Teaching & Catalyzing Innovation in the Vertically-Integrated Projects Program

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What is Innovation?

“The development of novel products, services, and processes for the benefit of society” (NSF)

“Inspiration plus Execution”

Why is it Important?

Innovation Creates Wealth
Exercises Processes and Ideals Worth Preserving
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The Role of Universities?
  – Research: Idea Generation
  – Education: Knowledge, Skills
  – Service: Commercialization

What is Missing?
  – Integration
  – Everyone can Participate
  – New Pathways
  – A Pervasive Culture of Innovation
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The VIP Goal: Foster Innovative Thinking & Entrepreneurial Behavior by Involving Students in Challenging Projects.

Ensure Success by Providing the Necessary:

- **Time**
- **Context**
- **Mentoring**
Students need Real Projects in which they Learn the Innovation Process

Research and Development Efforts Need Help at all Levels of Innovation
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VIP Program Architecture

- Long-term, Large-scale Research/Design Projects:
  - Large teams: 10-20 undergraduates; 1-4 grad students
  - Long-term participation – up to 3 years for each student
  - Sophomores through seniors on each team
  - New students replace those who graduate
  - Teams continue for many years
  - Academic credit each semester
  - Senior design credit an option

- Challenging, Real-World Projects
Example – The eStadium Project

• 12-year old project:
  – CIRE at GaTech
  – Partnership with GaTech Athletics
  – Support of GaTech RNOC/OIT

• R&D in wireless networks
  – Wireless sensor network research, design and deployment
  – WiFi, 3G, 4G network design, optimization, and deployment
  – Infotainment, user studies and application development

• Industry Involvement: Cisco, National Instr., Texas Instr.
• 8 conf. papers; 5 journal articles; Deployed Systems!
• Deployed Systems!
The eStadium VIP Team at Georgia Tech (F’10)
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eStadium Web-Apps Sub-Project

On your smartphone during a game: http://estadium.gatech.edu
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eStadium Wireless Sub-Project

- WiFi Mesh to Connect to Parts of the Stadium without Wired Access
- 802.11a Backbone; b,g,n for Fan Access
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eStadium Wireless Sub-Project
A WiFi Mesh Node
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Sensor Net Sub-Project:
- Few wired gateways
- Many sensor motes
- Multi-hop architecture
- 6-month football season
- Supports many applications

Sensing Tasks:
- Vibration, Audio, Images
- Sensors vary node-to-node
- Processing tasks differ
- Energy varies node-to-node
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Structural Vibration Monitoring at Stadium
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Sensors and Sensor Nets in eStadium

Accelerometer and Signal Conditioning Board

Vibration Sensor Connected to Wireless Sensor Node

2/23/13
Structural Vibrations ↔ Events in a Football Game

- Touchdown by Miami
- Advertisement on the big screen
- Introducing 1990 national champion team + half time show
- Introducing GT fans
- Touchdown by GT
- Touchdown by Miami
- "Make some Noise"
- Half-time break
**Research**: Collecting a Packet from Each Node in a Hexagonal Sensor Cluster – Communication Energy vs Delay

![Graph showing communication energy vs delay for different numbers of hops (k). The graph includes multiple curves for various values of k, with labels k=1, k=2, k=3, k=4, k=5, and k=6. The graph is labeled with $a=200$, $\lambda_R=1$. The notation k = Number of Hops in the Cluster.](image-url)
Georgia Tech VIP Teams

- **eStadium (GT/Purdue/OSU/Morehouse)**
  - CEE, CS, CM, CEE, ECE, MGMT, Law
  - Wireless, Multimedia, Sensor Nets, etc

- **eDemocracy**
  - CS, ECE, ISyE, INTA
  - Election Monitoring System, Redistricting, Policy, etc

- **Collaborative Workforce**
  - CS, ECE
  - Multimedia Content; Collaboration Tech.; etc

- **Intelligent Tutoring Systems**
  - CS, ECE, ISyE
  - Learning Theory, Databases, GUIs, Ontologies, etc
Georgia Tech VIP Teams

- **GTRI Robotics Team**
  - CS, ECE, ME
  - Design and develop robot/unmanned systems

- **eCampus**
  - CS, ECE
  - Wireless, Mobile Apps, Databases, GUIs

- **Computational Structural Biology**
  - BIO, ChBE, CS, Physics
  - Macromolecular Simulations, Algorithms, etc.

- **BioBots**
  - BIO, BME, ChBE, ECE, ME, Physics
  - Create microrobots that can traverse biological barriers
Georgia Tech VIP Teams

- **USLI Rocket Team**
  - AE, ECE
  - Rocket design, instrumentation, construction and flight

- **Intelligent Transportation Systems**
  - CS, ISyE
  - Optimal control of transportation fleets; Tech Trolley

- **I-Natural**
  - CS, ECE, ME
  - Design of robots that interact with people

- **Brain Beats**
  - BME, CS, ECE, ME
  - Neural basis of human ability to maintain “rhythmic time”
Georgia Tech VIP Teams

- **AquaBots**
  - CEE, CS, ECE, ME
  - Underwater/surface vehicles, map/explore underwater

- **Open Academic Environment**
  - CS, ECE, IC, CM
  - Web tools supporting learning & research collaborations

- **RoboBoats (New for Spring 2013)**
  - ECE, ME, CS, MGMT
  - Design of autonomous coordinated fleets of ships

- **Physics MOOCs (New for Spring 2013)**
  - Physics, ECE, CS, MGMT
  - Create tools for inquiry-based intro physics courses.
Growth and Dissemination of VIP

Disciplines of Faculty and Students in VIP at GT:
- Engineering: AE, BME, CEE, ChBE, ECE, ISyE, ME
- Computing: CS, CSE, CM
- Science: Biology, Physics
- Liberal Arts: CM, Public Policy
- MGMT+Law: via TI:GER Program

Universities with VIP Programs:
- Purdue University: 25 VIP Teams
- Morehouse College: 2 VIP Teams
- Univ. of Strathclyde, Glasgow, UK: 5 VIP Teams
- National Ilan Univ., Ilan, Taiwan: 6 VIP Teams
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Univ. of Strathclyde’s VIP Teams

- **Systems Biology of Polarized Growth**
  - BIO, ECE, Math
  - Automated eval of genetically manipulated antibiotics

- **TextLab**
  - CS, English
  - Computational Analysis of English literary works

- **Building Strathclyde’s Enterprise Community**
  - MGMT
  - Match MGMT students with new enterprises

- **Sustainable Energy for Development**
  - ECE (initially)
  - Long-term energy system evolution for dev. countries
Univ. of Strathclyde’s VIP Teams

- Microfluidic Nano-Medicine for Cancer Research
  - BIO, Chemistry, Engineering
  - Cancer treatments based on microfluidics/lab-on-a-chip
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