

### **Mission of the Brook Byers Institute for Sustainable Systems**

The Brook Byers Institute for Sustainable Systems (BBISS) at Georgia Tech (GT) embodies GT's commitment to a sustainable and prosperous future. BBISS's mission is to provide GT's local, regional, and global partners with the scientific and technological knowledge base, workforce, and innovations needed to address the complex challenges that are associated with environmental and resource management, human development, and economic advancement. The BBISS meets the challenges of sustainability through a comprehensive systems-based approach that brings together scientific, technological, social, economic, policy, and design expertise.

### **Active Areas of Research**

**Gigatechnology** – Gigatechnologies are the largest engineered systems that humans create. They include regional electric power grids, networks of interstates and roads, municipal water systems, and clusters of buildings that aggregate to form blocks, neighborhoods, and cities. The Science of Gigatechnology is the study of properties that emerge as a result of big systems interacting with each other, and with social, economic, and natural systems. It challenges investigators to recognize the interdependencies between infrastructure components that presently result in sub-optimal systems that are viable only because of the availability of cheap fossil fuels, non-renewable resources, and the externalization of costs, risks, and harms. The BBISS strategy toward Gigatechnology research is fivefold: (1) to uncover the interconnections and interdependencies among civil infrastructure systems and their interactions with social, financial, and natural systems; (2) to work with industry and government to create an interoperable systems platform that is necessary to design, simulate, test, monitor, build, manage, and protect massive, open, and complex infrastructure systems; (3) to develop and test the laws, rules, standards, and best practices for designing, building, operating, and decommissioning sustainable and resilient infrastructures across their total life cycle; (4) to develop the design and engineering pedagogy of massive, open, and complex infrastructure systems; and (5) to recruit and train the first generation of gigatechnologists that is as diverse as the communities in which they will serve.

**Water Treatment**- The removal of emerging contaminants from waste water is a significant concern for both human and environmental health, as existing water treatment technologies are largely inadequate in handling such novel compounds. These include pharmaceuticals, personal care products, endocrine disrupters, and nanoparticles from both municipal and industrial waste water streams. BBISS's research on water treatment methods, such as Advanced Oxidation Processes and membrane technologies, is at the forefront of water treatment innovation.

**Sustainable Engineering Education** - Educating the next generation of engineers so that they can practice their profession in a more sustainable way is critical for the future, and teaching sustainable engineering requires an understanding of whole systems thinking. The BBISS is a founding member of the Center for Sustainable Engineering, a "teach the teacher" organization that offers peer

reviewed curriculum modules and organizes workshops and seminars to help fill this gap.

**Food, Energy, and Water Systems** - The BBISS is facilitating research in the integration and convergence of food, energy, and water (FEW) systems in order to improve system function and management, address system stress, increase resilience, and ensure sustainability. Within this broad field, the BBISS is especially focused on urban, peri-urban, and confined environment agriculture as these underutilized food production approaches are, if designed appropriately, potentially well-poised to fully leverage past heavy investments in water, energy, and transportation infrastructure systems in ways that traditional rural outdoor agriculture cannot. Research includes investigations that broadly conceptualize FEW systems, incorporating physical processes (such as built infrastructure and new technologies for more efficient resource utilization), natural processes (such as biogeochemical and hydrologic cycles), biological processes (such as agroecosystem structure and productivity), social/behavioral processes (such as decision making and governance), and cyber-components (such as sensing, networking, computation and visualization for decision-making and assessment).

**Climate Change, Mitigation, and Adaptation** - The BBISS facilitates collaborations among researchers studying the science of climate and global change. Research topics include how climate change affects the natural and built environment; its impacts on society and the economy at multiple scales; and planning, policy, design, and technological strategies for mitigation and adaptation that will result in more sustainable and resilient outcomes. BBISS is a convener of researchers internal to campus, and partners external to the Institute; a facilitator for inter- and transdisciplinary collaboration; and a portal for internal and external communications regarding Georgia Tech climate and global change research.

**Air Quality** - Poor air quality remains a persistent threat for many domestic and international communities. While collaborating with others at Georgia Tech, air quality research in the BBISS has primarily focused on forecasting near-term air quality as a result of varying meteorological conditions (i.e. weather), natural hazards (e.g. wildfires), and human activity (e.g. transportation, energy production, or prescribed burning).

## **Organizational Structure**

The Brook Byers Institute for Sustainable Systems is one of twelve Interdisciplinary Research Institutes (IRIs) at Georgia Tech, and is directed by Professor John Crittenden. Under the auspices of Georgia Tech's Executive Vice President for Research, the IRIs bring together a mix of researchers – spanning colleges, departments, and individual labs – around a single core research area. IRIs also connect a large portfolio of basic and applied research programs, support world-class research facilities and laboratories, engage Georgia Tech students, and collaborate with government and industry research partners. In addition to Director Crittenden, the BBISS is served by a permanent staff consisting of Deputy

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Director (Michael Chang), Senior Administrative Professional (Susan Ryan), Accountant (Gay Burchfield), and Communications Manager (Brent Verrill).

### **Facilities & Resources**

The offices of the Brook Byers Institute for Sustainable Systems consists of 3419 square feet of open plan workspace with modular seating for 36 faculty, staff, and students. The office is located in Technology Square, the heart of Atlanta's Midtown Innovation Hub. Professor Crittenden has laboratory privileges in the JL Daniel Laboratory building, primarily to conduct water treatment related research.

Being an Interdisciplinary Research Center, the BBISS collaborates with a wide diversity of partners across the Georgia Tech campus. These partnerships enable the participation of distinguished experts with access to virtually all of the world class facilities in Georgia Tech's portfolio. Some of BBISS's recent projects have included the participation of the Institute for Data Engineering and Science, the Construction Research Center, the Center for Biologically Inspired Design, the Center for Geographical Information Systems, the Sustainable Design and Manufacturing Program, and the Strategic Energy Institute.

The partnerships that the BBISS cultivates also extend to universities across the country, and around the world. Recent collaborations include investigators and research institutes from Carnegie Mellon University, Syracuse University, University of Michigan, and the University of Texas at El Paso. International collaborators come from China's Northeastern University, the National Natural Science Foundation of China, Chinese Academy of Sciences, and Tianjin University in Shenzhen, China.

### **Impact & Contributions**

Since its inception in 2009 through the end of Fiscal Year 2017, the BBISS has contributed to more than \$8.1M in research grants and contracts awarded to Georgia Tech. As of July 2017, five submitted proposals totaling more than \$25M remain pending sponsor decision. The latter includes the selection of a BBISS led team as a finalist for a \$19.75M NSF Engineering Research Center for Gigatechnology. In total, the BBISS has participated in the submission of 61 proposals since 2009 totaling \$101.5M, with 31 having been awarded.

For the 2016-2017 Academic Year, the BBISS is hosting fourteen visiting scholars from universities across China. Since 2009, the BBISS has hosted more than 75 visiting scholars and students, many from China, but also from Ukraine, South Korea, and Columbia.

The BBISS sponsors two programs within Georgia Tech to foster the community of scholars who are active in sustainability research: Brook Byers Professorships, and BBISS Fellowships. The Brook Byers Professors program provides resources to enable and enhance cross-disciplinary, collaborative research and education in sustainability, energy, and water. Nominated by a peer committee, the three recipients were approved by the Provost and confirmed by the Georgia Board of Regents. The appointments recognize superior scholarly achievement and the potential for further progress. The Brook Byers Professorship is the

highest title bestowed at Georgia Tech for those specifically engaged in sustainability related research and education. Current Brook Byers Professors are:

- Bert Bras, George W. Woodruff School of Mechanical Engineering
- Marilyn Brown, School of Public Policy
- Elsa Reichmanis, School of Chemical and Biomolecular Engineering

The BBISS has 12 appointed Fellows. This diverse group of faculty and researchers come from all six of Georgia Tech's Colleges as well as the Georgia Tech Research Institute. The purpose of the Fellows program is to serve as a board of advisors to the BBISS; to foster the culture and community of sustainability researchers, educators, and students at Georgia Tech; and to communicate broadly the vision, mission, values, and objectives of the BBISS. Current BBISS Fellows are:

- Baabak Ashuri, School of Building Construction
- Atalay Atasu, Scheller College of Business
- Kevin Caravati, Georgia Tech Research Institute
- Kim Cobb, School of Earth & Atmospheric Sciences
- Bistra Dilkina, School of Computational Science & Engineering
- Ellen Dunham-Jones, School of Architecture
- Tom Fuller, School of Chemical & Biomolecular Engineering
- Ashok Goel, School of Interactive Computing
- Randy Guensler, School of Civil & Environmental Engineering
- Dan Matisoff, School of Public Policy
- Juan Moreno-Cruz, School of Economics
- Marc Weissburg, School of Biological Sciences