1982

30 YEARS

Proof of Effectiveness

2012

2012 Annual Report

30
YEARS

A MESSAGE FROM THE PRESIDENT

SRC has made many critical contributions to the technical and human resources of its members over the past 30 years, yet we are acutely aware that past successes do not guarantee future performance. And in view of the extraordinary rate of change of information technology, it is imperative that SRC maintains constant vigilance to help anticipate the future technologies required by its members.

One successful mechanism is the constant stream of advice provided to us by our members through the Board of Directors and our many Technical Advisory Boards. As part of SRC's recent strategic planning processes, the Board suggested that SRC consider expanding its research portfolio into areas that are adjacent, yet strongly connected, to semiconductor technologies. SRC also conducts one or two international forums each year to obtain valuable insights into emerging research opportunities related to its members' interests. University faculty members are also a rich resource for identifying technology trends and discontinuities, and we have unprecedented access to them. Finally, SRC staff are encouraged to remain professionally active, as they make important contributions to the research planning processes. One thing is clear: *SRC must remain flexible and responsive to execute research in a timely manner.*

In 2012 our members and government partners played leadership roles in the execution of two long-term SRC research programs, FCRP, now redefined and refocused as STARnet, and NRI. Also noteworthy was the assignment of two distinguished technical leaders to assume leadership of these respective programs (Dr. Thomas Theis of IBM for NRI and Dr. Gil Vandentop of Intel for STARnet). Clearly SRC member companies are aggressively preparing for new information technologies to sustain their historical growth trajectories.

It is impossible to forecast the specific technologies that SRC members will require over the forthcoming decades, but it is clear that human creativity is almost limitless. Perhaps technologies inspired by living systems will be developed to address energy consumption issues, manufacturing cost control, and information security enhancements. Or inspiration may come from a new physical understanding of our world. I can't say for sure, but I think that we would be amazed if we could foresee what will be wrought by SRC research over the next three decades…and as we move forward, collaboration of industry, university and government researchers will help SRC find the right paths in a timely way.

Sincerely,

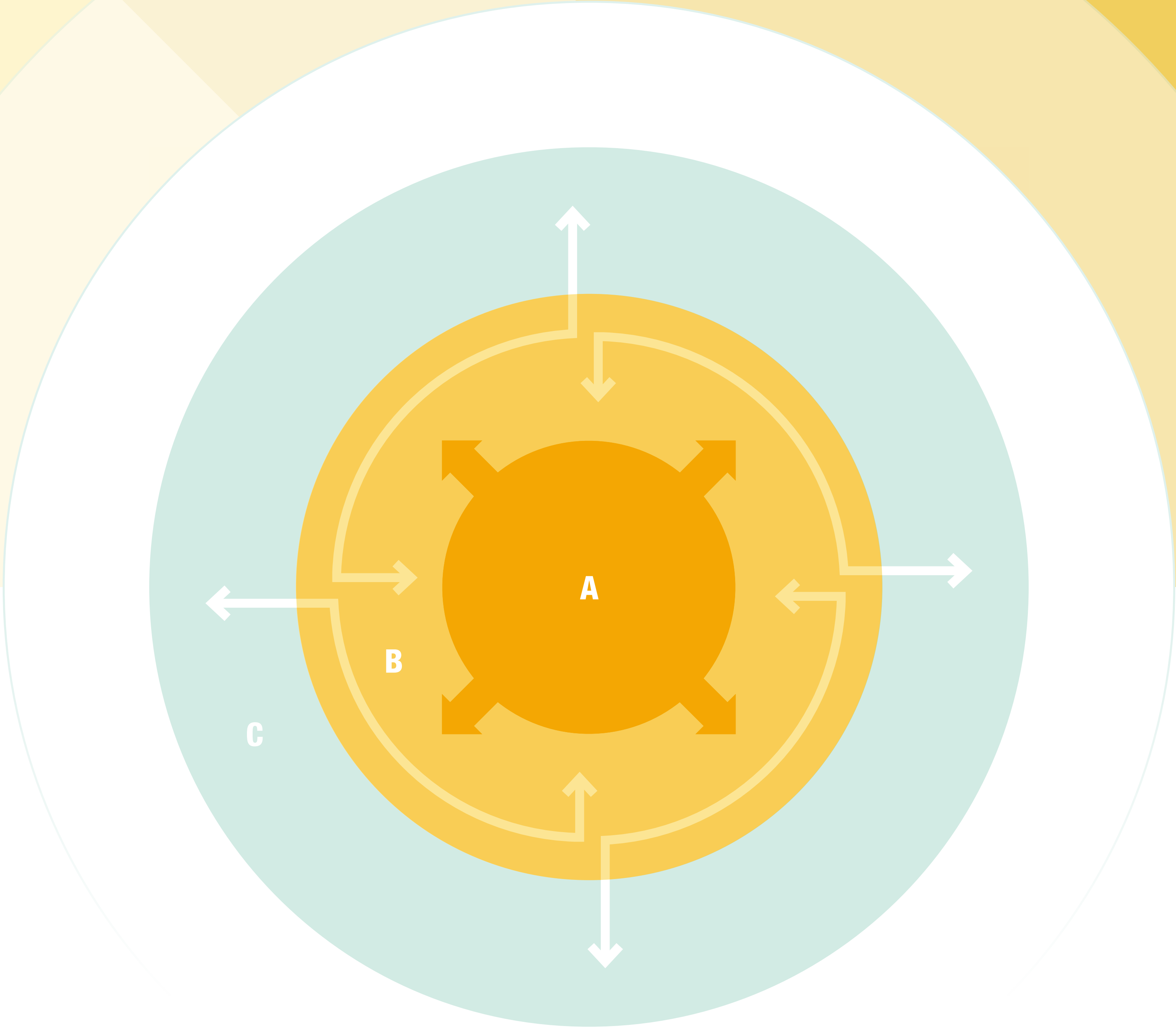
Larry W. Sumney,
President & CEO

PROOF OF EFFECTIVENESS

Necessary Action Turned Bold Experiment

In 1982, faced with decreasing market share and the rapidly improving technical competence of its competitors, the newly organized Semiconductor Industry Association (SIA) Board of Directors chose an unconventional path to regain a competitive status for its members. Their hypothesis was that **if they collectively supported a university-based research program focused on topics of mutual interest, then they, individually, could improve their market competitiveness.** The SIA Board commitment was not just to set a research vision and invest in research; it also included a plan to engage their premier technical staff members with the funded university researchers to provide advice and support for the research created by the program. It's not surprising that the Board turned to the U.S. university system to execute the research, given its acknowledged status as one of the world's leading research and education enterprises. Unfortunately for SIA members, the attention of university researchers at that time had been largely diverted to information processing technologies based on material systems other than the industry mainstream silicon technology, drawn by the preponderance of government support for non-silicon technologies. The SIA Board had to increase university focus on research issues related to their silicon technologies…and they did so by providing an alternative funding opportunity.

To implement this bold experiment, the SIA formed **Semiconductor Research Corporation (SRC)** in 1982, with Larry Sumney appointed as its President and CEO. One of the mandates of the SIA Board, and subsequently, the SRC Board of Directors, was that **SRC should operate in such a manner that most of the fees from SRC members would support university research with a special emphasis on graduate student support.** This has been translated over time into a goal that no more than 13% of fees can be used for all SRC operations. During the summer of 1982, SRC issued its first broad solicitation focusing on integrated circuit design, silicon devices and manufacturing. The university response was immediate and highly gratifying with 166 proposals for research offered by 63 universities. In addition to funding 77 individual investigator projects, SRC also selected and funded three research centers at the University of California at Berkeley (design), at Carnegie Mellon University (design) and at Cornell University (devices), respectively. Thus began the long SRC tradition of **supporting large collaborative efforts where the synergy between faculty and students often results in outcomes that far exceed what could be expected from individual investigator grants.** These initial centers were stand alone, with all participants located at a single university. Over time, however, the center concept has evolved to refer to multi-university efforts guided by a lead university. This approach takes advantage of the widely distributed knowledge base throughout the university system.



SRC PATHWAYS FOR COLLABORATION

- **A)** SRC MEMBER COMPANIES & GOVERNMENT PARTNERS
- **B)** UNIVERSITIES
- **C)** SOCIETY

Graduates
Funding
Industry Needs
IP & Spin-offs
Liaisons
Publications
Research Results
Reviews

The involvement of industry members in the operation of SRC research programs has been simply outstanding. For example, **there have been over 1,700 individuals from member companies who have served on SRC Technical Advisory Boards (TABs), with 314 presently engaged.** There is no way to overestimate the impact of these TAB members on the quality, relevance and productivity of the SRC research program. **Industry has also honored its initial commitment to provide hands-on support for SRC research by providing over 3,000 liaisons for the programs.** These individuals essentially serve as “friends of the research” by providing ongoing advice; supplying technical services from their companies; creating internships for graduate student researchers; coauthoring papers; serving on graduate committees; and providing their member companies with ready access to the research results. This role has proved so vital to the collaborative process that SRC created the Mahboob Khan Award to annually honor those liaisons making extraordinary contributions each year.

So…does it really work?

After three decades, can effectiveness be proven? Are there truly success indicators for SRC? Well, at its inception SRC believed that proposing challenging research topics would be an effective vehicle to attract highly innovative students — a philosophy that has been maintained for 30 years. In fact, **of the 9,000 former SRC students, over two thirds have gone on to work in the SRC community, comprised of SRC member companies, universities and the government.** Many of these alumni are now in leadership positions in industry and academia.

Another success measure is the **impact of the research on the technology infrastructure of SRC member companies.** SRC has obtained literally thousands of testimonials from members about the impact of specific research projects on their company operations. These accounts are consistent in their profound gratitude, describing evidence from the creation of critical new devices and interconnect technologies, to research that guided a technology solution that saved millions of dollars, to new design verification tools that caught an error prior to fabrication commitment. And the inspiring list goes on and on.

To obtain a more quantitative measure of its research impact, SRC commissioned a study to determine the most highly cited papers published with SRC support, as well as the number of companies citing these papers. What quickly became evident is that the **highly cited papers were solid indicators of the impact of SRC research on the semiconductor industry.** Over 200 papers were identified that received over 100 citations, and about two-thirds of these papers collected over 15% industry citations. And by tracing SRC archives back to the initiation of the research that ultimately resulted in the highly cited paper, it was possible to gain insight into the latency between the launch of the successful research and its eventual appearance in the member technology infrastructure: about 11 years.

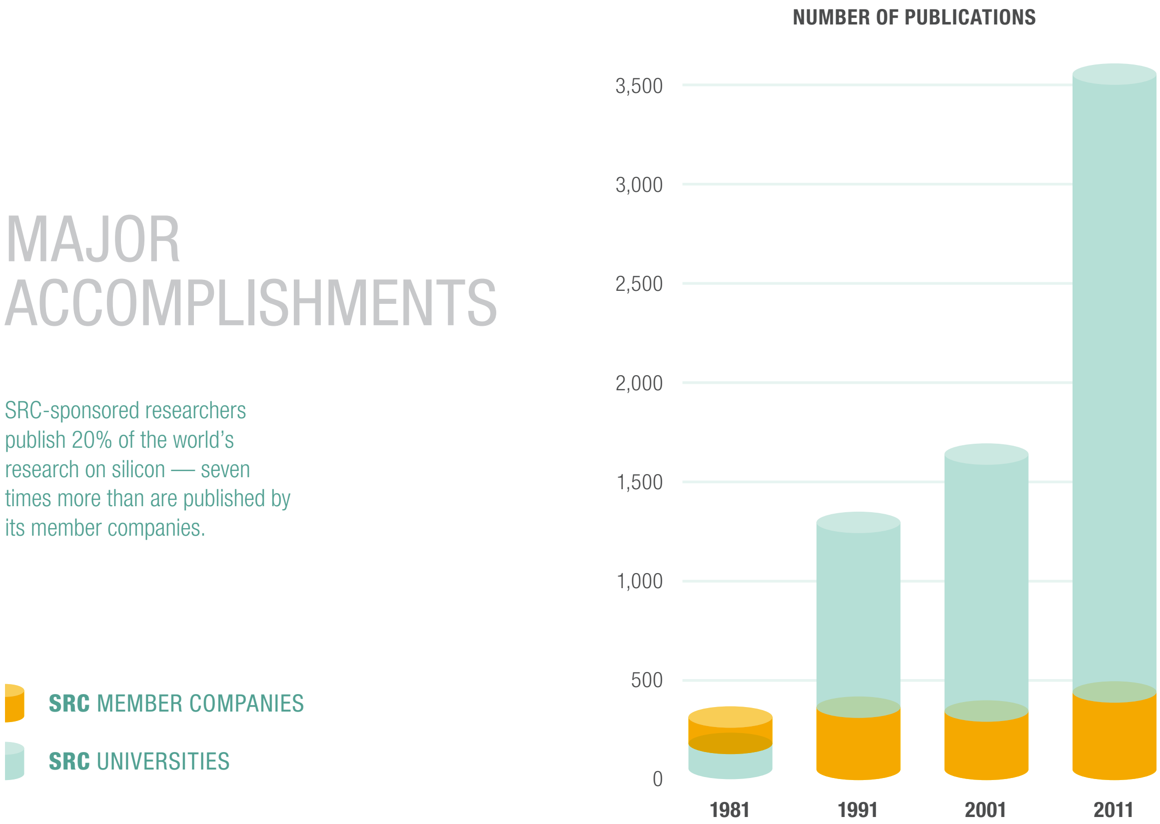
Some of the papers strongly cited most recently by industry may provide hints of future technology directions. Included in this category are the use of directed self-assembly for sub-16 nanometer patterning; III-V MOSFET channel materials for higher performance; on- and off-chip optical interconnects; and 3-D integrated circuits.

Clear Commitment

In its first 30 years, SRC has directly invested nearly $1.1 billion in university research. Some of these programs have been co-funded by government agencies with matching funds of approximately $300 million. Moreover, through participation with government partners, it’s estimated that SRC has played a key role in influencing government research investments — on the order of $400-500 million dollars. **Over the 30-year life span of SRC, about $1.9 billion dollars have been invested into research relevant to the needs of member companies.**

MAJOR ACCOMPLISHMENTS

SRC-sponsored researchers publish 20% of the world's research on silicon — seven times more than are published by its member companies.



THE INFLUENCE OF SRC-SPONSORED RESEARCH

The following are just some of the remarkable contributions of SRC-sponsored research through the years.

- → The introduction of copper for interconnect systems.
- → The development of high dielectric constant gate materials to enable scaling of MOSFET transistors.
- → The technologies enabling lead-free flip chip packaging.

The commitment of faculty to the SRC mission has also been extraordinary. These remarkable men and women serve as teachers, mentors, counselors and friends to their students throughout their careers. So in recognition of the lifetime of dedication to providing fundamental advances for semiconductor science and technology, and for their equally strong investment in the lives and professions of their students, SRC created the Aristotle Award in 1996. Since that time, 18 faculty have received this prestigious recognition for their outstanding impact on semiconductor technology and on the careers of their students.

When SRC was launched in 1982, it adopted specific 10-year research goals that many individuals considered outlandish at the time. For example, some thought that the goal of achieving functional devices with minimum feature sizes of 0.25 microns was not physically possible. But the focused research of the larger SRC community soon established that this fear was unfounded. Over a period of years, **the SRC 10-year research goals morphed into what has become the International Technology Roadmap for Semiconductors.**

NEW COMPANIES EMERGE

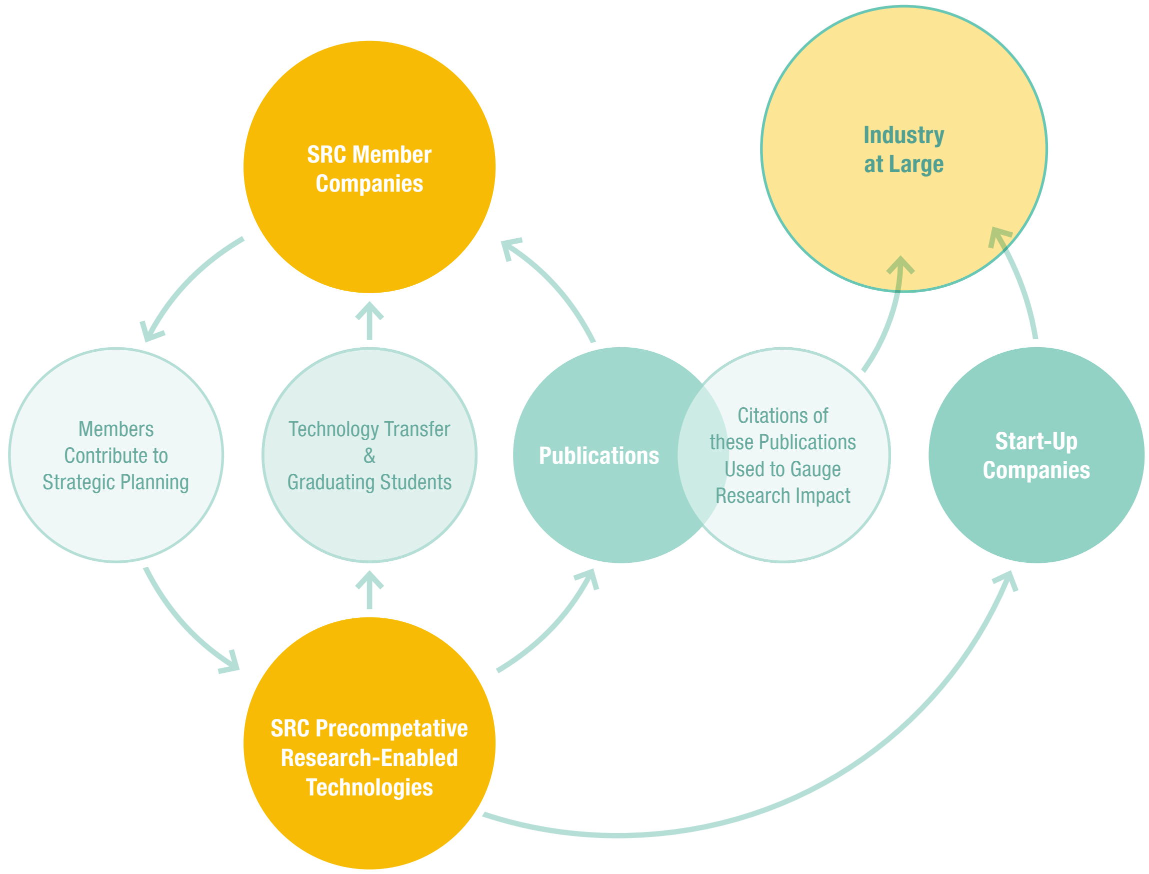
More than 25 start-up companies have been created as a result of SRC research. These new industry players, mostly launched by faculty and/or students, primarily function in areas that support member technical endeavors.

Looking at today's challenges, SRC remains undaunted. When others say, "It's not possible," SRC replies, "Just watch us." Most recently SRC has created the STARnet research program, along with our partner DARPA, to address the problems associated with achieving feature sizes of a few tens of nanometers that provide low-power, high-performance information technologies. We have also extended Nanoelectronics Research Initiative (NRI) with our partner NIST and several state governments, as we turn toward natural living systems as a rich source of inspiration for even more radical and efficient information technologies.

SRC began as a bold and risky experiment. Thirty years later we exist as a proven entity…and, guided by our members, we will continue to pursue game-changing research that will impact the world's technological future.

THE INFLUENCE OF SRC-SPONSORED RESEARCH

- The development of the FinFET transistor now being employed by industry in various forms.
- The development of compact modeling technology for circuit simulation.
- The development of design tools for timing analysis and formal circuit verification.
- The understanding of hot-electron injection into insulators, a key discovery underlying the vast solid-state memory so prevalent today.



GLOBAL RESEARCH COLLABORATION

Funding the most relevant and critical research around the globe

Global Research Collaboration (GRC) programs address the most critical challenges for the semiconductor industry, delivering the solutions that drive the industry's growth. The GRC program is the original core program of SRC and has a 30-year record of delivering university research to industry. The program was renamed in 2005 to acknowledge global funding and membership, and to distinguish it from the other collaborative research programs established under the SRC corporate umbrella. Synergy among researchers and the industry members is the cornerstone of GRC. Within all GRC programs the operational model involves intense industry engagement in formulating, shaping and executing the research agenda, thereby ensuring that the programs meet individual member company needs with high-leverage, compelling return-on-investment research.

GRC research has been focused on the current priorities of the semiconductor industry: *continued scaling of semiconductor technologies and finding diverse applications for this technology.* The 2012 research results show significant progress in all areas. Three areas particularly worth highlighting are **low power design, patterning** and **test.**

Low Power Design

Advances in very low power circuits are a high priority for our members. One example of success in this area is a new mostly digital phase locked loop design that is more tolerant to power supply noise. This novel approach to the circuit architecture allows for more efficient power use by shortening the time required for circuit locking. This technique, shown in Figure 1, uses both analog and digital circuits and is a good example of the cross-disciplinary nature of the research.

Patterning

Research directed towards making the ultra-small devices necessary for next-generation Integrated Circuits (IC) has resulted in more effective ways to create small features without relying on expensive new lithography tools. Directed Self Assembly (DSA) is an area of research that has shown dramatic progress over the last year. This technique is a practical way of producing regular features having the dimensions of the molecules of the chemical polymers used in this process. The progress this year has been in making single-layer and double-layer templating strategies, based on lithographic posts, and processes for locally generating two or more patterns from a single polymer film. Figure 2 shows research results from MIT that are examples of both of these results using Block Co-Polymers (BCP) to create the patterns.

Test

Complexity of integrated circuits has created formidable challenges in the testing of current and future devices and systems. An approach developed by researchers at the University of California, Santa Barbara, uses knowledge discovery (data mining) tools and methodologies integrated with existing test and design flows to predict failures. This technique allows the data analysis and the classification of potential field failures based on the test characteristics. This would provide considerable cost savings for test and qualification for the manufacturer and would reduce customer returns. This sequence is shown schematically in Figure 3.

FIGURE 1
PHASE LOCK
LOOP DESIGN

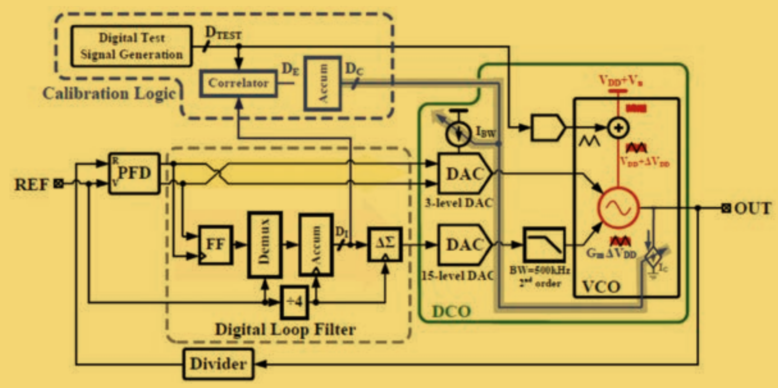


FIGURE 2
EXAMPLES OF
DSA PATTERNS

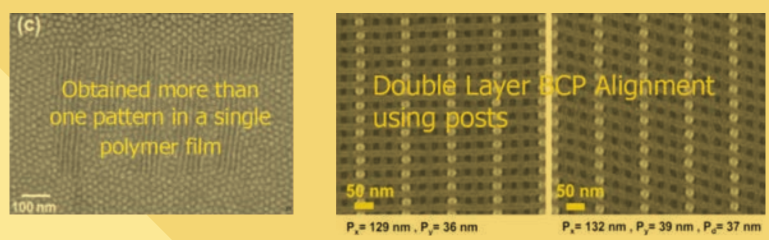
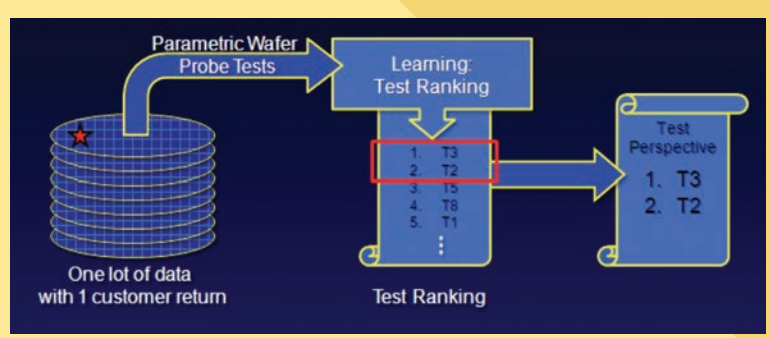


FIGURE 3
USING DATA MINING
AND CUSTOMER
RETURNS TO
IMPROVE TEST



FOCUS CENTER RESEARCH PROGRAM

U.S. Security, Innovation & Economic Competitiveness

December 2012 marked the completion of the fifth three-year phase of SRC's Focus Center Research Program (FCRP). First launched in 1998, FCRP originally consisted of two centers aimed at supporting advanced research with focused efforts in extending CMOS technologies to the limits of device scaling. To help stimulate creative thinking, FCRP was structured to be managed by faculty while guided by sponsors. SRC entered into partnership with the Department of Defense (through DARPA) to support this program, along with the industry sponsors. ***In 2012 FCRP consisted of six research centers spanning research from materials all the way to platform systems, involving 36 top U.S. universities across 16 states, 248 faculty and 452 graduate students.*** The highly successful FCRP has been one of DARPA's longest running research programs. In the latter half of 2012, the FCRP sponsors agreed to start a new phase with increased annual funding and an extended length of five years. With six completely new centers and longer horizon research plans, the new program, called STARnet (Semiconductor Technology Advanced Research Network), was launched in January 2013.

The many research contributions recognized by sponsors over the past 15 years serve as excellent examples of this collaborative, multi-disciplinary, multi-center approach to research. 2012 was no exception, as the six centers continued to work in harmony towards solving major problems impeding the progress in semiconductor scaling and productivity. Of particular focus was the research in all centers towards more energy-efficient electronics. Research on materials that can enable continued scaling of devices and interconnects at lower power progressed well, as did circuits that are configured to take advantage of these new materials and devices. At the next level, new systems architectures and algorithms have been achieved that result in more energy-efficient applications. Finally, at the platform level, software and algorithms that coordinate the operation of large systems (such as server farms) were found that make major contributions to overall power. Without such efforts in energy reduction, continued progress for the entire semiconductor industry and many of its end applications would soon slow to a crawl.

In our new world of massive data needs, applications demand fast, low-power memory that maintains the data even with power loss, especially for handheld devices. The **FENA Center** continued research on new wide bandgap materials, including ZnO and GaN for making better non-volatile memory devices, as well as in graphene-based memory devices. They also developed super-high thermal interface materials with a record-high enhancement of 2300% in graphene-polymer mixes that would dramatically improve heat dissipation for microchips.

The **MSD Center** has investigated the phase-change mechanism that is responsible for resistance change in materials used in PCM memories. MSD also demonstrated InGaAs nanowire devices with record-high on-state and off-state performance, showing great promise for this technology in 10-nm and beyond high-speed low-power logic applications. Finding more power-efficient on-chip interconnect solutions is critical for future applications.

The **IFC** has found that optical interconnect can provide high bandwidth and low latency for input/output communications to the chip, and that plasmonics are useful in power-efficient sources and detectors with materials that can be integrated on-chip.

FIGURE 1
(A) Schematic of the test structure with High-K/ Graphene/SiO_2/Si stack.

(B) A physical model of the internal photoemission spectroscopy measurement.

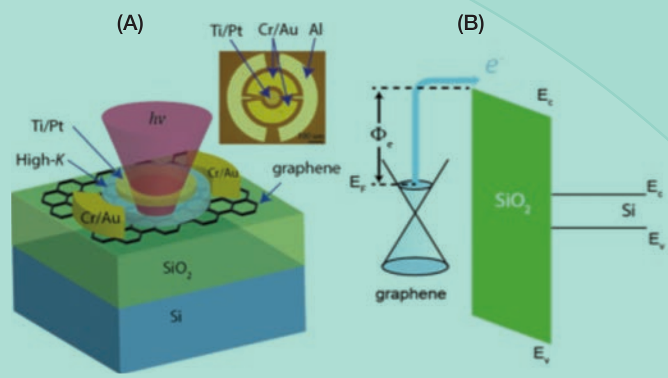
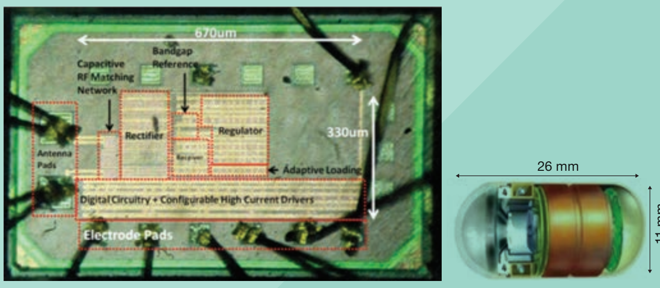


FIGURE 2
A wireless prototype of a miniature, low-power system for efficient fluid propulsion in sub-mm scale locomotive implants.

(LEFT) Die shot of chip design.

(RIGHT) Sealed capsule that contains chip.



In the **C2S2 Center**, the focus was on theory and circuits for delivery of energy with the utmost efficiency. While most of this work was very general in nature, the projects were all collaboratively focused on wireless power delivery to modules within the human body. The project on locomotive-driven body implants was recently highlighted in *EE Times* as the most exciting paper to be presented at ISSCC 2012 in February. The researchers have successfully demonstrated the control and locomotion of a tiny module and antenna (Figure 1 and Figure 2 above) in a fluid environment similar to that of the human body.

The **GSRC Center** has been researching specialized ultra-low-power programmable platforms for classification using machine learning for human health applications. These platforms have the potential to serve as the foundations for future architectures in this space. They also developed low-power applications that analyze ECG and EEG signals for clinical disorders ranging from sleep disorders to cardiovascular diseases.

There were many outstanding achievements of FCRP in 2012 and even more are expected in STARnet in the coming five years, along with hundreds of new PhDs to fill the needs of our industry.

NANOELECTRONICS RESEARCH INITIATIVE

Seeing 2020 and Beyond

Goal-Oriented, Basic-Science Research

The Nanoelectronics Research Initiative (NRI) is a consortium of companies in SRC. NRI works closely with federal government funding agencies and state governments to fund university research aimed at new devices for computing. ***The goal is to discover and demonstrate one or more new devices that have the potential to take computing beyond the inherent physical limits of CMOS transistor technology, thereby extending the historical trends in cost and performance of information technology.*** Future generations of electronics will be based on new devices and circuit architectures, operating on physical principles that cannot be exploited by conventional transistors. NRI's exploratory research challenges the most talented students at top U.S. universities to become the innovators and leaders of tomorrow's nanoelectronics industry.

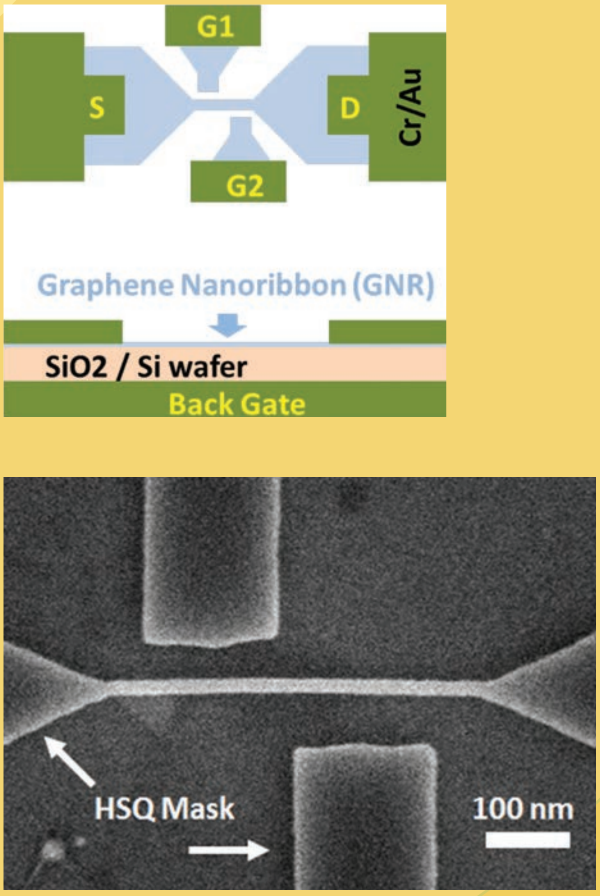
In 2012 NRI funded groundbreaking research at over 40 universities in 19 states. The research is organized into multi-university research centers, jointly funded with the National Institute of Standards and Technology (NIST) and several states, and in joint projects with the National Science Foundation (NSF). **Building on their work of prior years, the multi-university centers devoted significant research effort to *device performance benchmarking*, a comprehensive assessment of the various NRI device concepts.** An industry team led the effort, ensuring that the potential performance of every device was evaluated under identical engineering assumptions. Key results and conclusions were detailed in an important white paper and presented in August 2012 at the NRI Benchmarking Workshop hosted by Notre Dame.

These results provided crucial technical background and guidance as NRI partnered with NIST to solicit proposals for new multi-university research centers to be funded in 2013. This initiative, called **NRI Phase 2**, will focus on key research opportunities identified in the benchmarking study. It will ensure continued federal and state government support, which amplifies the industry investment. NRI thus remains a leading example of how industry, government and academia can work together to identify, nurture and accelerate the development of emerging fields of research with the potential to transform an entire industry.

Making the Phenomenal Practical

One of the primary challenges for NRI is to foster strong connections between diverse disciplines. Physicists, chemists and materials scientists make basic scientific breakthroughs (often in emerging fields where new discoveries come at a rapid pace), and researchers from various engineering disciplines figure out how these phenomena might revolutionize computing technology. A scientist discovers a new, energy-efficient way to switch the magnetic orientation of a tiny nanomagnet, and an engineer seeks to fabricate and test a new digital device based on that novel switching mechanism. Another engineer designs complex circuits and explores new computing architectures enabled by the unique characteristics of the new device. **By fostering such connections among top university researchers, NRI aims to radically reduce the time from "lab to fab" for completely new device technologies.**

Schematic diagrams and scanning electron micrograph of a graphene nanoribbon tunneling field-effect transistor (GNRTFET) with a width of 10 nm fabricated in the MIND Center. Promising device characteristics, indicating the potential for fast, ultra-low-power operation, have motivated an expanded research program under the new STARnet Center for Low Energy Systems Technology (LEAST) led by Notre Dame.



To ensure the connection is direct, NRI companies have full-time assignees working directly with the universities. These assignees not only provide daily feedback to the university researchers from the practical industry perspective, they also give immediate access to intermediate results — and student talent — that can often impact technology *today*, long before NRI reaches its final goal of finding the next nanoelectronic switch. Of course, every NRI member company has access to all of the powerful SRC tools for management and transfer of research results, as well as student interaction.

LOOKING AHEAD: EMERGING INITIATIVES

Whether continuing along the path defined by Moore's Law or exploring new directions and technologies for diverse applications, our industry is facing new challenges. SRC has a mandate to look ahead and identify new initiatives that complement current programs and address the needs of a broad set of businesses and government agencies.

Trustworthy and Secure Semiconductors and Systems (T3S)

Semiconductor-based technology is at the heart of today's networked and intelligent world. However, growing complexity of integrated circuits and systems, coupled with the lengthening and increasingly global supply chain, lead to vulnerabilities in the design and manufacturing process. Examples include gaps in specification and verification tools and processes, which in turn leave open the possibility of "side channels" that allow unintended access or control or even malicious tampering at various stages. These vulnerabilities may impact reliability and trustworthiness of semiconductor-based products, thereby posing risks to businesses and national security, as well as to personal safety of consumers.

A group of interested companies has formed to identify research for improving the ability to design, manufacture and distribute products that are trustworthy, secure, and that can be authenticated in the field. Research in this area can benefit from strategies in the realms of design automation, hardware verification and software assurance. SRC is discussing collaborative approaches to work in partnership with Federal government agencies having aligned interests.

Semiconductor Synthetic Biology (SemiSynBio)

It is becoming increasingly clear that information processing plays a central role in enabling the functionality of biological systems from the molecular to the body scale. Conversely, semiconductor information processing is providing tools for fundamental biological discovery and medical applications. Synthetic biology is a relatively new discipline focusing on the design and construction of new biological parts, devices and systems, as well as the redesign of existing natural biological systems for alternative purposes (medical applications, agriculture, energy systems, new material development, etc.). Advances in synthetic biology science are beginning to suggest possible pathways for future semiconductor technologies. Recent research suggests that some of the physical limits faced by semiconductor technology may be overcome by borrowing from synthetic biology principles.

At the request of ATIC (Advanced Technology Investment Company), **SRC has begun to explore technical opportunities and promising research at the intersection of synthetic biology and semiconductor science and engineering.**

ENERGY RESEARCH INITIATIVE

Seeking Tomorrow's Smart Energy Solutions

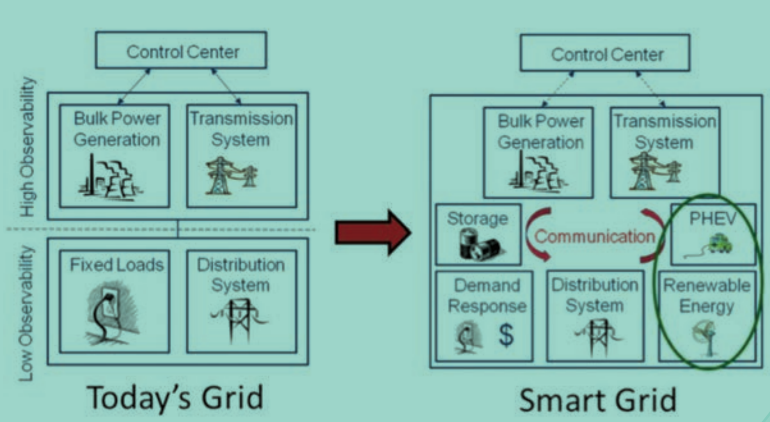
SRC's Energy Research Initiative (ERI) program began in July 2010 with seven founding members: ABB, Applied Materials, Bosch, First Solar, IBM, Nexans and Tokyo Electron. Initial projects selected by ERI members were launched in October 2010 at two new Centers of Energy Research Excellence: the Network for Photovoltaic Technology (NPT) at Purdue University, and the Smart Grid Research Center (SGRC) at Carnegie Mellon University. In January 2012 three additional companies (Hydro One Networks, NEC and ON Semiconductor) joined ERI, enabling the creation of a third "distributed" center focused on Energy Storage and Power Electronics (ESPE) with initial projects started in September. **Today, with a total of 10 members and three centers focused on enabling research for energy sustainability, ERI is spearheading the fundamental precompetitive energy research that will have broad benefits as the world strives to meet its future energy needs.**

During 2012 significant progress was made towards achieving ERI's mission of enabling reliable, low-cost renewable energy systems and efficient energy use and distribution through an enabled and optimized smart grid. The NPT Center at Purdue University continued to progress towards its overarching goal of developing end-to-end models for the PV industry by demonstrating that the spatial and temporal distribution of shunt conductance are universally described by log-normal distribution and voltage-dependent on-off transition, respectively. When embedded in a generalized SPICE-based compact model, the universality of shunt conduction explains the intrinsic gap between cell and panel efficiencies, as well as power loss due to shadow degradation.

Working at the forefront of transformative smart grid systems research, the SGRC at Carnegie Mellon University provided renewed understanding of Adaptive Load Management and successfully applied a preliminary model to a real-world case. The SGRC also demonstrated how energy-based control logic can be used on a Static Var Compensator to stabilize a grid with high amounts of volatile wind power. Moreover, SGRC demonstrated a modeling and control approach to ensure pre-specified frequency standards by utilizing online resources such as frequency sensors.

Lastly, to further enhance ERI's smart grid research portfolio, a partnership was forged with NSF on a joint solicitation in the area of computation related to smart grid within NSF's broader program on cyber-enabled sustainability.

ERI's **SMART GRID** research focuses on incorporating renewable energy resources and providing the modeling, simulation and control tools needed to manage, optimize and secure the power grid.



EDUCATION ALLIANCE

Producing leaders. Making a difference.

Student Programs: 30 Years of Significant Impact

Since 1982 over 9,000 students at more than 260 universities have already contributed significantly to SRC's extensive research portfolio: 400 patents, more than 720 software tools and 57,000 technical documents published in top journals. On average, SRC supports more than 1,200 advanced-degree students, more than 340 undergraduates and 500 faculty supervisors at top universities around the world each year. Always at the center of the collaboration, SRC students have many meaningful interactions with industry scientists and engineers, as well as with researchers from the academic community. Even more significantly, SRC has a 30- to 40-year impact through careers of students who have participated in its programs. These graduates will address pressing challenges in technology, energy, healthcare, national security and environmental protection for years to come.

Along with the profound impact made on the global semiconductor industry, SRC students are a major beneficiary of SRC's unique pre-competitive collaborative research programs.

Graduate Fellows & Master's Scholars Bring Distinction to SRC & the Industry

The Graduate Fellowship Program (GFP) and the Master's Scholarship Program (MSP) have been fundamental to SRC's numerous successes over the years. These programs provide full funding for doctorate and master's degree study by exceptionally talented students committed to conducting relevant research at prestigious universities and pursuing careers in the semiconductor industry. By supporting university research that establishes the foundation for the industry and provides the next generation of engineers and scientists, these key SRC programs help member companies maintain leadership roles and global marketplace competitiveness.

- More than 300 Fellowships have been awarded since the program was founded in 1986, and upwards of 60% of those individuals have been hired by SRC industry members and assumed leadership within the industry.
- Since 1997 when the program was created, more than 100 Master's Scholarships have been awarded, and 80% of those students continued on to a Ph.D. or were hired by member companies.

SRC STUDENTS

Students Managed in 2012	2,036
Resumes on web	890
2012 Graduates	388
2012 Internships	136

2012 Graduates:

Ph.D.	186
M.S.	35
B.S.	120
Post doc.	47

URO Program: Fueling the Next Generation

Undergraduate students are the foundation for our future. Bright minds brimming with creativity, hope and intelligence can affect all that we do and offer an immense source of opportunity for the semiconductor industry. That is why SRC invests so much in cultivating their talents and skills to help them achieve their education goals and also provide meaningful research to the academic and professional worlds. These students are our next generation of scientists and engineers.

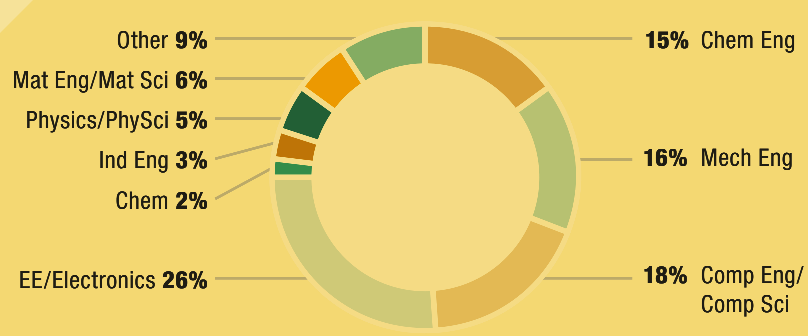
SRC's Undergraduate Research Opportunities (URO) program provides students with valuable research experience, mentoring and contact with industry representatives. Participating undergraduates not only gain confidence in their ability to perform hands-on research, but they also come to appreciate the doors that are opened to those with an advanced degree. The program takes education beyond the classroom to achieve its objectives:

- Rigorous and engaging training for Science, Technology, Engineering & Mathematics (STEM) undergraduates;
- Increased retention of students interested in STEM majors;
- Increased participation of women and under-represented minorities; and
- Increased numbers of STEM students progressing to graduate school programs.

The URO program achieves its objectives first and foremost by supporting students in research under the guidance of faculty and graduate student mentors. However, several aspects of our program distinguish it from other research programs. First, the program provides funding at the university level, establishing on-campus program managers to assist students. Second, our network of universities gives students the opportunity to participate in summer exchange programs, allowing them to acquire new technical skills and broaden their view of the research field. Third, the program also funds workshops and other activities to inform students about graduate school and entering the workforce. Finally, the program provides contact between student and industry experts, exposing them to different career opportunities and preparing them for an advanced degree.

SRC knows that the future of the industry belongs to talented undergraduate students. Through its efforts to facilitate the needs of U.S. students in STEM, SRC can protect and grow the semiconductor industry's economic and social significance.

CURRENT URO STUDENTS



TECHCON

SRC's Annual Technical Conference & Research Showcase

Just six years after its inception, Semiconductor Research Corporation initiated an event to highlight the best member-sponsored research within this unique pre-competitive collaborative endeavor. With a title theme of "Cooperation in the Semiconductor Industry", TECHCON '88 showcased the bright, talented students performing the research, and recognized the university and industry participants making SRC a world-class research management organization.

Since that first conference in 1988 with over 650 in attendance, TECHCON has continued to develop and grow into a premier international event for technology research. The collaboration, peer interaction and exciting research results have become so inspirational, in fact, that the event became an annual occurrence beginning in 2007. And in 2010 TECHCON added undergraduate research presentations through its newly formed URO (Undergraduate Research Opportunities) program. Not only do students get to present their research in an exciting, competitive fashion, but they get to meet and network with industry representatives as they look forward to life after graduation.

TECHCON has welcomed some impressive speakers through the years including Jack Kilby, Intel's Craig Barrett and Nobel Laureate Professor Richard Smalley.

Today TECHCON continues to be the most unique format for ongoing industry development and face-to-face interaction among the best-of-the-best STEM student researchers.

TECHCON 2012

Fueled by SRC's devotion to sponsoring use-inspired university research, supporting student development, and promoting connection between industry innovators and academic researchers, **TECHCON 2012** was a stellar success. The event, held in Austin, Texas, showcased the quality of the SRC research portfolio, the excellence of SRC students and faculty, and the magnitude of the collaborative research investment made by the semiconductor industry through SRC. Total attendance reached 423, including 181 industry participants, 8 faculty, 214 students and 20 SRC technical and support staff. Industry and faculty attendees included about 30 SRC student alumni.

This year's sessions included papers from GRC, FCRP NRI, and ERI with 145 student-presented technical papers and posters representing a broad cross-section of SRC-funded research. Twenty-one students from GRC, six from FCRP, four from NRI and one from ERI won Best in Session Awards. Representatives from member companies served as judges, using a standard set of criteria and considering both paper presentation and poster. Eleven Fellows and Scholars presented posters in the TechFair sessions following each of the paper sessions. A relatively new addition to TECHCON was a section of posters from 28 students participating in the URO program.

AWARDS

Recognizing Excellence Within the SRC Community

Aristotle Award

The Aristotle Award recognizes SRC-supported faculty whose deep commitment to the educational experience of SRC students has had a profound and continuing impact on their professional performance and, consequently, a significant impact for members over a long period of time. The 2012 recognition went to **Professor Andrew Neureuther**, an inspirational teacher and mentor for nearly five decades of students at the University of California, Berkeley. The letters of nomination for this award from Professor Neureuther's former students all have glowing praise for his teaching, mentoring and guidance during their years under his supervision.

Technical Excellence Award

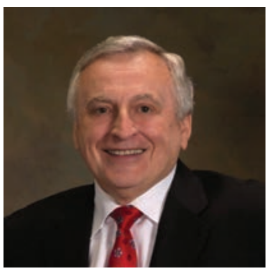
The Technical Excellence Award recognizes researchers who have made key contributions to technology that has significantly enhanced the productivity of the semiconductor industry. For 2012 the $5000 award was presented to **Dr. Jesus del Alamo**, professor of Electrical Engineering at Massachusetts Institute of Technology, for his SRC-funded work advancing silicon and compound semiconductor transistor technologies for RF, microwave and millimeter wave applications.

Mahboob Khan Outstanding Industry Liaison Award

The Industry Liaison Program captures the essence of SRC, bringing together faculty researchers, graduate students and technical experts from SRC member companies. Industry Liaisons provide input and feedback to the researchers during the course of the project, act as mentors to students, and facilitate technology transfer back to the member companies.

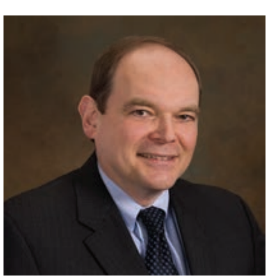
The Mahboob Khan Outstanding Industry Liaison Award, named in memory of a long-time mentor and advocate for the Industry Liaison program from Advanced Micro Devices, is presented to those individuals who have made significant contributions to the GRC community in their roles as Industry Liaisons. This year 18 individuals were recognized for their extraordinary commitment to the program.

2012 OFFICE OF THE CHIEF EXECUTIVE & BOARD OF DIRECTORS



Larry W. Sumney
President & Chief Executive Officer

Betsy Weitzman
Executive Vice President, SRC
Executive Director, FCRP



Steven Hillenius
Executive Vice President, SRC
Executive Director, GRC
Chief Operating Officer, ERI

Board of Directors

Venu Menon *(2012 Chairman)*
Texas Instruments Incorporated

Chekib Akrout
Advanced Micro Devices, Inc.

Om Nalamasu
Applied Materials, Inc.

Sami Issa
Advanced Technology Investment Company (ATIC)

Ken Hansen
Freescale Semiconductor, Inc.

Gregg Bartlett
GLOBALFOUNDRIES

T.C. Chen
IBM Corporation

Michael Mayberry
Intel Corporation

Pat Lord *(6/5/2012-12/31/2012)*
Lam Research Corporation

Walden C. Rhines
Mentor Graphics Corporation

Pat Lord *(through 6/4/2012)*
Novellus Systems, Inc.

James Gibson
Research Triangle Institute

Larry W. Sumney
Semiconductor Research Corporation

Masayuki Tomoyasu
(through 6/27/2012)
Tokyo Electron Limited (TEL)

Alex Oscilowski *(as of 6/28/2012)*
Tokyo Electron Limited (TEL)

Ex-Officio

Dan Armbrust
SEMATECH

Brian Toohey
SIA

Board Secretary:

W. Clark McFadden II
Dewey & LeBoeuf, LLP

SRC Membership

ABB, Inc.
ERI

Advanced Micro Devices, Inc.
GRC

Advanced Technology Investment Company (ATIC)
GRC

Applied Materials, Inc.
GRC, FCRP, ERI

First Solar, Inc.
ERI

Freescale Semiconductor, Inc.
GRC

GLOBALFOUNDRIES
GRC, FCRP, NRI

Hydro One
ERI

IBM Corporation
GRC, FCRP, NRI, ERI

Intel Corporation
GRC, FCRP, NRI

Lam Research Corporation
GRC, FCRP

Mentor Graphics Corporation
GRC

Micron Technology, Inc.
FCRP, NRI

NEC Corporation
ERI

Nexans
ERI

Novellus Systems, Inc.
(through 6/2012)
GRC, FCRP

ON Semiconductor
ERI

Raytheon Company
FCRP

Research Triangle Institute
GRC

Robert Bosch LLC
ERI

Texas Instruments Incorporated
GRC, FCRP, NRI

The MITRE Corporation
GRC

Tokyo Electron Limited (TEL)
GRC, ERI

United Technologies Corporation
FCRP

Government Participation

DARPA
FCRP

Commonwealth of Virginia
NRI

NIST
GRC, NRI

NSF
GRC, NRI

Project Future
South Bend, Indiana
NRI

SPAWAR Systems Center
FCRP

State of Arizona
GRC

State of California
NRI

State of Georgia
GRC

State of Indiana
NRI

State of New York
GRC, NRI

State of Texas
GRC, NRI

Engineering & Physical Sciences Research Council
GRC

Strategic Partners

SEMATECH
GRC

SEMI
GRC, FCRP

SIA
GRC, FCRP, NRI

MOSIS
GRC

"As we near the physical limits of scaling for performance and enter the Cognitive Systems Era, SRC is now faced with increasing challenges and opportunities. And I am confident they will meet and conquer each one."

Dr. John E. Kelly III
Senior Vice President and Director of Research, IBM

1101 Slater Road
Brighton Hall, Suite 120
Durham, NC 27703

PO Box 12053
RTP, NC 27709-2053
919.941.9400

Visit Semiconductor Research Corporation online at **www.src.org**.