Systemic Reform of Higher Education: The Vertically Integrated Projects (VIP) Program and Consortium

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What is Innovation?

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

“Inspiration plus Execution”
(Works in all Disciplines!)
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The Barriers: 3 Forms of Fragmentation

– By Mission
  • **Research**: Exploration, Idea Generation
  • **Education**: Knowledge, Skills
  • **Service**: Partnerships, Economic Development

– By Time
  • Semesters, Academic Years

– By Discipline
  • Budget Lines, Culture
The VIP Approach: Foster Innovation by Involving Students in Challenging Projects Embedded in Faculty Research

Ensure Success by Providing the Necessary:

**TIME**

**CONTEXT**

**MENTORING**
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Bringing People Together

Undergraduate Students

Faculty can Benefit from Help at all Levels of the Innovation Process

Students need Real Projects in which they Experience the Innovation Process

NSF
VIP Program Architecture

• **Long-term, Large-scale Projects:**
  - Projects led by faculty; embedded in their research
  - Large teams: 10-20 undergraduates; 1-4 grad students
  - 2nd year through 4th year students on every team
  - Long-term participation – up to 3 years per student
  - New students replace those who graduate
  - Teams continue for years, decades
  - Academic credit each semester
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The Stadium-IoPT VIP Team: In Operation for 16 Yrs
Football Game at Bobby Dodd Stadium, the Stadium-IoPT Team’s Internet of Things (IoT) Testbed
People + Information: In-Stadium Web-Apps:

Video clips, stats, tracker on your phone during a game: http://estadium.gatech.edu
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Stadium-IoT Wireless: **Baseball Stadium**

- WiFi–Mesh for easy installation in old stadiums
- 802.11a Backbone; b,g,n for Fan Access
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Stadium-IoT Wireless Sub-Project

A WiFi Mesh Node: 3 APs per node

One 802.11a Backhaul; Two 802.11b,g,n for Fans
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Sensor Net Sub-Project:
- Many sensor motes
- 6-month football season
- Supports many applications

Sensing Tasks:
- Vibration, Audio, Spectrum
- Sensors vary node-to-node
- Processing tasks differ
- Energy varies node-to-node

WSN NODE
SENSOR
INSIDE A NODE
MSP-430, CC-2520, BATTERIES
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RF Sensor Node and Vibration-Net Clusterhead on top of Concessions Area in North Stands
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Sensor Net Architecture

- 40~50 Sensor Motes
- 10~12 ClusterHeads
- Cognitive Radio Backhaul
- <125μsec Synchronization
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Structural Vibration Monitoring at Stadium
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Structural Vibrations ⇔ Events in a Football Game

- Touchdown by Miami
- Advertisement on the big screen
- Half-time break
- "Make some Noise"
- Introducing 1990 national champion team + half time show
- "Make some Noise"
- Introducing GT fans
- Touchdown by GT
- Touchdown by Miami

Graph showing acceleration in g over time in seconds.
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Georgia Tech VIP Teams: Fall 2017

• 55 Teams; 790 Undergraduates Enrolled

• Students and Faculty from Every GT College: Architecture, Business, Computing, Engineering, Liberal Arts, and Science

• List of GT VIP teams. Click on any team’s icon to see a one-page description of that team and the list disciplines from which that team is seeking students:

  http://www.vip.gatech.edu/teams
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VIP Enrollment by Semester at Georgia Tech, 2009-17
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UG Enrollment by Academic Rank, Fall 2017

- Freshman: 4 (1%)
- Sophomore: 158 (20%)
- Junior: 269 (34%)
- Senior: 358 (45%)
Disciplines of VIP Advisers and Co-advisers, Fall 2017
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VIP Course Structure

VIP-X60Y

- X = Year: 2=Soph; 3=Junior; 4=Senior
- Y = Credits: 0, 1, 2, or 3 (0 is for-pay; others for-credit)
- Each course can be taken multiple times
- Currently: 2601 -- 3601, 3602 -- 4601, 4602, 4603
- 4813 for Senior Design, Project, Thesis, …
- Each team is one section of every course
- No Auditors, Volunteers, or P/F Students
- Available to all Disciplines
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One Model for How VIP Credits Count

**Incentive to Participate Multiple Years**

- **Take 5 or fewer credits:**
  - All are Approved-Elective (Free-Elective) Credits

- **Take 6+ credits:**
  - 3 to 6 Become Technical Elective Credits
  - Rest are Approved-Elective (Free-Elective) Credits

**VIP + VIP Senior Design: 8+ Credits**

- 3+ Credits as a Junior
- 2 Credits (4811) 1st-Semester Senior Year
- 3 Credits of VIP Senior Design (4813)
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Access and Diversity

• Credit bearing + counts toward degrees: Enables *all* students to participate

• Joining teams:
  No interviews; No GPA requirements; No prerequisites

• Unique among High-Impact Programs:
  %URMs in VIP = % in overall student population.

• High Participation amongst Transfer Students
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Assessment

• Ongoing Study of Learning Outcomes and Impacts on Faculty, Depts, and Institutions.
  – Eval. Teams at Boise State, Georgia Tech, Univ. of Michigan

• Institutional Research:
  • Ability to work in a multidisciplinary team ($t(1982) = 4.437, p < 0.001, d = 0.313$);
  • Ability to work with individuals from diverse backgrounds ($t(1987) = 3.271, p = 0.001, d = 0.231$);
  • Understanding of technology applications relevant to your field of study ($t(2002) = 3.19, p = 0.001, d = 0.224$);
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Assessment (cont.)

• Social Network Analysis of VIP Teams:
  – Peer Evaluation Tool Used for Grading Twice a Semester
  – Students Indicate Who/How-Often They work with Each Peer
  – Linked with VIP Database of Students + Registrar’s Database
  – Enables Monitoring of Teams Health
  – Helps Identify Best Practices in Team Management for Advisers
  – EI Index Computed for Populations of Interest
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Perfect Heterophily:
Interact only with dissimilar classmates

Perfect Homophily:
Interact only with similar classmates

- Race/Ethnicity
- Major
- Sex
- Domestic/International

X = Mean
Shaded Areas = Middle Quartiles
Lines = Upper and Lower Quartiles
VIP: Benefits to all Students

• Realistic Team Experience
• Opportunity to Learn/Master different Roles/Skills
• In-Depth Experience in their Field
• Authentic Multi-Disciplinary Experience
• Knowledge Exchange across many Boundaries
• Provide a Compelling Reason to be on Campus
• Preparation for Work / Grad School
• Understanding of the Innovation Process
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VIP: Benefits to Universities

- Enhances Student Learning
- Enhances Faculty Research
- Enables New Partnerships
- Creates Multidisciplinary Opportunities
- Compelling Reason to have a Campus
- Everyone Participates in Innovation
- Deepens/Broadens the University Community
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The VIP Consortium …. So Far:

- Arizona State Univ.
- Boise State Univ.
- Colorado State Univ.
- Florida International U.
- Georgia Tech
- Howard Univ.
- Inha Univ.
- Morehouse College
- Natn’l Dong Hwa Univ.
- New York University
- Purdue University
- Rice University
- Riga Technical Univ.
- Texas A&M Univ.
- Universidad del Norte
- UC Davis
- Univ. of Pretoria
- Univ. of Delaware
- Univ. of Georgia
- Univ. of Hawaii
- Univ. of Michigan
- Univ. of Strathclyde
- Univ. of Washington
- VA Commonwealth Univ.

Pending:
- Drexel Univ.
- Georgia State
- Malmö Univ.
- Notre Dame
- Tuskegee Univ.
- UC Riverside
- Virginia Tech

Legend
- Non-US University
- URM Serving Univ.
- State of Georgia
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Annual VIP Consortium Meeting
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VIP Sites by Wave, Campus Size, Number of Departments from which Instructors Drawn
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Essential Characteristics of VIP

• VIP Program Led by Faculty
• Projects embedded in Professors’ Research Efforts
• Large-Scale Projects Lasting Years/Decades
• Multidisciplinary Teams Possible/Encouraged
• Program is Curricular; All Students Graded
• Incentives for Students to Participate for 2+ Years
• Classroom and Meeting Space Supporting Teams
• Learning Outcomes Include Development of both Disciplinary and Professional Skills
VIP Consortium Characteristics

• All Institutions Have a Professor-Led VIP Program
• Program Must Have Essential Elements of VIP but Adapt to Local Conditions
• Share Resources/Tools/Processes/etc.
• Everyone Contributes What They Can
• Participation in Evaluation and Dissemination
• Publish Papers and Write Proposals Together
What could you do if you had a VIP team?

http://vip.gatech.edu

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