The Stevens Research Environment

RESEARCH ENVIRONMENT AND FACILITIES

At Stevens, we are strengthening a proud tradition of conducting high-quality research by developing ways to ensure that laboratory breakthroughs and new technologies are translated into successful commercially-viable products and processes. We believe the future lies in Technogenesis and the beneficial university-industry-government collaboration.

Stevens' research initiatives are interdisciplinary; they have a strong connection to our undergraduate course offerings. From the process of investigation and discovery through applications in the marketplace, regardless of the particular discipline under which they are created, our projects are interconnected; this prepares our students for professional work. Our research initiatives reflect the Stevens academic philosophy of a comprehensive and unified approach to engineering, science, technology and management.

Since research problems can no longer be solved in classrooms and academic research laboratories alone, a third mode has been created: the Steeples of Research Excellence (www.steeples.org). The Steeples — comprised of the Center for Environmental Engineering, Center for Improved Engineering and Science Education, Davidson Laboratory, Design & Manufacturing Institute and Highly Filled Materials Institute — draw together technologists from academia, industry and government to develop practical solutions to core challenges facing business and society. Descriptions of each component, as well as a multitude of other Stevens research facilities, follow.

Center for Environmental Systems (CES)

The Center for Environmental Systems is dedicated to basic and application-motivated inter- and multi-disciplinary research aimed at creating basic scientific knowledge, advanced technology, and innovative management practices that lead to novel solutions for a sustainable utilization of our environmental resources. The Center conducts research sponsored by governmental agencies and private industry in a variety of environmental research areas, promotes environmental technology development, transfer and implementation, and fosters partnerships with industry, government and environmental service organizations for cooperative approaches to solving environmental problems. It also develops and maintains degree, certificate and continuing professional education programs for the Department of Civil, Environmental and Ocean Engineering.

Over 25 faculty members and 40 undergraduate and graduate students are involved in environmental research projects. The research is multifaceted, and includes hazardous and toxic waste engineering soil and ground-water modeling and remediation; dispersion and monitoring studies of contaminants in inland and coastal waters; physical, physicochemical and biological waste treatment technologies; and residential water conservation, flushability and drinking water safety.

The research facilities of the center include the James C. Nicoll, Jr. Environmental Laboratory (JNEL), the Keck Geoenvironmental Laboratory, the Vincent A. Rocco Technology Center, and the Analytical, Plasma, and Water Conservation Laboratories. These state-of-the-art facilities provide unique capabilities for bench scale treatability stud-

ies on complex wastes, waste minimization studies, consumer and non-consumer product environmental compatibility studies, fate and transport evaluation of organic and inorganic contaminants, and the development and transfer of environmental technologies.

Center for Global Technology Management (CGTM)

The Center for Global Technology Management (CGTM) is the Howe School's focal point for research and educational programs in global studies. In research, the center focuses on issues related to global innovation practices and theory. The center's educational program includes a range of courses leading to a "global concentration" in several Howe School graduate programs. The center also plans a series of executive courses as well as student exchange programs at the undergraduate and graduate level with global corporations and international business schools.

Center for Improved Engineering and Science Education (CIESE)

The Center for Improved Engineering and Science Education (CIESE), www.ciese.org, was founded in 1988 to lend Stevens' expertise in integrating computers into its curriculum to improve science, mathematics, engineering, and technology education. CIESE's mission is to increase the pool and improve the capabilities of all students to pursue higher education and careers in these disciplines. In pursuing this mission, CIESE's work has encompassed both precollege educators, as well as post-secondary education. The Center helps K-12 educators exploit the power of technology to improve teaching and learning in science, mathematics and other disciplines. These activities complement Stevens' objectives by helping students acquire the foundations necessary to excel in science, mathematics and other subjects. Achievement in these "gateway" subjects enables students to go on to the advanced study required in engineering and other technologically-rich fields.

CIESE works collaboratively with teachers, school system administrators, as well as university faculty to provide intensive, hands-on training, support and counsel to infuse technology, in meaningful ways, into the curriculum. Technology is seen as both a tool for teachers and a new mode for bringing exciting content to students. In the past, students might have read in a textbook about earthquakes that happened several years ago; today it is possible for them to log onto a web site and see the location and intensity of earthquakes that have occurred within the past 24 hours. Bringing these real-world phenomena into the classroom both motivates and engages students to learn in ways not possible with more traditional tools.

Through partnerships with school districts, as well as colleges, universities and other organizations in New Jersey and four other states, the CIESE program is in the process of training 10,000 teachers and reaching more than a quarter-million children. CIESE is currently implementing: a five-year, $9.28 million U.S. Department of Education Technology Innovation Challenge Grant; a three-year, $750,000 AT&T Foundation grant; a three-year, $600,000 New Jersey Department of Education grant; a three-year, $1 million program to strengthen science education for New Jersey's neediest schools; as well as several specific teacher-training programs with New Jersey and New York schools and districts.

Central to CIESE activities are unique and compelling Internet-based curriculum materials for K-12 science and mathematics education. The Savvy Cyber Teacher (SCT) workshop series is a 10-part, 30-hour teacher-training program providing educators with hands-on experience using e-mail, web browser software and search engines. It uses

original Internet-based curriculum material that features "real time" data on scientific and natural phenomena and opportunities for global collaboration with scientists, experts and school children around the world. Teachers create their own web pages to organize their lessons and post student work. SCT materials and other training programs are available to schools and teachers through grant-funded programs or fee-for-services arrangements with CIESE.

Center for Mass Spectrometry

Mass spectrometry, a rapidly advancing scientific discipline with tremendous employment potential, has far-reaching qualitative and quantitative applications in environmental, biological, biochemical, pharmacological, forensic, and geochemical fields.

As one of the best equipped academic facilities in the United States, the Center welcomes collaborative research projects from the Stevens community and from outside sources. Frontier-level research programs incorporate the efforts of those who would like to gain experience with mass spectrometry as well as advanced-level researchers involved with the latest developments in the field. Our instruments are amenable to a wide variety of organic compounds including proteins, peptides, amino acids, alkaloids, steroids, flavanoides, saccharides, lipids, nucleic acids, polymers, petroleum products, and organo-metallics. Our mass analyzers are based on time-of-flight and quadrupolar techniques. One of the new instruments featured in this center is a Q-TOF API-US mass spectrometer. This hybrid instrument incorporates two mass analyzers in tandem: a high performance quadrupole filter as the first stage and a orthogonal-acceleration time-of-flight analyzer with a mass resolving power of 17,500 as the second.

Center for Product Lifecycle Management (CPLM)

Another research facility is the Center for Product Lifecycle Management (CPLM), a focal point for both information and technology on plastic products over their life-cycle: design, manufacture, use and disposal. Working with industry and government, CPLM emphasizes the development of products and fabrication processes that reduce the potential for significant environmental problems and risk, and promote sustainable growth. CPLM's activities include contract product and process research, engineering studies, educational and training programs and technology transfer industrial extension services. The center uses two other facilities:

• ***The Blandford Water Quality Laboratory*** is equipped for all standard chemical and microbiological determinations used in the water and wastewater field. These include atomic absorption spectroscopy, gas chromatography and high-performance liquid chromatography.

• ***The Waterfront Tower Facility***, a ten-story, 3,000-square-foot tower, is used to conduct pilot scale waste treatment and destruction technology development and testing. This unique facility can accommodate construction of very high treatment setups. Several pilot-scale setups are in operation, including a 40-foot-high steam-stripping parked column.

• ***The Research Vessel, Phoenix***, is used for conducting pollution studies in estuarine and coastal waters. This 25-foot-long vessel has been equipped to perform dye tracer experiments, collect water quality samples and obtain observations of water velocity, salinity and temperature. The Phoenix is named after an early 19th-century steamboat constructed by the Stevens family.

Center for Technology Management Research (CTMR)

CTMR conducts research on issues related to innovation and the management of technologies in a global context. Our mission is to develop concepts and frameworks to help executives address the challenges of a rapidly changing technology-based world. Research results are disseminated through publications, books, working papers, an annual conference, and sponsor forums.

CTMR supports the Stevens Institute of Technology theme of Technogenesis—the educational frontier wherein faculty, students and colleagues in industry jointly nurture the process of conception, design, and marketplace realization of new technologies.

Computer Vision Laboratory

The primary objective of the research performed in the Computer Vision Laboratory is to apply rigorous physical and mathematical principles towards image interpretation. The work performed in the lab is multidisciplinary, combining diverse academic disciplines, including physics, mathematics, engineering and, above all, computer science. Some of the major thrusts in the lab include photometry, 3D shape reconstruction, shape analysis, object recognition and multispectral imaging.

The Laboratory offers students a hands-on experience with image capturing and processing equipment. A dedicated workstation is used mainly for the capture of still images and movies. The laboratory's electronically tunable filter capable of fast, dense, multispectral imaging is unique among computer vision laboratories in academic institutions. The environmental conditions in the lab are strictly controlled. If needed, the lab can become a dark room. An optic table allows for the precise positioning of equipment. A collection of optical components allows for experimentation with enhanced image capture. The lab has its own server and multiple Unix workstations for storing, processing and analyzing images.

The Consortium for Corporate Entrepreneurship

The Consortium for Corporate Entrepreneurship *(http://www.ceconsortium.org)* continues to focus its research in three areas: optimizing the front end of innovation, approaches and organizational structures for getting to breakthroughs and knowledge creation, and knowledge flow in the front end.

Through its mission statement—to better understand the Front End of Innovation in order to increase the number, speed and success probability of highly profitable products entering development—the Consortium offers a collaborative environment, where academia and industry are dedicated to the discovery portion of the front-end leading to breakthrough innovation.

Although these are topics of growing interest within the corporate creative community, little has previously been established. In a world of rapidly evolving technologies, the success of interdependent relationships spawned between creator-innovators and their corporate environments is based on an increasingly synchronized set of events. The Consortium and its industry sponsors seek to recognize behaviors and activities that can be applied as powerful tools in enhancing creativity, productivity and profitability. Industry sponsors include: ExxonMobil; Ethicon, a J&J Franchise; and Aventis.

Davidson Laboratory

The Davidson Laboratory, founded in 1935, is one of the largest and most renowned hydrodynamic and ocean engineering research facilities in the nation. The

Laboratory is part of The Center for Maritime Systems which has as its focus: marine hydrodynamics, environment modeling, observing systems and sensors, port security and commerce and acoustic detection and surveillance (www.dl.stevens-tech.edu). The Laboratory was featured in the February 1996 issue of *Sea Technology*.

Pioneering marine hydrodynamic studies in both physical modeling and computer simulation of marine craft designs (ranging from high-speed planning boats to submarines) conducted over 70 years have contributed to the Laboratory's international reputation. Contributions to the field of ocean engineering include wave tank simulations of various sea states and the analysis of forces on offshore structures.

The Laboratory's interest and expertise extends to research on observing systems and sensor design developing instruments to measure specific water properties or processes and developing arrays of sensors to monitor a region of the marine environment. The State of New Jersey funds the Laboratory to administer the New Jersey State Coastal Protection Technical Assistance Service (CPTAS) (www.dl.stevens-tech.edu/cptas/cptas.html), a unique resource created to both inform and counsel New Jersey citizens and government officials regarding coastal protection technology.

Computational hydrodynamics at the Davidson Laboratory encompasses both environmental hydrodynamics and naval architecture. The approaches to these disciplines are designed to take advantage of the rapidly evolving high performance computational and communications technologies. The basis of the environment modeling systems is POM, The Princeton Ocean Model. POM is a state of the art, sigma coordinate, free surface, primitive equation coastal ocean model. POM is the central modeling component of the Laboratory's New York Harbor Observing and Prediction System (NYHOPS).

The primary research facilities within the Laboratory are two unique wave tanks. The first is a high-speed towing tank with a length of 313 feet, width of 12 feet and a variable water depth to 6 feet. A monorail-supported cable-driven carriage is capable of speeds up to 100 ft/sec. The tank also contains a programmable wave maker capable of generating monochromatic and random wave fields, as well as several types of wave spectra. Shallow water conditions can be simulated in the tank with the installation of an adjustable slope false bottom. Nearshore beach conditions are studied by placing 40 tons of quartz sand on a 65-foot-long, 1-on-20 sloping false bottom. The second tank is a rotating arm and oblique-sea basin, with dimensions of 75-feet-long by 75-feet-wide and a variable water depth to five feet. The facility has been designated an International Historic Mechanical Engineering Landmark and is one of only two of its kind in the nation.

Estuarine and coastal field research is accomplished through the use of the Laboratory's two research vessels, equipped with advanced global positioning systems, radar and 1-ton deployment winches. Research instrumentation includes topographic and bathymetric surveying equipment, a CODAR high frequency radar system, Acoustic Doppler Current Meters, PUV meters, laser-based Suspended Sediment Particle-size Distribution Meters and a Turner-design fluorometry system. In addition to the mobile research instrumentation, the Laboratory maintains a host of in-situ instrument platforms that automatically monitor weather and water conditions along the New Jersey Coast (sql.dl.stevens-tech.edu) and in New York/New Jersey Harbor as part of the New York Harbor Observing System (NYHOS).

The research efforts of the Laboratory are supported by the Instrumentation and Design Group that designs and manufactures the specialized equipment needed to support research activities. Computational resourses center around the Laboratory's cluster:

6 dual 2.8Ghz Xeon processors, scheduled to be expanded to 12 nodes over the next 6 months. Each processor has 140Gb and 10,000 RPM RAID drives. A wide range of processing tools, including visualization and animation routines, is available for use.

Design & Manufacturing Institute (DMI)

The Design & Manufacturing Institute (DMI) (www.dmi.stevens-tech.edu) is an interdisciplinary center integrating materials processing, product design and manufacturing expertise with simulation and modeling utilizing state-of-the-art computer software technology. Located in the historic Carnegie Laboratory, DMI bridges the gap between academic- and application-oriented research and development. DMI partners with industry and government to create practical solutions to product-design challenges that address cost, performance and productibility across the product life cycle. DMI's expertise spans processing studies and modeling, competitive product development, multi-component, multi-process system design and optimization, life cycle analysis, material characterization and testing, and rapid prototyping and manufacturing.

Building on more than a decade of experience in cutting-edge product design solutions, the Design & Manufacturing Institute continues to lead in developing "next generation" solutions to today's challenges to product development. DMI's expertise in manufacturing processes and knowledge-based software is epitomized in its Automated Concurrent Engineering Software (ACES) system and methodology development. The ACES system offers product designers performance and process modeling and life-cycle optimization for multi-component, multi-process systems. In its continuous refinement of "next generation" product development methodologies and tools, such as ACES, DMI is engineering the future of polymer and metals-based products.

DMI has particular expertise with polymers and composites, and maintains extensive modeling capabilities and databases on materials, processing, tooling and machinery. The Learning Factory at DMI, a 6,000-square-foot facility, provides a computer-controlled, state-of-the-art manufacturing environment. It offers industry representatives and students the research, testing and training for product design and testing, materials characterization, rapid prototyping and production. Part of DMI is the Advanced Manufacturing Laboratory, which contains industrial scale NC machines with CAD/CAM software.

Electrical and Computer Engineering Laboratories

Laboratory facilities in the Department of Electrical and Computer Engineering are used for course-related teaching and special problems, design projects and research. Students are exposed to a range of practical problems in laboratory assignments. Research laboratories are also heavily involved in both undergraduate and graduate education with special projects and dissertation projects. All research laboratories serve this dual-use function.

• ***Image Processing & Multimedia Laboratory***

The high-computing power and large data storage capabilities of contemporary computer systems, along with the high data rates of today's data networks, have made practical many sophisticated techniques used for two- and three-dimensional images and video. The Image Processing & Multimedia Laboratory highlights advances in the underlying image processing and computer vision algorithms that serve as foundations for a wide range of applications. Related to these visual environments is the general area of multimedia, combining visual, audio and other sensory information within an

integrated framework.

• ***Physical Electronics Laboratory***

Miniaturized devices used in today's electronic and optoelectronic components (and their packaging) dominate the underlying physical components of contemporary systems. The Physical Electronics Laboratory provides an interdisciplinary facility highlighting design/realization of miniaturized components, test/evaluation of such components and the demonstration of advanced systems concepts.

• ***Secure Network Design Laboratory***

Today's extensive use of electronic information systems (including data networks, data storage systems, digital computers, etc.) has revolutionized both commercial and personal access to information and exchange of information. However, serious issues appear in the security of information, assurance of the end user's identity, protection of the information system, etc. The Secure Network Design Laboratory provides both physical testbeds and computer systems/resources for exploration of this broad issue.

• ***Signal Processing in Communications Laboratory***

Communication systems rely on extensive signal processing, in preparation for their transmission, to correct for distortions of the signal during transmission and to extract the original signal from the received signal. Digital signal processing is an important enabler of contemporary communication systems, providing the flexibility and reliability of computational algorithms to enable a wide variety of operations on signals. The Signal Processing in Communications Laboratory focuses on advances in the underlying principles of signal processing and on the application of signal processing to contemporary communication systems.

• ***Wireless Information Systems Engineering Laboratory***

The Wireless Information Systems Engineering Laboratory highlights the design and engineering of advanced wireless systems, including cellular and PCS telephony, wireless LANs, satellite communications and application-specific wireless links. Research includes the application of advanced signal processing algorithms and technologies to wireless communication systems. A major motivation of wireless communications is the elimination of a physical wire connected to the user's system. In the case of computer communications (e.g., LAN and modem capabilities), the transition to wireless connections allows the realization of true "any place" connectivity to data communications services.

Engineered Materials Laboratory

The Engineered Materials Laboratory focuses on the design and manufacturing aspects of high-performance composite materials. Current project thrusts include development and validation of a multi-physics composite manufacturing simulation system, studies on process-induced residual stresses and composites behavior in thermally-aggressive environments. The laboratory features a two-axis filament winder, an instrumented resin transfer mold and a robotic lamination system.

Highly Filled Materials Institute (HFMI)

The Highly Filled Materials Institute (HFMI) (www.hfmi.stevens-tech.edu) was established at Stevens Institute of Technology in 1989 to investigate, both experimentally and theoretically, the rheological behavior, microstructure, processability and ultimate properties of highly filled materials, including suspensions and dispersions.

Highly filled materials, loading levels of which are typically very close to their maximum packing fraction of the solid phase, are encountered in various industries, including solid rocket fuels and explosives, personal care products, intermediary and final food products, batteries, polymeric master-batches and compounds, construction products, composites, magnetics and ceramics. HFMI stays in contact with these industries in order to better define its research goals and to help focus efforts on some of the immediate and long-term concerns. An industrial advisory board guides HFMI in carrying out short- and long-term contract research for government agencies and corporations.

The facilities of HFMI are furnished with state-of-the-art equipment, including a mini-supercomputer and graphic workstations for numerical simulation, industrial-size continuous and batch processors including co-rotating and counter-rotating twin screw extruders, shear and extensional rheometers, computerized data acquisition and process control systems, differential scanning calorimetry, thermogravimetric analysis and equipment for characterization of microstructural distributions, magnetic and electrical properties, wettability and image analysis. The proprietary technologies of HFMI include magnetic shielding methods, on-line rheometry, disposal methods for chemical munitions, X-ray based quantitative degree of mixedness and particle-size distribution analysis techniques, and three-dimensional FEM-based source codes for simulation of EMF mitigation, extrusion, molding and die flows.

Information Technology

Information Technology (www.stevens.edu/it) supports academic and administrative computing systems, campus networking and telecommunication facilities, web servers and many computing and networking resources located throughout the campus. Infrastructure services are based on a multivendor UNIX platform and Windows2000.

An extensive network supports communications from all academic and administrative buildings and residence halls to all major systems. Over 6,500 nodes are supported in the campus network with access speeds of up to 100Mbps and core network speeds of 1Gbps. Off-campus connectivity to the Internet is provided by fractional T3 service. High speed (OC3) connectivity to the vBNS (Internet 2) research network provides high-bandwidth connections to other vBNS- and Internet 2- connected education and research institutions. A wireless network provides access to the campus network and the Internet from locations around the campus. Remote access to the campus network is supported by a dial-in modem pool as well as VPNs. With a high level of connectivity and advanced functionality accessible from on- and off-campus locations, our network has been recognized as an award-winning model environment for other academic institutions and commercial organizations.

In addition to the notebooks and personal computers owned by all undergraduate students, a PC laboratory operated by Information Technology is available to support access for members of the campus community 7 days a week except holidays. It includes a large cluster of personal computers, printers, a scanner, and network jacks and wireless access for general use by members of the Stevens community. Additional computer labs are maintained by some academic departments to meet their needs.

Information Technology provides a variety of services. The User Services staff assists users by providing a staffed help desk, training seminars and workshops, web-based and hardcopy versions of documentation, timely news updates, and advice on

systems access and usage. The staff coordinates a seminar series intended to aid in the use of networked resources. Users may request individual or departmental assistance in planning, implementing and using information resources, as well as help with general system information, connecting to and interacting with the network, using workstations and accessing the Internet resources.

Information Technology assists members of the community in evaluating, acquiring and supporting networked resources. This includes help in planning new facilities, implementing new technologies and establishing support programs. The Networking Staff assists users and departments in designing and implementing local area networks, network expansion plans and network applications. User assistance can be obtained by calling (201) 216-5500. Help in purchasing computers can be obtained by calling (201) 216-5108.

The staff of Information Technology has a long-standing tradition of close cooperation with students. Undergraduate and graduate students are employed as part-time user (help desk) consultants, residence hall technical assistants, personal computer lab assistants, and network support technicians. All of these students work closely with the Information Technology staff, gaining valuable practical experience while pursing their degrees.

W. M. Keck Geoenvironmental Laboratory

The W. M. Keck Geoenvironmental Engineering Laboratory is a fully-equipped facility for state-of-the-art computer automated geotechnical, as well as environmental, testing of soil and water media. Some of the major equipment available includes: optical and polarizing microscope capabilities for geological sample analysis, X-ray diffraction capabilities for mineralogical characterizations; scanning electron microscope for surface morphological studies; zeta potentiometer for solid surface charge analyses; integrated wet chemistry facilities to accommodate any type of physicochemical and environmental soil testing, such as particle and pore size distribution, surface area, cation exchange capacity, batch and sequential extraction, oxide content, consolidation, triaxial and direct shear strength testing, flexible and rigid wall permeameters, and CBRs; durability chambers for simulating environmental stresses, such as freeze and thaw, wetting and drying, salt fog and acid rain exposure, as well as other accelerated weathering field conditions; and full sample collection and specimen preparation set-ups.

Some of the current studies involve geoenvironmental characterization of heavy metal contaminated firing range soils from different installations across the US; fly ash, incinerator ash and other industrial waste-by-product materials to evaluate their use in construction applications; evaluating the properties of dredged materials for reuse in transportation projects, treatment and management of hazardous wastes; focusing on heavy metal and petroleum hydrocarbon immobilization in geoenvironments; study of the fate and transport of contaminants in the subsurface; surface enhancement of currently used industrial wastewater filtration media; and development of leaching protocols. To view brief project descriptions, journal, engineering reports and other pertinent publications you may visit Professor Dermatas, the Laboratory director's homepage *(http://attila.stevens-tech.edu/~ddermata/)*.

Laboratory for Secure Systems

The Laboratory's mission is to pioneer new technologies for high-assurance and secure systems and prototype tools that can provide guarantees that a system will not exhibit unpredictable behavior in a hostile environment. The objective is to consolidate

and organize research and tool-building efforts already underway at Stevens. The Lab is funded by grants from the New Jersey Commission on Science and Technology, the National Science Foundation and the Stevens Institute of Technology Technogenesis Fund. The facilities of the Lab include several desktop machines, PDAs with wireless Ethernet, and Bluetooth devices for experimentation. The Lab is affiliated with the New Jersey Institute for Trustworthy Enterprise Software.

Part of the research work is focused on building better trust models for components. Some of this work is using static analysis techniques to check access control and information flow properties for untrusted components. There is also work on pushing type safety from high-level languages down to the assembly language level and, in the process, checking properties of heap space usage. Other work has been on type systems for dynamic linking and "hot" updates of program libraries at run-time.

Another thrust of the work in the Lab has been in network security, particularly for wireless networks. Work continues on attacks that can be mounted on ad-hoc wireless networks and in the design of new authentication and key establishment protocols that can be used to improve the security of wireless communication in general. Recent work has also looked at type-based approaches to cryptography, to specify and ensure trustworthiness guarantees for communication channels.

A new area of research at the Lab is the study of secure electronic transactions, such as banking operations or voting. The work consists of using secure patterns of communication described using type-systems to detect unauthorized modification of data between trusted communicating parties.

The Lab has a seminar series where guests from industry and academia as well as members of the Stevens community present recent advances in all areas of computer security. For more information about the Lab, visit out web site at *http://www.cs.stevens-tech.edu/Lab/SecureSystems_Lab*

Lawrence Schacht Management Laboratory

Today, educating engineers, scientists and managers requires more than traditional laboratory facilities. The Lawrence Schacht Management Laboratory provides facilities to learn and practice business skills in realistic environments: to learn the art and science of making effective presentations, to understand and improve interpersonal and organizational skills, to develop the computational skills needed in today's competitive world, and to conduct research in management and technology management.

The laboratory is composed of a seminar room and five conference rooms, a computation laboratory and a networking and video control center. Video cameras and screens in each of the conference rooms can be operated and controlled remotely from the control center. Network and video connections are installed throughout the laboratory, enabling laboratory activities to combine the use of audio, video and computing techniques, with facilities that equal and often exceed the typical commercial facility.

These facilities are well suited for use in many academic programs. For example, students practice presentation skills in the seminar room, and undergraduate and graduate students simulate a variety of managerial situations in the conference rooms as they learn the dynamics of small groups. Exercises can be monitored and videotaped by an experienced manager who may both intervene in the process and guide it, or offer criticism and feedback immediately after its conclusion.

In addition to providing students with valuable educational experiences, the labora-

tory is used in management and other small-group research. The laboratory is designed to accommodate controlled experimentation on managerial functions and processes. Our ultimate goal in management research is to understand the managing mechanism as it relates to individuals involved, their organization and the community at large.

The computing center portion of the laboratory includes several dozen advanced personal computers, all connected to the campus-wide network. The equipment supplements the training of management students by allowing them access to, and training them in the use of, fully-supported analytical tools in accounting, statistics and simulations. From the Schacht Lab computers, the student can access and use the worldwide capabilities available through the Internet on their projects and assignments.

Materials/Structures Laboratory

The Materials/Structures Laboratory is equipped for state-of-the-art materials testing. Equipment includes a universal 400,000 lb. compression/200,000 lb. tension testing machine; a computerized data acquisition system; beam loading frame, freeze-thaw testing apparatus; Versa test compression machine; high-pressure flexible wall permeameters and environmental testing chambers. Current studies include high-strength concrete, fiber-reinforced concrete, use of by-products in concrete production and durability of materials in construction.

Mechanical Engineering Labs

• ***Alfred W. Fielding Computer-Aided Design Laboratory***

This laboratory contains a number of high-speed workstations and peripherals serviced via local area networks. The installed software includes the general purpose CAD/CAM package Pro-Engineer and Solid Works, as well as finite element codes ABAQUS, ALGOR, ANSYS and Pro-Mechanica. Also installed are several special purpose design, analysis and educational packages.

• ***Clean Air Vehicle Facility***

The Clean Air Vehicle Facility focuses on methods to reduce automotive pollutant emissions. The laboratory houses a 50-hp single-axle chassis dynamometer and a 1000-hp engine dynamometer with fully-computerized instrumentation. The emission sampling and analysis systems permit accurate determination of CO, CO2, Ox, NOx, total hydrocarbons, methane and non-methane hydrocarbons in raw or constant-volume sampled exhaust.

• ***Engineered Structural Materials Laboratory***

This laboratory focuses on the design, modeling and analysis and characterization of modern micro/nano structurally engineered materials. The laboratory has filament Winding, Resin Transfer Molding and Robotic Lamination equipment for prototyping tailored composite materials. The laboratory is capable of characterizing physical and mechanical properties, long-term durability and failure behavior of composite structures.

• ***Fluid Mechanics Laboratory***

This laboratory includes a low-noise subsonic wind tunnel with several custom-fabricated test sections, a pump performance test-rig, a blower and internal-flow test-rig, a hydraulic bench and experimental set-ups for flow metering, force of a jet, and dimensional-analysis/similitude. The laboratory is fully networked and includes space to support undergraduate and graduate design and research projects in aerodynamics and hydraulics

with modern flow instrumentation and computer-aided data acquisition systems.

• ***Kenneth A. Roe Senior Design Laboratory***

This facility provides work space and support (instrumentation, tools, etc.) for the design, construction, and testing of capstone-design projects in Mechanical Engineering. The laboratory serves as a base for all the senior design teams. It has workbenches for at least ten design teams to build and assemble prototypes.

• ***Mechanical Systems Laboratory***

This laboratory houses 10 experimental set-ups in mechanisms, machine systems, and robotics including apparatus for experiments on vibrations of machine systems (natural response, step response, frequency response, resonance, etc.), gear mechanisms (train value, rigid vs. flexible machine, etc.) and balancing of rotors as well as the experiments with various displacement sensors to measure beam deflection and calculate beam stiffness; to measure backlash existed in mechanical joints and motion system; to measure motion errors in mechanical systems of various components. Several educational robot manipulators and Lego-based mobile platforms are included.

• ***Metal Forming Laboratory (MFL)***

This Laboratory focuses on advancing the state of the art in computer modeling of thermo-mechanical processing of metals. The results of the computer simulations are verified using experimental techniques. The manufacturing processes investigated include forging, rolling, extrusion and stamping. Recent projects explored the microstructure changes in metals during the hot forging of aerospace components, whereby the resulting grain size is predicted as a function of the processing parameters using heuristic models and numerical approaches on multiple lengths scales.

• ***Noise and Vibration Control Laboratory***

Research activities in the areas of engineering acoustics, vibrations and noise control are conducted in this Laboratory. The Laboratory has an anechoic chamber with internal dimensions of 4.52m x 5.44m x 2.45m high. In addition, the Laboratory houses sophisticated instrumentation such as multi-channel signal analyzer and sound and vibration transducers, transducers with adapters for mounting to a robot end effector and a number of grippers designed and constructed by students.

• ***Precision Engineering Laboratory***

The facility focuses on advancing the state of the art in the areas of precision machine design, precision robot design and precision manufacturing. Nano-precision sensors and actuators, as well as precision coordinate measuring machines provide powerful tools for research, development and education. Current experimental studies include the development of an innovative diamond wheel sharpening process at high-speed; a six degree-of-freedom robotic measuring system; precision industrial robot design and performance evaluation techniques; service robots; and ultra-precision fine-position systems for industrial robots.

• ***Robotics and Control Laboratory (RCL)***

The Robotics and Control Laboratory (RCL) provides experimental research support in advanced intelligent control of robotic systems with emphasis on nonlinear systems adaptive control, intelligent control, neural networks and optimization-based design and control. Projects include investigations on man-machine systems, telerobotics, haptics, robotic deburring and robust and adaptive motion, force and vision-based control. The major facilities consist of one PA-10 robot, a Phantom haptic device with GHOST development software, two PUMA 500s and several robotic arms. The PA-10 is equipped with

a JR3 wrist and an ATI base force sensor and a Sony eye-in-hand camera system.

• ***Thermal Engineering Laboratory***

The principal equipment in this Laboratory includes: a single cylinder CFR engine with dynamometer and data acquisition systems, a fully-instrumented oil-fired hot water furnace and a heat pump experiment and reciprocating air compressor setup. Modern emissions testing equipment and computer-aided data acquisition systems are available for student use.

• ***Thermodynamics Laboratory***

This laboratory includes a CFR engine set-up equipped with a custom made power controller and a fully computerized data-acquisition system, a two-stage, 10-hp, air compressor with inter-cooling instrumented with a computer-assisted data acquisition system, a hot water furnace experimental set-up and an educational version of a vapor-compression refrigeration/heat pump cycle. Modern emissions testing equipment and computer-aided data acquisition systems are available for use.

New Jersey Center for MicroChemical Systems (NJCMCS)

The New Jersey Center for MicroChemical Systems was recently established under the auspices of the New Jersey Commission on Science and Technology and with grants from several major federal government agencies such as the US Department of Energy and the Defense Advanced Research Projects Agency (DARPA). NJCMCS exemplifies the Stevens approach to doctoral education—students, faculty, and industrial partners work closely together, sharing ideas and nurturing technology from innovation to implementation.

NJCMCS uses a systems approach to design, manipulate, and control chemical reaction and separation processes that occur in micro-volume environments. This research area includes a broad range of new technologies such as microfluidic biochips for drug discovery, combinatorial catalyst evaluation, micro-reactor systems for on-demand chemical production and micro-power systems. The center's vision is to become a global leader in developing innovative micro-kinetic test and design methodologies for rapid microchemical systems development, demonstration and commercialization. In partnership with industry and government, the Center develops microchemical systems that can be used in miniature power devices, in on-demand chemical production facilities and in biomedical devices.

New Jersey Center for Software Engineering (NJCSE)

Members of the Computer Science Department hold a large grant from the New Jersey Commission on Science and Technology (NJCS&T), focused on research in software engineering aspects of networks and distributed programming. This grant is held jointly with New Jersey Institute of Technology (NJIT) and Rutgers University, New Brunswick.

The New Jersey Center for Software Engineering (NJCSE) was founded in mid-2000 as the corporate outreach (technology transfer) arm of this research activity. NJCSE is based at Stevens.

Academic institutions affiliated with NJCSE are Stevens Institute of Technology, New Jersey Institute of Technology, Rutgers University in New Brunswick, and Monmouth University.

NJCSE activities include regular technical meetings with Stevens, Rutgers and NJIT researchers, and industry representatives. Other activities include a Student Project Showcase and a Career Opportunities Program. As of January 1, 2001, Industry Affiliates

included Avaya, Telcordia, Rational and IBM. NJCSE offers companies state-of-the-art technical programs and early access to some of the best CS graduates in New Jersey.

New Jersey Institute for Trustworthy Enterprise Software

The New Jersey Institute for Trustworthy Enterprise Software was established by a grant from the New Jersey Commission on Science and Technology. The focus of the Institute is on improving the trustworthiness, reliability and security of enterprise software, particularly for distributed and Internet applications. The Institute comprises partners at Stevens, Rutgers University and New Jersey Institute of Technology. It is based at Stevens and is involved in the following research: secure electronic business, reliable Internet programming, saft components and componential programming, document processing, software design process and web engineering. The Institute is affiliated with the Laboratory for Secure Systems and the Software Engineering Laboratory, and has sponsored several research symposia in Trustworthy Software and Cybersecurity, held at Stevens. Further information is available at *http://www.njites.org*.

New Jersey Marine Sciences Consortium

Stevens is a member of the consortium which was established to provide resources for the conduct of marine science and engineering research in New Jersey coastal waters. The consortium maintains three research vessels, ranging from 25 to 60 feet in length, together with an extensive suite of oceanographic instrumentation, which is available for use by Stevens faculty and students. In addition, the consortium operates field stations at Sandy Hook and Seaville, NJ. Finally, the consortium serves as a focal point for bringing together diverse specialists to attack substantial interdisciplinary problems in the marine environment. Our faculty and students have participated in several large studies undertaken by the consortium.

Optical Communications Laboratory

Research is conducted in this Laboratory on optical communication systems and components with computer-assisted electronic and optical instrumentation. The properties of single-mode optical fibers, Er-doped optical fiber amplifiers, wideband optical transmitters and receivers, external cavity tunable semiconductor lasers, single-frequency laser diodes and fiber optic sensors are studied and tested using fast-pulsed lasers, signal synthesizers, spectrum analyzers, spectrometers and a wide variety of optical instruments. The effects of cabling and temperature on the propagation of optical signals are investigated. Ultra-high frequency fiber optic communication systems are being designed and tested for use in telecommunications and video leaks.

Physics and Engineering Physics Research Laboratories

The Physics and Engineering Physics facilities include the following:

- ***Laboratory for the Study of Electron-Driven Processes - Prof. K. H. Becker***

Electron collisions with atoms, molecules and free radicals; experimental and theoretical studies of excitation, dissociation and ionization processes; measurement of electron attachment and detachment cross sections and rates; collision induced emission spectroscopy; laser-induced fluorescence experiments; collision processes in low-temperature plasmas; atomic processes in atmospheric pressure plasmas; application of collisional and spectroscopic data to plasma diagnostic techniques; atomic, molecular,

and plasma processes in environmental systems; internal collaborations with the Center for Environmental Systems (CES) and the John Vossen Laboratory for Thin Film and Vacuum Technology; external collaborations with the Universität Greifswald and the Institut für Niedertemperaturplasmaphysik (Institute for Low-Temperature Plasma Physics), Greifswald, Germany and the Universität Innsbruck, Austria.

- ***John Vossen Laboratory for Thin Film and Vacuum Technology – Prof. A. Belkind***

  Basic and applied research in the field of plasma generation at low and atmospheric pressure, plasma diagnostics, and plasma implementation with particular emphasis on plasma-assisted deposition, surface cleaning, and environmental processes; special efforts are being devoted to the development of novel pulsed power plasma sources. Collaborations exist with industry (power supply and vacuum deposition system manufacturers) and, internally, with the Laboratory for the Study of Electron-Driven Processes and the Center for Environmental Systems.

- ***Solid State Electronics and Nanodevices - Prof. H. L. Cui***

  Theoretical research on quantum electron transport, resonant tunneling devices and optical devices; modeling and simulation of semiconductor devices and acoustic wave devices and networks; large-scale, massively-parallel simulations of MM-wave spectroscopes and fiber optical communication devices.

- ***Quantum Electron Physics and Technology - Prof. N. H. Horing***

  Quantum field theory of many-body systems; nonequilibrium and thermal Green's function methods in solid state and semiconductor physics and response properties; open quantum systems; nonequilibrium fluctuations; surface interactions; quantum plasma; high magnetic field phenomena; low dimensional systems; dynamic, nonlocal dielectric properties and collective modes in quantum wells, wires, dots, superlattices; nanostructure electrodynamics and optical properties; nonlinear quantum transport theory; magnetotransport, miniband transport, hot electrons and hot phonons in submicron devices; mesoscopic systems; spintronics; relaxation and decoherence in semiconductor nanostructures; nanoelectrical mechanical systems (NEMS); device analysis for quantum computations.

- ***Light and Life Laboratory - Prof. K. Stamnes***

  Atmospheric/Space Research including satellite remote sensing of the environment. Measurements of broadband and spectral radiation including solar ultraviolet (UV) radiation. Inference of cloud and stratospheric ozone effects on UV exposure. Numerical modeling of geophysical phenomena and comparison with measurements. Study of radiation transport in turbid media such as the atmosphere-ocean system and biological tissue.

- ***Photonics Science and Technology Lab - Prof. E. A. Whittaker***

  The theme of this laboratory is the development and application of laser-based methods for remote sensing, chemical analysis and optical communications. Techniques used include frequency modulation spectroscopy, laser vibrometry and free space optical communications. The laboratory is equipped with a wide range of laser sources and detectors, high frequency electronic test equipment, computer controlled measurement systems and a Fourier transform infrared spectrometer.

- ***Ultrafast Laser Spectroscopy and Communication Lab - Prof. R. Martini***

The realization of ultrahigh-speed communication networks at and above Terahertz bandwidth is one of today's most challenging problems, as the limiting factors are given by fundamental physical properties and laws. To overcome the restrictions, new concepts and materials have to be invented and utilized. In this laboratory we investigate the high-speed response of new lasers and materials, as well as passive and active optical systems using ultrashort laser pulses (<100fs) to develop towards higher speed networks.

In addition to this, the ultrashort laser techniques in this laboratory enable us to apply many different measurement techniques accessing the world of the "ultrafast." Time-resolved Terahertz (THz) spectroscopy setup, for example, gives us the unique ability to measure optical as well as electrical properties in this ultrahigh-speed frequency region and use it also for new and fascinating applications in this new "frequency world."

Samuel C. Williams Library

Service Philosophy

The S.C. Williams Library *(http://www.lib.stevens-tech.edu)* offers just-in-time service tailored to the needs of Stevens faculty, students and staff. This model maximizes use of Library materials and serves individual information needs.

Using networked computers, students, faculty and staff can access bibliographic and full-text databases to locate references to millions of books, articles, patents, theses, conference proceedings, technical reports and statistics. The databases are available 24 hours a day.

Information Services

Information Specialists are available to members of the Stevens community to do the following:

- assist in library research,
- visit departments for one-on-one or group instruction,
- teach students the effective use of library resources, and
- provide customized database searching by appointment.

Document Delivery Services

Through the Library's just-in-time service model, the Stevens community benefits from 24-hour on-campus and remote web-based access to subscription databases in diverse subject areas, including science and engineering, management and business, and the humanities. The Interlibrary Loan and Document Delivery department, conveniently located on the main floor of the Library, supports research needs by determining the most prompt method of retrieving documents and materials requested by faculty, students and staff.

Also, located directly across the Hudson River from Stevens is New York City, where important publishers, bookstores and major research libraries provide additional resources.

Cultural Services

The Library functions as a cultural campus center offering a wealth of artworks, mechanical models, special collections and musical recitals. The Library's art collection includes two works by Alexander Calder, a 1919 Stevens graduate: the "Stevens Mobile," created and presented by Calder, who developed this art form, is exhibited in the three-

story Great Hall; a jagged black metal stabile, "Hard to Swallow," stands on the second floor.

"Safari," a mural by Pierre Bourdelle, an internationally renowned craftsman and teacher, is exhibited above the Information Services area. His cast aluminum "American Spread Wing Eagle" adorns a south-facing exterior wall. A stunning three-part gilded bronze work designed by American sculptress Mary Callery, called "Moon and Stars," hangs over the entrance portico. On the great lawn is Anna Hyatt Huntington's magnificent sculpture, "The Torch Bearer."

Special Collections

A collection pertaining to Leonardo da Vinci is one of the finest accumulations of manuscripts, notebooks and drawings in facsimile available for the use of scholars, media professionals and humanities students.

The Library also houses manuscripts, drawings, artifacts and monographs by and about Frederick Winslow Taylor, Class of 1883, who originated Scientific Management. Furniture from Taylor's home is also included in the collection. Additional holdings of the Library include the Stevens archives, the original construction drawings for the Civil War ironclad U.S.S. Monitor, and treasures from the Stevens family 1854 "Castle." The four-story Library building, a showplace in library architecture, was designed by Perkins & Will. It is dedicated in memory of Samuel C. Williams, Class of 1915.

Software Engineering Laboratory

The Laboratory for Quantitative Software Engineering, supported by a grant from the New Jersey Commission on Science and Technology and by affiliates of the New Jersey Center for Software Engineering, has several Windows and Linux workstations connected by Ethernet and wireless LANs. The Lab is affiliated with the New Jersey Institute for Trustworthy Enterprise Software.

The Lab's use is two-fold:

First, it is used by students in the required two-semester Senior Design sequence. Their projects are more profitably implemented on networked workstations than on personal laptops, with which all Stevens students are equipped. A special feature of the Senior Design course is that it uses a novel pedagogic methodology entitled "Live-Thru Case Histories." Further development of, and the study of, the efficacy of the Live-Through Case History Method, are being studied under grants from the New Jersey Commission on Science and Technology and the National Science Foundation, in part with the aid of custom software being developed in the Lab.

Second, as affiliates of both Prof. Barry Boehm's University of Southern California Center for Software Engineering and of the DOD-sponsored CEBASE (Center for Experimentally-based Software Engineering) led by Prof. Boehm and Prof. Victor Basili of the University of Maryland, the Software Engineering Lab's faculty are using the lab for experimentation in software engineering technologies and methodologies. Subjects of these studies include high-reliability software, methods for avoiding the need to perform full-scale defect detection and elimination, and modern agile software development practices pair programming, refactoring, etc.

Stevens Alliance for Technology Management

The Alliance is an industry-university partnership under the auspices of the Wesley J. Howe School of Technology Management at Stevens Institute of Technology. It was founded in 1991 to identify, disseminate and facilitate the deployment of more effective

practices for the development and utilization of technology. Current Alliance Sponsors, in addition to Stevens Institute, are AT&T, Bestfoods, ExxonMobil Research and Engineering, ISO, Lucent Technologies, Pershing, Teknor Apex and the US Army Research, Development, and Engineering Center. Past Sponsors have included AlliedSignal, Bellcore, Engelhard Industries, GTech, IBM, Merck, and SIAC.

Visualization Laboratory (VLAB)

Research in the VLab falls under the general areas of visualization, computer graphics and computer vision with applications in medical imaging and diagnostics, cell biology, scientific computing, robotics and computational finance. Current research projects include the development of new geometric methods and efficient computational algorithms for representation, recognition and visualization of surface shapes and shape deformations, and for pre-compression data reduction in visual data communications.

The VLab is part of the mV2 (multimedia vision and visualization) group, and has close ties with the Vision Lab at Stevens.