NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are a principal means by which NSF fosters interdisciplinary research.

NSF Centers Funding
(Dollars in Millions)

	Program initiation	Number of Centers in FY 2008	FY 2008 Actual	FY 2009 Plan	FY 2010 Request	Change over FY 2009 Plan Amount	Change over FY 2009 Plan Percent
Centers for Analysis & Synthesis	1995	4	$13.80	$17.41	$23.00	$5.59	32.1%
Centers for Chemical Innovation	1998	9	7.87	15.50	24.00	8.50	54.8%
Engineering Research Centers	1985	15	53.42	53.55	63.20	9.65	18.0%
Materials Res. Science & Engineering Ctrs	1994	31	57.15	68.51	66.01	-2.50	-3.6%
Nanoscale Science & Engineering Centers	2001	19	45.95	45.16	45.16	-	-
Science and Technology Centers	1987	17	64.73	61.61	57.79	-3.82	-6.2%
Science of Learning Centers	2003	6	14.89	12.50	25.80	13.30	106.4%
Total, Centers			$257.80	$274.24	$304.96	$30.72	11.2%

Totals may not add due to rounding.

CENTERS DESCRIPTIONS

Centers for Analysis and Synthesis (BIO)

The Centers for Analysis and Synthesis are designed to continue development of new tools and standards for management of biological information and meta-information, support data analysis capabilities with broad utility across the biological sciences, host workshops that bring together scientists from a variety of disciplines, and begin to host and curate databases. The centers have a critical role in organizing and synthesizing biological knowledge that is useful to researchers, policy makers, government agencies, educators, and society.

The National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California at Santa Barbara promotes integrative studies of complex ecological questions and serves as a locus for the synthesis of large data sets. Funding for NCEAS remains at $3.70 million for FY 2010. The National Evolutionary Synthesis Center (NESCent) is a collaborative effort by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill to foster a greater conceptual synthesis in biological evolution by bringing together researchers and educators, extant data, and information technology resources. In FY 2010, funding doubles from $2.50 million to about $5.0 million per year as NESCent ramps up activities for the next five years.

The National Institute for Mathematical and Biological Synthesis (NIMBioS, formerly CIMBS), located at the University of Tennessee-Knoxville, fosters cross-disciplinary approaches in mathematics and biology to address fundamental and applied biological questions, including national needs research in modeling of infectious diseases of plants and animals. The center will design education programs aimed at the mathematics-biology interface, thereby building the capacity of mathematically competent, biologically knowledgeable and computationally adept researchers needed to address the vast array of challenging questions in this century of biology. Although predominantly supported by BIO, MPS and the Department of Homeland Security also contribute. NIMBioS funding increases from $2.05 million in FY 2009 to $3.50 million in FY 2010.

A Plant Science Cyberinfrastructure Collaborative (iPlant, formerly PSCIC) led by the University of Arizona uses new computer and information science, and cyberinfrastructure solutions to address an evolving array of grand challenges in the plant sciences. This center is a community-driven effort, involving plant biologists, computer and information scientists and engineers as well as experts from other disciplines, all working in integrated teams. Awarded in FY 2008, iPlant ramps up from $9.16 million in FY 2009 to $10.80 million in FY 2010 .

Centers for Chemical Innovation (MPS)
The Centers for Chemical Innovation (CCI) are designed to support research on strategic, transformative "big questions" in basic chemical research. The program is stimulating the chemical sciences community to perform work that is high-risk and of potential high scientific and societal impact. CCIs promote the integration of research and education through the extensive involvement of students and postdoctoral fellows in all phases of the work. CCIs are expected to be agile, responding to scientific opportunities as they arise, and to creatively engage the public. Grand challenges include emulating and even surpassing the efficiency of the natural process of photosynthesis to capture the sun's energy; activating strong bonds as a means to store and use chemical energy and to lower energy costs in chemical processing; and designing self-assembling, complex structures, such as molecular computers, with emergent and useful functions not yet known or foreseen.

The program is designed as a staged competition, supporting several Phase I centers at $500,000 per year for three years, which then compete for Phase II awards at $4.0 million to $5.0 million per year for five to ten years. The Phase II Center awarded in FY 2007 is developing chemistry needed to transform raw materials, such as plants, into high value organic compounds, such as fuels and chemicals for industry. The Phase II Center awarded in FY 2008 is researching the chemical fundamentals of solar energy capture and conversion to a chemical fuel.

In FY 2009, NSF plans to support a total of three Phase II centers and about ten Phase I centers. In FY 2010, the requested $24.0 million will launch two new Phase II centers (for a total of five) and four new Phase I Centers (for a total of eleven as some Phase I centers either move to Phase II or sunset).

Engineering Research Centers (ENG)
NSF's Engineering Research Centers (ERCs) are proven cauldrons of innovation, bridging the energy and intellectual curiosity of university research focused on discovery with real-world engineered systems and technology opportunities through partnerships with industry. These centers also are successful in educating a technology-enabled workforce with hands-on, real-world experience. These characteristics create an environment that catalyzes the development of marketable technologies to generate wealth and address engineering grand challenges, many of which intersect the National Academy of Engineering's Grand Challenges. This is particularly evident in ERCs that address the need for intelligent electric power grid systems to integrate the distribution of electricity from a range of variable sources including wind and solar, innovations in healthcare derived from tissue engineering and microelectronics research, sensing systems that improve the prediction of tornados, and intelligent robotic systems to assist the aging and disabled in daily tasks.

ERCs are also devoted to the integration of research and education by creating collaborative environments, and producing curricula and course materials for bioengineering, manufacturing, renewable resource use, optelectronics, and other fields. Also, all ERCs have active programs that involve pre-college teachers and students to bring engineering concepts to the classroom to stimulate interest in engineering among pre-college students; several have sites at local museums to educate the general public about engineering and technology.

In FY 2008, a new third-generation of ERCs was funded that builds on lessons learned from the impacts of the 40 successful ERCs since 1985. Five new Gen-3 ERCs have added goals of speeding innovation through involvement with small firms in transnational research and partnerships with state, local, and venture capital organizations devoted to innovations and entrepreneurship. Five new ERCs in FY 2008 brought the total number to 15. The FY 2009 solicitation (NSF 09-545) will add three new ERCs in 2010 to replace two graduating centers from the Class of 2000 and increase the total number of centers to 16. Two additional centers will also be added in early 2011 to bring the total portfolio to 18.

Materials Research Science and Engineering Centers (MPS)
Materials Research Science and Engineering Centers (MRSECs) address fundamental research problems of intellectual and strategic importance that will advance U.S. competitiveness and the development of future technologies. MRSECs also support shared experimental facilities, place strong emphasis on the integration of research and education at all levels, and provide seed money to stimulate emerging areas of materials research. They support cutting-edge areas such as electronic and photonic materials, polymers, biomimetic and biomolecular materials, magnetic and ferroelectric materials, nanoscale materials, structural materials, and organic systems and colloids. MRSECs have strong links to industry and other sectors, enabling the development of marketable technologies that depend on new classes of materials and the discovery, control, and innovative exploitation of materials phenomena. Areas of potential technological impact include computers and communications, transportation, energy conversion and storage, structural engineering, health, and medicine. MRSECs also foster partnerships among academic institutions in the U.S. as well as internationally. A significant component of new MRSEC awards are expected to tie to cross-Foundation activities, particularly Science and Engineering Beyond Moore's Law (SEBML).

Open competitions for NSF support are held triennially. The FY 2008 competition yielded five new centers for a total of 31. Four other centers are currently phasing out with final funding in FY 2009 and FY 2010. FY 2010 funding for MRSECs will be comparable to FY 2009, at about $66.0 million, with 27 MRSECs expected to be supported. A new competition is planned for FY 2011.

Nanoscale Science and Engineering Centers (multi-directorate)
Nanotechnology, which addresses the smallest of scales, is projected to be one of the largest drivers of technological innovation for the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale through NSF-funded Nanoscale Science and Engineering Centers (NSECs) aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science, and many other fields. Each center has an extended vision for research. Together they provide coherence and a long-term outlook to U.S. nanotechnology research and education; they also address the social and ethical implications of such research. NSEC funding will also support education and outreach programs from K-12 to the graduate level, which is designed to develop a highly skilled workforce, advance pre-college training, and further public understanding of nanoscale science and engineering. These centers have strong partnerships with industry, national laboratories, and international

centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies.

NSF funded 19 NSECs in FY 2008, including the Nanotechnology in Society Network, and expects to continue funding these 19 in FY 2010 at the same funding level of $45.16 million. Of these, four NSECs on nanomanufacturing established the core of the National Nanomanufacturing Network in FY 2007, and two Centers for the Environmental Implications of Nanotechnology were established in FY 2008 with an annual budget totaling $7.30 million.

Science and Technology Centers: Integrative Partnerships (multi-directorate)
The Science and Technology Centers: Integrative Partnerships (STC) program advances discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and development of a diverse workforce. The STC portfolio reflects the disciplines of science and engineering supported by the NSF. Examples of continuing investment include cyber-security, advanced sensors and embedded networked sensing, revolutionary materials for information technology, advanced nano/microfabrication capabilities, new materials and technologies for monitoring water resources and water quality, modeling and simulation of complex earth environments for improving their sustainability, and weather/climate prediction.

STCs engage the Nation's intellectual talent and robustly draw from its full diversity through partnerships among academia, industry, national laboratories, and government. These partnerships enhance and ensure the timely transfer of knowledge and technology from the laboratory to appropriate industries, the application of patents derived from the work of the STCs, the launching of spin-off companies, and creation of job opportunities. STCs have impressive records of publications and research training of students, postdoctoral fellows, established researchers, and educators as well as strong partnerships with K-12 and informal education communities and industry.

In FY 2009, after ten years of funding, support for five centers from the Class of 2000 will end. A new competition was initiated in FY 2009 to identify and fund up to five new STCs in FY 2010. A total of 17 new and continuing STCs are expected to be funded in FY 2010.

Science of Learning Centers (multi-directorate)
The Science of Learning Center (SLC) goals are to advance fundamental knowledge about learning, transform the way people learn and teach, secure the U.S. leadership role in innovation and technology, and prepare the Nation's workforce for the 21^{st} century. The six SLCs will continue to harness and integrate knowledge across multiple disciplines to create a common groundwork of conceptualization, experimentation, and explanation that underlies new lines of thinking and inquiry leading to a deeper understanding of learning. The SLC portfolio represents synergistic, exciting research efforts that address different dimensions of learning, including:

- combined modeling and experimental studies to link brain function and behavior and permit innovations in technology
- development of learning technologies to study robust learning in classrooms in support of educational data mining, machine learning, and developing principles to inform the use and design of new technologies that enhance learning
- the processes involved in learning visual languages and how this knowledge can improve language processing and reading in deaf, hearing-impaired, and hearing learners
- the influence of time and timing on learning across multiple scales and multiple levels of analysis, to inform understanding of learning from the cellular level to social interactivity in classrooms

- the role of social interaction in learning, including the interplay between learning in informal and formal environments
- spatial intelligence and learning, the malleability of the underlying processes and how they can be enhanced to improve learning in STEM domains

In FY 2010, almost $26.0 million will provide continuing funding for the second cohort of SLCs, enable award renewal for the first cohort of SLCs, and provide support for programmatic activities, including administrative costs, workshops, external evaluation, and infrastructure to support the network of centers.

Estimates of Centers Participation in 2008
(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total FY 2008 NSF Support	Total Est. Leveraged Support	Number of Participants
Centers for Analysis & Synthesis	9	48	$14	$8	1,535
Centers for Chemical Innovation	27	16	$8	$1	242
Engineering Research Centers	432	455	$53	$100	4,302
Materials Research Science & Engineering Centers	357	351	$57	$54	3,950
Nanoscale Science & Engineering Centers	160	295	$46	$18	2,000
Science & Technology Centers	121	443	$65	$30	3,061
Science of Learning Centers	32	59	$15	$16	487

No. of Participating Institutions: all academic institutions participating in activities at the centers.
No. of Partners: the total number of non-academic participants, including industry, states, and other federal agencies at the centers.
Total Leveraged Support: funding for centers from sources other than NSF.
No. of Participants: the total number of people who use center facilities, not just persons directly support by NSF.

Centers Supported by NSF in FY 2008

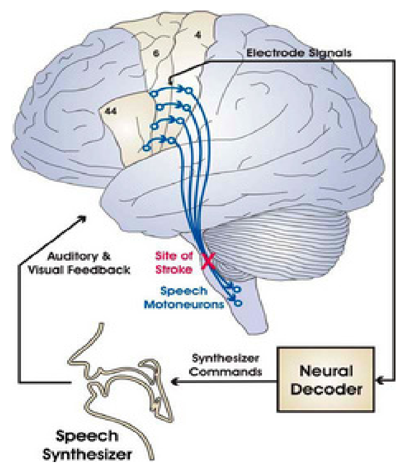
Center	Institution	State
Centers for Analysis and Synthesis		
National Center for Ecological Analysis and Synthesis	U of California-Santa Barbara	CA
National Evolutionary Synthesis Center	Duke, NC State U, U of N. Carolina	NC
National Institute for Mathematical & Biological. Synthesis	U of Tennessee- Knoxville	TN
Plant Science Cyberinfrastructure Collaborative	U of Arizona	AZ
Centers for Chemical Innovation		
Center for Enabling New Technologies through Catalysis (phase II)	U of Washington	WA
Powering the Planet (phase II)	California Institute of Tech	CA
Center for the Chemistry of the Universe (phase I)	U of Virginia	VA
Center for Green Materials Chemistry (phase I)	Oregon State U	OR
Center for Molecular Cybernetics (phase I)	Columbia	NY
Center for Molecular Interfacing (phase I)	Cornell	NY
Chemistry at the Space-Time Limit (CaSTL) (phase I)	U of California-Irvine	CA
Fueling the Future (phase I)	U of Massachusetts-Amherst	MA
The Origins Chemical Inventory & Early Metabolism Proj. (phase I)	Georgia Institute of Tech	GA
Engineering Research Centers		
Biomimetic Microelectronic Systems	U of Southern California	CA
Biorenewable Chemicals	Iowa State U	IA
Collaborative Adaptive Sensing of the Atmosphere	U of Mass-Amherst	MA
Compact and Efficient Fluid Power	U of Minnesota	MN
Extreme Ultraviolet Science and Technology	Colorado State	CO
Future Renewable Electric Energy Delivery & Mgmt. Systems	North Carolina State U	NC
Integrated Access Networks	U of Arizona	AZ
Mid-IR Tech for Health and the Environment	Princeton	NJ
Quality of Life Technology	Carnegie Mellon/U of Pittsburgh	PA
Revolutionizing Metallic Biomaterials	North Carolina A&T U	NC
Smart Lighting	Rensselaer Polytechnic Institute	NY
Structured Organic Composites	Rutgers	NJ
Subsurface Sensing and Imaging Systems	Northeastern	MA
Synthetic Biology	U of California-Berkeley	CA
Wireless Integrated MicroSystems	U of Michigan	MI
Materials Research Science and Engineering Centers		
Brandeis Materials Research Science and Engineering Center	Brandeis U	MA
Center for Complex Materials	Princeton	NJ
Center for Emergent Materials	Ohio State U	OH
Center for Materials for Information Technology	U of Alabama	AL
Center for Materials Research	Cornell	NY
Center for Materials Science and Engineering	Massachusetts Institute of Tech	MA
Center for Micro- and Nanomechanics of Materials	Brown	RI
Center for Multifunctional Nanoscale Materials Structures	Northwestern	IL
Center for Nanomagnetic Structures	U of Nebraska	NE
Center for Nanoscale Science	Pennsylvania State	PA
Center for Nanostructured Interfaces	U of Wisconsin	WI
Center for Nanostructured Materials	Columbia	NY
Center for Polymer Interfaces and Macromolecular Assemblies	Stanford, UC-Davis, IBM	CA
Center for Research on Interface Structures and Phenomena	Yale	CT
Center for Response-Driven Polymeric Films	U of Southern Mississippi	MS
Center for Science and Engineering of Materials	California Institute of Tech	CA
Center for Semiconductor Physics in Nanostructures	U of Oklahoma, U of Arkansas	OK, AR
Ferroelectric Liquid Crystals Materials Research Center	U of Colorado-Boulder	CO
Genetically Engineered Materials Science and Engineering Center	U of Washington	WA

Laboratory for Research on the Structure of Matter	U of Pennsylvania	PA
Materials Research Center	U of Chicago	IL
Materials Research Science and Engineering Center	Carnegie Mellon	PA
Materials Research Science and Engineering Center	Johns Hopkins	MD
Materials Research Science and Engineering Center	Harvard	MA
Materials Research Science and Engineering Center	Georgia Institute of Tech	GA
Materials Research Science and Engineering Center	New York U	NY
Materials Research Science and Engineering Center	U of California-Santa Barbara	CA
Materials Research Science and Engineering Center	U of Maryland	MD
Materials Research Science and Engineering Center	U of Minnesota	MN
Materials Research Science and Engineering Center on Polymers	U of Massachusetts	MA
Renewable Energy Materials Science and Engineering Center	Colorado School of Mines	CO
Nanoscale Science and Engineering Centers		
Affordable Nanoengineering of Polymer Biomedical Devices	Ohio State	OH
Center for Environmental Implications of Nanotechnology	Duke	NC
Center for Integrated and Scalable Nanomanufacturing	U of California-Los Angeles	CA
Directed Assembly of Nanostructures	Rensselaer Polytechnic Institute	NY
Electronic Transport in Molecular Nanostructures	Columbia	NY
High Rate Nanomanufacturing	Northeastern, U of New Hampshire, U of Mass-Lowell	MA, NH
Integrated Nanomechanical Systems	U of California-Berkeley, Cal Tech, Stanford, U of California-Merced	CA
Integrated Nanopatterning and Detection Technologies	Northwestern	IL
Molecular Function at the Nano/Bio Interface	U of Pennsylvania	PA
Nanotechnology in Society Network: Center at ASU	Arizona State U	AZ
Nanotechnology in Society Network: Center at UCSB	U of California-Berkeley	CA
Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Urbana Champaign	IL
Nanoscale Systems in Information Technologies	Cornell	NY
Nanoscience in Biological and Environmental Engineering	Rice	TX
National Nanomanufacturing Network: Center for Hierarchical Manufacturing	U of Massachusetts-Amherst	MA
Predictive Toxicology Assessment & Safe Implementation of Nanotechnology in the Environment (CEIN)	U of California-Los Angeles	CA
Probing the Nanoscale	Stanford, IBM	CA
Science of Nanoscale Systems and their Device Applications	Harvard	MA
Templated Synthesis and Assembly at the Nanoscale	U of Wisconsin-Madison	WI
Science and Technology Centers		
Adaptive Optics	U of California-Santa Cruz	CA
Advanced Materials for Purification of Water Systems	U of Illinois-Urbana Champaign	IL
Behavioral Neuroscience	Georgia State U	GA
Biophotonics Science and Technology	U of California-Davis	CA
Center for Remote Sensing of Ice Sheets	U of Kansas	KS
Coastal Margin Observation and Prediction	Oregon Health and Science U	OR
Earth Surface Dynamics	U of Minnesota-Twin Cities	MN
Embedded Networked Sensing	U of California-Los Angeles	CA
Environmentally Responsible Solvents and Processes	U of North Carolina-Chapel Hill	NC
Integrated Space Weather Modeling	Boston U	MA
Layered Polymeric Systems	Case Western Reserve U	OH
Materials and Devices for Information Technology Research	U of Washington	WA
Microbial Oceanography: Research and Education	U of Hawaii-Manoa	HI
Multi-Scale Modeling of Atmospheric Processes	Colorado State U	CO
Nanobiotechnology	Cornell	NY
Sustainability of Semi-Arid Hydrology and Riparian Areas	U of Arizona	AZ

Ubiquitous Secure Technology	U of California-Berkeley	CA
Science of Learning Centers		
Center for Excellence for Learning in Education, Science, & Tech.	Boston U	MA
Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms	Carnegie Mellon	PA
LIFE Center - Learning in Formal and Informal Environments	U of Washington	WA
Spatial Intelligence and Learning Center	Temple	PA
The Temporal Dynamics of Learning Center	U of California-San Diego	CA
Visual Language and Visual Learning	Gallaudet	DC

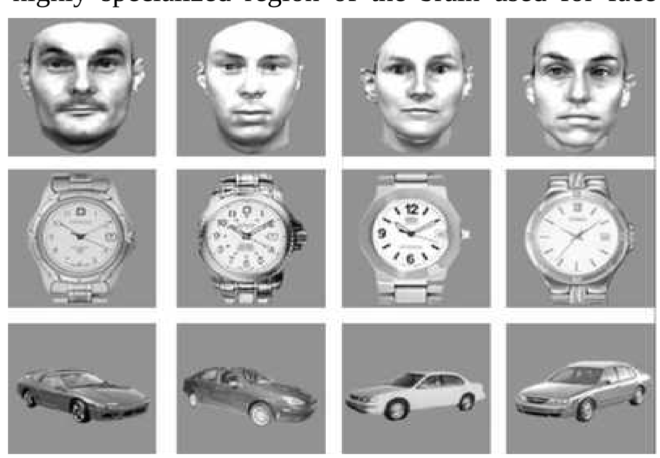
Recent Research Highlights

► **Restoring Speech to Paralyzed Individuals:** At the Center for Excellence for Learning in Education, Science, and Technology (CELEST), an NSF Science of Learning Center, a Boston University research team has succeeded in creating synthetic speech sounds from the thoughts of a paralyzed volunteer while the volunteer imagined producing those sounds. The volunteer suffers from locked-in syndrome, a fully paralyzed condition due to a brain-stem stroke, but he is fully conscious because his higher brain centers were spared. The researchers designed a special electrode that was implanted into the region of the volunteer's brain that controls speech movements. A system translates neural signals measured from the electrode into the speech sounds being thought of while the electrode measurements are being made. So far the sounds have been created offline; the implant recipient's brain signals were recorded to a computer disk and later analyzed by the system to reproduce the speech sounds. The researchers plan to implement a real-time version of the system that allows the volunteer to hear the speech sounds while thinking them.



This figure displays the Neural Decoder and Speech Synthesizer. *Credit: Image courtesy of Frank Guenther, Boston University.*

► **Memory Advantage for Faces:** Researchers at the NSF-funded Temporal Dynamics of Learning Center at the University of California at San Diego found that humans can hold more faces than other images in short-term memory. Humans have a highly specialized region of the brain used for face processing, but apparently this expert skill requires time. Researchers at Vanderbilt University found when participants studied faces or objects for a brief amount of time – half a second – they stored fewer faces than objects such as watches and cars in visual short-term memory. They believe this is because faces are more complex and require more time to be encoded. When participants were given added time to encode the images – up to four seconds – an advantage for faces over objects emerged. Interestingly, only upright faces, with which we are most familiar, and not upside-down faces, show this advantage. This work challenges previous models that assume the capacity of visual short-term memory is inflexible.

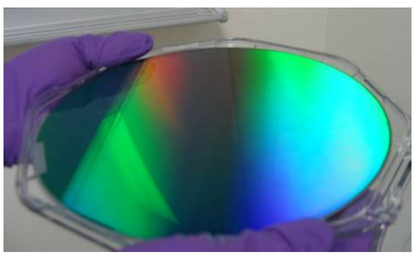


This image shows sample stimuli like those used in Curby & Gauthier (2007) to demonstrate a visual short-term memory advantage for faces over other non-face objects. *Credit: Kim Curby & Isabel Gauthier.*

► **Discera Success Due to NSF-funded Technology:** In 2004, start-up company Discera introduced to the market its proprietary, award winning PureSilicon Resonator technology to provide an effective replacement solution to quartz crystal, ceramic, and other frequency control and timing products. Discera's resonators offer a significant breakthrough in technology used to create the industry's most advanced and economical frequency control and RF circuits. These products uniquely address the miniaturization requirements of digital consumer products and other mobile applications. Resonator-based timing devices are found in all cell phones and radios, for example. Through strategic partnerships with foreign suppliers of wireless products, Discera is expected to capture a significant share of the $3.5 billion worldwide timing market. The company's success is the result of a spin-off technology from an NSF-funded Engineering Research Center at the University of Michigan.

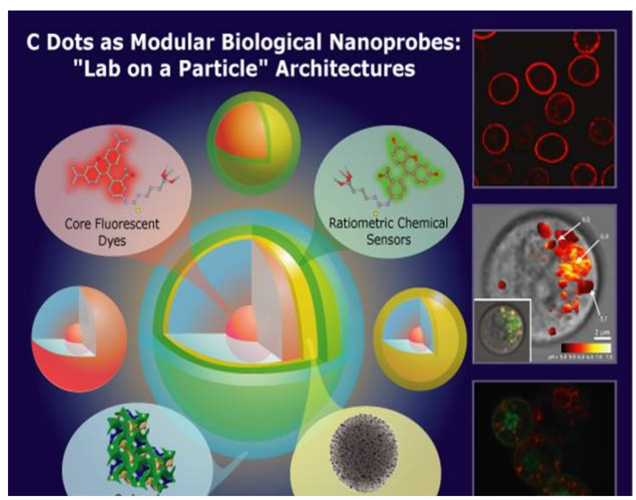
Discera was featured on the cover of EE Times. *Credit: EE Times.*

► **Environmental Technology Adapted for Medical Imaging and Treatment:** The NSF Science and Technology Center for Environmentally Responsible Solvents and Processes at the University of North Carolina conducts research to protect people from hazardous chemicals. The center recently adapted a technology developed to reduce the environmental impact of the microelectronics industry for medical diagnoses and therapy purposes. The "Particle Replication in Non-wetting Templates" technology produces nanoparticles in a wide variety of sizes and shapes that serve as carriers of conventional anti-tumor drugs and other medicines, or as contrast agents that enhance X-ray and MRI scans for better diagnosis. The particles can be targeted to specific sites in the body. The new technology is now a cornerstone of the Carolina Center of Cancer Nanotechnology Excellence.



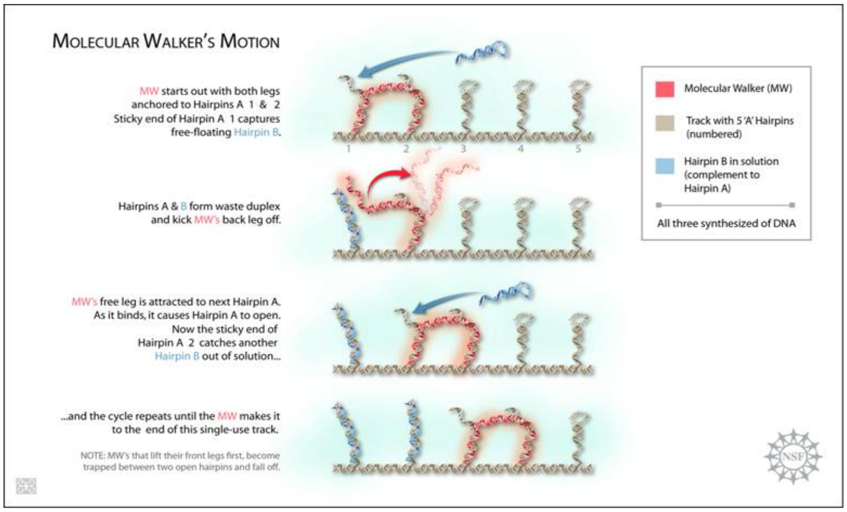
The 8-inch master disc that looks multi-colored in the photo can produce templates which in turn (for the same size) can produce on the order of 10 billion engineered particles. *Credit: Stephanie Gratton and Joseph DeSimone.*

► **Lab-on-a-Particle:** Researchers at the Cornell University Materials Research Science and Engineering Center have developed nanoscale particles that can be loaded with molecular "cargo," such as a drug or other therapeutic agent. When delivered to their target, the nanoscale particles release their cargo and then sense the reaction to the release. These multifunctional nanoparticles form the basis of a "Lab-on-a-Particle" – nanoscale structures capable of performing multiple tasks. By modifying the structure of the particle and its payload, the researchers are developing a new class of materials capable of seeking out specific cellular locations, delivering payloads of therapeutic agents to these locations, and subsequently monitoring the cell's response to these agents. These materials will give researchers the ability to monitor drug therapy in real time. Ultimately, the combined delivery of a drug or therapeutic agent with a sensing capability of its efficacy could revolutionize medicine.



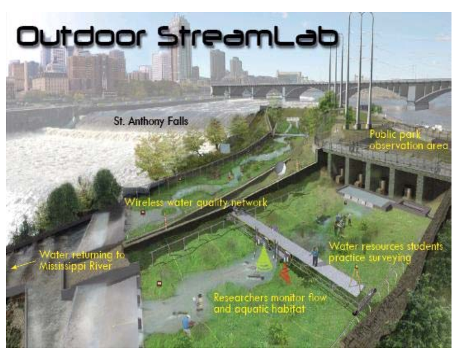
The schematic shows the structure of Cornell Dots (C-Dots) which are porous spherical particles built of multiple shells such as an onion. The inner core is a fluorescent dye that acts as a sensor, intermediate shells can be loaded with drugs or other therapeutic agents, while the outer most shell can be functionalized to stick to specific targets in a cell, such as shown in the center photo at right. *Credit: Uli Wiesner.*

► **Molecular Walker Takes Baby Steps:** Researchers with the Center for Molecular Cybernetics report they are able to program the pathways by which DNA molecules self-assemble and hence to engineer diverse dynamic functions at the molecular level. This capability is essential for something like the memory of a DNA computer, which would need large groups of molecules that can toggle from the on/off position in a fast and reliable fashion. To illustrate their approach for encoding self-assembly and disassembly pathways into DNA sequences, the researchers experimentally demonstrated the locomotion of a two-legged DNA walker that moves along a DNA track without human intervention. Exploiting self-assembly is essential to constructing a molecule with the desired features. In addition to computers, dynamic molecular systems also have great potential for medical therapies and biosensing applications.



Researchers have synthesized a molecular structure designed from single and double-stranded pieces of DNA that responds to a similarly modeled track by walking down it autonomously. The walker places foot-over-foot as each appendage is attracted biochemically to the next hairpin along the track. As foot and hairpin make contact, the hairpin unravels. The free end of the hairpin then catches a complementary hairpin that floats freely in the surrounding solution. Both hairpins coil together to form a double helix and release the walker's foot for its next stride. If the walker reaches the end of the track successfully, it leaves behind non-reusable material, and the track is spent. If the walker lifts the wrong foot and finds itself trapped between two open hairpins, it falls off and never reaches the end of the track. *Credit: Zina Deretsky, National Science Foundation after figure by Peng Yin, Harry M. T. Choi, Colby R. Calvert and Niles A. Pierce, California Institute of Technology.*

► **A River Runs Through It: Outdoor StreamLab:** The National Center for Earth Surface Dynamics, a NSF-sponsored Science and Technology Center, and St. Anthony Falls Laboratory hosted a grand opening celebration for their Outdoor StreamLab in Minnesota. The lab is a premier research facility using two abandoned flood-bypass channels associated with the St. Anthony Falls. The lab enables groundbreaking science and both formal and informal education opportunities. Historically, research in habitat restoration, dam removal, channel realignment, and bank stabilization has been limited to separate indoor laboratory and field work studies. The Outdoor StreamLab enables laboratory-quality measurements within a field-scale reach, bringing the best of both worlds together in one publicly visible facility. Water has been flowing in the Riparian Basin since the grand opening and multiple research projects are underway. Plans are to develop the adjacent Riverine Corridor. Interest in the StreamLab spans many areas, including agricultural engineering, biology, civil engineering, ecology, geology, soil sciences, and water resources sciences. Research participation will include educators, federal and state agencies, and consultants from private industry.



Outdoor StreamLab. *Credit: Efi Foufoula*