Vertically Integrated Projects
Project-Based Learning that Serves Faculty, Students, Institutions, & Society

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VIP Teams at GT: http://vip.gatech.edu/teams
Stakeholder’s Needs
Needs of Education Institutions

Need scalable and affordable high impact experiences

Need better gains for African American & Hispanic Students
Needs of Employers, Gov’t, Start-Ups, etc

Need Wide Knowledge Base and Deep Expertise

Need Collaboration & Leadership Skills

Need Agility, Adaptability, Resilience
Needs of Faculty and Students

**Faculty Needs**
- Ambitious, multidisciplinary projects that benefit research
- Access to Expertise from other Disciplines

**Student Needs**
- Faculty mentors
- Interesting projects
- Connect coursework with real world
- Have a Purpose/Goal

**Possible Solution:** Undergraduate Research & Design
Problem: *Traditional* Undergrad Research/Design can not be scaled in an Affordable Way

- Faculty can’t mentor many students in apprentice-style research or senior capstone teams.
- Paid experiences are cost-limited.
- Course-based Undergraduate Research (CURE) requires planning, time and resources.
Solution: Vertically Integrated Projects (VIP)
The VIP Model

Faculty lead large student teams
Teams embedded in faculty projects that last many years
10-20+ students/team
Vertically integrated, multidisciplinary teams

Curricular
1-2 credits each semester
Letter grades

Students return for multiple semesters
Returning students:
- Mentor new students
- More responsibility
- Help manage

Team Listings: https://vip.gatech.edu/teams
Results of the VIP Model

Time for Students to Learn, Contribute, Lead

Long-Term, Large-Scale, Ambitious Projects

Peer-to-Peer Learning, Mentoring, Leadership
Multidisciplinary by Nature

Fall 2021 VIP Teams at Georgia Tech
Scalable & Sustainable

VIP Enrollment History: Spring 2009 – Spring 2022

1504 students, Spring 2022

Nominal costs

Faculty benefit from their team, stay engaged

Students want to participate

VIP Student-Faculty ratio ≈ Campus Student-Faculty

Vertically Integrated Projects Program
VIP Scales and is Affordable: STEM Participation

Atlanta Campus, AY 2022
Use options to the right to filter by college and major

VIP Participant 32%

By College, AY 2022
% of Total Distinct count of GTID

- College of Computing
- College of Design
- College of Engineering
- College of Sciences
- Ivan Allen College
Impact

Collaborative Unmanned Aerial Vehicles
Virginia Commonwealth University

Flight control systems (autopilots)
Algorithms and artificial intelligence to control teams of UAVs
Higher Job Placement for VIP Participants

GT Career Exit Survey

Job Placement Prior to Graduation

- Overall: 72.6% (Non-VIP) vs. 78.8% (VIP)
- Co-op participant:
  - Non-VIP: 50% (not shown)
  - VIP: 80% (not shown)
- No Co-op participant:
  - Non-VIP: 60% (not shown)
  - VIP: 90% (not shown)
Higher Job Placement for VIP Participants

GT Career Exit Survey

Substantial difference among non-Co-Op students (8.1% higher)

Job Placement Prior to Graduation

- Overall
  - Non-VIP: 72.6%
  - VIP: 78.8%
- Co-op participant
  - Non-VIP: 67.3%
  - VIP: 83.7%
- No Co-op
  - Non-VIP: 75.4%
  - VIP: 85.8%
Campus-level Inequity in Job Placement

Job placement for comparison groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Job Placement Prior to Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>URM</td>
<td>69.7%</td>
</tr>
<tr>
<td>Asian</td>
<td>70.3%</td>
</tr>
<tr>
<td>White</td>
<td>76.1%</td>
</tr>
</tbody>
</table>
No Inequity among VIP Participants

- Gains for all races/ethnicities
- Compensatory gains for URM & Asian students
- Representative enrollment of URMs in VIP
- **Not published** digging deeper to understand

![Job Placement Prior to Graduation](chart.png)

<table>
<thead>
<tr>
<th>Race</th>
<th>Non-VIP</th>
<th>VIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>URM</td>
<td>69.7%</td>
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</tr>
<tr>
<td>White</td>
<td>76.1%</td>
<td>78.0%</td>
</tr>
</tbody>
</table>
Professional Skills

Ability to work with individuals from diverse backgrounds
Interact more often with students of other races/ethnicities

Ability to work in multidisciplinary teams
Interact more often with students from other majors

Understanding of technologies relevant to their field

Leadership & Technical Growth
Growth in Organizational Leadership Skills

Coordination of team’s work *as reported by peers*
Growth in Technical/Content-Area Leadership

Role as technical/content area leaders as reported by peers
Establishing a VIP Program

Aircraft for Rhino & Environmental Defense
University of Pretoria

Drone identifies and follows poachers
Sends information back to ground troops
Key Elements of VIP

1. Projects are embedded in faculty mentors’ research, creation and exploration.
2. Projects are long-term and large-scale, continuing for many years, even decades.
3. Program is curricular and all participating students are graded.
4. Students can participate and earn credits toward their degrees for 2+ years.
5. Learning outcomes focus on both disciplinary and professional skills.
6. Multi-disciplinary teams are encouraged but not required.
7. Dedicated classroom and meeting spaces.
8. Faculty/student participation is based on mutual interest
People
Recruit Instructors

• **Voluntary**

• **Selling points**
  • Easy access to students from other departments
  • Enables larger-scale longer-term projects that benefit research
  • Low-risk setting to try new ideas
  • “Broader impacts” and educational components for proposals

• **Low Hanging Fruit**
  • Faculty working with undergrads; Need students from other majors

• **Team information sheet (goals, methods, majors, etc.)**
  • Project must last 3 or more years
  • Project description general enough to last multiple years; Updates over time
Release Time

• **VIP Director**
  • Lighter teaching loads: 1 course per year
  • Heavy teaching loads: 1 course per semester

• **Models for Instructors**
  • 1 course per academic year for first 2 years, OR
  • 1 course per academic year, ongoing, OR
  • 1 course per academic year for first 2 years + Capstone-like credit beyond, (best model), OR
  • No release time
    • Advances faculty research
    • Not an option at institutions with heavy teaching loads
Faculty Stay Engaged

Morris Cohen
VIP Instructor
Fall 2014 – Present

Lightening from the Edge of Space

Team Activity Over Time

Vertically Integrated Projects Program
Student Recruiting, Selection & Equity

- Enthusiasm is the strongest predictor of student success
  - Do not screen by GPA
  - No interviews, No recommendations, No resumés

- Equity
  - Representative enrollment of black/African American & Hispanic/Latino students
  - Return for 2nd, 3rd and subsequent semesters at the same rate regardless of race/ethnicity

- Aspects supporting equity
  - Allowing VIP to fulfill degree requirements
  - Online team listings
  - Rolling application process
  - Low stress application
  - Proactive recruiting
Courses & Curricula
Find or Create Courses for VIP

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Junior</th>
<th>Senior</th>
<th>Graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course #</td>
<td>2601</td>
<td>2600</td>
<td>3601</td>
</tr>
<tr>
<td>Credits</td>
<td>1</td>
<td>Pay</td>
<td>1</td>
</tr>
<tr>
<td>Section, team 1</td>
<td>VP1</td>
<td>VP1</td>
<td>VP1</td>
</tr>
<tr>
<td>Section, team 2</td>
<td>VP2</td>
<td>VP2</td>
<td>VP2</td>
</tr>
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- Campus-wide subject code for VIP at GA Tech: VIP-2601 through VIP-6603
- Each course can be taken multiple times
- Teams identified by Section Number: VP1 or VP2
Grading Framework

Grading Components:
- Teamwork
- Contributions
- Documentation

Grading middle and end-of semester

Observations
- Peer Evaluations
- Individual Notebooks
- Team Documentation
Navigate Enrollment Management

• Each team needs
  • Balance of different majors
  • Balance of academic ranks
  • Enough space for returning students

• Require registration permits
  • Students apply
  • Once approved, VIP issues the permit
Department Policies: How Credits Count Affects Return-Rates

Student Persistence by Policy

- Free Elective No Minimum Req.
- Technical Elective No Minimum Req.
- 3 Free Elect, 3 In-Major 6 Credit Minimum
- JR Design Option No PreReq

Effective Policy Models

• Threshold policy
  • 5 or fewer VIP credits = free electives
  • 6 or more VIP credits = in major electives (or a mix of in-major and free)

• Allow VIP to roll into capstone

• Allow VIP to fulfill a multi-semester design sequence
  • Example: GA Tech CS Junior Design sequence, 3-semesters, 5 credits total
Can We Make Space in the Curriculum?

The Traditional Curriculum is like a Space Filling Curve

Can we add a Vertically Integrated Pathway

Vertically Integrated Projects Program
Community & Resources

Bits of Good
GA Tech

Extension of a student club
Develop software for on-profit organizations
VIP Consortium – 43 Institutions, 6 Continents

“As we enjoy great advantages from the inventions of others, we should be glad of an opportunity to serve others by any invention of ours; and this we should do freely and generously.”

Benjamin Franklin
43 Consortium Institutions

**South America**
- Universidad de Chile
- Universidad del Norte
- Universidad ICESI
- Universidad Mayor
- Universidade Estadual de Campinas

**Europe**
- Malmö University
- Riga Technical University
- Riga Stradiņš University
- University of St. Andrews
- University of Strathclyde

**Asia**
- Inha University
- National Dong Hwa University
- National Taiwan University

**Middle East**
- American University of Beirut
- Lebanese American University
- The American University in Cairo

**United States**
- Arizona State University
- Boise State University
- Colorado State University
- Drexel University
- Georgia Institute of Technology
- Georgia State University
- Howard University
- Iowa State University
- Kennesaw State University
- Morehouse College
- NYU Tandon School of Engineering
- Polytechnic University of Puerto Rico
- Purdue University

**Africa & Australia**
- Rice University
- Stony Brook University
- Texas A&M University
- The Cooper Union
- University of Arizona
- University of California Davis
- University of Delaware
- University of Georgia
- University of Hawaii
- University of Michigan
- Virginia Commonwealth University
- Virginia Tech
Howard ABET site visit

- “[Teams] offer early exposure to the design process. In addition, students benefit from informal mentoring from seniors and graduate students on the teams. This program greatly enhances the engineering experience for the students.”
- “This program demonstrates true multi-disciplinary team work experiences, enables peer learning and support, and develops leaders in the engineering students.”

NYU site visit

- ABET chair announced the number one institutional strength for NYU was a focus on interdisciplinary and experiential learning opportunities demonstrated by VIP.

2019 ABET Innovation Award
VIP Consortium Activities – Annual Meeting

• VIP Site Handbook (under development)
• Grading and Peer Evals Tools in the Cloud
Benefits to Partners of Project Teams

- Work with Motivated, Team-Oriented Students
- Early Recruiting of Students for Internships & Permanent Jobs
- Diverse Backgrounds and Majors
- Doing real R&D work in Area of Partner’s Interest
## Opportunities for Industry to Support Teams

<table>
<thead>
<tr>
<th><strong>Student Activities Support (20K/year)</strong></th>
<th>Company/team interactions tailored to fit mutual interests (100% of funding goes to students)</th>
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<tbody>
<tr>
<td>(per team)</td>
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</table>

<table>
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<tr>
<th><strong>Program Activities Support (40K/year)</strong></th>
<th>Logo on website; invites to annual poster sessions, meet &amp; greet for company representatives</th>
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| **Sponsor (50K/year) of**               | Prominent recognition at and participation in annual Innovation Competition or Consortium Meeting; logo on website; invites to poster sessions; meet & greet for company representatives |
| **Annual Innovation Competition**       |                                                                                               |
| **or**                                   |                                                                                               |
| **Annual Consortium Meeting**           |                                                                                               |
Questions?

- Key Websites:
- List of VIP@GT Teams: [http://vip.gatech.edu/teams](http://vip.gatech.edu/teams)
- List of VIP@NYU Teams: [https://engineering.purdue.edu/VIP/teams](https://engineering.purdue.edu/VIP/teams)
- VIP Consortium Webpages: [https://www.vip-consortium.org/](https://www.vip-consortium.org/)

Purdue: Quantum Integrated Photonics VIP Team