Capital Connections
More than 2,000 alumni are making their mark on Washington
two new post-professional degree programs accepting students for the fall of 1998

Exposing students to an interdisciplinary investigation of architecture, building science, facility management, and computational systems, The Intelligent Workplace degree program offers students the opportunity to gain extensive knowledge of the design systems of advanced workplaces. These design systems will be positioned to investigate the impact of intelligent workplaces on architecture, building economics, and productivity. The curriculum, culminating in either a post-professional Masters of Architecture or Master of Building Science degree, stresses creative research and design-based work, emphasizing the unique challenges and opportunities of designing, prototyping, and evaluating tomorrow's intelligent workplace.

www.rpi.edu/dept/arch/TIW

THE INTELLIGENT WORKPLACE
INFORMATICS AND ARCHITECTURE

www.rpi.edu/dept/arch/IA

Providing a strong foundation in both theory and practice, degrees in Informatics and Architecture will prepare students with professional backgrounds for advancement in both academic research and professional development. Graduates will have developed an informed and critical knowledge of the latest computational systems available, and will be empowered to advance themselves and their profession together. The program offers both a post-professional Masters of Architecture and a Masters of Science, both in Informatics and Architecture, for professionals interested in advanced explorations of computer technology in their practice and for technologists interested in the role technologies play in the design of their architectural surroundings.
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Global Engineering: A Model for the Future

Early this year, leaders in education and industry met in Seattle at the headquarters of The Boeing Company. Their mission: to discuss issues and concerns about the future of the engineering profession and engineering education. Out of that brainstorming “summit” emerged projections about the future of engineering in a global marketplace, and a proposed educational model to support industry’s need for well-prepared engineering professionals in the 21st century.

The following article, written by R. Byron Pipes, Rensselaer president, and Philip M. Condit, president and chief executive officer of The Boeing Company, was published originally in the October 1997 Issues in Science and Technology, the policy journal of the National Academies of Science and Engineering.

et’s establish some basic principles. First, business is going global. Information and capital flow quickly and copiously without respect to borders. Skilled workers and industrial infrastructure can be found in a growing number of countries. Corporate nationality is becoming less relevant as all the components of a business become portable.

Second, global engineering work can be carried out anytime, anywhere. Centralized, monolithic engineering operations will give way to integrated project teams (IPTs) that will incorporate workers from across the globe. Work will be handed off “down-sun” in sequence to team members around the world, so that work on individual tasks progresses continuously around the clock.

Third, the profile of the global engineering work force will be driven by the changes in engineering practice just described. Global skill levels will rise, and Americans will comprise a smaller percentage of the engineering work force. Employers increasingly will hire not degrees per se but knowledge, capabilities, and skills; and, they will have reliable ways to test for standards of knowledge and skill.

As leaders in industry and academe, we have seen numerous reports about improving engineering education. By and large, they call for little more than minor adjustments or additions to current programs. Recognizing that tinkering at the margins would not be enough to meet the challenge of the changing industrial structure, we jointly convened a “summit” of leading industrialists and educators, who spent two full days in intensive exploration of the forces affecting the engineering profession at the beginning of the 21st century and what this means for the profession. The aim was to formulate a new model of multinational companies and the global engineer.

The result of this brainstorming session was a new “Model of the Global University.” Here again, some basic principles must be set forth. First, in the global environment we just described, academe and industry will converge. Just as industry follows the market, universities must follow industry, locating campuses close to the customer, around the world. Just as industry molds its organization

President Pipes recently visited an Analog Electronics class in the new Hewlett Packard studio classroom
and its product offerings to the needs of the customer, so the academic organization will reconfigure itself to conform to the educational needs of students, with a particular focus on practicing engineers and scientists.

To say that industry and academy will converge is not to imply that they will merge. The mission of the university will continue to revolve around basic research; broad education; the maintenance and dissemination of knowledge in an organized fashion; and a focus on educational processes and technologies.

Second, education will become continuous. For the global engineer, education is a continuum, not just a period of formal learning. As engineers mature personally and professionally, most find that they first require broader knowledge of other scientific and technical disciplines, then management skills, and ultimately the kind of wide-ranging humanistic knowledge that leads to greater personal development.

Third, educational standards will become more important. With engineers working on decentralized teams, with hiring decisions being made remotely, with education being delivered at remote campuses, the ability to reliably convey and recognize specific capabilities will become crucial. Recognized standards of educational delivery and achievement will be the academic equivalent of product quality assurance, going far beyond today's broad accreditation criteria.

The model of the global university is a logical response to these changes. In this vision, the university reshapes itself structurally to resemble its primary client, industry. The central core campus is still responsible for basic education of entry-level students, for fundamental research, and for management of the systemwide research and education enterprise. But much of the actual delivery of the educational product occurs at branch campuses and remote sites around the world that are located in close proximity to large industrial sites and areas of major industrial activity.

Each branch campus is a regional institution serving either a single large corporate customer installation or a cluster of companies. It provides educational programming to non-technical personnel such as managers as well as to scientists and engineers. Classroom formats can include interactive faculty-led, faculty-facilitated multimedia, and distance learning with and without an on-site instructor. Classes are open to local undergraduates and "transfer" students from the central campus as well as to company personnel. In addition to training students, the branch campus provides "technology park" facilities and services tailored to the needs of local industry customers.

This working industrial interface also allows the branch campus to provide educational "raw material" that is generalized and codified into educational programming at the central campus, industrial experience and project teaming opportunities for students and faculty from the central campus, and a conduit for industrial practitioners to participate in education as instructors, curriculum developers, and mentors.

Each remote site is a small-scale learning center focused on the educational needs of a single corporate customer. It provides multimedia access to educational programming as well as some advanced instruction by faculty as appropriate. It may be collocated with the customer.

Branch campuses and remote sites alike can be located anywhere in the world. Both are equipped for distance learning and can be networked into central campus multimedia educational programming. Faculty and students as well as educational material such as courseware flow into and out of the central campus, and to a lesser extent between branch campuses and remote sites.

The university will serve as a clearinghouse for knowledge and will certify educators who can organize and impart that knowledge in the most effective way possible. Thus, as the university makes the transition into the global model, the effect will be to provide a new dimension of educational support for the global corporation. That new resource will strengthen the global corporation, either to commercial service providers or to other universities, is one possible response to this specialization.

Collaboration on the granting of academic degrees by universities will increase at the same time that emphasis on degrees by industrial employers will diminish. With greater standardization of the educational product, educational content will be more uniform and grading more objective. Education can be tailored to the individual, and the details of an individual's educational itinerary will present an accurate composite profile of the person.

The involvement of more industrial practitioners directly in the delivery of engineering education, although highly beneficial for education, will also alter the employment patterns and profiles of faculty. Tenure policies will be affected, and alternative academic employment patterns will emerge.

As the demand by industry for this new dimension of educational support grows, those universities that adapt to meet the demand will thrive; those that do not will become less and less relevant. Over time, then, it is likely that the number of academic engineering programs in the United States will decline.

Other potential implications may be envisioned, and undoubtedly many surprises await. But we believe that the model will work—and work well. More than that, we believe it must be pursued. Global engineering is already a reality. Engineering education and the education system must adapt to that reality.
Broadcast Kudos

In the Biz
In September, we wrote about several Rensselaer alumni who are applying their technological training behind the scenes in the world of television. We asked other alumni in the industry to tell us a bit about their own careers. Following are excerpts from some of the responses we’ve received. To see the full text, visit our online magazine at http://www.rpi.edu/NewsComm/Magazine/dec97/followups.html

What a delight to read the September Rensselaer alumni magazine article on my friends and former colleagues in the television industry. Before I retired in 1993, I was part of that group. As a vice president of Tektronix Inc., I supplied television broadcast equipment and participated on the board of the Society of Motion Picture and Television Engineers. Of course, as a member of the Class of ’60, I was the old man in the crowd, sometimes categorized with Allen B. Du Mont on the age scale.

Each year, at the annual convention of the National Association of Broadcasters, Monday night dinner was reserved for the RPI alumni. Even though the current state of the industry was discussed, the conversation always drifted back to days at WRPI...

Steve Kerman ’60
sdkerman@hevanet.com
Portland, Ore.

When Charlie Jablonski said, “If you’ve watched TV today, you’ve seen RPI,” it was not an overstatement.

I too am a WRPI alumnus (’80-’84), serving as president ’81-’82. I’m surprised no one mentioned Tom Dewitt or VideoLab, which was down the hall from WRPI. This is where a lot of us really got to play with video.

Thanks again for stirring up fond memories.
Fred Gotwald, P.E. ’84
fgotwald@nv1.com
San Diego, Calif.

I was an announcer/producer at WHAZ-AM, the school’s first station, from 1946 to 1949, located atop the Sage building... I joined the Du Mont Television Network in 1948, the first year of commercial television station operation, and was fortunate to be involved in most of the early activities of that “new” medium. After several twists and turns, Du Mont became Metromedia, one of the leading group broadcasters in the 1960s and ’70s.

I left Metromedia to restructure an ailing communications conglomerate, and then in 1971 founded the first of the Broad Street Companies [which] owned and operated a number of radio stations and CATV systems...

After 50 years, it’s time to watch the scene from the sidelines, although I am active in trying to keep up with the world of cyberspace and the new forms of electronic communication.

Dick Geismar ’49
Riverside, Conn.

Regarding the articles about 40 years of WRPI in the September 1997 issue, it was a shame you couldn’t have gotten in a comment or two pointing out that WRPI, lively that it was and is, was not the first radio station on campus. It was preceded by many years (at least 20, if not more) by WHAZ, an AM station affiliated with the Mutual Broadcasting System. WHAZ went on after sundown and off the air at midnight. The license was held by faculty members in the Department of Electrical Engineering. The studio was in the Sage Building as was the transmitter. The antenna was strung between the towers on the roof of the Sage Building.

As for your request as to what we think about your new look, it ain’t bad. I personally don’t think it’s that great, but it ain’t bad.

Alumni Giving Affects Rankings

I urge all of my fellow alumni to contribute to the Rensselaer Annual Fund. Here is why.

Many national college and university ranking services use alumni giving rate as a criterion when scoring institutions. Throughout the years, RPI has done fairly well in all categories except alumni giving.

The Sept. 1, 1997 issue of U.S. News & World Report gives RPI an overall ranking of 48 but an alumni giving ranking of only 82. Alumni giving rate counts for only 5 percent of their score, but the scores are so tightly bunched that a substantial increase in giving would boost RPI a few notches.

College rankings are somewhat subjective. Nevertheless, they are hung out there for the public to see. And they do influence the views of prospective RPI students.

If you would like to see RPI improve in rankings, please contribute regularly to our alumni fund. Alumni giving shows that we care about our alma mater.

It isn’t how much we give that affects our ranking. Rather, it’s the percentage of us who give. Let’s work toward 100 percent giving and a few notches higher in the national collegiate rankings.

Jay B. Winderman ’62
Claremont, Calif.

In order to provide space for as many letters as possible, we often must edit them for length. Please address correspondence to: Rensselaer Magazine, Office of News and Communications, Rensselaer Polytechnic Institute, 110 Eighth St., Troy, NY 12180, or e-mail at alum.mag@rpi.edu, or call (518) 276-6531.
It's the Shoes!

Rensselaer's football team made the most of a picture-perfect fall day as the Engineers reclaimed the Dutchman's Shoes trophy for the first time since 1992 with a 30-7 victory over Union at '86 Field Oct. 18.

A well-attended Fall Alumni Weekend crowd cheered the team from the stands, and Rensselaer's mascot, Red Hawk, parachuted onto the field during the half-time ceremonies (see Alumni News, page 29).

The rivalry between Rensselaer and Union — the oldest in New York state and the eighth oldest in the nation — saw its first game played in 1886, although the two teams did not begin battling for the Dutchman's Shoes trophy until 1950. Union holds a definitive edge in the series, with a 71-20-4 series lead.

This year's game featured several memorable performances on the gridiron, including 222 yards in the air and three touchdown passes from sophomore quarterback Matt Robbens. Two of those touchdowns were caught by junior split end Tim Jordan, who finished the day with nine receptions for 90 yards. Senior tailback Dan McGovern wound up with 107 rushing yards and 44 receiving yards, while scoring the first touchdown of the day — a 37-yard catch on the first play of Rensselaer's first possession — as well as rushing nine yards for a touchdown with 33 seconds left in the game. The defense came up big as well, including a sack by senior defensive tackle Glenn Arnold that resulted in a safety.

The Dutchman's Shoes was actually the second trophy the Engineers regained this season. A week earlier, Rensselaer defeated WPI 37-16 to claim possession of the Transit Trophy for the first time since 1994. The game was tied at 16 at halftime before the Engineers' defense, and in particular sophomore Matt Vittengl, came through with some clutch play. Vittengl picked off a pass and ran it back for a touchdown, then returned a fumble 24 yards for another score. Offensively, senior tailback Krishaun Gilmore gained 227 yards and one touchdown on the ground.

With an 8-1 record at press time, the Engineers have had their best season in the program's history. They captured the UCAA Championship and were granted a bid to the ECAC Championship for the fourth time in six years.
Milestones

**Joseph Ecker**, professor of mathematical sciences and of decision sciences and engineering systems and acting dean of the Lally School of Management and Technology, has been named Edward P. Hamilton Professor of Science Education. The professorship was created in 1975 with gifts from Edward P. Hamilton '07 “to encourage excellence in education in all fields and at all levels at Rensselaer by recognizing and rewarding an outstanding faculty member and providing that faculty member with resources to pursue the development of new programs.”

**Boleslaw Szymanski**, professor of computer science, has been named associate dean of science for information technology. In the newly created post, Szymanski will lead School of Science participation in the new Institutewide initiatives in information technology.

**Linda Schadler**, assistant professor of materials science and engineering, received the Bradley Stoughton Award for Young Teachers from The Materials Information Society “in recognition of excellence in the teaching of materials science and engineering with emphasis on design and processing and for the ability to serve as a role model for future engineering educators.”

(continued on page 7)

**RANKINGS**

**Rensselaer Moves Up in U.S. News**

**U.S. News & World Report** ranked Rensselaer as one of the top 50 national universities in its 11th annual “America’s Best Colleges” issue and guidebook published in September.

Rensselaer, which was listed in the second tier last year, climbed into 48th place this year. Rensselaer was also listed 30th on the magazine’s “best value” list, a category that considers the cost of attending top-ranked schools.

In a new category this year, **U.S. News** listed the schools with the highest percentage of business, education, and engineering majors, noting that these are the areas in which job opportunities are best. Rensselaer placed 10th on the engineering list, with 63 percent of its students majoring in engineering.

**U.S. News** considers 1,400 colleges and universities in compiling its “Best Colleges” rankings. Criteria for national universities include academic reputation, retention, faculty resources, student selectivity, financial resources, value added, and alumni giving rate.

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**Data Base**

**Left Out in the Cold?**

It’s January and the parking is easy. Only 196 visitors parking passes were requested in January, compared with 534 the previous October.

A 1,140-foot vertical drop is the challenge facing ski club members. About 450 members of the ski club, Rensselaer’s largest winter club, will head to Jiminy Peak to tackle the challenge of New England’s steepest night terrain.

Last year, Health Services on campus doled out 1,450 flu shots. This year, they’re shooting for 1,600.

The folks in Undergraduate Admissions stay warm through the cold winter months by carrying in applications. Admissions received 79.5 percent of their applications between Dec. 15 and the end of January. Last year, 3,720 applications flew in the door as the snow was flying.

According to the New York state code, the design snow load for a nominally flat roof in Troy, N.Y., is 45 pounds per square foot (psf). This corresponds to about 27 inches of snow on the roof.

Snowfall and temperature data for Capital Region from the National Climatic Data Center. Figures are for the last 50 years.
Physicists Make Exotic Discovery

Physicists from Rensselaer and other scientists working at the U.S. Department of Energy's Brookhaven National Laboratory have found evidence of a new and rare subatomic particle, called an "exotic meson" (pronounced mezzone). The finding helps validate the central theory of modern physics, called the standard model.

The team of 51 researchers, led by physicists from the University of Notre Dame and including scientists from Brookhaven, Rensselaer, and five other institutions, found the particle evidence after five years of needle-in-a-haystack searching through the reaction products of billions of particle collisions at Brookhaven's Alternating Gradient Synchrotron (AGS) accelerator. Their paper is published in the Sept. 1 issue of Physical Review Letters.

"People have been looking for exotic mesons since the 1970s," says Jim Napolitano, associate professor of physics and one of the researchers involved in the project. "We believed theoretically that these particles existed. Now we have the most convincing evidence to date that our theory is correct."

"When physicists do experiments, what we are after is the existence of matter and the rules by which matter interacts," says Gary Adams, professor of physics and leader of the Rensselaer research team. "If our theory is right, it will agree with the physical observations. If it doesn't, we have to give up our beliefs or modify our theory."

"To find evidence of a particle that has never been detected before, and one that's so important to our understanding of elementary particles, is hugely satisfying," said Brookhaven's Sub-Urk Chung.

Chung explained that the collaborators' experiment, known as E852, closely examined each of the particles produced when an 18-billion-electron-volt AGS particle beam hit a target of liquid hydrogen in an instrument called the Multi-Particle Spectrometer. The physicists then weeded out possible exotic mesons from the billions of particles produced in the target, and analyzed their results using sophisticated statistical techniques.

Rewarding Student Invention

Five student teams at Rensselaer have received grants from the National Collegiate Inventors and Innovators Alliance (NCIIA) to help commercialize their classroom design projects.

The NCIIA is an interdisciplinary program administered by the Jerome and Dorothy Lemelson Foundation to foster and promote the teaching of invention, innovation, and entrepreneurship. The program supports educational programs and student projects. Central to its vision is the formation of E-Teams (E for excellence and entrepreneurship) comprising students, faculty, and mentoring professionals.

"The NCIIA program is quickly becoming a key ingredient in Rensselaer's program in technological entrepreneurship," according to Burt Swersey, lecturer in mechanical engineering.

Two student projects from the senior-level Design of Mechanical Systems (DMS) course, and three from the sophomore-level Introduction to Engineering Design (IED) received grants.

"Innovation requires highly motivated students," says Swersey. "The prospect of receiving outside funding toward the patenting and commercialization of student projects has helped to increase the motivation and dedication of our students."

A team in a DMS section taught last year by Joseph Pegna, assistant professor of mechanical engineering, received $12,000 to continue development of their improved design of an overhead projector. A new light source remains cool, eliminating the need for a fan and lowering operating costs.

A group in Swersey's DMS section received $14,895 for an improved fabric permeameter, an instrument used in quality control and research in the paper and fabric industries. The team used sophisticated computer simulation to model and redesign the instrument, and members are now adding sensors and micro-

Milestones

(continued from page 6)

Thierry Blanchet, assistant professor of mechanical engineering, aeronautical engineering, and mechanics, received the 1997 STLE (Society of Tribologists and Lubrication Engineers) Walter D. Dodson Award for a paper on his work on modeling wear in composite bearings.

Allan Greenwood, the Philip Sporn Professor of Electric Power Engineering, received the 1996 Rayleigh Prize from the Institution of Electrical Engineers in London for his book Vacuum Switching, described as "an extremely valuable and authoritative text."

Herta R. Leng, age 94, died July 17 at St. Mary's Hospital in Troy after a brief illness. She received her Ph.D. in physics in 1926 and a teaching degree in 1930 from the University of Vienna. Leng began her 25-year career at Rensselaer in 1943 as an associate professor of physics and was named Rensselaer's first woman full professor on July 1, 1966— a position she held until her retirement in 1968.

(continued on page 9)
Milestones (continued from page 7)

Shyam Murarka, director of Rensselaer’s SRC (Semiconductor Research Corporation) Center for Advanced Interconnect Science and Technology, has been named a fellow of the Electrochemical Society. The award honors “individual contributions and leadership in the achievement of science and technology in the area of electrochemistry and solid state sciences.”

Michael Podowski, professor of environmental and energy engineering and director of the Center for Multiphase Research, was elected a member of the Board of Directors of the American Nuclear Society in July.

Mark Shephard, the Samuel A. Johnson ’37 and Elisabeth C. Johnson Professor in Engineering, received the Computational and Applied Sciences Award of the U.S. Association of Computational Mechanics. The award was given “in recognition of outstanding and sustained contributions to the broad field of computational and applied sciences.” Shephard is director of Rensselaer’s Scientific Computation Research Center.

Michael Waecholder, director of the Rensselaer Technology Park and the Office of Economic and Technological Development at Rensselaer, was recognized with the Career Achievement Award from the Association of University-Related Research Parks at its annual conference in

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processors and preparing a patent application.

An IED team designed a climbing wall they believe will be "the ultimate exerciser" and received $15,500. The team, advised by Swersey, used part of the money to analyze the sporting goods industry and expects to file a patent application by Dec. 1.

Another of Swersey’s IED teams received $5,850 for continued development of a mini-"Zamboni" that can be used to resurface small ponds and ice rinks. The team is improving the design this year in an independent study project with Swersey.

An IED team advised by William J. Foley, clinical associate professor of decision sciences and engineering systems, received $6,000 for the "Sidewinder," a wheelchair that can move in all directions to enable physically challenged players in basketball and other sports to have a better experience. The team completed patent searches this summer and will be applying for a new grant to improve the design.

CIVIL ENGINEERING

Learning By Doing

FOURTEEN RENSSELAER CIVIL engineering students spent a week in Baltimore, Md., this summer designing a commuter rail station. The students, all seniors this year, were hosted by KCI Technologies Inc. in the inaugural session of the Admiral Lewis B. Combs '16 Memorial Design Retreat, sponsored by Rensselaer alumni.

The idea for the annual retreat grew out of talks with civil engineering alumni, explained George List, chair of civil engineering.

"One thing struck me as being unique about alumni who graduated during the late '50s and early '60s," List says. "They forged friendships that have lasted throughout their professional careers. They all had participated in surveying camp, and this served as a bonding experience."

List and key alumni discussed ways to provide a similar experience for today’s civil engineering students. The result was a retreat that honors the memory of Combs, founder of the U.S. Navy Seabees and former head of Rensselaer's Civil Engineering Department.

Jack Kinstlinger '52, chairman of Rensselaer's Civil Engineering Advisory Board, is chairman of the board and chief executive officer of KCI Technologies. With his help, the first retreat was planned for Baltimore, where the students were asked to design a commuter rail station, based on parameters used to design and build an actual facility. At the end of the week, the students visited their model — the award-winning Dorsey Commuter Rail Station.

"The retreat was successful in building and strengthening friendships among the students," List says. "The students presented design solutions that won praise from a number of practicing engineers and users of the station, including David Winstead, secretary of the Maryland Department of Transportation," List adds. "This shows the strength of their Rensselaer training."

Staying Connected

Rivals Meet at Big Red Freakout

This year's Freakout on Jan. 31 features a clash between RPI and cross-town rival Union College. The action begins with Big Red Freakout Ice House at the Heffner Alumni House, featuring a buffet dinner, face-painting for the faithful, and lots of pre-game excitement. At the post-game victory party, fans can meet the team and enjoy hot drinks and dessert. Make your reservations for Ice House now — it's always a sellout! Contact Peter Pedone at (518) 276-6061 or pedone@rpi.edu to register.

Answering the Call

The Rensselaer Annual Fund's volunteer phonathons are taking the country by storm! The amazing totals are in for the following cities: Syracuse ($53,810); Long Island ($37,000); Delaware Valley ($55,585); New York City ($53,474); New Jersey ($48,178); Houston ($21,076); Capital District ($37,992); Boston ($50,749); Baltimore ($65,600); Washington, D.C. ($13,700); Westchester ($76,479); Rochester ($20,700); and Hartford ($125,713), with a few more scheduled after press time. Still on tap: the MBA Phonathon (Feb. 23) and the RAA Phonathon (March 5). If you’re interested in helping out the Annual Fund by making calls, contact Terri Van Patten at (518) 276-6068 or vanpatt@rpi.edu.

Read All About It!

The RAA publishes a newsletter for alumni volunteers three times a year. The Approach features articles on volunteer opportunities and successes, and gives you the tools you need to be effective in your volunteer role. If you currently don’t receive The Approach and would like to, contact Ellen Johnston at (518) 276-6068 or approach@rpi.edu.
Milestones
(continued from page 8)

Monterey, Calif. The Tech Park also was recognized with the association's first-ever Technology Transfer Award, acknowledging the role that research parks and incubators play in the process of transferring technology from the lab and nurturing it into a viable and growing business.

Wilfredo Colon, assistant professor of chemistry, is one of only 11 young professors at American universities to receive the Dreyfus New Faculty Award. The highly competitive award, which includes $25,000 for each scientist to start a research program, was awarded to new faculty members at Princeton, Stanford, Harvard, and other leading universities. Colon joined the Rensselaer faculty Aug. 1 following postdoctoral research as a National Science Foundation Fellow at Fox Chase Cancer Center.

Rena Bizios, professor of biomedical engineering, has been invited to serve as a member of the Surgery and Bioengineering Study Section, Division of Research Grants, for the National Institutes of Health (NIH). Her term runs from July 3, 1997, to June 30, 2001. Study sections review and make recommendations on grant applications submitted to the NIH, and survey the status of research in their fields of science.

MINDS AND MACHINES
It's Not Just Programming Code

INCOMING STUDENTS TO A new degree program at Rensselaer can expect to change the world by creating the future. The Minds and Machines program will teach students how to make smarter machines — and how to design the machines that make people smarter.

"We see an exploding demand for machine systems that are so sophisticated they can interact with people on their own terms," says Selmer Bringsjord, director of the Minds and Machines program that begins next fall. "Minds and Machines is about building, deploying, and managing smart machines like robots, softbots, androids, cyborgs, immobots.

And it's about machines that make us smarter. This might be an adaptive and intelligent computer interface like a Web browser smart enough to learn what the user wants to experience and find it autonomously, systems that enable telepresence, and intelligent Internet searchers, to name a few.

"Minds and Machines is a degree program that students at most colleges can only dream of," says Bringsjord, associate professor of philosophy, psychology, and cognitive science. "Students won't just be writing code, they'll be dissectiong everything from human evolution, to Buddhism, to artificial intelligence in order to understand how humans interact with machines." The program will offer a bachelor of science degree and a one-year master's degree.

As industry and government increasingly produce and deliver their products and services in computer-mediated environments, the demand is increasing for people who understand human intelligence, machine intelligence, and the social and organizational aspects of the interface between human and machine systems.

The Office of Technology Policy of the U.S. Department of Commerce estimates that there are 190,000 unfilled technology jobs in mid- to large-sized U.S. companies.

According to a recent survey conducted by the Information Technology Association of America, jobs in this area are exploding with starting salaries ranging from $75,000 to $100,000.

Alumni Datebook

Feb. 13, 1998
Satellite Hockey
Live satellite broadcast of the RPI vs. Clarkson game to sites around the country. See "Directory of Services" on pg. 48 for locations. Contact Pam Rose '95 at rosep2@rpi.edu or (518) 276-2567.

June 4-7, 1998
Reunion '98
Attention, classes ending in 3 or 8! Mark your calendars for your special Reunion. If you didn't receive a Reunion '98 newsletter with this issue of the magazine and you'd like one, contact Valerie Beck at beckv@rpi.edu or (518) 276-6206.
Rensselaer at Hartford

Sign of the Times

On Sept. 11, a new sign bearing the name Rensselaer at Hartford was hung atop the building formerly known as the Hartford Graduate Center.

In 1955, rapidly changing technologies in the aircraft and defense industries created the need for graduate education for professionals in Connecticut. At the urging of the United Aircraft Corporation (now United Technologies), Rensselaer established a branch campus in Hartford.

The center became independent in 1975, but continued to offer Rensselaer programs under a licensing arrangement. Last December, trustees of both Rensselaer and the Hartford Graduate Center voted to transfer Hartford’s assets into a corporation that Rensselaer controls. Under the new arrangement, Hartford has its own board of trustees named by the Rensselaer president while the former Hartford board and new appointees assume an advisory role.

As part of the change, the Hartford campus offers M.S. and MBA degrees from the Lally School of Management and Technology.

“I think our future will be a number of campuses very much like the Hartford campus, spread around the globe... Hartford will be a model,” said Rensselaer President R. Byron Pipes.

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Archives

A New Approach

Alumni of all ages surely remember The Approach, a neoclassical stairway of solid granite blocks and Ionic columns just below Eighth Street. While graduates of more recent years probably remember it as a crumbling remnant of the past, those of earlier generations look back fondly on The Approach as a direct link to downtown Troy.

After the great fire of 1904 destroyed Rensselaer’s Main Building and threatened to close the school, city leaders from Troy expressed their solidarity for the Institute by commissioning a monument linking the campus physically and symbolically with Troy’s thriving downtown. In 1907, The Approach, as the monument came to be known, was dedicated with fanfare and public celebration.

The massive stairway provided easy access from the new campus above Eighth Street to the railroad station, to the commercial areas of the city, and to student rooming houses. After World War II The Approach gradually fell into disrepair. From time to time efforts were begun to rebuild it, but declining city finances, coupled with the changing shape of Rensselaer’s campus and even the city itself, discouraged the renovations.

In 1996 Rensselaer County was awarded a HUD Small Cities Development Block Grant to begin restoration of Troy’s historic riverfront district. Included in this grant is partial funding for the rebuilding of The Approach, which will become the eastern terminus of the Broadway corridor leading to the Hudson River. The Institute, the Louis and Hortense H. Rubin Foundation, and the Rensselaer Alumni Association have also committed funds to the project.

Fund-raising is under way. It is hoped that the renovations will begin in the spring, with completion by summer’s end. To contribute to the project or to learn more, contact Bruce Matthews at (518) 276-6054 or matthew@rpi.edu.
Politics, culture, and a thriving business climate have attracted more than 2,000 Rensselaer alumni to our nation’s capital

By Margaret M. Knight

In the 1824 presidential election, none of the candidates received the required majority of electoral votes. The contest moved to the House of Representatives, and on Feb. 9, 1825, delegates from the 24 states gathered to choose a chief executive from the three remaining contenders.

For two months, supporters of all three men exerted intense political pressure on the representatives. None endured more pressure or suffered greater indecision than one member of the divided New York delegation. The House vote hinged on the New York delegation, and the New York ballot would be determined by “the old Patroon” Stephen Van Rensselaer. With an agonized vote for John Quincy Adams, Stephen Van Rensselaer decided the election.

But if Van Rensselaer was indecisive about the election, he was firmly resolved to establish a new institution. Two of his letters became the “constitution” for the Rensselaer School. The first was written on Nov. 5, 1824. He posted the second from Washington, two days after his momentous vote in the House.

Thus began a connection between what would become a great technological university and the nation’s capital city. Today, more than 2,200 Van Rensselaer “descendants” live and work in Washington. They are engineers, educators, scientists, athletes, politicians, attorneys, and entrepreneurs.

“I love Washington—this is my home—and I’m glad to be back,” Janet Rutledge ’83 says. “Growing up around an obsession with politics made it part of my blood, so I like being where it’s front-page news.”

Rutledge returned to Washington two years ago for a short-term assignment with the National Science Foundation while on the faculty of Northwestern University. She welcomed the change. “I love the lush greenery. I think the cold in Chicago was warping my personality.”

On Sept. 1 she made the move permanent and accepted a position as research associate professor, otolaryngology-head and neck surgery, at the University of Maryland Medical System. For the next two years she’ll continue working at the NSF and pursue her research one day a week in Baltimore. But “my heart is in academe,” she says, and when the NSF contract expires, she will go back to full-time faculty status.

Despite the hiatus from teaching, Rutledge has remained deeply involved in education. She is a Rensselaer trustee, and, as a program director in the NSF Division of Engineering Education and Centers, she is in charge of NSF-funded research experiences for undergraduates at schools across the country.
The rotunda in the U.S. Capitol
In addition to the people in this article, there are many Rensselaer alumni who are affiliated with the federal government in Washington. Here are just a few:

Richard Chait '59, laboratory management director, Research & Technology, Department of the Army
Robert Hanfling '59, president, Robert I. Hanfling Associates; senior adviser, Putnam, Hayes & Bartlett; member of the Department of Energy Advisory Board (along with Rensselaer President R. Byron Pipes)
Louis Ianniello '54, associate director for basic energy sciences in the Office of Energy Research in the Department of Energy
P. Patrick Leahy '79, chief geologist and chief of the Geologic Division, U.S. Geological Survey
John Olver '55, U.S. Congressman (D-Mass.)
Rob Suminsby '81, U.S. Air Force Major, executive assistant in the Office of Current Readiness and Capabilities, Joint Chiefs of Staff
Barry Valentine '66, assistant administrator for policy, planning, and international aviation, Federal Aviation Administration
Kathryn Zoon '70, director, Center for Biologics Evaluation and Research, Food and Drug Administration

“Knowing that I will spend most of my life trying to get money for my work I’ve found it very interesting to understand the whole funding process,” Rutledge says.

On July 31, 1997, Art Gajarsa '62 moved beyond the reach of politics. “That’s the value of an independent judiciary,” says the newly confirmed judge of the U.S. Court of Appeals for the Federal Circuit. “It’s a lifetime tenure.” But for that reason, the confirmation of federal judges is highly political. Once you’re in, you’re in; but getting there is no easy matter. In fact, the number of unfilled federal judgeships has reached what President Bill Clinton called a “vacancy crisis in our courts.”

Gajarsa was first nominated by Clinton in April 1996, but his name never reached a vote in the Senate. If Clinton had not been re-elected, that would have been it. But Gajarsa was renominated. He went for a second hearing and was again approved by the Senate Judiciary Committee. This time the Senate acted, and on July 31, 1997, Gajarsa was finally confirmed.

One step below the Supreme Court, the U.S. Courts of Appeals issue the final word in the vast majority of cases. Of course everyone has the right to appeal to the Supreme Court, Gajarsa says, but it hears only a few of the cases that come before it. “Last year my court heard 2,000 cases and only five of them made it to the Supreme Court.”

Gajarsa is now tackling his new duties and adjusting to his new position. Political affiliations and his private law practice are gone forever, but he’ll maintain many of the relationships he’s established over the years, including his seat on the Rensselaer Board. If a person or organization with which he’s associated ever comes before his court, he’ll recuse himself. But could he hear a case involving Harvard, for example? “Absolutely, or even MIT!” he laughs.

Another Rensselaer graduate making her mark in court is Althea Walker Davis '81, a trial attorney for the U.S. Department of Justice who was born and raised in the District. She’s particularly interested in mentoring young minority women. “When I told my high school guidance counselor I wanted to go into engineering, I was told I was nuts,” Davis recalls.

After several years working for Kodak in Rochester and Chicago, Davis returned to attend law school in Washington. Today she litigates cases involving injuries from vaccines. “Manufacturers were being swamped by lawsuits,” Davis explains, “so Congress passed legislation saying that people who believe they or their children have been injured by certain vaccines must sue the secretary of health and human services first.” She represents the secretary in these cases.

Although she admits her work has made her a little nervous about having her new baby immunized, she says working with some of the top doctors in the country has put her mind at ease. Malcolm will get all his shots. And he’ll grow up in the District. “We just moved—from one side of Washington to the other—and we’ll be staying here in Washington proper,” Davis affirms.
Vic Reis ’57, assistant secretary for defense programs at the Department of Energy, has been in Washington since 1981. “I’m a government sort of guy, and in the defense business, Washington is where the action is,” he explains offhandedly.

For Reis, the “action” is an extraordinary technical challenge with worldwide ramifications. “My responsibility is for all the U.S. nuclear weapons programs. We’re particularly interested in major technical and scientific programs to maintain our nuclear stockpile forever without nuclear testing.”

“IT’s a very interesting conjunction of technology and national policy,” Reis says. The stockpile stewardship program is integral to the Comprehensive Test Ban Treaty, which President Clinton sent to the Senate for ratification Sept. 22.

Reis and his wife also find Washington an excellent place to get away from the action. They live in the District and are only 10 or 12 minutes from everything. They spend a lot of time in museums and particularly enjoy walking in Rock Creek Park (a rustic expanse of 1,754 acres in the city) and along the C&O canal, a national historic park that stretches 184 miles from Georgetown to Cumberland, Md.

Washington is a great outdoor city,” says Robin Martin ’71. “There are wonderful bike paths, a lot of tennis, golf. My older son, who’s a coxswain, is out on the Potomac every afternoon.

“About 12 years ago I decided New York was not the place for kids. I had loved Washington when I lived there before and knew it would be a great place to raise a family,” he says.

Martin, president and chief executive officer of The Deer River Group, owns radio stations and is an acquisitions and financial consultant to the broadcast industry. He educates people about the industry and helps them acquire stations, from developing a strategy and finding an appropriate station, to closing the deal.

“New York was good from a financial standpoint,” Martin says, “but Washington turned out to be great because the FCC and the regulators and the lawyers who work on the deals are all here.

“Here, you get the best of both worlds,” he says. “We live in the District. You can have a car and a backyard, and a dog, right in the city. And our three kids actually ask to go to museums. I think that’s because there are so many, they can pick what they like best. And everything’s so accessible; we can go at 10 in the morning and be home for lunch.”

Martin, a Rensselaer trustee since 1986, sees himself as an anomaly in the nation’s capital. “I’ve always been interested in politics,” he says, “but I’m not a lawyer, I’m not a lobbyist, I don’t work for the government, and I don’t plan to do any of those things. I’m just a businessman, and Washington is a wonderful place to do business.”

Ivan (Skip) Schatz ’57 agrees wholeheartedly. “Washington has all the culture and sophistication and glamour of New York, but on a smaller scale and at a slightly slower pace. In the 1960s New York was the financial hub, but with the growth of government, Washington has clearly become the center of what happens.” And that’s great for business.

In 1978 Schatz met a woman who was combining a job in an orthopedic surgeon’s office with selling adjustable beds out of her garage to people suffering from back pain. Schatz suggested she open a store. He subsequently became her business partner and, in 1979, her husband. Soon there were six JoAnne’s Bed and Back Shops specializing in products designed to ease chronic pain and promote healthy backs.

Washington, Schatz says, is the perfect location. It’s a large metropolitan area where there’s a high level of affluence and a large number of people who are aware of issues related to health and well-being. And there’s a constant turnover in the population.

Skip and JoAnne have done so well in Washington that they recently opened four stores in metropolitan New York and plan to add three in Baltimore by year’s end.

Washington’s importance as a financial center has brought in thousands of nongovernment professionals like Bob Swanson ’58. Swanson is executive vice president of Mobil Corporation, a director of Mobil Corporation and Mobil Oil Corporation, and a member of their executive committees. He arrived in 1989 when Mobil moved its headquarters to northern Virginia. Today he has contact responsibility for Mobil’s businesses in the Asia/Pacific
region, Africa, and the Middle East, as well as for Mobil's chemical and technology activities.

Despite—or perhaps because of—his position at the helm of a corporate giant, Swanson has maintained strong ties to Rensselaer. "It was not an easy four years," he says of his student days. "But it's become clearer and clearer to me how valuable that educational process was." Swanson will be named a Rensselaer trustee at the December board meeting.

FOR BUSINESSES CLOSELY ALLIED TO FEDERAL priorities, Washington has always been the place to be. Jorge Carnicero Sr. '46 transferred to Rensselaer from his native Argentina on an international scholarship to study aeronautical engineering. When he graduated, he was "very interested in outer space, and Washington was the center for this type of activity. So I decided to stay here a while to learn how to do business the American way," he says.

In 1946 Carnicero founded Dynalectron (later Dynacorp). "It started with two people. When I retired in 1988, we were the largest ground services corporation for airports in the entire world with 22,000 employees. We were a technical services organization in commercial aviation, airport ground services, and aviation in general. We were heavily involved with the Apollo project and all kinds of outer space activities," he says.

Carnicero became chairman and/or director of many companies (several of them subsidiaries of Dynacorp), founded Riggs National Bank in 1977, has served on the Argentine-U.S. Chamber of Commerce, and been an adviser to both the U.S. Senate Committee on Latin American Affairs and to the president of Argentina. He is now president and treasurer of Trans-American Aeronautical Corp., which he founded in 1953.

ARCHITECT HARRY Gordon '73 opened the Washington office of Burt Hill Kosar Rittelmann Associates in 1980 to serve primarily government clients interested in energy-related issues. His firm now has a broad clientele in both the public and private domain.

One of his projects was the "greening of the White House," designed to improve the energy and environmental performance of the White House and the Old Executive Office Building, and to set an example for other federal agencies and private citizens.

"A lot of our private-sector clients have real interest in these areas," Gordon says. His firm recently renovated an older building to create an environmentally responsible headquarters for National Public Radio and is currently doing the same for the American Institute of Architects.

Gordon heads the Rensselaer Building Council, a group of alumni in the Baltimore/D.C. area engaged in all aspects of the building industry. "We learn what's happening at Rensselaer and sometimes help graduates find employment. There's a real business purpose to this also. Networking can result in new clients or in consultants for one of my projects," Gordon explains.

"THE D.C. AREA IS MECCA FOR AN EXECUTIVE IN A NONPROFIT ORGANIZATION," Lauck Walton '84 says. Walton is director of operations for the Accrediting Council for Independent Colleges and Schools. The ACICS presently accredits 570 career-enhancing institutions in the United States and abroad that educate almost 300,000 students each year. "Through this accreditation, our institutions can establish eligibility to participate in federal financial aid programs," Walton says.

Walton is also liaison for the D.C. Chapter of the Rensselaer Alumni Association. "Our chapter is an interesting balance of people who want to help Rensselaer and to benefit from networking with Rensselaer graduates," Walton says. We have some social events, like going to see Joe Juneau '91 and Adam Oates '91 play at the new MCI Center in January, but mostly it's a group of friends and colleagues who come together for common purposes."

JILL CLAUS '92 IS AN ENVIRONMENTAL ENGINEER WITH OGREN ENVIRONMENTAL AND ENERGY whose admissions work for Rensselaer is a major personal priority and source of satisfaction.

Clauss helps the admissions office with college fairs and organizes local receptions for accepted students and Rensselaer Medalists. She follows up invitations with phone calls to students and their parents, and has even sent cookies to students she takes a shine to. "What gives me the most satisfaction is getting e-mail from students telling me they would never have considered Rensselaer, or from a woman who says..."
she never would have gone into a technical field, if it weren't for an event I took part in."

TONY KANE ’67 HAS LIVED AND WORKED in Washington since 1972. He was hired by the Federal Highway Administration in the late 1960s and worked his way up. Today he's executive director of the agency whose 3,500 employees are located in every state. The Highway Administration provides grants in aid and technical assistance to states for their highway programs from a $22 billion annual budget, designs and constructs roads on federal lands, and regulates the motor carrier industry.

Although they live in the suburbs, the Kanes chose parochial schools in the District for their children. "They were exposed to a much greater diversity of students and got to see more of what the world really is than I think they would have in a suburban school. And," he says, "they got to appreciate the city's long history. In fact my daughter's school is the oldest Catholic high school in the country."

WASHINGTON'S HISTORY AND CULTURAL DIVERSITY also appeal to Kenneth Neu ’67. Neu has been assigned to Washington twice in his 28 years with the FBI, this time since 1990. Today he’s chief of the Safe Streets and Gang Unit at FBI Headquarters. His unit is in the Criminal Investigative Division of the Violent Crimes and Major Offenders Section of the bureau. "We have over 150 multiagency task forces made up of federal (FBI and other agents), state, and local officers that address violent crime matters that rise to federal jurisdiction," Neu explains. His office oversees all of the FBI's investigations of violent street gangs in the United States.

Neu has found it particularly interesting to be in Washington during a time "when violent crime and the issue of street gangs was a high-profile matter. I've testified at Congressional hearings, and it's been gratifying to be in a position to influence policy matters."

He also likes Washington in its own right. Neu and his wife frequent the Kennedy Center and the National Theater. "We see all the shows coming through town, and I get to make sports events. There are world-class universities and a lot of history. Plus, because this is the nation's capital, there are many events with ethnic variety and an international flavor that you can't find anywhere else."

CHERRY BLOSSOMS AND HISTORY, MARCHES, taxes, international affairs and intrigue, the American way of life, power, politics—Washington means many things to many people. But it's never "just another city."

Lauck Walton has worked there eight years. "But," he says, "I still get a chill on my morning drive across the Potomac when I see the Jefferson Memorial and the Washington Monument."

The photographers: Award-winning photographer Lou Jones '67, who resides in Boston, grew up in Washington, D.C. Robert Allen Straus is an Arlington-based photographer whose daughter, Mary Elizabeth, is a '95 Rensselaer graduate.
A Strong Force in Microelectronics

Renselaer's interdisciplinary team approach to research, coupled with a strong focus on interconnect technology, positions the Institute as a leader in microelectronics research.

By Gary Dagastine / Photographs by Gary Gold

When Professor Shyam Murarka strode into former Provost James Meindl's office one day in 1987 to talk something over, he was both excited and fearful. Excited, because a unique opportunity lay before Rensselaer to work on a problem that, if left unsolved, would bring continuing progress in microelectronics to a halt by about the year 2000.

And fearful, not only because he knew industry would view his unconventional ideas with skepticism and disdain, but because failure might consign Rensselaer to the backwaters of one of the world's most dynamic and important industries.

Murarka, the Elaine S. and Jack S. Parker Chair in Engineering, received two simple words of wise advice: "Be bold." And with that as inspiration, he and his colleagues mounted a research effort in a critical microelectronics technology known as interconnect. Their success has propelled Rensselaer into the front ranks of electronics-industry researchers. In fact, when IBM announced in late September that it would begin to use copper for the wiring in new computer chips — a development that ultimately will lead to much more powerful computers — IBM advised journalists to call Murarka with technical questions about it.

To know why copper is so important, consider that computer chips are the building blocks of the electronic systems that pervade our economy and our lives. Some people even call them the crude oil of the Information Age, and while oil companies might disagree with that metaphor, the fact is we can hardly make a telephone call or banking transaction, take a trip in a modern automobile, or do much else today without using systems that rely at least in part on them.

The world market for chips, or semiconductors, is expected to reach some $200 billion in 1999, up from $50.5 billion in 1990, and U.S. semiconductor manufacturers produce about 40 percent of the total. The industry is a linchpin of U.S. economic competitiveness.

Gary Dagastine is a writer and public-relations consultant in Niskayuna, N.Y. He has 16 years' experience writing about and publicizing developments in semiconductors and other areas of electronics.
(l-r) Don Millard, Teh-Ming Lu, Michael Shur, and Shyam Murarka, outside the Class 100 Clean Room, are part of Rensselaer's microelectronics team.
Murarka and his colleagues mounted a research effort in a critical microelectronics technology known as interconnect. Their success has propelled Rensselaer into the front ranks of electronics-industry researchers.

Today's chips are packed with millions of microscopic transistors that switch on and off to control the passage of electricity on the chip. A series of transistors makes a circuit, and the path the electricity follows in the circuit depends on which transistors are "on" or "off." These changing on/off states represent digital information, and manipulation of that information is the basis of computing.

The more transistors there are on a chip and the faster they can switch on/off, the more the chip can do. Thus, one of the industry's highest priorities always has been to pack more transistors onto chips of a given size (e.g., to increase its density). Intel Corporation co-founder and chairman Gordon Moore predicted in the 1960s that chip density would double about every 18 months, leading to regular, predictable increases in performance.

This prediction, the widely cited Moore's Law, has held up well as chip-makers learned how to make incredibly small transistors through the years. Because each new generation of microprocessors—the chips at the heart of PCs—is faster and more powerful, the power of computers has continually increased even while their cost often goes down.

There's just one problem. The industry is fast approaching the point where Moore's Law won't apply anymore.

MESSAGES CAN'T GET THROUGH
Pause for a moment and think about water flowing through a pipe. Say a certain amount of water needs to flow through the pipe in a certain amount of time. If the pipe is replaced with a narrower one, and if that pipe itself is then replaced with a still-narrower one, and so on continually, getting the same amount of water through the pipe in the required time becomes difficult, on a practical basis.

That's a useful way to think about what happens when a computer chip's interconnect—such as the very wiring or pathways that connect the transistors, and the area where Rensselaer plays such a large role—shrinks to extremely small dimensions along with the diminishing size of transistors in each new generation of computer chips.

The main culprit is electrical resistance in the aluminum from which the interconnect is made. For the generation of computer chips needed soon after the year 2000, aluminum's electrical resistance would actually inhibit the passage of digital messages through the interconnect. The result would be a backlog of messages, jamming the pathways that tie the transistors together, and capping overall chip performance.

That's where Rensselaer enters the picture. Murarka was the first university researcher with the vision and courage to tell a skeptical technical community that copper would be a solution to the coming interconnect bottleneck. He also was the first university researcher to recognize the importance of the two other critical interconnect technologies: chemical-mechanical polishing (CMP) to flatten chip layers for optimum placement of the interconnect, and low dielectric-constant materials to insulate the chip layers without creating certain unwanted electrical phenomena that would hinder interconnect performance.

Under the leadership of Professor Ronald Gutmann '62, director from 1989 to 1994 of what was then called the Center for Integrated Electronics, and Murarka, Rensselaer researchers have made major contributions in all three areas.

Many chips sold today have transistors that are 0.35 microns wide, one micron being equivalent to about a hundredth the width of the human
hair. The most advanced chips have transistors about 0.25 microns wide, and those to be developed in the next few years are expected to have 0.20 micron-wide transistors. That's the point at which aluminum interconnect gets in the way.

Without interconnect that can take advantage of 0.20µm-sized and smaller transistors, the electronic industry's remarkable progress will cease.

Copper might seem to be an obvious contender to replace aluminum. After all, it forms the wires in the products we use on a daily basis. Copper has less electrical resistance than aluminum and wouldn't impose the same limitations on chip performance. But copper is burdened with a rather large Achilles' heel: it tends to bleed into and poison the silicon from which chips are made.

That's why there was such a stir in late September when IBM announced it had discovered a practical way to use copper instead of aluminum for the wiring within integrated circuits. IBM's stock price soared nearly 5 percent that day, leading the Dow Jones Industrials to a nearly 80-point gain. Commodity traders were quoted wondering whether there would be a copper shortage. Leading newspapers called it a major breakthrough and said the industry was likely to follow IBM's lead. Indeed, IBM's competition scrambled to make public its own work in the area.

The key to the IBM breakthrough, apparently, was the development of a barrier layer that prevents the copper from contaminating the silicon. Rensselaer has performed much research on copper barrier layers and, says Murarka, "While we don't know exactly what process IBM used because they consider it a secret, we do know we contributed significantly to their knowledge base."

RATIONAL IDEA, RATIONAL RESULTS
"If you're in the mainstream of technology you attract top faculty, students, and industry support for your work," says Toh-Ming Lu, Rensselaer professor of physics. "Microelectronics is one of the world's most important industries, growing fast and driving many societal changes. In the mid-1980s we asked ourselves, since the electronics industry is so large and we're so small, what should be our niche? Where can we make a mark in the next 10 years? We came together as a group on interconnect, and within that, we decided to focus on copper and low dielectric-constant insulators," he says.

Rensselaer's interconnect reputation has come about through a true team effort by Rensselaer faculty and graduate students, as well as researchers from other universities, and Murarka was its catalyst and key technical figure. Before arriving at Rensselaer in 1984 he spent 12 years at Bell Laboratories, where he was world-renowned for his pioneering work in silicides (for low-resistance on-chip electrical contacts) and metallization. Interconnect is an aspect of metallization.

"When I proposed copper research, I was scared," Murarka says. "I had just come back from a visit to IBM where they seemed to indicate copper might be a worthwhile idea to pursue. But at that time it was a radical idea, not easily accepted by industry in general."

In 1986-87, Rensselaer began its focused research effort with work on three main areas important to interconnect: copper, chemical mechanical planarization, and low-K dielectrics. Dielectrics are insulating materials, and K is the dielectric constant, a measure of a material's insulating strength.

It was about this time that SEMATECH, a U.S. government/industry consortium, was formed to conduct and sponsor research in areas important to U.S. semiconductor competitiveness.

"SEMATECH saw we were the only group that brought together expertise in all three main areas of copper, low-K dielectrics, and CMP," Murarka says. "They gave us funding in 1989 for research in these areas."

At about the same time, IBM funded an advanced low dielectric-constant materials program at Rensselaer that included research on copper interconnects. Then, in the early 1990s, Murarka was asked to serve on the interconnect panels convened by the National Advisory Committee on Semiconductors. Murarka also represents Rensselaer as a member of the Semiconductor Industry Association's National Technology Roadmap committee.

Rensselaer's success in these focused efforts led the Semiconductor Research Corporation (SRC), the research arm of the U.S. semiconductor industry, to establish a one-of-a-kind research center at Rensselaer in September 1996. Called the Center for Advanced Interconnect Science and Technology, or CAIST, and directed by Murarka, it is the largest SRC center in the country and the only one for interconnect.

Funding includes $10 million from the SRC over five years and an additional $4.5 million over five years from New York state, along with some Rensselaer funds and other industry money. The 1997 research budget is $3.4 million.

The CAIST research team includes not only 18 Rensselaer researchers,
Interconnect research requires the talents not only of electrical engineers and materials scientists, but of computer scientists, chemical and mechanical engineers, chemists, physicists, and others.

but five from the University at Albany and others from Clarkson, Cornell, Georgia Institute of Technology, Stanford, the University of North Texas, and the University of Texas at Austin. In effect, it is a virtual research organization that taps the expertise of the best researchers, wherever they may be located.

It has been such an extraordinary success that Rensselaer is a strong participant in a proposal to land a larger interconnect research center with a somewhat different mission. The Semiconductor Industry Association will establish a Focused Research Center at a university to take a longer-range look (10 to 18 years out) at interconnect issues. This effort will complement synergistically the research presently being carried out in CAIST.

AN INTERDISCIPLINARY APPROACH
Rensselaer drew strength in building the interconnect program from its interdisciplinary, multidepartmental approach to research, something that faculty elsewhere do not always favor. It serves to multiply the resources available, because teams can be assembled to tackle projects too large or complex for any one department. For example, interconnect research requires the talents not only of electrical engineers and materials scientists, but of computer scientists, chemical and mechanical engineers, chemists, physicists, and others. The CAIST takes this approach one step further by adding geographically dispersed colleagues into the mix.

The approach extends to Rensselaer's overall electronics research programs, which besides interconnect cover nearly the entire spectrum from development of novel transistors and electron devices on up through process-, packaging-, and board manufacturing-related research, as well as an interactive multimedia program designed to facilitate hardware/software combinations.

Rensselaer researchers conduct more than $15 million worth of microelectronics research annually, while additional budgets cover tools and facilities. These programs command industry respect, as evidenced by the fact that the campus receives a visit from an electronics-industry/government partner nearly every working day.

Don Millard, research associate professor and director of Rensselaer's Center for Integrated Electronics, Electronics Manufacturing, and Electronic Media (CIEEM), says, "Rensselaer's impact has been so huge because we've been steeped in a multidisciplinary culture since the George Low era. We have been able to take 60 faculty in different areas that relate to electronics and have them work together on problems in a cohesive manner. It is impossible to overemphasize the impact this has had."

PUSHING THE LIMITS OF INTERCONNECT
At present, CAIST researchers are conducting more than 30 interconnect research projects. One team is focused on materials and processing issues, working on ways to deposit thin films of copper and copper alloys, and to create the barrier layers needed to separate them from silicon so the copper doesn't contaminate it.

They are also exploring novel insulating materials to deal with an unwanted electrical effect called capacitance that acts to slow the passage of electricity through the interconnect. Computer chips are built from multiple layers of material, including layers of insulating dielectric material. The interconnect is woven horizontally and vertically throughout every part of a chip, including the insulating layers. The capacitance arises from the interaction of the interconnect with an insulating material with a high dielectric constant. Researchers are exploring promising low dielectric-constant materials such as polymers (plastics) and aerogels/xerogels (very porous substances).

Another group is developing ways to model and simulate interconnect designs, processes, yields, reliability and costs. Others are developing methods and tools to measure key characteristics that affect interconnect reliability, while yet another team is looking farther ahead, toward a time when copper itself will no longer be adequate and a completely different technology will be needed. CAIST researchers are exploring optical interconnect, using light instead of electricity to transmit digital messages. They are also developing packages that could allow chips to operate at low temperatures (~196°C, the temperature of liquid nitrogen), where changes on the atomic level cut electrical resistance.

BENEFITS OF AN INTEGRATED PROGRAM
Rensselaer is an attractive place for companies and government agencies to conduct research because the Institute's broad, integrated electronics research program and multidisciplinary orientation provide useful synergies among totally different lines of inquiry.

A non-contact test-probe technology Rensselaer researchers originally developed for use with densely packed circuit boards, under a contract from Digital Equipment Corporation, shows promise for use in testing the interconnect in computer chips. It is tricky to touch the extremely small, delicate features on these boards with a relatively large and clumsy test probe. In the non-contact system, a high-power laser beam is focused on a conductive metal foil like tungsten or copper to create a tightly focused, conductive plasma (a collection of charged par-
Toward the Future

The trend for corporations to cut back on longer-range research and to redirect internal R&D activities toward solving specific practical problems means that industry is relying much more heavily on Rensselaer and other top-ranked research universities.

But while that trend is expected to continue, the future is by no means assured. Lu says that despite past successes, Rensselaer must sharpen its focus even more if it is to capitalize on new opportunities for partnership with industry. "No university that wants to have an impact can work only on odds and ends. We have to organize our efforts to have an impact. Some people say we're too small to compete, but look at the tremendous success we've had so far in interconnect," Lu states. "I think many of the faculty here appreciate the interdisciplinary work. But there are nearly 400 faculty here altogether. What if an even larger percentage of them worked toward a common purpose? We could be much bigger and a very strong force."

"The IBM announcement has given credence to our ability to be visionary," says Millard, "and these are exciting times indeed for Rensselaer."
Urban Vistas

Steven Ehrlich's architecture fuses modern aesthetics and primitive values

By Meg Gallien

To enter a residence designed by Steven Ehrlich, B.S. '68, B.Arch. '69, is to escape urban chaos for tranquility, to inhabit a contemplative fusion of modern materials and primitive values designed to connect with the surrounding landscape.

To enter one of Ehrlich's public buildings is instead an opportunity to engage in civic discourse, to court the chance encounter so valued in more native cultures.

Ehrlich, who cites as major influences both classic modernism and multicultural, often indigenous, societies, also coins mottos. One is: It all adds up.

In May, the body of work he has accomplished in his architectural firm, Steven Ehrlich Architects, added up to three of the coveted National Honor Awards the American Institute of Architects (AIA) conferred in 1997. Only three internationally renowned architects had previously achieved the rare honor of receiving three or more such awards in one year: I.M. Pei in 1974; Skidmore, Owings and Merrill in 1964 and 1967; and Richard Neutra in 1952.

Ehrlich, who opened his practice in the Los Angeles area in 1979, had been winning prestigious awards at the state and local level for years.

"But this year, somehow the sky opened up and we were tapped on the shoulder," he says. Ehrlich's firm includes his partner, Nick Seierup, and from 12 to 15 or more others, depending on project demand.

The firm designs a wide variety of projects, both in type and in scale, from residences, "even including residential renovations, if our clients are interested in openness to design ideas," to civic buildings, such as libraries and recreation centers, to retail, including shops and restaurants, to large corporate campuses.

The largest current project is Dreamworks SKG's animation studios, a 320,000-square-foot, five-building cam-
The Schulman Residence, Brentwood, Calif. — Ehrlich’s private residences are noted for their lofty volumes, crisp geometry, and integration into the landscape. Sliding glass window walls allow barriers between indoor and outdoor spaces to disappear. A landscaped forecourt encourages a journey of transition from the chaotic outside world to a tranquil private world.
pus now under construction where the new movie studio, created by Steven Spielberg, Jeffrey Katzenberg, and David Geffen, will produce animated films.

Ehrlich's firm does work overseas as well, and is currently designing an office tower in Taipei, Taiwan. For some of the larger and overseas projects, his firm has associated with an executive architecture firm, which manages the construction documents and administration phases while Ehrlich's firm is the design architect.

Although Ehrlich grew up in Radburn, N.J., and remained in the Northeast for college, he eventually chose to locate in Southern California following a formative experience in Africa. He had joined the Peace Corps in 1969 and was the first architect sent by the Corps to Marrakech, Morocco, who completed a two-year assignment with L'Urbanism et L'Habitat. After that, he remained in Africa, traveled much like a nomad in and around the Sahara Desert for a year, then taught architecture at the Ahmadu Bello University in Zaria, Nigeria, for three years.

"I became open-minded to how architecture was built without architects, to how sensitively these builders understood their climate and their culture, and were able to do such wonderful works in ecological balance with such simple and modest means," says Ehrlich.

"After I had been in Africa for almost six years, my East Coast tapes were erased," he says. "I had become increasingly fascinated by courtyard architecture—how people lived indoors and outdoors." On a visit to his sister in Los Angeles, he found a climate that would allow him to explore indoor-outdoor relationships in his architecture.

"I also felt a certain energy," says Ehrlich. "L.A., in a way, is a melting pot. I felt a lot of different cultural influences, and a kind of excitement that I had experienced overseas."

And, he has found a lot of industries with open-minded people, entertainment being a prime example. "These people tend to be creative people on their own."

His clients' needs and his own sensibilities have melded well, inspiring many creative and award-winning architectural solutions.
"I'm always trying to pave some new road to creating a better place to work, gather, or live in."

The difference between Ehrlich's approaches to homes versus work places is striking. "In private projects, I'm attempting to create peaceful environments for my clients that give them tranquil places to be and engage the landscape," he says. "In my public places, I'm really looking to bring people together in some synergistic way."

One of his recent national AIA awards recognized a residence he designed in a Los Angeles canyon for Tom Schulman, the Oscar-winning screenwriter of Dead Poets Society. The awards jury commented: "There is a sumptuous materiality in this house, which is a complement to the dramatic vistas seen through the living room to the meadow and surrounding wooded hills outside. The inherent grandiosity of the house is countered with simplicity and consistency."

The variety of Ehrlich's work was represented in the three award-winning projects. He was also recognized for the Paul Cummins Library at the Crossroads School in Santa Monica where, in contrast to the Schulman residence, limited budget and site constraints required creative solutions using inexpensive, durable materials. The jury commented: "This structure lends energy to this otherwise mundane site. The library becomes the heart and soul of the school as well as a natural welcoming area for students."

The third award was for the adaptive reuse of a 1930s warehouse, which Ehrlich transformed into a high-tech broadcasting facility for Sony Pictures Entertainment's Bow Truss Studios/Game Show Network.

"If I had to generalize why all of these projects got awards, I would say it's because they're innovative," says Ehrlich. "But also, they really solve the clients' issues. They resolve and
become containers for what they were meant to be and for the people who are using them."

Another motto: If you don't have a client, you don't have a building.

While Ehrlich does not subscribe to a particular style, he has been greatly influenced by modernists, and calls his own work "evolving modernism." And he has incorporated certain devices in many of his buildings, such as Japanese-style shoji screens that open onto side walls, glass garage-door walls that "disappear" into the ceiling, and interior and exterior fountains.

"Those elements become agents for me to explore the disappearing barrier between indoor and outdoor space," says Ehrlich.

But these devices only become part of a design after a careful consideration of the specific site and the client's particular needs. "My clients become willing partners in all of these projects and are, obviously, the key ingredient," says Ehrlich.

This empirical approach to architecture is a reflection of the education Ehrlich received and one of the reasons he chose Rensselaer.

"The school did not teach dogma. It was very open-minded, and we looked at architecture from very many points of view, and studied all the masters, including Le Corbusier, Mies van der Rohe, Louis Kahn, and Frank Lloyd Wright," he says. "It had a very broad problem-solving spirit to it."

He also enjoyed the small size of the architecture school, and the shared intimacy with fellow students and faculty. "There was a real commitment to learning among that group, and there weren't a lot of distractions. The Greene Building was like a ship out at sea."

Ehrlich is still enthused about Rensselaer's architecture program and currently serves on the Architecture Advisory Board. "I'm very excited by Dean Alan Balfour. I think he has a great mind and great energy. The school is lucky to have him."

Ehrlich knew early on that he wanted to be an architect. He built tree houses and lean-tos, and by the age of 12 was winning state science fair awards for designing solar homes.

"I just loved the thrill of building something, and I still do," says Ehrlich.

As the national awards indicate, the architectural world is taking note of Ehrlich's work. In 1995 Rockport Publishers introduced its series on Contemporary World Architects with the book Steven Ehrlich. Reviewer Michael Webb described Ehrlich as "one of L.A.'s most humane, creative, and disciplined architects. Best-known for the airy volumes of his houses, and the urbaneity of his institutional buildings, Ehrlich has begun to win commissions for projects that should enrich the public realm."

In the preface to the book, architect Jon Jerde notes Ehrlich's "reverence for thoughtful change and exploration" and calls him "a quiet but seminal figure" who "remains focused on the hard chore of serving the people, all the people, with conceptions that honor the common man and his experiences."

In late 1998, the publisher Rizzoli will produce a hard-cover monograph on the firm's work.

One early result of the awards' national focus on Ehrlich has been an increase in invitations for him to lecture, nationwide and even internationally, and to serve on design juries. He enjoys lecturing, "talking about the origins of design." At the same time, a strong staff and more associations with executive architects allow him to focus on the core of his practice: helping clients create the one architectural solution that serves their functional and emotional needs and interacts perfectly with their site.

Ehrlich once described to Angeles magazine the process of fitting a house onto a demanding site on a ridge. Once the house was built, he said, you couldn't envision anything else there.

"It was like in mathematics; the discovery of the inevitable," he said. "There might be a thousand possibilities, but once the truest one is discovered, you get the feeling that it really was inevitable."

The fusion of his education and his varied work and travel experiences, says Ehrlich, has enabled him to approach each architectural solution both analytically and sensitively, and to coin this final motto: Design from the heart as well as from the mind. 

Paul Cummins Library, Crossroads School, Santa Monica, Calif. — A midblock parking lot is the "campus" for this inner-city middle and secondary school. Classrooms open onto this gathering space. The glazed, wood-framed upper level draws light into the library. The project displays a "sensitivity to placemaking in chaotic urban circumstances," wrote critic David Dillon.

PHOTOS BY ERICHARD PFEIFER
Fall Alumni Weekend attracted a variety of “special interest” alumni groups to campus to celebrate anniversaries, network professionally, socialize with old friends, and reunite with campus.

One cause for celebration was the outstanding performance of the Engineers on the football field, where they triumphed over Union College, 30-7, recapturing the Dutchman’s Shoes Trophy for only the 20th time in the history of the 95-year rivalry. (See Hawk Talk, page 5.)

To highlight the lofty goals of the players, halftime entertainment included the descent onto the field of four parachuters, including the newly outfitted Rensselaer mascot, Red Hawk.

Cheering the team on, in a specially erected set of bleachers, was the Class of ’52, who planned their 45th reunion festivities to coincide with Fall Alumni Weekend rather than the traditional June reunion. More than 95 members of the class and their families returned to campus and enjoyed a variety of activities, including receptions, a class dinner, campus tours, and an “alumni college” class.

Prior to the game, the Class of ’52 gathered in front of the Troy Building where they dedicated a tree to the memory of classmates who have died. The plaque reads, “To our classmates who have passed on to their final resting place...45th Reunion - Class of 1952. May they rest in peace.”

Other groups who held mini-reunions during the weekend were health professionals, former members of the Model Railroad Society, minority alumni, and Phi Kappa Tau, which celebrated its 75th anniversary on campus. Rensselaer's distance learning program, RSVP, celebrated its 10th anniversary. The Rensselaer Alumni Association board of trustees held meetings as well. All who returned enjoyed the weekend, held at the peak of the region's fall season.
Class Notes

Class Notes Deleted for Privacy Concerns
Rensselaer Hockey: Live Via Satellite!
The Engineers take on Clarkson Feb. 13 in the sixth annual telecast.
Watch the action live via satellite at a site in one of the cities listed below.
Contact Pam Rose '95 at (518) 276-2567 or e-mail: rosep2@rpi.edu.

See the World With RAA Tours
The RAA's alumni travel program for 1998 kicks off in February. These specially priced tours are a chance to take in some of the world's most exciting destinations with other Rensselaer alumni and their families. For more information, contact program coordinator John Buckley '49 at (518) 274-6562.

Hidden Islands of the Grenadines, Feb. 7-15
Cruise Europe / Amsterdam / Budapest, May 3-19
Canary Islands on the QE2, June 10-20
Alumni College of Ireland, June 24-July 2
South America Discovery, Ft. Lauderdale to Rio de Janeiro, Oct. 21-Dec. 4
Hong Kong, November 30-Dec. 7
(Extension to Bangkok, through Dec. 10)

Rensselaer Hockey: Live Via the Web!
Fans can now listen to live broadcasts of Engineers hockey via the World Wide Web. With funding from the Rensselaer Alumni Association, which provided money to buy the necessary hardware and software, WRPI 91.5 FM began broadcasting live on the Web in November.
Using Real Audio technology, users who visit the WRPI Web site can listen to the station live on their personal computers. This means hockey games—along with other sports broadcasts and the rest of WRPI's programming—can be enjoyed by alumni anywhere in the world.
"The influx of talent from the new EMAC major provides an extremely competent group of students ready to maintain WRPI's Web presence," says WRPI's president Steve Pierce, a Ph.D. student in science and technology studies. "And we're grateful to the RAA for their support."
Visit AlumServ at http://www.alumni.rpi.edu to find out how to hear the broadcasts from your computer.

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