BUILD IT Underwater Robotics Scale Up & Partnership Opportunities

National Girls Collaborative Project

Center for Innovation in Engineering and Science Education (CIESE) at Stevens Institute of Technology

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Goals for Meeting

- Introduction of CIESE, Background, Capabilities
- Overview of BUILD IT Project (Current & Future Possibilities)
- Opportunities for Expansion/Scale-Up
- NGCP and Member Institutions Share Programming Models, Implementation Needs, Capabilities
- Identify Synergies and Next Steps

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Who is CIESE?

- @Stevens Institute of Technology, Hoboken, NJ
- K-12 Focus on STEM disciplines
- Formal education settings
- Teacher professional development
- Curriculum development (use of cyber resources, real time data in K-12 science and mathematics)
- Educational research on student STEM learning

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Who is CIESE?

- Large-scale, national, statewide programs
  - 8,000 teachers in 3 states w/3 community colleges
  - 250 faculty at 41 community colleges in 21 states
- Focus on K-12 engineering→2,000 teachers in NJ, standards revisions, learning research
- Bridging research and education (e.g., SAGE, BUILD IT)

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What is BUILD IT?

- 3 year ITEST program (*NSF ESI-0624709)*
- 36 diverse middle and high schools
- ROV Curriculum = LEGO robotics in underwater environment w/wire guided switches
- NXT Curriculum = adds controller design and programming
- Extension Activities = Autonomous Underwater Vehicles

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Why Underwater Robotics?

- Presents unique, complex design challenges (e.g., buoyancy, control in 3-D)
- LEGO enables rapid prototyping, testing, redesign
- Exposure to concepts like propulsion, drag, buoyancy and stability, gearing, torque, speed, and thrust

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Why LEGOs?

- Familiarity
- Ease of use and durability
- Variety of pieces
- Rapid construction and redesign
  - “Tweak friendly”
- Fewer components required to create start-up kit

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Project Challenge

- Using LEGO and related components, create an underwater ROV (remotely operated vehicle) that will be able to pick up weighted wiffle balls and deposit them in a bin.

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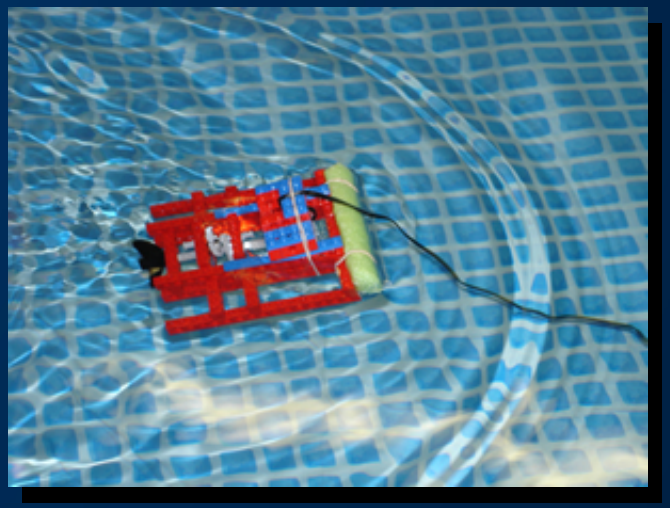
Task 1 – Straight Line Challenge

- Use a single motor to build a vehicle that can travel the diameter of the pool on the surface as quickly as possible; optimize gearing to achieve best propeller speed.



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Task 2 – Figure Eight Challenge

- Use a second motor to enable steering; maneuver on surface to complete a slalom course around two buoys in shortest time.

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Task 3 – Submerge Challenge

- Use a third motor and other materials to control the vehicle's buoyancy in order to descend and rise vertically in water.

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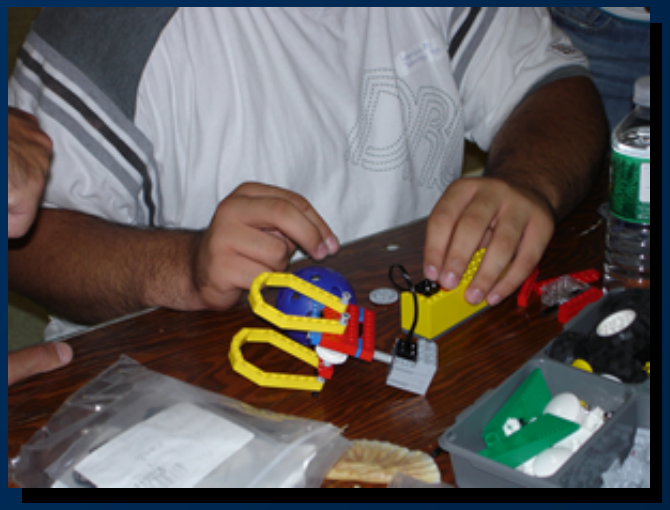
Task 4 – Grabber Challenge

- Design a motorized mechanical manipulator which can grasp specified objects; build an electrical control system which uses 4 switches to control 4 motors; each switch must have 3 positions (forward, backward, off).



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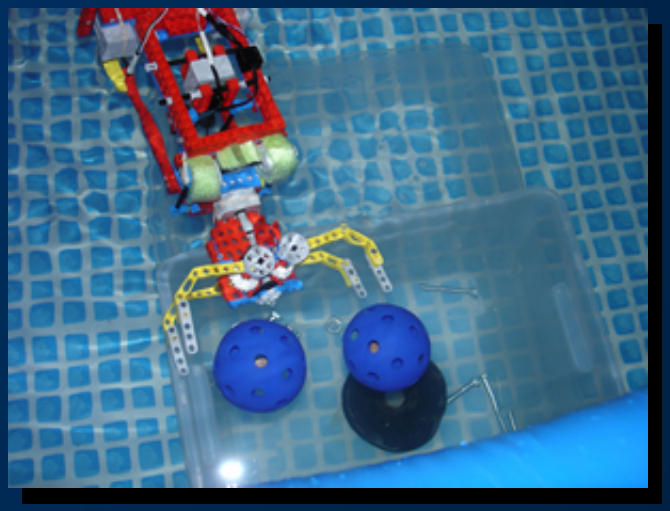
Task 5 – Final Challenge

- Produce a vehicle that can retrieve the greatest number of objects from the bottom of the pool within a specified period of time.
- Objects must be deposited in bins at various depths in the water to score points.



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Key Concepts, Skills

Buoyancy	Density
Newton's Laws	Momentum
Gear Ratios	Energy
Torque	Forces
Volume	Mass-Weight Distribution
Simple Machines	Programming
Iterative Design	Teaming
Systems Thinking/Engineering	Distributed Design Teams

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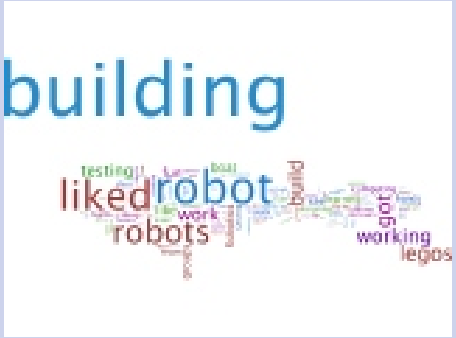
Boys v. Girls

	Boys	Girls
Middle School		
High School		

Girls in BUILD IT (observational)…

- LEGO provides low project entry threshold—engineering design less intimidating
- Girls less wedded to poor designs than boys; more willing to adopt/adapt designs and learn from others what works well
- Girls' attention to detail in the design, programming

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Research Questions

- Student learning of core concepts
- Knowledge about, attitudes toward engineering
- Impact of pedagogical strategies embedded in the curriculum, including hands-on learning and group work
- Gender differences in above

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ITEST

- *STEM learning and motivation as they lead to STEM workforce development, participation and improvement*.
- Emphasizes **design**, **implement, and synthesize** components of DRL Cycle
- How motivation relates to preparation and participation.
- LOI ~ February; Full proposal ~ mid-April

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ITEST

- Improving STEM workforce and building students' capacity to participate in it
- Grades K-12, all areas of the STEM workforce, emphasis on technology-related areas
- Capturing and establishing reliable knowledge base about dispositions toward and knowledge about STEM workforce skills among U.S. students

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ITEST Products

- Strategies that encourage K-12 students to be intellectually prepared for careers in information technology and STEM fields and to consider careers in those fields.
- Strategies that equip teachers (and providers) with resources to ensure students consider and are prepared for STEM workforce.
- Research tools and findings to build knowledge base about approaches, models, and interventions with K-12 aged children and teachers that are most likely to increase US capacity in the STEM workforce, including ICT fields.

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Scale Up Projects

- Implement and test models about preparing students for information technology or the STEM workforce in a large-scale setting such as a state or national level based on evidence of demonstrated success.
- Especially interested in projects that target students who are underserved and underrepresented in STEM ICT-intensive careers, including those residing in rural and economically disadvantaged communities

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Scale Up Projects

- Evidence from previous projects or related theoretical and empirical evidence…
- Provide new evidence of the feasibility or impact of implementing the models on a broader scale
- Address question of whether models and programs that have proven effective locally can be extended to wider implementation

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Scale Up Projects

- Enactment of interventions whose efficacy has already been established in new contexts (to produce) positive impacts in larger, more diverse populations
- May involve scaling up ideas (broaden original conceptual focus) or scope of implementation (obtain quantitative change in the number and types of people involved…), or both
- Provide systematic evidence that the proposed innovation would broaden (it) to new settings.

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Info on NGCP Program Models

- Direct services to girls or turnkey trainer or ??
- Middle school or high school grades or both?
- Duration of programs: < 30 or > 30 hours?
- Equipment (see equipment list)
- Fee-based or grant funded or both?
- STEM background of leaders/instructors?
- Ability to do data collection? How?
- Key elements of successful programs?
- Important NGCP/partner research questions?

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Next Steps

- Synthesize, summarize
- Gather additional information
- E-mail distribution list
- Work toward proposal development

www.stevens.edu/ciese

www.stevens.edu/ciese.org/buildit/

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