

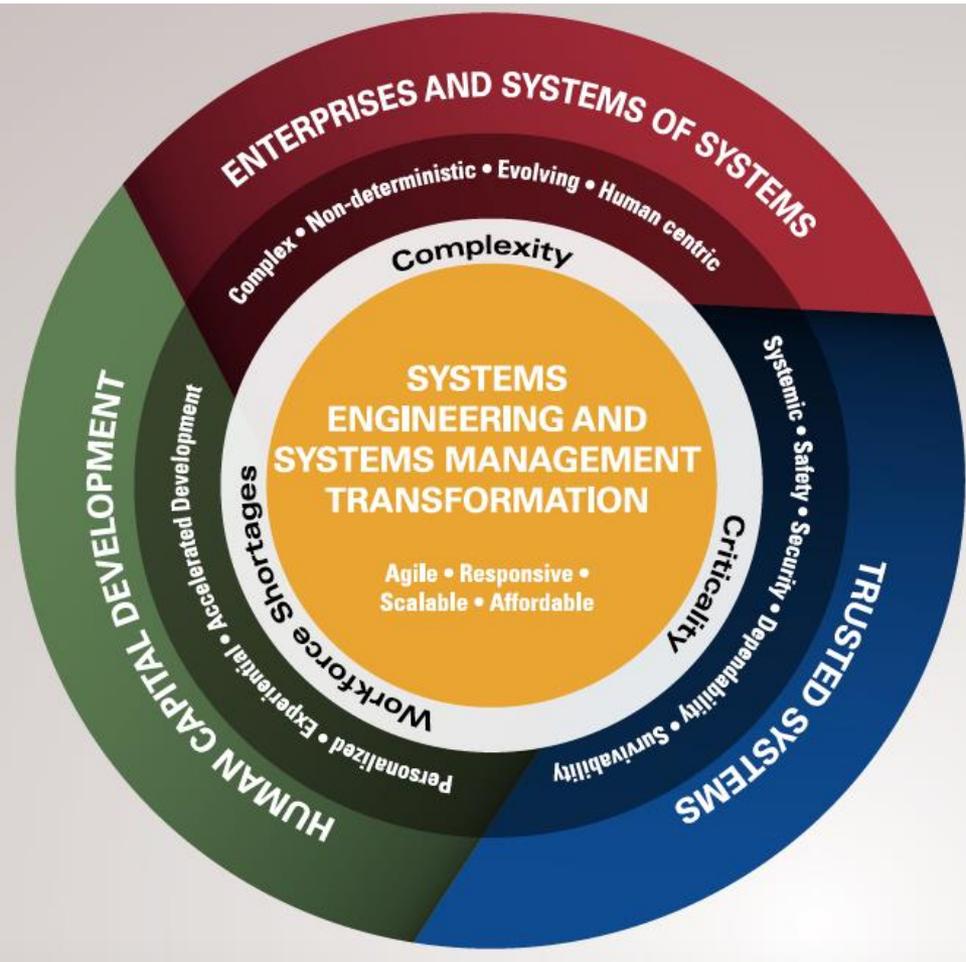
Systems Engineering Research Center (SERC) Capstone Marketplace Nov 2018



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Capstones Align with SERC Research



Enterprises and System of Systems (SoS)

- *Enterprise Analysis*
- *System of Systems Modeling and Analysis*

Trusted Systems

- *Systemic Security*
- *Systemic Assurance*

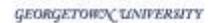
Human Capital Development

- *Evolving Body of Knowledge*
- ***Experience Acceleration***
- ***System Engineering (SE) and Technical Leadership Education***

SE & Systems Management Transformation

- *Affordability and Value in Systems*
- *Quantitative Risk*
- *Interactive Model-Centric Systems Engineering*
- *Agile Systems Engineering*

Capstones Leverage SERC' Research Network



“Outside” Capstone Projects:
 San Jose State University
 Oklahoma State University
 North Carolina A&T
 US Naval Academy
 University of Texas-Austin
Interest in Future Projects:
 Rice University
 University of Houston
 University of Illinois

- **2018 SOF 18 Traumatic Brain Injury Self Assessment**

The government is interested in the development of a Traumatic Brain Injury (TBI) assessment Android Tactical Assault Kit (ATAK) app. This will provide an immediately available assessment app on performer's personal ATAK.

2018 NSW 11 "Flare" Sensor

Military freefall parachuting requires operators to execute a unique "flare" maneuver to reduce their rate of descent and forward velocity as they land. Analysis of the problem and identification of new methods, sensors, equipment, procedures, indicators, etc. are sought--to make the flare maneuver more reliable and safe, giving the operator a consistent soft landing with minimal risk of injury.

Research Topics 2

- **2018 Army 01 Novel Back-packable Power Sources**

Army units require new, backpack portable fuel and power sources and electrical storage systems that reduce the size, weight, volume and logistics burdens associated with currently available battery systems

- **2018 SOF 16 Self Intubating Airway Device**

The government is interested in a Self-intubating snake, the development of a multidirectional device that can be loaded with an endo-tracheal (ET) tube and advanced into the mouth of a warrior in need of an airway. This device reduces the exposure of the operator to hostile fire

Creating a Capstone “Niche”

Many types of Capstones done at Universities today—

- “Capstones” are “finishing” projects for senior undergraduate students. Can be found in engineering, scientific, management, business, other academic departments
- Professors generally select teams and assign project topics
- Two semester projects are common, some Capstones are one semester
- Can include Industry sponsorship and participation

SERC-Sponsored Capstones have to provide unique advantages to existing institutional efforts

- A web-based marketplace. “Outside” universities can participate
- Multidisciplinary Teams—Topics are selected to cut across engineering, management, business curriculums
- Problems come from “operators” in military units and government organizations. Minimum “filters”
- Direct contact between student teams and government/military “users”
- Subject Matter Experts actively participate in guiding problem solutions--and serve as the “customer”

More SERC Capstone Characteristics

- Team funding provided. Typically \$5K per project in Firm Fixed Price contracts, with milestone payments
- Universities expected to provide collaborative support
- Introduces System Engineering processes along with common business approaches for tracking tech, schedule, cost performance.
- Emphasizes student skills in forming, justifying, presenting project decisions and outcomes—to a real customer

Past Performance

Problem—Configure a Water Activated Personal Flotation Device that won't inflate in heavy spray on small boat operations, but will protect an unconscious or injured user who may fall into the water inadvertently

- A team of students from Stevens Institute of Technology developed, tested, and demonstrated a functional prototype personal floatation device (PFD) with a sensor that enables the wearer to preset a time and depth profile which activates the device.
- DOD Sponsor was exceptionally pleased with the project outcomes. The Sponsor noted that previous attempts at solutions through more traditional acquisition approaches spent significantly larger R&D expenditures--without useful results.

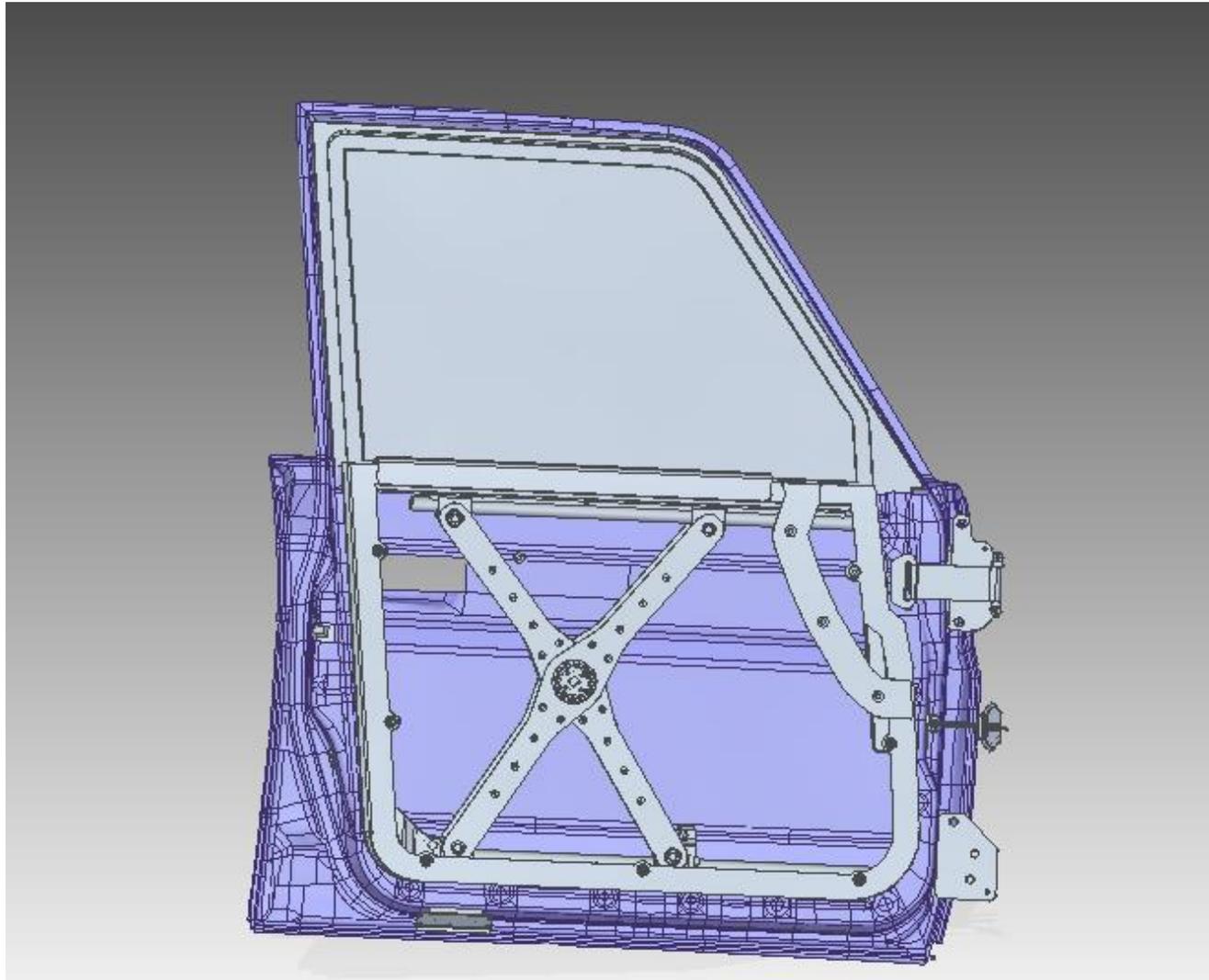
Personal Flotation Device



Armored Window Improvements

- A University of Alabama/Huntsville team worked to redesign the window mechanism for a SOF small armored small vehicle. Desired attributes included faster open and close times, full opening capability, and dual mode actuation to allow for manual override. A modified Chevy Suburban was provided as a test vehicle.
- Team successfully developed a full scale prototype window regulator system that retained the vehicle's original scissor lift mechanism.

Improved Armored Window and Mechanism

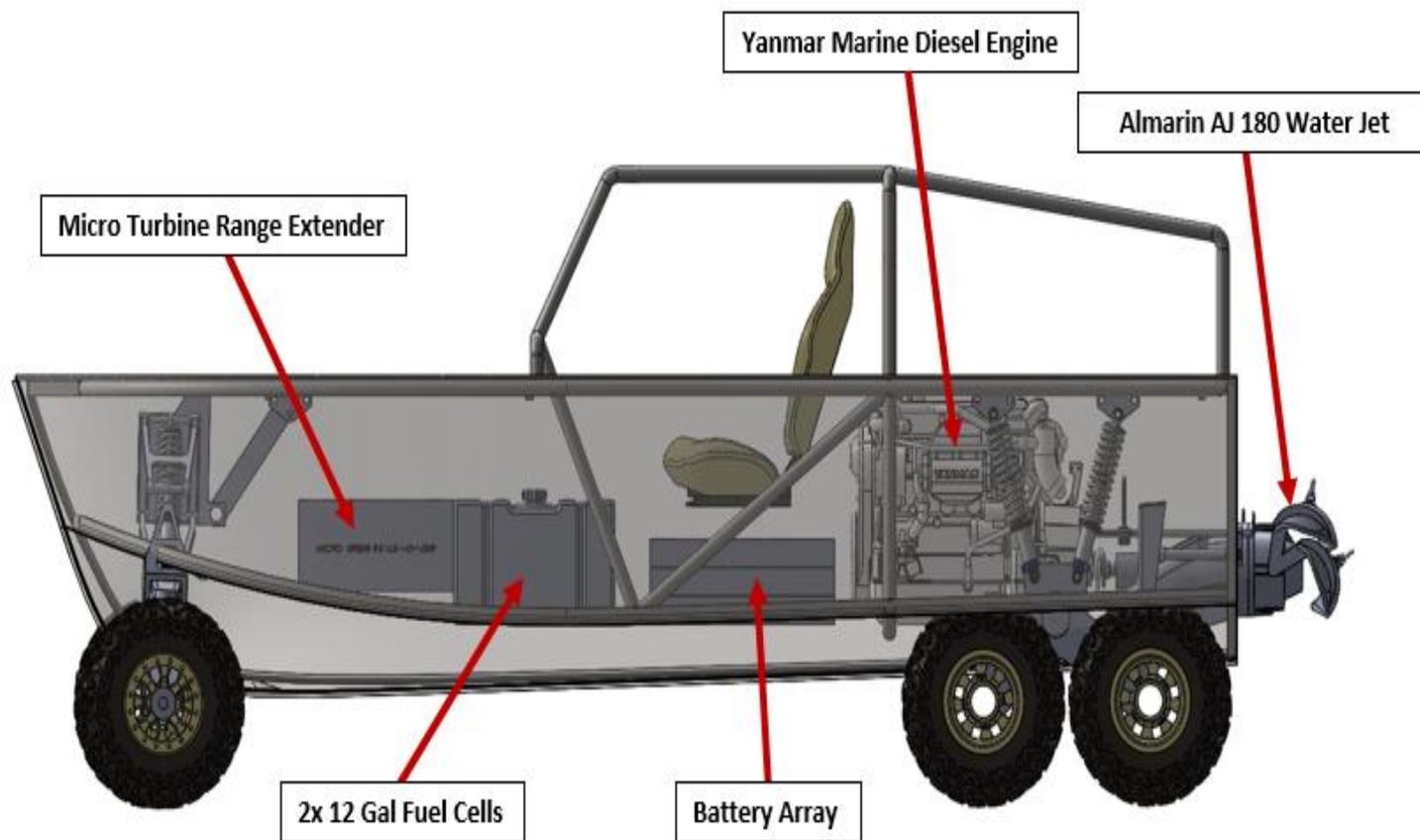


Vessel Disablement

Stopping non-compliant vessel under sail or with highly robust, protected propulsion



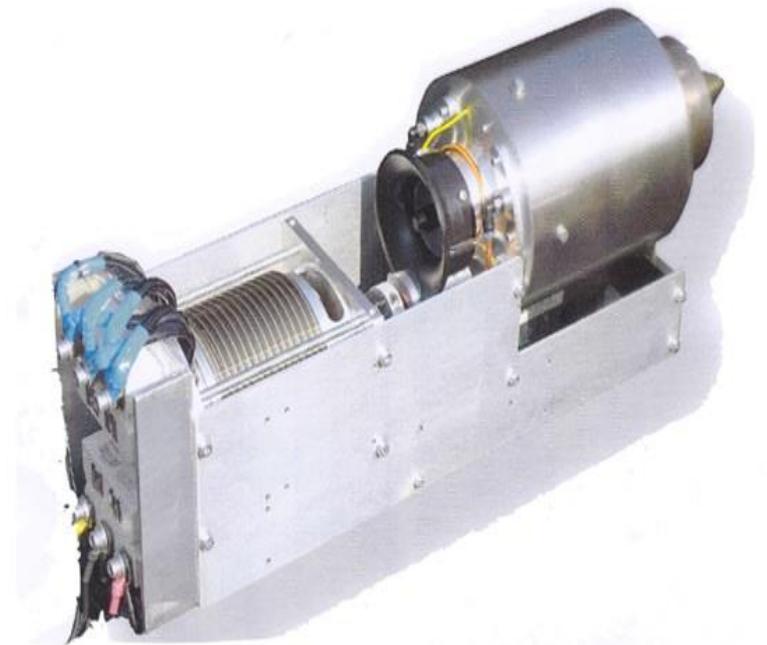
**Prototype Developed by Academic Team Proved 100% Effective
in 5 of 5 Underway Tests duplicating Operational Scenarios**



Vehicle Layout

Micro Turbine Range Extender

- Supplies additional energy to vehicle battery pack
- System redundancy
- Produces 11 kW
- Fuel type: Diesel
- Consumption rate of 2.6 gal/hr
- Acoustic output of 65 dB
- Paired with a 12 gallon tank:
- Can supply an additional 50 kWh
- Adds 150 miles of range for 250 total miles
- Reduction in battery size is possible



In-Wheel Electric Motors

- No need for a complex mechanical gearbox
- Can be made water resistant. Avoids rotating thru-hull seals
- Supplies individual torque to each wheel
- Changes wheel torques automatically based on soil via an integrated controller



Exploded View of Protean Motor

Motor-in Wheel Technology now being assessed by USSOCOM for future vehicle applications

**30 Projects from
SOCOM
Air Force Research Lab
USCG**

Academic Performers:

Auburn

Michigan Technological University

Missouri University S and T

**North Carolina A & T State
University**

Oklahoma State University

San Jose State

Stevens Institute of Technology

Texas A&M University

University of Texas at Austin

USNA

Virginia Tech

“Flipping the Capstones”

Universities

- Professors pick the teams
- Professors decide the project topics
- Professors schedule the team processes and interactions
- Typically “Department” centric

SERC CM

- Works through a Marketplace
- Real problems
- Interaction with military Subject Matter Experts
- Introduces “System” thinking
- Funded against “Deliverables”
- Promotes business management tools and processes

Capstone Benefits for DOD

- Ideas and approaches to solutions often unconventional and “Out of the Box”
- Value added– Can be high return on moderate investments in comparison to resources needed for industry or govt studies. Average project is \$5K for 2 Semesters’ work
- Generates student interest in DOD and future employment and service
- Increases DOD Client knowledge of technical issues, and interest in advanced technical education opportunities for SME’s and other personnel

DOD “Client” Quotes

"Employment of a student team ensures that the results of the project reflect views unfettered by organizational prejudices and preconceptions...**a perfect ‘tabula rasa’.**"

"In one project related to maritime issues, a student team outperformed a warfare laboratory that had been involved in the same project **for over ten years.**"

"One Naval Special Warfare Group has enjoyed the use of multiple student teams. In each case, the recommendations and work performed by the teams has been employed to actually field an item (PFD actuator) and to inform the way ahead for myriad topics-
-maritime disablement, vehicle armor, etc."

Future Capstone Plans

- More “Flip the Classroom”. Students form their own teams and capture their own projects through the Marketplace
- Students and Universities propose their own research topics which can be shopped to DOD and others in the “Marketplace”
- Networked Capstone teams from different universities work together to pursue Research Topics
- “Whole of Government” participation in Capstones
- Attract industry collaborators in Defense, IT, Aerospace, Health Care, other sectors to participate in student Capstone efforts

How to Learn More

- Capstone Marketplace website:

www.capstonemarketplace.org

- Email us:

capstonemarketplace@stevens.edu

wshephe1@stevens.edu

Questions?

Backup Slides

“Systems Thinking” in Undergraduate Capstone Projects

- Broad engineering integration and management skills are generally not acquired by engineering students entering the workforce until exposure post graduation “on the job”
- SERC is now shifting some of its focus to the undergraduate “terrain”

“Capstone Marketplace” seeks to energize Human Capital Development in System Engineering (SE) by moving the target

“To the Left”

- **Goal of “30/50/300”**
 - 30 Universities in Capstone activities
 - 50 Projects per year
 - 300 Students working projects
- **Barriers**
 - Contracts and money
 - Communications—use of best IT tools to facilitate robust virtual Marketplace
 - Commitment and Availability of Subject Matter Experts (operators)
 - Academic “friction”

Enhanced Performance Exoskeleton



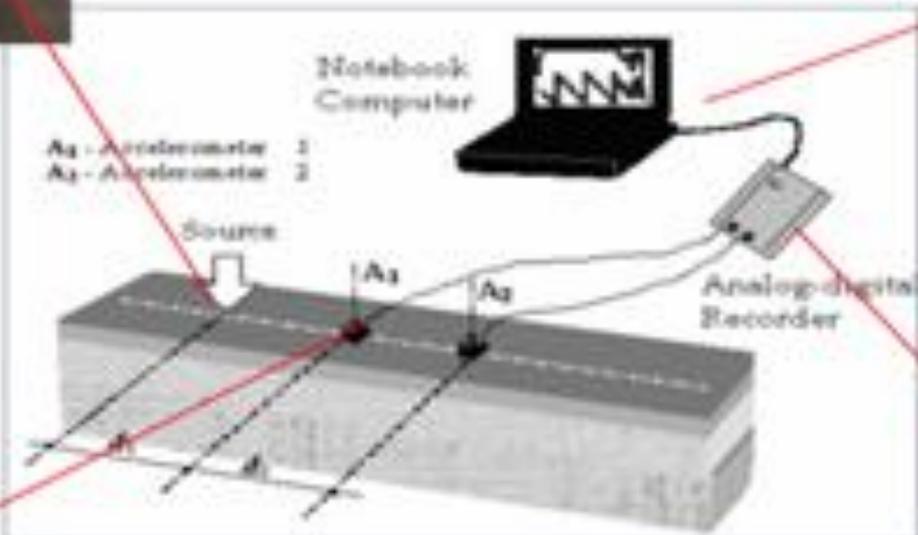
Austere Landing Zone Assessment

DESIGN



Accelerometer Mount: each mount was pressed into the ground so the attached accelerometer was at ground level.

Signal Analyzer to Computer: the vibrations picked up by the signal analyzer box are sent to the laptop which converts the readings into a graph showing all the frequencies over a specific time span.



Accelerometer: accelerometers measured the soil's vibrational energy when the nearby soil was excited with a hammer.

Signal Analyzer to Accelerometer: Vibrations recorded by accelerometers are sent to this box.



About the SERC

- The System Engineering Research Center (SERC) is a U.S. Department of Defense sponsored University Affiliated Research Center (a UARC), one of 13 UARCs doing DOD research.
- Stevens Institute leads a consortium of over 20 universities that comprise the SERC, in systems engineering research activities. Only the SERC UARC is an academic consortium.
- SERC manages DOD funds to universities' principal investigators, and their graduate and undergraduate students.
- In the last 9 years, SERC has engaged more than 450 researchers to enhance understanding of “systems” across engineering, finance, telecommunications, computing, transportation, and other domains important to defense.

Defining SERC “Theory of Capstones”

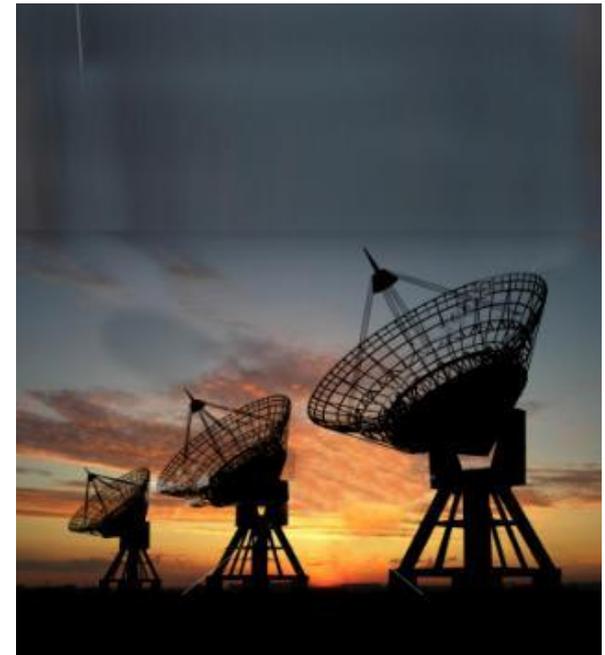
- **Give students simulated “real world” development experiences**
- **Interface to “operators”, and connection to actual need or problem is key**
- **Build something**
- **Show the utility of “System Engineering” at the Undergraduate student level**

Vision: The *Networked* National Resource to further systems research and its impact on issues of national and global significance

Mission:

The SERC will be the primary engine for the U.S. government in Systems Engineering (SE) research. In doing so, the SERC will:

- **Catalyze** community growth among SE researchers and end users by enabling collaboration among many SE research organizations (who),
- **Accelerate** SE competency development through rapid transfer of its research to educators and practitioners (how),
- **Transform** SE practice throughout the government by creating innovative methods, processes, and tools that address critical challenges to meeting mission outcomes (what).



Systems Research--with Networked Impact