



Center for Bio-mediated & Bio-inspired Geotechnics

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As I See It: View from Director's Chair

New Directions for Year 3

As the CBBG approaches the end of its second year of operations, we are pleased to welcome new projects to our portfolio and new senior investigators to the CBBG team. The new projects both build upon our strengths and establish new directions for CBBG research, and the new investigators enhance the diversity of our cadre of senior researchers. These new projects also include the first CBBG project co-funded by one of our Industry Partners. The new projects were selected following comprehensive reviews of both our current portfolio of projects and 21 proposals for new projects. The Leadership Team had a difficult task selecting which projects to fund, and several very good proposals had to be declined due to lack of sufficient financial resources.

The new projects beginning in Year 3 include three projects that focus on mineral precipitation, including projects that build upon our leadership in research on calcium carbonate precipitation, and extend our research in a new direction, precipitation of silica extracted from biological materials. With respect to carbonate precipitation, we have approved projects on a MICP Large Tank Test to Demonstrate Effectiveness of Industry-Grade

Treatment Reagents, Improvement Uniformity, and Nitrogen By-Product Removal and Remediation led by Jason DeJong of UC Davis; EICP for Subgrade Improvement and Erosion Control in Sloping Ground led by Paola Bandini of New Mexico State University; and Colloidal Facilitation MICP led by Susan Burns of Georgia Tech. Another new project that builds upon technology developed in our work on carbonate precipitation via denitrification is Biogenic Gas Generation to Improve Compaction. Leon van Paassen leads this project, which seeks to improve the ability to compact saturated silts and sands via desaturation induced by denitrification. CBBG research also will move into a new realm of mineral precipitation, silica precipitation, in a project on Stabilization of Sands and Control of Clay Swelling Using Silica Gel led by Claudia Zapata and Hamed Khodadadi Tirkolaei of ASU. We welcome the addition of Susan Burns, Leon van Paassen, Claudia Zapata, and Hamed Khodadadi Tirkolaei as Senior Investigators to the CBBG research team.

Other new CBBG Senior Investigators include Alejandro Martinez, Katerina Ziatopoulou, and Ross Boulanger of UC Davis and Treavor Boyer of ASU. It is particularly gratifying to see Alejandro, who as a graduate student at Georgia Tech was president of the CBBG Student Leadership Council, move into the ranks of our Senior Investigators. Alejandro's project on Snakeskin-inspired Anisotropic Surfaces: Prescription of Frictional Interactions at Soil-Structure Interfaces represents a new direction for CBBG research, and enhances our portfolio of Bio-inspired technologies. Katerina and Ross will be taking lead roles in the ongoing UC Davis MICP work, with Katerina focusing on numerical modeling and Ross focusing on physical modeling in the centrifuge. Treavor Boyer's project on Development of a Reactive Geocomposite Mat (RGM) Containing Steel Slag Fines and Organic Media to Remove Nitrogen and Phosphorus from Impacted Ground and Surface Water will be co-funded by CBBG Industry Partner, Phoenix Services. As the first CBBG project co-funded by an Industry Partner, this represents a significant milestone in the development of CBBG.

Alejandro, Katerina, Ross, and Treavor are welcome additions to the CBBG Senior Investigator team.

Another new project for Year 3 of CBBG operations is a collaboration between Georgia Tech and New Mexico State on Bio-inspired Geothermal Heat Exchange Systems. This project further broadens the CBBG portfolio, moving us into the emerging field of shallow geothermal energy development. Sheng Dai of Georgia Tech and Doug Cortes of New Mexico State are the Senior Investigators on this project. Year 3 also will see the completion and initiation of research at the ASU Polytechnic Campus research station. The large bio-geotechnical test pit and the rainfall simulator testbeds located at this site are scheduled for completion by the end of September of this year. Planning has already begun for initial experiments that will be conducted using these testbeds.

We look forward to an exciting third year of CBBG preparations. And we look forward to sharing our Year 2 accomplishments with you at the CBBG Annual Meeting on October 18-20 in Tempe, Arizona. I hope to see you all there!

Important Dates

August 4, 2017

ERC 360 Closes for Grant Year 2

September 14, 2017

CBBG Year 2 Annual Report Due to NSF

October 18-20, 2017

Year 2 NSF Site Visit to CBBG
ASU Memorial Union
Tempe, Arizona

April 11-13, 2018

CBBG Mid-Year Meeting
Georgia Institute of Technology
Atlanta, Georgia

Research Highlights

GT Project Funded by European Research Agency



Chloe Arson

In the February CBBG Newsletter, we reported how Dr. Chloe Arson and Dr. David Frost had participated in a workshop organized by L3SR laboratory in Grenoble, France. As a result of that meeting, a proposal was submitted to the European research agency (IDEX Grenoble Alpes) to support co-advised Ph.D. students on bio-

inspired geotechnics ("BIOinMECH: The Mechanics of Bio-Inspired Processes: a Multi-scale Study of Multi-Functional Systems").

We recently have been informed that this proposal is being funded and the first Ph.D. student, Ms. Floriana Anselmucci, will begin her Ph.D. program at University Grenoble Alpes in October 2017. She will be co-advised by Dr. Luc Sibille from UGA and Dr. Chloe Arson from Georgia Tech.

Dr. Arson was recently caught learning to ride a BMW motorbike while visiting research colleagues in France.

GT Students Summer in Paris on NSF-Funded Exchange Program



CBBG graduate student researchers, Mahdi Roozbahani and Seth Mallett, are spending the Summer in Paris as participants in an NSF funded exchange program with ENPC. Both are working closely with Dr. Jean-Michel Pereira from ENPC on numerical modelling of roots and ants. When time permits, they are enjoying dining in Paris as well as fitting in time to watch some exciting mountain stages in the Tour de France.

GT Students Track Ant Progress



Georgia Tech graduate student, Karie Yamamoto, discusses the progress of a group of fire ants in tunneling using the time-lapse photography system with other students in the bio-inspired processes lab at Georgia Tech.

GT Students Discuss Slow Growth of Leek Plants



CBBG REU student, Caroline Colbert, and Georgia Tech graduate students, Rodrigo Salgado and Sangy Hanumasagar, discuss the slow growth of a batch of leek plants that will be subjected to pull-out tests over a period of the next several months. The plants are fertilized multiple times daily.

Natural Experiment Provides Valuable Insight for Ongoing Bench-Scale Tests



Jody Frost, wife of CBBG Co-PI, Dr. David Frost, provides scale in the photo of the root bulb of a live oak tree that was uprooted during Hurricane Matthew as it blew through Savannah, Georgia last Fall. This full-scale natural experiment provides valuable insight for

ongoing bench-scale tests on root analogs being conducted at Georgia Tech by CBBG graduate researcher, Seth Mallett.

Shurley Earns Student Internship with CBBG

When the 2017 CBBG summer program ended, Young Scholar, Dion Shurley, decided he wanted to do more. Dion is a second-time participant in ASU's summer program. Last year, he worked on enzyme extraction, and this year his work, with his mentor, CBBG Graduate Student, Kimberly Martin, involved measuring the effectiveness of Enzyme-Induced Carbonate Precipitation for liquefaction mitigation through a test program on the shake table. Dion knew we had more testing to do after the summer program concluded, and he wanted to



be a part of wrapping up the research and writing the subsequent conference paper. Dr. Kavazanjian was happy to keep him on through a student internship, and we look forward to seeing the results of Dion's hard work. Dion is entering the engineering track at Scottsdale Community College in the Fall, and plans to transfer to ASU later. He was introduced to CBBG as part of our ongoing partnership with the Phoenix Indian Center.

CBBG Co-PI Frost Contributes to NHERI Science Plan



Dr. David Frost of GT made an important contribution to the Science Plan of the Natural Hazards Engineering Research Infrastructure (NHERI). The plan that was released in mid-July included an important piece for MICP and EICP researchers, “to develop approaches by which the characteristics of natural geomaterials can be enhanced either alone or in concert with other components using natural and/or human inspired and/or mediated techniques so that their performance during extreme loading events is enhanced.”

UC Davis-Lafayette College Collaboration on Reduction of Permeability in Sands using Biofilms

Over the summer, two Lafayette College undergraduate research students, Ziqi Chen and Vivian Chen, worked side-by-side with graduate students at UC Davis to continue their collaborative work on developing a method to uniformly grow biofilms in sand. The vision is for biofilm to uniformly fill the pore space in sand, thereby reducing the permeability. Recently the Lafayette College faculty PIs, Mary Roth and Laurie Caslake, visited UCD.

Below is a picture of the research team finalizing the plans for an upcoming experiment and a picture from the first day of treatment for the experiment. The collaboration has been enjoyable and beneficial on many fronts - undergraduate studies learning about graduate school, developing a framework for primarily undergraduate institutions to collaborate with NSF engineering centers, combining expertise from different disciplines and researcher expertise.



(Left) Collaboration meeting at UC Davis to finalize next experimental program. From left to right: Mary Roth (Lafayette, engineering, faculty), Jordan Greer (UCD, graduate student, engineering), Ziqi Chen (Lafayette, undergraduate student, engineering), Charles Graddy (UCD, graduate student, microbiology), Laurie Caslake (Lafayette, faculty, biology), Jason DeJong (UCD, faculty, engineering), Rebecca Kandel (UCD, undergraduate, microbiology), Vivian Chen (Lafayette, undergraduate, biology), and Rebecca Parales (UCD, faculty, microbiology) (Not pictured: Doug Nelson, UCD, faculty, microbiology and Ruixing Wang, China, visiting scholar, engineering).

(Right) Ruixing Wang and Ziqi Chen active during first day of the experiment.

CBBG Develops Collaboration Program

Another objective for the CBBG in Year 3 is the development of our National and International Collaboration program. While we already have established relationships with a number of institutions in the U.S. and abroad, we recently completed a Memorandum of Understanding that will formalize these relationships, and will commit both parties to sharing of information, development of joint projects, and student and faculty exchange programs. By the time this newsletter is published, we should already have several partners who have signed on to this program.

Krajmalnik-Brown and Colleagues Publish Ground-Breaking Study on Microbes



Dr. Rosa Krajmalnik-Brown and colleagues at the ASU Biodesign Institute (BDI) published a new study in the current issue of the Nature Publishing Group journal International Society for Microbial Ecology (ISME) exploring microbial communities in the human gut following weight lost surgeries. Researchers from Mayo Clinic and Pacific Northwest National Laboratory collaborated with BDI on this ground-breaking study.

Martin Presents at Society of Mining Engineer's Symposium



Kimberly Martin, CBBG Doctoral Student at ASU, was selected to serve on a panel and present at the Society of Mining Engineer's Symposium: Engineering Solutions for Sustainability: Materials and Resources 3 - Toward a Circular Economy. Kimberly presented in Session I: System Implementation. Her presentation was entitled “Alternative Deep Foundations to Enhance Sustainability of Infrastructure Projects.” Co-authors Dr. Hamed Khodadadi Tirkolaei of CBBG and Dr. Ranjiv Gupta of Geosyntec Consultants.

Pasillas Rodriguez Spends Five Weeks in CBBG ASU Lab



Dr. Hamed Khodadadi Tirkolaei (left) and Jose Pasillas-Rodriguez

Jose Pasillas-Rodriguez, NMSU graduate student, spent five weeks in training at the CBBG ASU geotechnical lab this past Spring. He worked under the primary guidance and mentorship of CBBG Post-doctoral Research Associate, Dr. Hamed Khodadadi Tirkolaei of ASU, as part of a research collaboration between the two university partners. Jose was trained on Enzyme-Induced Carbonate Precipitation (EICP) techniques and specimen preparation procedures. Dr. Khodadadi Tirkolaei and Jose performed experiments to study viscosity-enhanced EICP, and are preparing a joint paper to disseminate their results. Jose brought back to NMSU the knowledge and experience he learned at ASU, and trained two other NMSU graduate students on EICP this summer. These graduate students will work under the direction of Dr. Paola Bandini on the new Year 3 collaborative project on EICP stabilization of subgrades and slopes.

Out & About

American Society for Engineering Education Annual Conference & Exposition Presentation

NMSU Students and Their Advisor to Present at American Chemical Society Meeting



NMSU Doctoral student, Neda Halalshah, and Master's student, Audrey Smith, along with their advisor, Dr. Lambis Papelis, will present their CBBG research at the 254th American Chemical Society National Meeting

& Exposition, in Washington, DC, August 20th-24th. The presentations are entitled, "Arsenic removal from water using zeolites: Effects of zeolite treatment and geochemical conditions" and "Effect of geochemical conditions and chemical treatment of zeolites on their ability to bind selenium oxyanions." Neda and Audrey's research is on the development of a microbially-enhanced iron-modified permeable reactive barrier.

Frost Presents at Georgia Mining Association Annual Convention



Dr. David Frost, CBBG Thrust 4 Leader, presented, "The Evolving Role of Geomaterials in Infrastructure Systems" at a Purchasing Managers Seminar held at the Georgia

Mining Association Annual Convention in Ponte Vedra Beach, Florida, in July 2017.

Altizer Presents CBBG Research at Conferences



Altizer, M.A., Delgado, A.G. Ilhan, Z. E., Luna-Aguero, M., Aguiar, S., Torres, C.I., Krajmalnik-Brown, R. (2017, June). Tracking Hydrogen Flux in Soils to Improve

Bioremediation Potential Site Assessments. Poster presented at the American Environmental Engineering and Science Professors (AEESP) Conference 2017, Ann Arbor, MI.

Altizer, M.A., Delgado, A.G. Ilhan, Z. E., Luna-Aguero, M., Aguiar, S., Torres, C.I., Krajmalnik-Brown, R. (2017, May). Measuring Biotic Soil Hydrogen Demand as a Strategy for Bioremediation Potential Assessment. Poster presented at the Battelle Bioremediation Symposium, Miami, FL.

Nelson Presents at Joint Genome Institute

Dr. Doug Nelson, UCD Senior Investigator, presented an invited seminar on June 15, 2017, at the Joint Genome Institute (A DOE Office of Science User Facility; Walnut Creek, CA) entitled, "Can Ubiquitous Soil Bacteria Mitigate Earthquake-Induced Soil Liquefaction?" Nelson spent a full day there both touring the diverse sequencing facilities and having productive discussions with JGI scientists.

CBBG Represented at Southwest Geotechnical Engineering Conference



CBBG Director, Dr. Edward Kavazanjian, Jr. and CBBG Industrial Liaison Officer, Dr. Nasser Hamdan, made a presentation on "Applications for Enzyme Induced Calcium Carbonate Precipitation for Erosion Control" at the 42nd Southwest Geotechnical Engineering Conference (SWGEC).

The SWGEC is an annual meeting of State DOT officials from Hawaii, California, Arizona, New Mexico, Texas, Louisiana, Oklahoma, and Kansas. Attendance also includes representatives of the Federal Highway Administration and variety of technical professionals. The conference location rotates among the states involved in the SWGEC and was hosted by the Arizona DOT and held in Tempe this year.

The presentation sparked a lot of interest among the attendees, and Kavazanjian and Hamdan discussed CBBG activities with the many attendees who visited the CBBG booth in the exhibit hall.

van Paassen Gives Five Invited Talks in Malaysia and Singapore



Dr. Leon van Paassen was busy this Summer giving five invited talks in eight days in Malaysia and Singapore. At Nanyang Technological University in Singapore,

van Paassen presented on "Bio-based barriers for seepage and erosion control in water retaining structures," and "Biochemical decomposition of Organic Matter and its effect on Shrinkage and Water Retention Behavior of Fine Grained Organic Sediments."

At the Symposium on New Technologies for Urban Geotechnical Constructions being held at the Nanyang Technical University, van Paassen presented his research from CBBG and Delft University of Technology in the Netherlands. van Paassen presented a one-day seminar on Geotechnics at Universiti Teknologi Mara. At the Institution of Engineers in Malaysia, van Paassen gave an evening talk on recent advances in Bio-based Geotechnics.

CBBG Participates in SEE ASU



CBBG graduate student, Kimberly Martin, and CBBG Young Scholar, Dion Shurley, participated in an outreach event, SEE ASU. The purpose of the event is to provide students entering their senior year of high school with information about engineering academics, and information regarding opportunities available to engineering students at ASU.

The event, which took place July 13th and July 20th, required the CBBG team to present to three sessions of 25 high school students each day. Kimberly and Dion used the shake table to demonstrate why soil liquefaction is a geohazard, and then described to each session how CBBG is working to find bio-mediated and bio-inspired solutions for this problem.

Honors & Awards

Cortes Receives Tenure at NMSU



Congratulations to Dr. Douglas D. Cortes for receiving tenure and being promoted to Associate Professor. His contributions and commitment to the mission of New Mexico

State University are greatly appreciated by his peers. In recognition of this milestone, the Office of the Executive Vice President and Provost of New Mexico State University hosted a reception on May 3, 2017, where the formal announcement was made. The focus of Douglas' research efforts lies in the development of creative solutions to geotechnical engineering challenges that stem from the characteristic performance levels of soils in their natural state. In contemporary geo-challenges, performance can be defined in a variety of forms and often involves intricate relationships between mechanical, thermal, hydraulic, and biological properties.

Torres Receives Grant from DOD-NAVY: Office of Naval Research (ONR)



Dr. Cesar Torres, CBBG Senior Investigator at ASU, received a grant in the amount of \$60,000 from the ONR for his project on the "Development of Substrate-loaded Microbial

Fuel Cells for Powering Remote Sensors."

Yamamoto Continues for MS Degree



Karie Yamamoto received her bachelor's degree in Spring 2017 from Georgia Institute of Technology. She has decided to continue on to her Master's degree.

Almajed Successfully Defends Ph.D. Dissertation at ASU

Abdullah Almajed, ASU graduate student, successfully defended his dissertation, "Enzyme-Induced Carbonate Precipitation for Soil Improvement," on June 26, 2017.

Mostafazadeh-Fard Accepted into NSF Innovation Corps (I-Corps) and Aggie I-Corps



Saman Mostafazadeh-Fard, graduate student in the Civil Engineering Department at New Mexico State University, successfully completed the NMSU Arrowhead's LAUNCH entrepreneurship program as a finalist this spring, and has been accepted into NSF Innovation

Corps (I-Corps) and Aggie I-Corps tech entrepreneurship training programs.

The National Science Foundation (NSF) I-Corps program prepares scientists and engineers to extend their focus beyond the university laboratory, and accelerates the economic and societal benefits of NSF-funded, basic-research projects that are ready to move toward commercialization. Acceptance into the NSF I-Corps program is highly competitive, with only 20 teams selected to participate each year.

Through NSF I-Corps, Saman will test the feasibility of commercialization of his research focus, a Liquid Organic Fertilizer produced from grass clipping waste. The goals of these programs are to spur translation of research, to encourage collaboration between academia and industry, and train students to understand innovation and entrepreneurship.

Saman will receive mentorship, coaching and \$2,000 stipend for Aggie I-Corps and \$50,000 in participant support for NSF I-Corps training program beginning in October 2017. Saman's research at NMSU is sponsored by CBBG. Saman's LAUNCH and NSF I-Corps mentors and graduate advisors are Dr. Zohrab Samani and Dr. Paola Bandini. Saman and his advisors are applying for a utility patent. Saman successfully defended his Master's thesis on July 12, and will continue his graduate education at NMSU as a Ph.D. student in civil engineering this Fall.

Delgado Joins SSEBE, CBBG Faculty



Dr. Anca Delgado, CBBG Senior Investigator, has agreed to join the faculty of the ASU School of Sustainable Engineering and the Built Environment as an Environmental

Engineering Assistant Professor in August 2017. Anca received a Ph.D. in Microbiology from Arizona State University in 2013, and is currently a Research Scientist in the Biodesign Swette Center for Environmental Biotechnology.

Delgado's expertise is in bioremediation processes and environmental biotechnologies that combine microbial catalysts and chemical oxidants or reductants. Her research interests are in the fundamental understanding of soil and water microbial processes that sequester and transform carbon and chlorine to remove contaminants and improve soil quality. For CBBG, Anca is working on a Microbial Metabolic Chain Elongation project. She is a passionate educator, having taught multiple classes during her Ph.D. and her postdoctoral appointments.

Pasillas Rodriguez Receives Master's Degree from NMSU



NMSU graduate student, Jose N. Pasillas Rodriguez, graduated this summer with a Master of Science in Civil Engineering degree, emphasis on geotechnical engineering.

He began his research work as an undergraduate research student for a CBBG project at NMSU. Immediately after receiving his Bachelor's degree, Jose continued his project at NMSU as a CBBG graduate research assistant. He completed his graduate program in 18 months with advisers, Dr. Paola Bandini and Dr. Craig Newton. Jose successfully defended his Master's thesis on July 17. As part of his research, Jose was trained in EICP techniques and testing at the CBBG ASU laboratory for 5 weeks this past Spring.

Rangan Defends Master's Thesis

ASU graduate students, Srivatsan Mohana Rangan successfully defended his master's thesis, "Trade-offs in Field Application of Zero-Valent Iron for Synergistic Biotic and Abiotic Reduction of Trichloroethene and Perchlorate in Soil and Groundwater."

Rittmann Named Fellow in Association of Environmental Engineering and Science Professors



Bruce Rittmann, Ph.D.
Director, Biodesign Swette Center for Environmental Biotechnology
Regents' Professor, Ira A. Fulton Schools of Engineering,
School of Sustainable Engineering and the Built Environment
Distinguished Sustainability Scientist, Global Institute of Sustainability

More than three and a half decades of exceptional contributions to research, scholarship and professional service, as well as steadfast dedication to teaching and mentorship, have earned Regents' Professor Bruce Rittmann the honored status of Fellow in the Association of Environmental Engineering and Science Professors (AEESP). This international organization's membership of about 700 boasts some of the most accomplished professors who provide education in the sciences and technologies of environmental protection.

The AEESP Fellow designation adds to Rittmann's voluminous list of awards and achievements. Among the most prestigious was his election to the National Academy of Engineering in 2004. He has since become a Distinguished Member of the American Society of Engineers and earlier this year, Rittmann also was made a Fellow of the National Academy of Inventors.

UC, Berkeley Honors Kavazanjian as Distinguished Alumni



CBBG Director, Dr. Edward Kavazanjian Jr., has been elected to the University of California, Berkeley's Civil and Environmental Engineering Academy of Distinguished Alumni. He earned his doctoral degree at Berkeley in civil engineering, specializing in geotechnical engineering.

Through membership in its alumni academy, the program honors graduates who "have contributed greatly to societal well-being and development, both in the U.S. and around the globe."

Kavazanjian is an international leader in the field of geotechnical engineering, particularly landfill engineering and seismic design to fortify structures against the impact of earthquakes. He has served as lead engineer for analysis and design of some of the most significant hazardous waste sites in the world.

He was the lead author of the Federal Highway Administration guidance document on Seismic Design of Geotechnical Transportation Features and Structural Foundations.

In recent years, he has emerged as one of the researchers working at the forefront of the emerging field of biogeotechnical engineering, which focuses on using or emulating natural processes in developing innovative methods and technologies for engineering geotechnical systems.

Pham Successfully Defends Ph.D. Thesis at Delft University of Technology



Dr. Leon van Paassen participated in the committee that approved Vinh Pham's defense of her Ph.D. thesis, "Bio-based ground improvement through Microbial Induced Desaturation and Precipitation (MIDP)." Dr. Pham is a guest member of CBBG at partner institute, Delft University of Technology, in the Netherlands.



Diversity & Inclusion

Saenz Leads Webinar on Diversity and Inclusion



Dr. Delia Saenz, CBBG Diversity Director, lead a webinar on diversity and inclusion on July 5, 2017. The webinar was about the importance of broadening participation in engineering. Webinar participants included CBBG summer program personnel (REUs, RETs, and Young Scholars) at all four collaborating universities.

Webinar exercises included describing "Who Am I?" and identifying ways in which we can "stay on task" and "make awesome choices" regarding projects, assignments, and opportunities that arise in the future.

AccessERC Webinar Focuses on Students with Disabilities

On Monday, June 26, 2017, AccessERC hosted a panel of students with disabilities who shared information about their access to coursework, fieldwork, research labs, etc. Personnel from all four collaborating universities participated in this webinar.

Education & Outreach

High School Students Design and Test Bio-Inspired Adobe



Forty-six high school students, mostly from southern New Mexico schools, participated in CBBG's two-day activity on Bio-inspired Resilient Earthen Construction, and learned fundamental concepts on bio-inspired design, sustainability, and infrastructure resilience.

NMSU faculty, Dr. Brad Weldon and Dr. Paola Bandini developed and delivered this outreach activity as part of the 2017 NM PREP High School Academy, a two-week Pre-Freshman Engineering (PREP) summer residential camp for diverse, high-achieving students interested in engineering. The students used their STEM knowledge and creativity to design and construct small-scale sustainable, resilient adobe walls incorporating bio-inspired reinforcing elements using only natural materials and fibers.

Their tiny adobe walls were tested on a shake table simulating earthquake loading to explore the mitigating effects of their designs against natural hazards. Each team gave presentations highlighting the bio-inspiration behind their designs to peers, faculty, and student mentors. The participants included 66% ethnic minority students and 38% female students from various public and charter schools.

PREP mentors during this outreach activity included CBBG's graduate assistants, Eduardo Davila and Diego Garcia-Vera, and undergraduate student, Judit Gallardo. The engineering camp is organized and hosted yearly by the Engineering New Mexico Resource Network of the NMSU College of Engineering at no cost to participants.

Middle School Teachers Participate in Workshop at UC Davis



From June 10 to June 13, 2017, teachers from four local middle schools participated in a four-day workshop at UC Davis to connect CBBG research topics to K-12 education. All of the participating teachers had attended a 2016 CBBG workshop where they learned basic concepts in life cycle assessment, geotechnical engineering, and bio-inspired design. This year, the teachers collaborated with CBBG students and faculty to determine how sustainable and bio-inspired civil engineering applications and conceptual models can help achieve the Next Generation Science Standards for middle school students.

CBBG graduate students, Matthew Burrall, Jordan Greer, Annie Kirkwood, Sophia Palumbo, and Alena Raymond all updated teachers on their research projects, and brainstormed ideas for connecting content to middle school students. Two undergraduate students, Vivian Le and Jenna Kelmser (an REU student from Humboldt State University), currently working on K-12 modules on bio-inspired design and bio-films, also contributed to the productive discussion.

The workshop cohort will continue to share content and ideas throughout the upcoming academic year to refine the K-12 modules. Additional plans for the year include science class field trips to UC Davis, CBBG students visiting the four schools, and teachers providing feedback on education modules developed by CBBG students. Dr. Colleen Bronner facilitated the workshop and leads CBBG pre-college education efforts at UC Davis.

Publications

Evolution of microbial communities growing with carbon monoxide, hydrogen, and carbon dioxide, Sofia Esquivel-Elizondo, Anca G. Delgado, Rosa Krajmalnik-Brown, *FEMS Microbiol Ecol* (2017) 93 (6): fix076. DOI: <https://doi.org/10.1093/femsec/fix076>

Problem-Based Learning in Engineering Workshop



Dr. Krista Glazewski and Dr. Thomas Brush, both from Indiana University, Bloomington, presented workshops introducing Problem-Based Learning (PBL) instructional strategy, and how PBL can be incorporated into a wide range of classes to enhance student engagement and overall effectiveness of instructional objectives. Participants learned the differences between developing PBL with focus on Design versus Dilemma Problems.

CBBG Summer 2017 Research Experience Programs

This summer, 23 highly qualified and innovative participant-researchers, out of almost 200 applicants, were selected to participate in CBBG research programs: Research Experience for Undergraduates (REU), Research Experience for Teachers (RET), and Young Scholars (YS). Ten undergraduates (REU), nine K-14 teachers (RET), and four high school students (YS) were deeply engaged in technical research working in CBBG labs.

They learned about the many CBBG research projects, and about biogeotechnical engineering and topics related to being a successful scientist and researcher. Eight of the nine teachers and all of the Young Scholars were from CBBG partner schools and community colleges. Two of the REUs joined us from Lafayette College in Pennsylvania through a partnership program with CBBG researchers at UC Davis. In addition, two academic-year undergraduates and one high-school guest scholar participated in lab research and CBBG activities.

We are grateful to CBBG graduate students, and post-doc and faculty researchers who ably mentored these summer researchers in their labs, supported by a lab-based engineering mentoring program designed by Dr. Jennifer Chandler, and implemented across the Center.

All 23 summer Research Experience participants spent the first three days of the program at Arizona State University for orientation. There they completed safety training, and participated in research presentations from mentors at all four partner universities, lab tours, workshops on mentoring and design thinking, and fun, hands-on activities, some of which were shared across several ERCs.

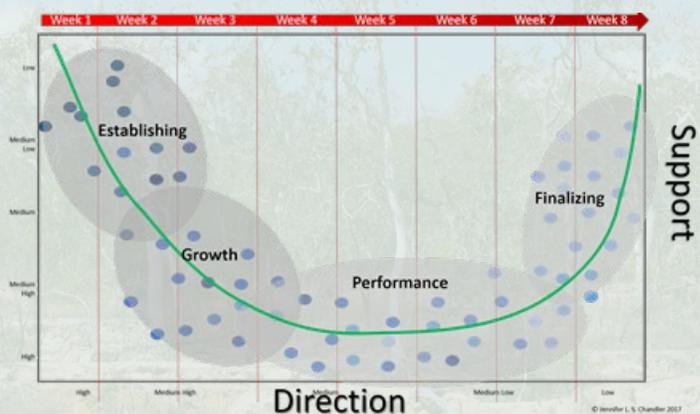
Eight of the REUs spent the next seven weeks at the CBBG partner universities: Georgia Institute of Technology, New Mexico State University, and University of California, Davis, but remained in contact through weekly webinars on innovation, inclusion, professional development, industry, and research topics. During the last week, the REUs from the four campuses each shared their research via video conferencing.

After working in the labs in the mornings, the RETs met as a group to work on CBBG-based curriculum to take back to their classrooms. They also collaborated in in-depth professional development sessions on Problem-Based Learning, presented by guest researchers from Indiana University, as well as interactive sessions throughout their five weeks on Design Thinking.

A session was arranged so the CBBG RETs could share their developed lesson plans with RETs from QESST (another NSF-funded ERC headquartered at ASU). Teachers began preparing posters in which they will present both their lab research project results and about their curriculum projects.

The high school students in the Young Scholar Program worked each day in the CBBG labs, and worked with their mentors to create a research poster based on their project. A poster reception was held in the ASU University Club on July 6th, so the students could present their research to family and friends. All participants will be invited to participate in the NSF Site Visit to CBBG on October 19-20, 2017, and will continue collaborating as mentors in different outreach activities organized by CBBG.

Mentorship Training for Summer Program Participants



This summer, the mentors and mentees participating in the CBBG Summer programs received mentoring training using a mentoring model tailored for engineers. Dr. Jennifer Chandler developed the model mentoring guide. She conducted training for the assigned mentors before the Summer Programs started, and also conducted training with the mentees during their orientation time at ASU. The mentoring model (depicted above) and the mentoring guide that Dr. Chandler produced for CBBG draws from recent leadership and mentorship research. The NSF-funded Nanotechnology Enabled Water Treatment (NEWT) ERC also used Dr. Chandler's mentoring guide in their Summer Programs.



Summer program participants with ASU faculty, students, and staff

Science of Sand Castles Demonstrations at Capitol Elementary School

On May 16, Ph.D. student, Hani Alharbi and Ds. Leon van Paassen and Dr. Jean Larson headed to one of CBBG's founding educational partners, Capitol Elementary School, to present a fun lesson on the science of sand castles. Each of the three first grade classes at Capitol participated in the demonstrations, and learned about the different properties of dry and wet sand, and causes of liquefaction. Small groups experimented with the sand and competed to build the strongest sand castle.

Estrella Vista STEM Academy Showcase

Estrella Vista STEM Academy, CBBG Educational Partner, held their annual school-wide STEM Showcase on May 17, 2017, to celebrate their inaugural year as an innovative STEM Academy. Design Thinking, with a special focus on engineering, has been implemented throughout the curriculum. Ph.D. student and Design Thinking expert, Krissy Elwood, along with Dr. Khodadadi Tirkolaei, Dr. Jean Larson, and Dr. Leon van Paassen were guided by 8th grade leaders, Carlos Frausto and Phoenix Kelly, to evaluate science and engineering projects throughout the school.

Picnic Day at University of California, Davis

In addition to being Earth Day, April 22, 2017 was Picnic Day at UC Davis. CBBG students dedicated to sustainable geotechnical solutions and embodying school spirit engaged the local community through interactive activities that increased awareness of and knowledge in civil engineering.

Exhibits allowed children of all ages to create their own seismic waves; construct, test, and evaluate buildings for earthquake preparedness; and model watershed processes in an augmented reality sandbox. For community members wanting to delve deeper into geotechnical engineering, graduate student posters describing current UC Davis research projects bordered the CBBG exhibit.

Throughout the four hours of the event, over 350 visitors, including about 160 girls and boys, interacted with the exhibits. Visitors included local community members, current undergraduate students interested in geotechnical engineering, and several alumni – including a geotechnical engineering Ph.D. alumnus and his family. While most visitors spent between 15-60 minutes, some families spent over 3 hours becoming engrossed in discussions about designing resilient and cost-effective structures.

The day's outcomes included an abundance of knowledge exchanged, more people thinking about earthquake engineering, K'nex scattered across the Ghauri Lobby, and several exhausted graduate students. The people responsible for the event's success included CBBG graduate students Charlie Graddy, Gabby Hernandez, Sophia Palumbo, and Alena Raymond teamed with Diane Moug, Alex Sturm, and Bao Li Zheng. Students were supported by CBBG faculty Colleen Bronner, Jason DeJong, Alejandro Martinez, and Katerina Ziotopoulou, all of whom attended the event.



Industry & Innovation

CBBG Industry Partners

McKenna Delivers Webinar on Innovation and the Entrepreneurial Mindset



Dr. Ann McKenna, Professor and Director of the Polytechnic School at ASU, delivered a June 19, 2017, webinar on “Enabling Education Innovation and Impact using an Entrepreneurial Mindset” Dr. McKenna’s presentation described different approaches underway that are advancing entrepreneurial thinking to enable broader impact of educational innovations.

Indian Institute of Technology, Hyderabad Director Visits CBBG



Dr. Uday B. Desai, Director of the Indian Institute of Technology, Hyderabad was invited by ASU University President, Dr. Michael M. Crow, to visit ASU on May 16, 2017. Dr. Desai spent time with CBBG Director, Dr. Edward Kavazanjian, Jr., discussing ways in which their two institutions could partner and foster engagement with India.

Lemmon Delivers Webinar on Continued Landslide Repairs along AZ SR 87



James J. Lemmon, RG, a Geologist with the Arizona Department of Transportation (ADOT), a CBBG Industry Member, delighted his audience with a webinar showing a realignment of Arizona State Route 87, which was completed in 2000 and began to show distress in 2005. He explained about a new construction project that will address initial repairs to a section of roadway embankment that has been observed to be settling and has been subjected to shallow slope failures for the past few years. The presentation also discussed some of the project history, and focused on the current round of repairs that are being undertaken.

Pasillas Rodriguez Accepts Position at Schnabel Foundation Company



At the CBBG mid-year meeting at UC Davis this past April, Jose Pasillas Rodriguez met Matt Niemann, P.E., V.P. of Research & Development of the Schnabel Foundation Company, a CBBG Industry Partner. Jose interviewed with Schnabel this summer, and has accepted a position with the company in their Denver branch as Construction Manager to start this August.



Partner Universities

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How does nature do it?

Nature has developed elegant, efficient and sustainable biologically-based solutions to many challenges that vex geotechnical infrastructure systems. Examples include ant excavation processes that are 1000 times more energy efficient than man-made tunneling machines, carbonate cemented sand that is exceptionally resistant to erosion and earthquakes, and self-sensing and self-healing tree root structures that are 10 times more efficient than any mechanical soil reinforcing/foundation system yet devised.

The NSF Engineering Center for Bio-mediated and Bio-inspired Geotechnics (CBBG) will focus on ecologically friendly, cost-effective solutions, inspired by nature, for development and rehabilitation of resilient and sustainable civil infrastructure systems. It will serve as a nexus for two transformative trends in engineering: biologically-based design and sustainability.



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biogeotechnics.org

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