.

Federal government agencies provided 84 percent of the funding; state and local governments, 6 percent; foundations, 6 percent; corporations, 3 percent; and other, 1 percent.

The funding base for 1992-93 (exclusive of large funding contracts) was $5.9 million. The base in 1991-92 was $6 million; it was $5.1 million for three preceding years.

Following is a list of the awards totaling $50,000 or more made to SMU faculty in 1992-93.

James Adevasio, Anthropology (ARP); Archaeological Resource Surveys in Support of Superconducting Super Collider (NSC) Program, $485,872, Universities Research Association Inc.

Edward Biehl, Chemistry; Preparation of Novel Poly cyclics via Aryne Annulation and Friedel-Craft Methodology, $30,500, Welch Foundation; Investigation of Synthetic Utility of Tandem Addition, Rearrangement, and Aryne Auration Reactions for the Elaboration and Annulation of Certain Fused Aromatics, $20,000, ACS/Petroleum Research Fund.

David Blackwell, Geological Sciences; Geothermal Resource Evaluation Based on Heat Flow and Thermal Conductivity (modification 2 to Task Order 2), $50,000, EG & G.

Christina Buchanan, Biological Sciences; The Penicillin-binding Proteins of Bacillus subtilis (year 10), $146,753, National Institutes of Health; Small Instrumentation Grant, $9,508, National Institute of General Medical Sciences.

Jerome Butler, Gary Evans, Electrical Engineering; Millimeter Software Development, $30,000, David Sarnoff Research Center.


John Buynak, Chemistry; Allenes of Synthetic and Biochemical Importance, $79,461, National Institute of General Medical Sciences; Rearrangements of Functionalized Organosilanes (year 2 of 3), $30,500, Welch Foundation.

Zeynep Celik-Butler, Electrical Engineering; Low-frequency Noise Measurements as a Characterization and Testing Tool in Solid State Devices (year 1 of 2), $104,060, National Science Foundation; Supplemental Grant for Underrepresented Minorities, $9,388, Texas Higher Education Coordinating Board.

Neil Cogen, Law; Political Asylum Project, $86,897, Department of Education.

Michael Dungan, Bradley Singer, Geological Sciences; The Life History of an Arc Volcano: Insights from a Collaborative Petrologic, Paleomagnetic, and Geochronologic Study (year 2 of 3), $111,703, National Science Foundation.

Michael Dungan, Michael Holdaway, Geological Sciences; The Life History of an Arc Volcano: Insights from a Collaborative Petrologic, Paleomagnetic, and Geochronologic Study (year 3 of 3), $56,336, National Science Foundation.

SPONSORED RESEARCH AND PROJECTS

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Michael Dungan, Bradley Singer, Geological Sciences; Acquisition of Normaski Interference Contrast Prisms and Image Analysis, $16,842, National Science Foundation.

Thomas Edwards, Teacher Preparation: Upward Bound (years 1 and 2 of 3), $505,752, Department of Education.

Margaret Esh, Computer Science and Engineering; Main Memory Database Recovery Issues (year 1 of 3), $50,000, National Science Foundation.

John Goodge, Geological Sciences; Pre-Middle Jurassic Accretion-related Metamorphism in the southern Klamath Mountains, northern California Phase II, $120,000, National Science Foundation.

Henry Gray, Richard Gunst, Wayne Woodward, Statistical Science; Statistical Examination of Climatological Data Relevant to Global Temperature Variations (year 3), $201,572, Department of Energy.

Henry Gray, Wayne Woodward, Statistical Science; Statistical Research in Nuclear Monitoring (completion), $69,000, Phillips Laboratory.

Herbert Haus, Institute for the Study of Earth and Man; Core Support for Archaticmographic Service of a Radiocarbon Dating Facility (year 2 of 3), $88,275, National Science Foundation.

Eugene Herrin, Geological Sciences; TEXESS and LUXEES Experimental Mini-arrays, $1,014,703, Hanscom AFB (ARPA); Project X: Research in Mini-array Technology, $371,974, Hanscom AFB (ARPA); Amarillo Project, $5,480, Sandia National Laboratories.

Eugene Herrin, Chris Hayward, Geological Sciences; Support of Pakistan NDC, $15,598, Science Applications International Corporation.

Michael Holdaway, Biswajit Mukhopadhyay, Geological Sciences; Determination of Intensive Variables in Medium- to High-Grade Pelitic Rocks, $65,000, National Science Foundation.

Harayn Hosmane, Chemistry; Heterocarbornes of Main Group Elements and Early Transition Metals; Chemistry in Novel Directions (year 3), $63,000, National Science Foundation; New Frontiers of Carboranes and Metallacarboranes (year 2 of 3), $30,500, Welch Foundation.

Lora Howard, Milton Gosney, Electrical Engineering; Development of a VLSI System for Improved Monitoring and Stimulating Action Potentials of Neuronal Networks - Supplemental Funding, $67,514, National Science Foundation.
**1992-93 FUNDING SOURCE DISTRIBUTION**

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**Roger Phillips**, Geological Sciences: Venus Radar Mapper (VRM) now Magellan Mission (mod 19); the Final Funding, $62,396, Jet Propulsion Laboratory.

**Mark Schell**, Chemistry: Nonlinear Behavior in Electrochemical Reactions (years 2 and 3 of 5), $61,000, Welch Foundation.


**Tomasz Skwarnicki**, Physics: SSC Fellowship, $100,000, Texas National Research Laboratory Commission.


**Mandyam Srinath**, Electrical Engineering: Support for Student Participation (Swaral) in Dr. Laton's Work at UT Southwestern Medical Center, $4,500, University of Texas Southwestern Medical Center.


**Brian Stump**, Geological Sciences: The Role of Near-Source Phenomenology on Regional Seismic Observations (year 1), $94,586, Air Force Office of Scientific Research; Source Contributions from Nuclear Explosions in Regional Waveforms (year 3 of 4), $61,000, Air Force Office of Scientific Research; Equivalent Seismic Source Functions for Chemical and Nuclear Explosions (last funding), $54,421, Phillips Laboratory.

**Vigdor Teplitz**, Physics: Research Infrastructure Enhancement for Southern Methodist University, $120,000, Texas National Research Laboratory Commission.

**Steven Vik**, Biological Sciences: Structure-Function Studies of E. coli ATPase (year 5), $141,579, National Institute of General Medical Sciences.

**Steven Vik, Douglas Patton**, Biological Sciences: Structure-Function Studies of E. coli ATPase: Minority Undergraduate Supplement (part 2), $14,185, National Institute of General Medical Sciences.

**John Ward**, Biological Sciences: Analysis of virB Genes in Agrobacterium TDNA Transfer (year 2), $95,000, National Science Foundation.


**Patty Wissel-Heinen**, Chemistry: Synthesis and Characterization of Poly (Alkyl/Arylophosphazenes) and Their Derivatives (years 1 and 2), $82,000, Texas Christian University (Army Research Office); Poly (Alkyl/Arylophosphazenes) Copolymers (year 1 of 3), $30,500, Welch Foundation; New Sulfor Containing Phosphazenes, $20,000, ACS/Petroleum Research Fund.