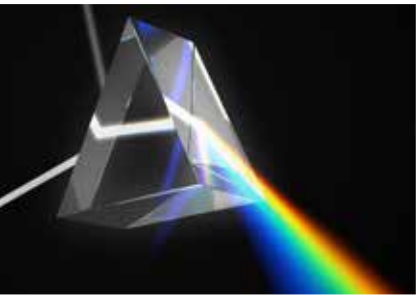
THE 2ND ANNUAL

SENIOR DESIGN EXPO








COLUMBIA | ENGINEERING

The Fu Foundation School of Engineering and Applied Science

THE 2ND ANNUAL

SENIOR DESIGN EXPO

THURSDAY, MAY 7, 2015, NOON–3:00P.M.

COLUMBIA | ENGINEERING

The Fu Foundation School of Engineering and Applied Science

The Senior Design Expo is possible this year through generous support from Turner Construction.

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Applied Physics and Applied Mathematics	Champagne
Biomedical Engineering	White
Chemical Engineering	Gold
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Computer Science	Navy Blue
Earth and Environmental Engineering	Red
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Collapsible Table
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Robotic Saxophone Player
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Flywheel Storage Device
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Robotic Package Gripper (cross-listed with Electrical Engineering)
NTR: Lydia Alfonso, Connie Phung, Jacqueline Nqabueze, David Boucard, Victor Campbell, Cristina Reveles

Ball Balancing Robot (cross-listed with Electrical Engineering)
I.P.O.W.R.: William Miller, Andrew Nederlof, Byran Ptucha, Alexander Arsenault

Automatic Glass Harp (cross-listed with Electrical Engineering)
NEPOLLO: Andre-Jacques de Beer, Jang Won Suh, Abdul Leite, James Thompson

APPLIED PHYSICS AND APPLIED MATHEMATICS

Synthesis of PbS Quantum Dots and Their Size-Dependent Optical Properties

Robyn Ridley

Adviser: Prof. Irving Herman

The size-dependent properties of semiconductor nanoparticles, also called *quantum dots*, offer a wide variety of potential applications in devices such as solar cells, lasers, and sensors. To fully investigate these properties and utilize semiconductor nanoparticles in such applications, it is necessary to have highly repeatable synthesis methods resulting in monodisperse samples of quantum dots. This project demonstrates repeatable methods to synthesize highly monodisperse samples of PbS nanoparticles involving the thermal decomposition of an organometallic lead precursor, incitation of a rapid nucleation event by injection of a sulfur precursor, and growth controlling surfactants at high temperatures. Optical properties, such as the absorption and photoluminescence, of the synthesized PbS nanoparticles are measured using FTIR and spectrometry. Nanoparticle size is determined by the use of transmission electron microscopy (TEM). An analysis of the relationship between PbS quantum dot optical properties and size is carried out using the measurements obtained from these methods.

Laser Crystallization of Zinc Oxide Thin Films

Joseph W. Eun

Adviser: Prof. James Im

The primary purpose of this project was to determine and understand the effects of laser crystallization and temperature on zinc oxide thin films, and to find regions at which the thin film underwent a phase transition and minimize cracking and ablation. My investigation involves a series of experiments (at various energy densities and temperatures) and observations using various modes of optical microscopy, scanning electron microscopy, etc.

Benchmarking of Dectris Mythen 1K Strip Detector for Pair Distribution Function Analysis of Synchrotron Diffraction Data

Karim Tanju Mukaddem

Adviser: Prof. Simon Billinge

The Mythen 1K Strip Detector from Dectris is an x-ray detector that promises, among many other features, an excellent signal-to-noise ratio. The purpose of this project is to determine the suitability of the Mythen 1K for atomic pair distribution

function (PDF) analysis of synchrotron powder diffraction data and to identify the challenges and advantages that come with it. The project entailed the collection and processing of data from samples with known structures, using this detector and benchmarking the obtained PDFs.

Understanding Load Transfer in Steel Suspension-Bridge Cables through Pullout Testing and Neutron Diffraction

Srishti Goel

Adviser: Prof. Ismail C. Noyan

Suspension bridges are a vital part of the world's transportation infrastructure. Many of them, located in heavily populated areas (such as New York City), are also irreplaceable due to economic constraints. Therefore, it is critically important to have an understanding of load transfer in the cables of the bridge to best optimize maintenance and repair practices. While these practices currently have a solid theoretical basis, there is very little actual experimental data to support them. In this small portion of a much larger endeavor, I conducted a series of tests to understand the effects of novel geometries on load transfer in standard seven-wire bridge cable specimens. I was also able to be part of a deployment to Oak Ridge National Laboratory, SNS, during which the team conducted experiments using neutron diffraction to determine the effect of wire twist on load transfer in a standard seven-wire specimen as well as mapped the effect of clamping on wire interactions in a nineteen-wire sample.

Maximization of Third Harmonic Generation in Few-Layer Graphene

Christopher Florencio-Aleman

Adviser: Prof. Richard Osgood

Graphene has been a subject of immense interest as of late, but most research is dedicated to studying its electronic and mechanical properties. Graphene also displays promising optical properties suitable for photonic applications. This project seeks to explore the nonlinear optical properties of graphene and the ways in which it can increase the energy of light with which it interacts as a result of increasing the number of graphene layers present in the medium. As the medium increases in layers of graphene, its properties change in such a way that they are desirable for certain photonic applications. The variation in layers changes the electronic structure of the material, which is the main determinant of its optical response. This project seeks to find the number of layers at which graphene maximizes its nonlinear optical response as well as to create a model that describes that point.

Laser Induced Phase Transformation of ZnO substrate and SiO_2 buffer on a Silicon Wafer

Laticia Lee
Adviser: Prof. James Im

The ultimate goal of this project is to figure out the properties of ZnO substrate and SiO_2 buffer on silicon wafer and use those results for a variety of applications, including building better smartphone screens.

BIOMEDICAL ENGINEERING

AbsTrack

Alan Zhao, Kelly Liu, Naureen Ghani, Paul Chang
Adviser: Prof. Paul Sajda

Childhood absence seizures are characterized by a sudden loss in awareness and eye fluttering (~3 blinks per second). These seizures are brief (~2–10 seconds) but can occur up to hundreds of times per day, impairing the child's ability to pay attention during school or other daily activities. According to the Epilepsy Foundation, 45,000 children under the age of fifteen develop epilepsy every year; 10–17% of these children are afflicted by absence epilepsy. Currently, neurologists use self-reported seizure occurrence data provided by families. However, the frequency of seizure occurrences is often underestimated, which leads to difficulties in achieving the correct medication dosage and tracking of epilepsy progression. To address this, AbsTrack has developed a portable electroencephalography (EEG) module and eye-tracking device for seizure monitoring. This combination provides families and clinicians with accurate, ongoing, at-home detection of absence seizures that does not interfere with a child's normal activities.

CerePlay

Christine Chen, Liane Darson, DeAnalisa Jones, Colette Woo
Adviser: Prof. Clark Hung

Spasticity, or stiffness in the muscles, is the defining physical symptom of CP, which requires physical therapy from a young age to attain and maintain mobility. Research shows that regular physical therapy, including at-home exercise regimens, can help children reach developmental milestones. However, it is challenging for caregivers to administer and monitor home exercises in a manner that is engaging, particularly for young children with CP. CerePlay brings a system that encourages active play therapy for children affected by CP while tracking exercise compliance. Our system allows the user to perform prescribed physical therapy exercises by playing interactive games. CerePlay provides a seamless integration of the home and the physical therapist's office with a user-friendly interface for patients and self-generated reports for tracking exercise performance.

Dynalign

Morgan Caglianone, Noyan Songur, Meredith Venerus, Byron Weiss
Adviser: Prof. Nicolas Chbat

In the United States, approximately 370,000 people have received transfemoral amputations. During the fitting of a prosthetic leg, it is important that the prosthesis is properly aligned both for static (standing) and dynamic (walking or running) conditions. Misalignment can result in discomfort, instability and compensatory gait habits, which can lead to chronic musculoskeletal damage. Traditionally, dynamic alignment is achieved through the prosthetist's visual evaluation of gait and patient feedback. However, the accuracy of alignment achieved during a fitting appointment is limited by both prosthetist and patient subjectivity and the variability of patient gait habits over time. DynAlign provides an objective method to dynamically align leg prosthetics. Our device integrates pressure measurements within the socket with on-board motion tracking of the leg, providing a quantitative representation of transfemoral amputee gait habits not only in the prosthetist's office, but in everyday life.

Hydrassistant

Daniel Huang, Jason Suh, Shawn Thomas, Jennifer Xiong
Adviser: Prof. Barclay Morrison III

The US military reports over 1,500 annual cases of heat illness attributable to dehydration. Military personnel are particularly prone to hydration-related issues due to extreme heat in field settings, heightened physical activity, inability to judge the severity of dehydration, and lack of continued water access. Even mild dehydration, characterized by 1% fluid loss, can impair cognitive abilities and physical performance that can have fatal consequences on the battlefield. Because one soldier's dehydration can affect the performance of an entire unit, measures must be taken to ensure that every soldier is operating without impairment. To combat dehydration in field settings, Hydrassistant has developed a device that analyzes saliva as a biomarker for dehydration diagnosis. Our innovative design combines portability, accuracy, and noninvasiveness, making it ideal for military use.

MilitEar

Daniel Campo, Ankita Gore, Willem Prins, Brian Zuckerman
Adviser: Prof. Elizabeth Olson

Noise-induced hearing damage is one of the most prevalent causes of long-term disability in US veterans. In 2013, the US Veterans Association provided

compensation to over two million individuals for hearing loss. Noises as low as 85 dB can damage hearing, yet soldiers are often exposed to sounds above 140 dB from gunshots, explosions, engine noise, etc. While devices exist that provide hearing protection, they often nonselectively reduce all sound, and therefore compromise a soldier's ability to discern what is occurring in the surrounding environment. As a result, soldiers often forgo hearing protection to retain situational awareness during field activities or combat. The MilitEar device enhances hearing protection through use of passive acoustic dampening in conjunction with dynamic compression that selectively attenuates loud noises. Initial testing demonstrates that the MilitEar device can successfully compress incoming audio in near real-time, reducing the dangerous sound levels to manageable levels while retaining situational awareness.

OstoCare

Alan Czemerinski, Sandeep Palepu, Shruthi Nammalwar, Molly Karna, Wilson Ho
Advisers: Prof. Samuel Sia and Dr. Ravi Kiran

Approximately 1.8 million patients worldwide have undergone ostomy surgeries. In this procedure, the intestine is transected and redirected outside the abdomen through an opening called a stoma. Waste output is collected in ostomy bags, which adhere to the abdomen over the stoma and must be changed two to three times weekly. Leakage is a common complication that occurs with ostomy bag use and can lead to severe skin irritation and discomfort. The OstoCare Continence Device is an insertable ostomy bag coupler that prevents leakage during use and bag changing. The device consists of: a tube inserted into the stoma with an inflatable cuff that creates a secure seal within the intestine; a valve that prevents leakage during bag changing; and a flat wafer that improves adherence with ostomy bags to the irregular surface of the abdomen. Our device is easy to use, comfortable, affordable, and compatible with current ostomy bag systems.

QSport

John Brady, Daniel Martinez, Shoshana San Solo, Stephanie Wells, Manali Yavatkar
Adviser: Prof. Andreas Hielscher

Currently 320,000 anterior cruciate ligament (ACL) tears occur each year, of which 100,000 require reconstructive surgery. Despite enhanced surgical and postoperative rehabilitation techniques, a patient's risk of sustaining a second ACL tear within one year remains sixteen times greater than individuals without prior injury. Much of the risk of reinjury is mitigated by proper and complete rehabilitative activity. Current rehabilitation methods are largely qualitative in nature; completion of a rehabilitative regimen is an inaccurate indicator of return-to-sport readiness.

Given the high incidence of reinjury, there is a need for quantitative assessment of rehabilitation. QSport has designed a wearable device that measures leg muscle activity and knee angles, objectively and accurately determining if a recovering ACL patient is physically ready to resume activity. This system will allow therapists/trainers to more accurately determine patients' progress as they strive to return to their sport.

ResiSTENT

Tolulope Akinade, Kathleen Atkatsh, Christina Boldosser, Clarice Zhou
Advisers: Prof. Henry Hess and Dr. Pasquale Casale

Ureteral stents are tubes that are cystoscopically placed in the ureter to maintain its structural integrity and patency. Each year in the United States, an estimated 92,000 urologists use ureteral stents to ease kidney stone passage, treat ureteral strictures, or otherwise prevent or treat ureter blockage. One key problem with ureteral stents is recurrent encrustation due to calcification and adsorption of proteins to the stent surface. Current stents have a 47.5% and 91.5% incidence of encrustation after three and six months, respectively. Stent encrustation leads to complications such as stent fracture, ureter blockage, pain, and difficulty removing the stent. Our product, ResiSTENT, consists of a ferromagnetic sheath that can be translated along a stent as directed by an externally applied magnetic field, noninvasively removing encrustation from the stent surface. Used at regular intervals, our product can prevent encrustation and its concomitant complications.

SpineAlign

Siqi Cao, Andrew Jin, Timothy Tang, Albert Zhou
Adviser: Prof. Qi Wang

Lower back pain is among the most common reasons for doctor visits: Americans spend $80 billion annually treating this health issue. Poor posture is one of the leading causes of lower back pain, straining the abdominal muscles, shifting excessive pressure onto spinal ligaments and discs, and destabilizing the spine by redistributing the pressure unevenly across its length. It has been shown that good posture can partially alleviate nonspecific lower back pain. We have designed a portable, comfortable, and wireless solution that assesses the user's posture by monitoring critical spine angles. The system alerts a user when posture is poor and tells him or her how to correct posture to prevent or reduce back pain. Initial testing has shown that SpineAlign is effective in reporting accurate angles from different locations along the back, making this a viable approach to alleviating lower back pain due to poor posture.

CHEMICAL ENGINEERING

Advisers: Prof. Venkat Venkatasubramanian, Dr. Euen Gunn (Johnson & Johnson Consumer Co.), Dr. Kevin Joback (Molecular Knowledge Systems, Inc.)

Aveeno Hand Cream Reformulation: A Shift Toward All Natural

Siphelele Mhlanga, Andrew Ryder, Andrew Tolbert, Emma Wagnon

Dodecylhexadecanol is a synthetic surfactant in Aveeno's Skin Strengthening Hand Cream. Unfortunately, as a petroleum derivative, it is considered by many consumers to be "unnatural" and potentially harmful. While dodecylhexadecanol can be synthesised from natural ingredients, the processing of these ingredients is far too complex for the final product to be considered natural as well. Thus, to find an efficacious replacement for this ingredient in the Aveeno formulation, five candidates were selected based on their structure and hydrophilic-lipophilic balance (HLB). All of the candidates were also deemed to be obtainable from natural sources. The feasibility of these candidates was then evaluated by comparing the HLB, critical packing parameter, melting point, and cost to that of dodecylhexadecanol. The recommended replacement, stearyl oleate, is a cost-effective solution that will maintain the product's efficacy, and unlike the other candidates it possesses all of the required characteristics. Most significantly, unlike dodecylhexadecanol, stearyl oleate can be marketed as a natural ingredient, as it can be synthesized in three steps from sunflower seeds. With future laboratory investigation, stearyl oleate can be incorporated into Aveeno's hand cream formulation, enabling the product to benefit from the economic advantages of all natural marketing.

Aveeno: A Problem of Natural Selection

Su Anne Lee, Kopano Ramsay, Jonah Richard, Nicole Riddle

Aveeno prides itself on being a brand that works to "Discover the most effective Active Natural ingredients sourced from nature . . . to deliver real skin care benefits for healthier, more beautiful skin." However, the Aveeno Active Naturals Hand Cream contains dodecylhexadecanol, which is not naturally derived. Our team worked to identify possible alternatives to replace dodecylhexadecanol while ensuring that a lamellar structure is maintained. The team identified three alternatives to dodecylhexadecanol: Olivem 1000, cholesterol, and beeswax, as well as a process in which dodecylhexadecanol can be naturally derived. The Guerbet Process would allow 2-dodecylhexadecanol to be synthesized via a natural route, which was determined to be the most suitable solution, as the client would be

guaranteed a working product, costs of extensive laboratory testing would be minimized, and the product could be quickly released to the public. However, should this process not be effective in naturally producing dodecylhexadecanol, the potential of Olivem 1000, cholesterol, and beeswax were also evaluated, and concluded to be feasible natural alternatives.

Blackhead Remover

Siddharth Anandalingam, George Carlson, Cherry Chu, Emilio Fajardo

We would like to design a face wash/exfoliating scrub for Johnson & Johnson that can remove blackheads on a person's face. While there are certainly a lot of products currently on the market, these products are aimed at cleaning the face, then removing the dirt or oil buildup in the pore that causes the blackhead. The problem inherent in this approach is the fact that after the pore is cleaned, it can get dirty again. We are looking for a solution that actually changes the color of the blackhead, thus fixing the problem cosmetically, and the one we are proposing involves retinoids and azelaic acid. In our report, we will discuss why we believe this is the best solution.

Reformulating Aveeno Skin Lotion Using Natural Chemicals

Dillon Fleming, Madison Friedman, Timothy Gilboy, Vincent Grob, Michael Ong

The public perception of a consumer product is the critical factor in the product's success or failure. Aveeno, a skin lotion product produced by Johnson & Johnson, is a market leader in the skin-care products industry and is renowned for its natural formulation. However, consumers are concerned with the petrochemical origins of dodecylhexadecanol, a key stabilizing component in the lotion. This project analyzes the role of dodecylhexadecanol in the Aveeno formulation, focusing on its effects on the physical liquid crystal structure of the lotion and proposing alternatives with a more natural origin. Analysis of key physical properties of both the dodecylhexadecanol and potential alternatives through theoretical calculations and computerized molecular modeling allowed for a comparison of these alternatives, and a mixture of 75% nervonyl alcohol and 25% solanesol is proposed as a potential solution.

Johnson & Johnson Blackhead Removal

Brandon Jowers, Christine Shim, Kabir Malkani, Minghuang Liu, Varun Jotwani

The United States Library of Medicine describes blackheads as dark spots that occur when sebum, a lubricant trying to drain out of a pore's opening, is exposed to air. Melanin in the sebum oxidizes with the surrounding air and becomes a dark color. Blackheads are also known to be the first stage of acne formation, occurring

before bacteria enters the pores, preceding the formation of pimples. They can affect people of any type of skin but are more common in teens, young adults, and those with oily skin. There are products out on the market that can dissolve the sebum and remove blackheads, but they tend to be harsh on the skin. Thus, the objective of this paper is to report our findings on possible remedies for the bleaching and/or cleansing and removal of blackheads without agitating the skin.

Sebum is an oily substance produced in the skin to lubricate the hair and skin, making them waterproof. In reference to blackheads, sebum also provides a protective layer that blocks attempts to remove the black coloring agent using water and other cleaning agents. Thus, the first step in blackhead curing is the removal of the sebum layer. Nonpolar solvents, which are hydrophobic, are effective in removing oils on a person's face. The level of hydrophobicity can be measured using the octanol/water partition coefficient. The larger the coefficient, the larger the octanol phase and potential oil removal capabilities. The size of the solvent components also determine the level of irritability. The larger the chain, the less irritability. For this project, we are thus searching for a large, nonpolar solvent.

Aveeno Skin Strengthening Hand Cream Proposal

Martin Rosenbaum, Bianca Sganga, Peri Shapiro, Caleb Solomon, Rachel Tang

Johnson & Johnson produces its Skin Strengthening Hand Cream under the Aveeno brand. The lotion's structuring aid, 2-dodecylhexadecanol, contributes to the unique ability of the formulation to self-assemble into vesicles, providing consumers with an effective and textured lotion. Even though Dr. Gunn, the lead research director behind the lotion, states that 2-dodecylhexadecanol functions beautifully, consumer criticism has surfaced surrounding the source of this crucial ingredient.

Although Aveeno prides itself on its "Active Naturals ingredients sourced from nature,"[1] 2-dodecylhexadecanol is a hydrocarbon-based product, derived from petrochemicals. Dr. Gunn has encouraged us to replace 2-dodecylhexadecanol with an ingredient that is more congruous with Aveeno's branding, without sacrificing the unique texture and healing power characteristic of the Skin Strengthening Hand Cream.

Our team began this project with the goal of finding a natural alternative for 2-dodecylhexadecanol. This straightforward goal developed into a multifaceted proposal incorporating a cohesive definition of "natural," in-depth analysis of Aveeno's current formulation, surfactant science, consumer perceptions, economic analysis, and extensive research. After analyzing the trade-offs between these competing forces, we recommend the following replacements for 2-dodecylhexadecanol: Isofol 24 or stearyl caprylate.

Blackhead Eliminator: Be Gentle

Temi Tuby-Lukan, Michelle Ynsinare, William Yolen, Boning Zhu, Yani Zhang

Millions of consumers in the world are affected by acne and its related skin symptoms, such as blackheads. Blackheads are clogs in the pores in the skin that are filled with oil (sebum), dead skin cells, and a single strand of hair. Since blackheads can potentially lead to infections that later causes acne breakouts, consumers are looking for a common solution. Currently, affordable blackhead-removing facial products are harsh on the skin and ineffective, due to the high concentration of salicylic acid in the formula, along with such harmful chemicals as hydrogen peroxide, in breaking the dead skin and oil layer called the *comedon*. Expensive options offer protection to the skin as well as removal of blackheads, but they are not ideal for the majority of consumers.

We are looking for a solution, one that would remove blackheads with organic, natural active ingredients, that involves a cost much closer to the $0.04 per wash for Clean & Clear Blackhead Removal Face Wash than that of Dr. Jart's $7.50 Master Blackhead Removing Strip. Our solution will revolutionize the way our consumers wash their face and treat the impurities on their skin.

CIVIL ENGINEERING

Adviser: Prof. Tom Panayotidi

The Bronx Stadium

Katherina Barguil, Imer del Cid, Alejandro Ortiz, Hao Pham, Mary Williams, Xili Zhou

Despite being the world's most popular sport, soccer does not yet have a home in New York City. This project presents a blueprint for the successful design, construction, and maintenance of a profitable soccer stadium in the city. The proposed stadium has a circular layout with a 330-foot radius and is supported by a braced steel-frame superstructure. It is able to comfortably accommodate 40,000 spectators, as well as players, security, and medical staff. The stadium features an elegant roof supported mainly by two arches, running the length of the field, that are supported by four structurally independent pylons. The roof has semi-retractable ETFE, lightweight panels that protect the field from weather conditions.

The stadium's proposed location in the Bronx was chosen in order to guarantee its financial viability and to sidestep the unique challenges and constraints posed by construction in a highly urbanized environment. The stadium is designed to be structurally sound and able to withstand dead, live, wind, snow, and seismic loads in accordance with ASCE 7-10 specifications. The design also aims to minimize the environmental impact of the proposed stadium by employing sustainable practices per LEED standards. This project makes extensive use of modern computer tools commonly employed in today's high-paced environment. As building information modeling becomes increasingly ubiquitous, the basic structural design is done in Autodesk Revit. Structural analysis is performed with SAP2000, and the results are then judiciously used to determine structural member sections and sizes per the 2014 *AISC Steel Construction Manual*. Autodesk Maya is utilized to render realistic three-dimensional models of the stadium. A small prototype is 3D printed for illustration purposes.

In sum and substance, the objective of this project is to design a breathtaking, innovative, financially viable, and sustainable stadium that will not only attract a diverse contingent of fans but will also be a source of pride for the local community and New York City as a whole.

Multistory Office Building

Ilan Casper, Charles Iselin, Navjot Kaur, Katherine Rivera, Lindsey Wickman, Hannah Wilson

Our project is the design for a concrete-frame office building located in Queens,

New York. The four-story, L-shaped office building has dimensions of 140 x 120 feet and is located between Northern Boulevard at the front and the Sunnyside rail yards to the rear. The design capitalizes on this unique location with glass curtain walls on the exposed sides, which maximize natural light within the building to create a healthier work environment while insulating heat and sound. Designed in accordance with requirements of ASCE 7-10, ACI 318-11 as well as local zoning regulations, the structure is a monolithic reinforced-concrete frame with concrete slab floors, resting on a reinforced-concrete mat foundation to account for the poor soil conditions on site. The building and its interior were modeled in Revit, and structural analysis was performed in SAP 2000. The design accounts for dead and live loads as well as location-specific earthquake, wind, and snow loads.

In addition to designing the structure, we performed a cost estimation and project schedule and investigated ADA requirements and LEED certification.

The Brunswick Heritage Crossing

Maika Abdallah, Phoenetia Browne, Heui Yung Do, Noureen Nanjee, Undrakh Sisunton

North Brunswick Township, New Jersey, is a residential town with two central hubs of commercial and social interactions within the township: two strip malls just across from each other filled with restaurants, stores, and offices. However, these two locations are separated by a six-lane highway that cannot be crossed on foot. In order to provide safe pedestrian access over the highway in a more time- and energy-efficient manner for shopping and socializing, we aimed to create a pedestrian girder bridge in this location—the Brunswick Heritage Crossing—which will not only connect the two malls but also foster a pedestrian culture. Only a six-minute drive away from Rutgers University, we believe that the bridge will serve the students as well as the local population.

We designed our bridge with a view toward accessibility, community involvement, and environmental and economic sustainability. Our bridge type, the girder bridge, was chosen with an economic budget in mind, and the design uses low carbon steel for durability, easy maintenance, and sustainability. The bridge follows the ADA guidelines for accessibility and includes stairs, lights, and a roofing design to keep pedestrians protected from inclement weather. Our bridge will also have a state-of-the-art elevator on both sides. The design, including the girders, floor beams, concrete slab, steel deck, rebar, and connections, follows the AISC, AASHTO, IBC, and NJ DOT building codes. Factors in our design include display, construction speed, lightness, stiffness, construction economy, and structural efficiency.

The Brunswick Heritage Crossing was designed to promote maximum

community involvement and regional pride and relevance. To this end the bridge's interior and skin design was inspired by Tim Howard, World Cup hero and goalkeeper for the United States men's national soccer team. Howard was born and raised in North Brunswick. He graduated from North Brunswick Township High School and later played for the Central Jersey Cosmos before launching his professional soccer career. The community in North Brunswick takes pride in Howard's local origins, so to honor him in our design, we put in a turf on the flooring of our interior deck that incorportates the markings of a soccer field, creating a more interactive environment for locals of all ages.

Additionally, the bridge provides a prime viewing location for the annual North Brunswick fireworks. The bridge is fully enclosed with a roof and glass walls, which ensure a safe and clear viewing area.

Our ultimate goal in designing the Brunswick Heritage Crossing was to provide a simple solution to people traveling between the two shopping centers in New Brunswick. The bridge promotes environmental awareness by limiting the use of vehicles, which would no longer be required in order to travel between the two centers. All design considerations will be thoroughly checked so that those using the bridge will be safe. Since only pedestrians will be crossing, we expect the bridge to have a long life.

George Deodatis Field at SEAS Stadium at Dean Mary C. Boyce Athletic Complex

Jaclyn Fu, Jennifer Mahan, Devin McManus, Sam Park, Sam Wilson

The objective of our senior design project is to satisfactorily design a soccer stadium located in Flushing Meadows, Queens, with regards to structural safety, construction management, and sustainability. The stadium is designed for a capacity of 40,000 spectators and includes a roof support system that provides shade and rain cover for the spectators. The foundation is a deep-pile system designed to withstand the less-than-ideal soil conditions. The roof is composed of two steel-truss tied arches with side trusses extending over the stands; the roof membrane consists of pretensioned PTFE sheets. All stand sections and concourses are composed of precast concrete, with beams and columns arranged in a boxed frame.

The soccer stadium was first designed in sections with AutoCAD and Revit, and then imported into SAP2000 for full structural analysis. The building has been designed to withstand all wind loads, seismic load, live loads, and dead loads. In addition, the team has analyzed and determined the construction strategy for the stadium, including scheduling and quantity take-off to environmental and LEED concerns. A physical model of the stadium was also created to increase spatial understanding in a 3D environment.

The stadium fulfills all FIFA design requirements for stadium structures.

All architectural and structural requirements were taken from the International Building Code (IBC) and the American Society of Civil Engineers Code 7-10 (ASCE 7-10).

Liberty Stadium

Viktoriya Andonova, Maria Balsinde, Luke Henderson, Lisette Hermida, Adam Sherman

Our project consists of a soccer stadium located on Randall's Island. Our design accounts for all the FIFA technical suggestions and requirements, while at the same time adhering to the American Disabilities Act and the International Building Code, and all the appropriate load conditions and combinations for the area. The stadium is big enough for 40,000 spectators plus team members, coaches, and staff. It also allocates space for training, lockers, concessions, restrooms, first aid, and retail.

The playing field is 100 meters long by 68 meters wide, with additional surrounding field area of at least 8.5 meters on each side and 10 meters on each end. Spectator seating begins approximately 7 feet above the playing field, so as to prevent the spectators from disturbing the players. In its entirety, the stadium measures approximately 750 x 625 feet and is about 140 feet high. The stadium is surrounded by towers, which are connected to a PTFE canvas by pre-stressed cables. The canvas covers the stadium, serving as a roof, not including the area right above the playing field.

The stadium is designed to have steel members and concrete floor slabs. All design is in accordance with AISC, ASCE 7-10, and IBC 2012 requirements. Dead and live loads are accounted for and evaluated, including seismic, wind, rain, and snow. The structural sections for beams and columns have been chosen based on structural analyses conducted in SAP2000. The stadium was also modeled in Rhino and Autocad for more detailed renderings. The foundation (footing) design takes into account the soil conditions of the area,and provides appropriate support for the structure.

The report also includes a work breakdown schedule, including a critical path method schedule, as well as a cost estimate for the entire project. The stadium has also been designed with sustainability in mind, and is planned to meet certain LEED specifications.

Soccer Stadium Design—Nassau County

James Cumming, Jakub Karas, Xiaoran Li, Lucas Oliver, Valentina Paiva Acosta, Erick Quinteros

Our senior design project has been to design a 40,000-person-capacity soccer stadium in line with FIFA regulations for stadiums hosting international matches. The stadium we propose will be located in the town of Hempstead, New York, on the site of the Nassau Coliseum, formerly home to the New York Islanders hockey team, which has relocated to Brooklyn. Our design is a hypothetical response to a Request For Proposals for the redesign of the Nassau Coliseum site, which was won by Forest City Ratner in September 2013.

The seating layout of our stadium is designed to produce optimal visibility for spectators while maximizing the number of seats the stadium may hold. Our stadium's structure has been designed to withstand all loading conditions one might expect in civil infrastructure, including earthquake and wind. Additionally, a foundation for the stadium was designed based on studies of the soil conditions of the proposed site. As this stadium is being designed in post–Hurricane Sandy New York, several stormwater management techniques have been applied to the parking lot in order to minimize stormwater runoff from the site. Further sustainability measures for our design will reduce the stadium's demand on the local water and power grids, as well as mitigate construction impacts on the local environment.

Other work includes preparing plans for parking spaces, conducting an accessibility study with regard to road transportation and hotel accommodations, and choosing environmentally friendly materials.

Designing the New York City Football Club Stadium

Efram Stone, Alyssa Ramos-Avila, Ezra Teferra, Michaela Reeser, Jenna Hermann

A stadium is not just a functional sports venue but an architectural landmark that reflects and represents its community. The New York City Football Club (NYCFC), currently playing their first season in the United States and Canada's Major League Soccer (MLS), uses Yankee Stadium for their matches in New York City but now, evidently, requires the construction of a new soccer stadium. Motivated by the architectural brilliance of the city itself, our capstone design proposal creates a stadium that will become a new symbol for the world's sport, soccer.

The initial design of the stadium, which is to be built near Metlife Stadium in nearby New Jersey, came from an intersection of the city, the site, and the team. One of NYCFC's logos includes an abstracted image of the top of the iconic Chrysler Building. The iteration of curves influenced the design of the three-layer roof of the stadium. The facade of Metlife Stadium is made up of a series of thin horizontal lines. In order to complement this existing building, the design for the facade of the NYCFC stadium is made up of a series of wide vertical sections that

are also reminiscent of the stripes on away-team soccer jerseys. As a result of these elements, the stadium's role as the home of New York City's soccer team will be unmistakable.

The design is full of state-of-the-art technology, including a mechanically opening roof, the latest in thin film photovoltaics, net zero water design metrics, and a "self-watering" turf. Two tiers of stadium seating, including a level for club and media boxes, will accommodate a capacity of 41,000 spectators. All design aspects were determined by the engineers in accordance with ASCE 7-10, 2011 IBC, and 2011 FIFA Technical Recommendations and Requirements. The proposal for the stadium includes seismic analysis, geotechnical consideration, and an evaluation of dead, live, and wind loads, and the structural design was based on analysis performed in SAP 2000. The report also includes a CPM schedule and the engineers' cost estimate. This avant-garde design, combined with cutting-edge sustainable metrics, provides for a dynamic venue for the world's most dynamic sport.

KNAAK: Bringing Art and Innovation to the Urban Landscape

André Fuqua, Kathilee Kenlock, Kyra Price, Nahtahniel Reel, Aron Taamrat

KNAAK is an experimental design collective that tackles issues surrounding urban art and creative development. The building that will house the collective is to feature three distinct studio spaces that serve as creative hubs for research and artistic innovation: (1) SoundSpace, an audio think tank; (2) ArtSpace, a visual arts think tank; and (3) MuseoSpace, a contemporary gallery space showcasing artwork and projects by creatives within the urban sphere. The chosen site for building construction is an open landscape in Deptford, New Jersey, an ideal location due to its close proximity to the city of Philadelphia.

The project criteria states that the building must be three stories, with out-to-out dimensions of 100 x 70 feet. The majority of the office building must be made of cast-in-place reinforced concrete, have a minimum ceiling height of 8 feet, and a maximum building height of 55 feet. The proposed design, supported by pile foundation, considers various loading conditions, including seismic loading, wind loading, and snow loads, in addition to standard building dead and live loads. The design was modeled and tested using a SAP 2000 model, after which an AutoCAD and Maya rendering was produced. After the design was finalized, the constructability and sustainability (including LEED certification) of the design was investigated. This involved construction management techniques such as cost estimating and project scheduling and took into consideration the energy footprint of the building's design elements.

EARTH AND ENVIRONMENTAL ENGINEERING

Indirect Heater Design and Emissions Abatement for Dynamo Micropower, LLC

Tanay Doctor, Caitlin Fedio, Malini Nambiar, Sigal Shemesh
Advisers: Prof. Robert Farrauto and Ivan Wang (Dynamo Mocropower, LLC)

The project aims to develop a comprehensive suite of solutions for Dynamo Micropower, LLC to achieve emissions reduction in their current and future range of heaters. Dynamo's patented InfernoCore technology uses a gas turbine as a direct fired heater to provide a hot stream of air/exhaust mix used for heating. This project provides a heat exchanger design that will keep the exhaust and air streams separate. The primary goal is to abate emissions from the heat exchanger for use in indoor spaces, enabling a wider variety of fuels for combustion process. A number of design priorities have been outlined by the Dynamo design team for this indirect heater project. First, it must increase environmental health and safety by providing emissions control and abatement. Second, it must allow for greater fuel flexibility to reach untapped customer bases. Third, it must maintain Dynamo's current value propositions of a highly robust and compact design (that is 25–50% lower than competitor offerings within the same heating capacity range). The project team believes that all of these goals have been accomplished through the comprehensive solution and alternatives outlined below.

Heat Exchanger

The primary objective of this project is to provide a design of a heat exchanger for Dynamo Micropower and integrate it into their current system. This will enable Dynamo to build it into a proposed line of indirect heaters, for deployment in the construction or oil and gas industries. The primary technology that will be developed should allow the heater to make use of flexible fuels (propane and flare gas) that will reduce emissions and improve energy efficiency. To meet these goals, the design team will present simulations of heat transfer and parameter optimization that inform the selection of an appropriate manufacturer. The customized solution will be visualized using CAD/Solidworks software.

Air Quality Regulations, Certifications, and Testing Frameworks

A secondary objective of this project is to conduct a comprehensive review of the regulations that Dynamo and their clients will be subject to. This involves domestic regulations regarding indoor and outdoor air quality as well as industry certifications regarding total emissions. Given the existing emissions data, the design

team will highlight areas where Dynamo does not meet regulatory requirements or certification criteria. Furthermore, the design team will provide a detailed emissions-testing framework that expands on the currently limited emissions data with cost estimates and recommendations.

Emissions Abatement
Finally, the last objective is the identification of potential emissions abatement systems applicable to Dynamo's existing direct flameless heater range (Infernocore) and the proposed indirect heater product with a thorough cost-benefit analysis.

Mill Basin Bridge Belt Parkway Stormwater Runoff Bioretention Solution

Eileen Li, Christine Liu, Brian McGrattan, Soo Young Yoon
Advisers: Prof. Robert Farrauto, Vjeko Matic, Kathleen McCarthy (NYC Department of Parks)
This senior design project is an examination of the environmental effects on Four Sparrow Marsh from the reconstruction of the Mill Basin in Brooklyn. Our role is to examine the effects of stormwater runoff from impervious surfaces on the new bridge's approach and bridge deck not currently considered by current environmental regulations. Using georeferencing tools and stormwater management calculators, we discovered that approximately 17,000 cubic feet of unaccounted-for, untreated stormwater will flow into the Four Sparrow Marsh during a 1.2-inch rainfall event. To mitigate this extra volume, we propose the installation of two additional bioretention areas that are collectively capable of treating approximately 18,000 cubic feet of stormwater. Since the original stormwater runoff prevention plan called for four bioretention areas, we have found that the additional cost will be marginal.

Bronx River Restoration Project

Karah Collins, Sean Cohen, Liza Faber, Mariah Gladstone
Advisers: Prof. Robert Farrauto, Prof. Pierre Gentine, Prof. Wade McGillis, Sarah Tobing (NYC Department of Parks)
This project consists of a series of proposed channel improvements along a river fork in the Bronx River. The river diverges around an island, which has created blockages along this section of the Bronx River. Included are our recommendations for improving recreational conditions in the river surrounding the island. These recommended solutions are based on hydraulic modeling, field testing, and additional research. Using data collected through field measurements, the characteristics of a single channel and a split channel flow were compared to

determine whether concentrating flow in one channel or converting the second channel to a high-flow channel might facilitate optimal conditions for canoeing and kayaking and provide a healthier habitat for indigenous plant species. This proposal was written and prepared by students of Columbia University's Department of Earth and Environmental Engineering with guidance from professors and members of New York City's Department of Parks and Recreation.

ELECTRICAL ENGINEERING

Drum Trainer

Antonio Basukoski, Shahrod Khalkhali, Edwin Mejia, Hilary Mogul
Adviser: Prof. David Vallancourt
Learning how to play a new instrument on your own can be hard. With Drum Trainer, we hoped to create something that bridged the gap between beginner and expert. A learning musician can practice rudiments, perform pieces, and even record new programs to play through on Drum Trainer. With Instrument Mode, a user can play different programmable sounds using the practice pad as an electronic instrument. The Drum Trainer uses an array of force-sensitive resistors as pressure sensors under the rubber of the practice pad to keep track of when, where, and how hard a user is playing. There are also three small cameras connected to Drum Trainer that capture the user's sessions. The side camera is used to keep track of stick heights, the overhead camera for relative stick angles, and a front camera to capture the user during the session. Using the front camera data in conjunction with an expert instructor can provide the user with valuable information in terms of posture and tension when playing.

Jaykhon: Wireless Security System

Olalekan Afuye, Jonathan Guzman, Jeremy Patcher, Hao Zheng
Adviser: Prof. David Vallancourt
Jaykhon Security is an easy-to-install wireless security system consisting of a central server connected to a series of wireless modules and sensors. The user can interact with the server wirelessly through a phone app to lock/unlock doors, arm the system, receive alarms, and so on. RFID tags replace keys to provide entry to the house, creating a "hands-free" way to unlock the door. The server-based nature of this project allows for easy addition of sensor modules and features.

Narwhal Power

Michael Wang, Monika Mohacsi, Michelle Haines, Daniel Rosenthal
Adviser: Prof. David Vallancourt
Narwhal Power is a portable power system that replaces individual device batteries, which can run out during an outdoor expedition, with a high-capacity battery pack that can be recharged in the field by solar, wind, bike-dynamo, or any other source between 5V and 30V DC, or 120V AC if you're at home. Outputs provide 5V DC, 12V DC, and 120V AC power. Capacity sufficient to fully recharge two laptop computers is available, and additional energy capacity can be added. The foldable

solar panel augments the product's ability to work outdoors by providing the user a powerful and portable power source with an expected peak power output of 96W. The product's multiple power outputs, scalability, and compact size are great for outdoor enthusiasts, soldiers, field researchers, or anyone in a situation where electronics need to be charged but power is not readily available.

Smart Lock

Alex Gopinathan, Brett Provance, Luc Davidson, Joe Sweeney, Oliver Jin
Advisers: Prof. David Gidony, Prof. Jan Janak
The Smart Lock is a physical door lock, based on a commercial product but modified using an open architecture, protocols, and interfaces, all controlled wirelessly. The commercial master unit of the lock is connected to our auxiliary unit featuring a Raspberry Pi with Wi-Fi and Bluetooth capability. A system administrator can upload the access list for a given door lock remotely (instead of through a wired connection, as is done currently), while users with proper credentials can unlock the door from their smartphone in addition to swiping with their student ID card. The Smart Lock is designed to be a simple mod to the commercial locks used in many Columbia buildings. Our vision is that they will be integrated throughout the campus.

Visible Light Communication

Mun Shin (*Lillian*) *Chik, Supanath* (*Mike*) *Juthacharoenwong, Andres Medina, Minh Trang Ngoc* (*Mindy*) *Nguyen, Jake Wood*
Adviser: Prof. Alexander Gazman
Visible light is, on a fundamental physical level, no different from the radio and infrared waves currently used in data transmission. As high-power LEDs replace incandescent and fluorescent lighting, transmitting data through visible light becomes possible: the same light source used to light a room can supply data. This was impossible with previous lighting, as modulation of intensity at usable data rates was impossible. In our prototype, the circuitry, LEDs, and photodetectors are fitted into a small form factor compatible with standard lighting fixtures. Each of our transceivers allows users to transmit files from computer to computer easily over a visible light channel.

Remotely Controlled LED Modules (Window Pixels)

Aaron Burger, Shanny Li
Adviser: Prof. Alexander Gazman
We turn one of the sides of a building on campus into an interactive art display by installing in each window an LED module consisting of a receiver with two LED light strips. Passersby can interact and play with the display through a phone app.

Multi-Channel Wireless Biomedical Signals Transmitter/Receiver

Elias Goodman

Adviser: Professor David Gidony

This technology allows for the detection, wireless transmission, and deciphering of EMG signals from a target muscle group. A prototype of a less bulky, more comprehensive, full-body suit, it demonstrates the functionality of biometric fitness apparel soon to hit the market. The multiple channels isolate, modulate, and transmit the signals of interest via Bluetooth to a receiving station, which performs signal analysis. The processing, storing, and display of pertinent data may be conducted by a smart device when implemented in its marketable form.

Ball Balancing Robot (cross-listed with Mechanical Engineering)

William Miller, Andrew Nederlof, Byran Ptucha, Alexander Arsenault

Advisers: Prof. David Gidony, Prof. Fred Stoli

A robot balances on an undrilled bowling ball. As the ball rolls, the robot stays upright on top of it.

Robotic Package Gripper (cross-listed with Mechanical Engineering)

Lydia Alfonso, Connie Phung, Jacqueline Nwabueze, David Boucard, Victor Campbell, Cristina Reveles

Advisers: Prof. Alexander Gazman, Prof. Fred Stoli

Amazon has proposed a drone that can carry packages to its customers. This robotic package gripper, a basic four-bar linkage gripper, can locate a standard cardboard box and grip it with a measured force. Packages of variable weight (between two and five pounds) can be lifted.

Robotic Glass Harp (cross-listed with Mechanical Engineering)

Andre-Jacques De Beer, Jang Won Suh, Abdul Leite, James Thompson

You can produce sound by wetting your finger and moving it around the rim of a wine glass. The robotic glass harp is a mechanism that produces music by having multiple wetted fingerlike mechanisms momentarily contact the rims of many rotating glasses filled to different levels.

INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH

Delivery Schedule Optimization

Adviser: Prof. Lucius Riccio

Jun Sen Ang, Chang Woong Yoon, Haseeb Jahangir, Yunhe Wang, Zhe Hu

One Acre Fund is a nonprofit organization that was established to alleviate poverty in Africa. The company targets smallholder farmers and provides them with an array of resources to boost harvest and improve their livelihood. One of their key operations is the distribution of seed and fertilizer to these farmers. Our client Carla Pellegrini, the primary lead of their Kenya Logistics Team, is responsible for delivering over 10,000 metric tons of seed and fertilizer to 150,000 subsistence farmers through seven warehouses. Due to differences in truck capacities and numerous farmer locations, the complexity of the problem is greatly increased, so we took on the task of creating a system to calculate optimal truck and route deployments in order to maximize reachability while minimizing transportation costs.

Although we had access to a previous team's solution, which utilized a nonlinear programming model (developed using the LINGO software), it had two main drawbacks: it was too complicated to utilize, since it lacked a user interface, and it employed a paid solver (LINGO) that the client was unwilling to invest in. Therefore, using the free open-source PyOpt module in Python, we created a new linear programming model, coupled with an intuitive front-end GUI (Graphical User Interface), to simplify interaction. In comparison with their traditional manual approach for truck and route allocation, our system generated a significant 24.9% in cost savings for year 2014 (46794.2 KSH saved) and 17.8% in cost savings (30,552 KSH saved) for year 2015, For future iterations of the program, data from GPS trackers on the trucks could be incorporated to determine exact distance measurements and improve cost estimation as opposed to utilizing the current distance matrices in the code.

MECHANICAL ENGINEERING

Advisers: Prof. Fred Stolfi, Prof. Robert Stark
Teaching assistants: Brian Jones and Michael Fernandez

Pistol Trigger Safety

A R M A: Yiqin Chen, Joshua Kin, Jay Shim, Michael Yu
A safety mechanism that will prevent a pistol from being fired by any unauthorized individual. The safety is locked and unlocked wirelessly by the user. May be patentable.

Quad Rotor Ball Cart

YEMEX: Xavier Alvarado, Elise Burch, Erik Elbieh, Yevgeniy Kvashnin, Mitchell Leoung
A rolling ball powered by a quadrotor helicopter. Rolling is much more efficient than flying for the quadrotor. The system can fly over any obstacle that it encounters.

Robotic Hand Gripper

Turbo Inferno: Mohamed Abdelmaksoud, Wensong Li, Donald Lovejoy, Justin Rehfeldt, Marsalis Roddy
NASA requested a Senior Design Project in a hand gripper. The underactuated scaled-up three-finger gripper (requiring only one motor to actuate) will grab a rail of the same dimensions as the outside rails on the International Space Station.

Dart Throwing Robot

DartBot: Brendan Chamberlain-Simon, Caroline Herald, Cooper Matthieson, Kevin Roark
A 3 degree of freedom (DOF), cable-driven robot arm that uses computer vision to throw darts at a dartboard in its field of view.

Collapsible Table

Rambunctious Solutions: Daniel Bish, Daniel Stark, Zachery Wills
Inspired by pop-up books, the collapsible table will fold flat on the floor and be capable of opening to table height. The table is fabricated with a unique material that was tested extensively. This may be patentable.

Robotic Saxophone Player

Saximus: Lauritz David, Giancarlo Lezama, Jose Mendez, Jessica Taylor
A mechanism capable of playing a standard alto saxophone. The project, an instrument that can play notes in a way that imitates a human musician, was proposed by the Columbia Music Department.

Delta Robot

Delta Force: Dylan Laurin, Bruce Lee, Christopher Muff [Mudd?], Stephan Stansfield, Erik Udbye
A delta robot is a type of parallel robot that consists of three arms connected to universal joints at the base. The robot keeps the end effector (the device at the end of the robot arm that can pick up parts) parallel to the work surface.

Mechanical Mimicking Hand

MimEx: Nicola Celi, Nicole Lewis, Kevin McCullough, Rachel Price
A strictly mechanical device (no electronics) that mimics the movement of a human hand and forearm. The human puts his or her hand in a glove that is connected to the mimic by cables.

Robotic Bass Guitar

Normcore: Justin Birmingham, Justin Martin, Noah Rauschkolb, Abegim Undieh
A mechanism that can play a standard bass guitar. The project was proposed by the Columbia Music Department. The system consists of a guitar body for the bridge and soundboard, a mechanism to select the note and pluck the string, and weights to provide tension.

Expandable Circular Desk

Dirty T & the Boys: Marcelo De Rada Ocampo, Christopher Peritore, Nicholas Savage, William Van Noppen, Tanya Zakowich
A strictly mechanical device (no electronics) that allows a desk to expand to a circular conference table. The leaves of the conference table are stored under the desk and move into place with gas springs.

Robotic Air Hockey Player

Turn Down for Watt: Seth Cawoski, Henrique Maia, Jessica Parker, Andrew Shoemaker
A mechanism that plays air hockey against a human opponent. The mechanism can move in both the x and y direction so it can both block the puck and return it. A camera captures the motion of the puck and a microcomputer calculates the

trajectory.

Flywheel Storage Device

Rotary Solutions: Gerardo Arevalo, Kiersten Gourlay, David Littlejohn-Carrillo, Matan Markind, Matthew Zebiak

A flywheel can be used to store energy and return it to the system for useful work. This system can connect to a cart or bicycle to accelerate the flywheel as the vehicle breaks and return the energy to the vehicle.

Robotic Package Gripper (cross-listed with Electrical Engineering)

NTR: Lydia Alfonso, Connie Phung, Jacqueline Nwabueze, David Boucard, Victor Campbell, Cristina Reveles

Amazon has proposed a drone that can carry packages to its customers. This robotic package gripper, a basic four-bar linkage gripper, can locate a standard cardboard box and grip it with a measured force. Packages of variable weight (between two and five pounds) can be lifted.

Ball Balancing Robot (cross-listed with Electrical Engineering)

I.P.O.W.R: William Miller, Andrew Nederlof, Byran Ptucha, Alexander Arsenault

A robot balances on an undrilled bowling ball. As the ball rolls, the robot stays upright on top of it.

Robotic Glass Harp (cross-listed with Electrical Engineering)

NEPOLLO: Andre-Jacques De Beer, Jang Won Suh, Abdul Leite, James Thompson

You can produce sound by wetting your finger and moving it around the rim of a wineglass. The robotic glass harp is a mechanism that produces music by having multiple wetted fingerlike mechanisms momentarily contact the rims of many rotating glasses filled to different levels.

Columbia Engineering
The Fu Foundation School of Engineering and Applied Science
500 W. 120th St.
New York, NY 10027