The Vertically Integrated Projects (VIP) Program and Consortium:
Enabling Everyone to Work Together

Director: Ed Coyle
Assoc. Director, VIP Consortium: Kitty Vogt
Asst. Director: Julie Sonnenberg-Klein
Program Manager: Chris Malbrue
Goal: Involve *Everyone* in Scholarship and Exploration

Scholarship and Exploration

- **Scholarship**: Development of Deep Knowledge and Expertise in One or More Fields
- **Exploration**: Acts of Discovery, Design, Creativity, Innovation, Research in One or More Fields
- Present in all Academic Disciplines!
Barriers: The 3 Forms of Academic Fragmentation

Fragmentation By Time
- Primarily affects Undergraduates
- Semesters; Academic Years

Fragmentation By Mission
- Primarily affects Faculty and Staff
- Exploration / Scholarship / Outreach

Fragmentation By Discipline
- Affects Everyone
- The “Thinkings,” Budget Lines, Culture
Barriers: The 3 Forms of Fragmentation

**Fragmentation By Time** 1995

VIP 1.0: Engineering Projects in Community Service (EPICS)
First Vertically Integrated Project (VIP) Teams: Focused on the Community

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First Vertically Integrated Project (VIP) Teams: Design for the Community

**Fragmentation By Mission** 2001

VIP 2.0: Vertically Integrated Projects (VIP) in ECE
VIP Teams embedded in Faculty Scholarship and Exploration in ECE

**Fragmentation By Discipline**

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The “Thinkings,” Budget Lines, Culture
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VIP 1.0: Engineering Projects in Community Service (EPICS)
First Vertically Integrated Project (VIP) Teams: Design for the Community

**Fragmentation By Mission** 2001

VIP 2.0: Vertically Integrated Projects (VIP) in ECE
VIP Teams Embedded in Faculty Scholarship & Exploration in ECE

**Fragmentation By Discipline** 2009

VIP 3.0: Vertically Integrated Projects Program and Consortium
Multidisciplinary VIP Teams embedded in Faculty Scholarship & Exploration
The VIP Approach: Integrate Scholarship & Exploration

Foster Scholarship & Exploration by Involving Students in Challenging Projects Led by Academic Staff

Ensure Success by Providing:

- Time
- Context
- Mentoring
VIP: Bringing People Together

Students need Real Projects in which they *Participate* in Scholarship and Exploration.

Faculty can Benefit from *Help* in all Aspects of Scholarship and Exploration.
VIP Program Architecture: The Basics

Enable Long-Term, Large-Scale, Multidisciplinary Teams

- Project teams led by faculty; embedded in their S&E activities
- Large teams: 10-20+ undergraduates; 1-4 grad students
- 2nd through final year undergraduates students on every team
- Long-term participation – up to 3 years per student
- New students replace those who graduate
- Students drawn from all disciplines needed by the project
- Teams continue for many years
- Academic credit and grades each semester
Example: The 19-year-old Stadium-IoPT Team
The Stadium-IoPT Team’s Testbed: Bobby Dodd Stadium
The Stadium-IoPT System as of 2019

http://estadium.gatech.edu
Stadium-IoPT: Sensor Net Subproject

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

Sensor Net Sub-Project:
- Many sensor motes
- 6-month football season
- Supports many applications
Stadium-IoPT: Sensor Net Subproject
Stadium-IoPT: Sensor Net Subproject
Stadium-IoPT: Sensor Net Subproject

- 40~50 Sensor Motes
- 10~12 ClusterHeads
- Cognitive Radio Backhaul
- <125μsec Synchronization
Stadium-IoPT: Sensor Net Subproject

Sensing Vibrations
Stadium-IoPT: Game Vibrations

- Touchdown by Miami
- Advertisement on the big screen
- Half-time break
- "Make some Noise"
- Introducing 1990 national champion team + half time show
- Touchdown by GT
- Touchdown by Miami
Georgia Tech VIP Teams: Spring 2020

• 81 Teams; 1300 Undergraduates Enrolled

• Students and Faculty from all colleges: Business, Computing, Design, 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
VIP@GT Enrollment: Spring 2009 - Spring 2020

| Year       | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring | Fall   | Spring |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 2009-2010  | 26     | 49     | 33     | 78     | 96     | 106    | 135    | 165    | 163    | 168    | 196    | 280    | 295    | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2011-2012  | 106    | 135    | 165    | 163    | 168    | 196    | 280    | 295    | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2012-2013  | 165    | 163    | 168    | 196    | 280    | 295    | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2013-2014  | 168    | 196    | 280    | 295    | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2014-2015  | 196    | 280    | 295    | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2015-2016  | 280    | 295    | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2016-2017  | 295    | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2017-2018  | 374    | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2018-2019  | 484    | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |
| 2019-2020  | 513    | 640    | 790    | 910    | 956    | 1103   | 1118   | 1292   |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
VIP Enrollment Spr 2020: Team Size + Majors

The graph illustrates the enrollment in VIP projects by major and team size for Spring 2020. The x-axis represents SectionNumber, and the y-axis shows the Count of students. Each bar in the graph corresponds to a major, with different colors representing various fields of study. The graph visually displays the distribution of students across different sections and majors, highlighting the diversity in enrollment across the VIP program.
VIP Enrollment by College & Team

Vertically Integrated Projects Program
Cross-Campus Collaboration, GT

1/3 of VIP teams draw instructors from more than one GT Unit.
VIP Team Composition: By Academic Rank, Spr 2020

- SR, 520
- JR, 420
- SO, 263
- MS, 41
- DR, 18
- SU, 11
- FR, 18
VIP Enrollment: By Major, Spring 2020

CS, 453
CMPE, 84
EE, 90
MTH, 16
BA, 11
ID, 9
MSE, 9
BCHM, 9
PUBP, 7
PHYS, 19
BIO, 24
CHBE, 25
CE, 25
ENVE, 36
AE, 40
IE, 67
BMED, 74
ME, 135
CM, 25
ID, 9
SPEC, 11
NEUR, 14
IAML, 8
Instructors & Co-Instructors by College & Department, Spring 2020
### VIP@GT Course Structure: Campus-wide Courses

<table>
<thead>
<tr>
<th></th>
<th>1 credit</th>
<th>2 credits</th>
<th>3 credits</th>
<th>For pay (0 credits)</th>
</tr>
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<tbody>
<tr>
<td>2nd Year</td>
<td>VIP 2601</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Year</td>
<td>VIP 3601</td>
<td>VIP 3602</td>
<td>VIP 3603 by dept. request</td>
<td>VIP 3600</td>
</tr>
<tr>
<td>4th+ Year</td>
<td>VIP 4601</td>
<td>VIP 4602</td>
<td>VIP 4603 by dept. request</td>
<td>VIP 4600</td>
</tr>
<tr>
<td></td>
<td>VIP 6601</td>
<td>VIP 6602</td>
<td>VIP 6603</td>
<td>VIP 6600</td>
</tr>
</tbody>
</table>

- Each course can be taken multiple times
- Each *team* is one section of *every* course
- Available to all Disciplines
Evaluating the Performance of VIP Students

- Grading Process: Middle and End of Each Semester
  - Every Student Graded A, B, C, D, F / Other Scales Possible
  - No P/F, No Auditing, No Volunteers

- Peer Evaluations – Specific to VIP (CATME not a good fit)

- Three Components in Grading:
  - **Documentation**: Journals, Wiki, GitHub, Presentations, Reports, ...
  - **Individual Contributions**: Judged by Team Advisers
  - **Teamwork**: Observations plus Peer Evaluations
# Vertically Integrated Projects Program

## Grading Interface for Instructors

<table>
<thead>
<tr>
<th>Credits</th>
<th>Class</th>
<th>Major</th>
<th>Semesters</th>
<th>Email</th>
<th>Wiki</th>
<th>Peer Eval</th>
<th>Enter Grades</th>
<th>Release Student Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JR</td>
<td>CMPE</td>
<td>1</td>
<td></td>
<td>Wiki of / by</td>
<td>Edit / View</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>1</td>
<td>SR</td>
<td>CS</td>
<td>2</td>
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<td>Wiki of / by</td>
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<td>CMPE</td>
<td>3</td>
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<td>Wiki of / by</td>
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<td>✓</td>
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<td>2</td>
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<td>Edit / View</td>
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<td>✓</td>
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<td>SO</td>
<td>CMPE</td>
<td>2</td>
<td></td>
<td>Wiki of / by</td>
<td>Edit / View</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>SR</td>
<td>EE</td>
<td>2</td>
<td></td>
<td>Wiki of / by</td>
<td>Edit / View</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Grading Form:

Categories

Documentation
A- Notebook Maintenance
A- To Do Lists
A- Meeting Notes
A- Usability
A- Overall Design Notebook Evaluation
B Wiki Content Quantity
A Wiki Content Quality
  SVN code logged frequently
  Code Quality
A Overall Documentation

Accomplishments and Effort
Tutorials and Learning Modules
Team and sub-team quizzes
Papers and Technical Articles
A Pursues Independent Learning
A- Self Motivated
A Independent Effort
B+ Quality of Effort (results)
A- Overall Effort

Teamwork and Interaction
Team meeting attendance
Team meeting participation
A sub-team meeting attendance
A+ sub-team meeting involvement
A Contributes useful ideas
A Recognizes others ideas
A Focuses effort on achieving goals
B Involves others in effort
A Assists others with their efforts
Manages time and tasks well
B Leadership skills
Final Presentation
Peer Evaluations
A- Overall Teamwork Evaluation
Grading Form: Personalized Feedback

You are an experienced and valuable member of the [blank] subteam. You document things well, help new members start-up, are active in many ways, are knowledgeable, etc. Recently you have started taking a leadership role, which is MUCH appreciated because the team was really drifting -- in part because there was a vacuum after [blank] graduated. I like that you volunteered to meet with your team's customer, the [blank] team.

One area in which you need to improve is how you lead now that you have assumed a leadership role. You need to be more organized and to keep things focused. You have a tendency in discussion to get off track, sometimes never returning to what really needs to be done. To fix this, come into each meeting with a checklist of things that the team needs to focus on and work through it. If you feel you need any help with leadership at any point, ask Randy or me for advice.

Also, please don't make the same mistake that [blank] made, which was to not foster other leaders before leaving.

Overall, you are doing a very good job, so keep working on improving your performance and the team's performance.
Team Structure

- **Team Size:** Avg = 16, Largest = 50, Smallest = 8
- **Almost Every Team has Sub-teams:** Typically 4 to 8 Students
  - Experienced Students are Sub-Team Leads
  - Experienced Students + Advisers Coordinate across Sub-teams
  - Takes 2-3 Semesters for a Team to Build Experience/Structure
- **Need to Understand Team Members’ Interactions**
  - Peer Evaluations
  - Social Network Analysis
<table>
<thead>
<tr>
<th>Question</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often do you interact with each person below?</td>
<td>5 / 5</td>
<td>5 / 5</td>
<td>5 / 5</td>
</tr>
<tr>
<td>2. How often do you get suggestions/advice from each person below?</td>
<td>5 / 4.7</td>
<td>5 / 4.7</td>
<td>4 / 4.7</td>
</tr>
<tr>
<td>3. How often do you give suggestions/advice to each person?</td>
<td>4 / 4.7</td>
<td>5 / 4.7</td>
<td>5 / 4.7</td>
</tr>
<tr>
<td>4. Participation in team meetings/class:</td>
<td>5 / 3.7</td>
<td>4 / 3.7</td>
<td>2 / 3.7</td>
</tr>
<tr>
<td>5. Participation in subteam meetings or breakout discussions:</td>
<td>5 / 4</td>
<td>4 / 4</td>
<td>3 / 4</td>
</tr>
<tr>
<td>7. Quality of work:</td>
<td>4 / 4.7</td>
<td>5 / 4.7</td>
<td>5 / 4.7</td>
</tr>
<tr>
<td>8. Communication:</td>
<td>5 / 4</td>
<td>5 / 4</td>
<td>2 / 4</td>
</tr>
<tr>
<td>10. When encountering obstacles, how does each person react?</td>
<td>5 / 5</td>
<td>5 / 5</td>
<td>5 / 5</td>
</tr>
<tr>
<td>11. Independent Learning:</td>
<td>5 / 5</td>
<td>5 / 5</td>
<td>5 / 5</td>
</tr>
<tr>
<td>12. Team management ability:</td>
<td>5 / 4</td>
<td>4 / 4</td>
<td>3 / 4</td>
</tr>
<tr>
<td>13. Imagine your team is a company and you are the manager. VIP, Inc. has asked you to divide $10,000 in bonus money among the members of your team. EXCLUDING yourself, decide how the bonus should be divided.</td>
<td>4000 / 3333.3</td>
<td>4000 / 3333.3</td>
<td>2000 / 3333.3</td>
</tr>
<tr>
<td>14. Comments: Please leave comments on each person below for your instructor(s). Constructive criticism is especially helpful.</td>
<td>Very passionate about the team.</td>
<td>Very dedicated to learning what is needed for the team. Could participate in discussion more.</td>
<td>Very knowledgeable on the material related to the team. Needs to be more committed.</td>
</tr>
</tbody>
</table>
Social Network Analysis

Arrows Show Direction of Advice/help

Weight of Arrows Shows Frequency of Advice

Size of Circles ~ Sum of Incoming Ratings
How VIP@GT Credits Count: ECE/BME Example

Provide Incentive to Participate Multiple Years

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

● Take 6+ credits:
  ● 3 or 6 of them Become Technical Elective Credits
  ● Rest are Approved-Elective (Free-Elective) Credits

● VIP + VIP Senior Capstone: 8+ Credits
  ● 3+ Credits as a Junior  (VIP-3601/2 then VIP-3602)
  ● 2 Credits (VIP-4602) 1st-Semester Senior Year
  ● 3 Credits of VIP Senior Design (VIP-4813)
ABET + “Senior Design” + VIP

• ABET is NOT a Problem for VIP
  • Can have multiple ways in your department to satisfy design requirements
  • Do not need to remove seniors from their VIP teams!
  • VIP provides a realistic, multidisciplinary design experience that is very difficult to achieve in traditional senior design.

• VIP teams are large, vertically integrated, and long-term, so the experience is much closer to what happens in industry.

• Ideal: Discipline-Centric Design early in curriculum, followed by or in parallel with a multi-year, multidisciplinary VIP experience.

• The VIP Consortium was awarded the 2019 ABET Innovation Award
Faculty Credit Options (Current Curriculum):

No Course Release for Adviser(s)
- Works in Depts with Low Teaching “Loads”
- Faculty will do VIP because it helps their research

One Course/Year _every year_ for Primary VIP Adviser
- ½ Course/Semester matches actual time commitment
- 24+ distinct students/year for each year team operates
- Works if VIP counts as dept elective(s)/capstone

One Course/Year for _first 2 Years_ for Primary VIP Adviser
- Gives credit when educating team falls on adviser
- Team is providing research benefits by year 2
- Allows dept to launch a specified # of new teams each year
Access and Diversity for VIP@GT

- **Credit bearing + counts toward degrees:** Enables all students to participate
- **Joining teams:** No interviews, GPA requirements, or Prerequisites
- **Unique among High-Impact programs:** %URMs in VIP = % in overall student population.
- **High Participation amongst Transfer Students**
Assessment: Many Aspects

Ongoing Study of Learning Outcomes + Impacts on Faculty, Departments, and Institutions

• Evaluation Teams at Boise State, Georgia Tech, Michigan

Exit Surveys: 233 VIP Students; 1781 non-VIP Students:

• Ability to work in a Multidisciplinary team:
  \[ t(1981)=4.437, \ p<0.001, \ d=0.313 \]

• 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:
  \[ t(2002)=3.19, \ p=0.001, \ d=0.224 \]
Assessment: Continued

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
VIP: Benefits for Students

• Team Experience Focused on Real Projects
• Opportunity to Learn/Master different Roles/Skills
• In-Depth Experience in their Field
• Long-term Multi-Disciplinary Experience
• Knowledge Exchange across many Boundaries
• Provides a Compelling Reason to be on Campus
• Preparation for Work / Grad School
• Understanding of the Innovation Process
VIP: Benefits for Faculty

- Better Organized, More Effective UG Research/Exploration
- Peer Leadership and Management Reduces Workload
- Continuity of Knowledge and Experience on Team
- Many Enthusiastic Students to Work With
- Beneficial “Education” & “Broader Impact” for Grants
- Recruiting for Graduate School
- Adds New Dimension to Research/Exploration Capability
VIP: Benefits for Universities

- Enhances Student Learning/Scholarship
- Enhances Faculty Research/Exploration
- Enables New Partnerships
- Creates Multidisciplinary Opportunities
- Compelling Reason to have a Campus
- Everyone Participates in Scholarship and Exploration
- Deepens/Broadens the University Community
The VIP Consortium: 36 Members, So Far…..

**United States (24):**
- Arizona State University
- Boise State University
- Colorado State University
- Drexel University
- Georgia State University
- Georgia Tech \(\text{AAU,1}\)
- Howard University \(\text{MSI}\)
- Iowa State University \(\text{AAU}\)
- Morehouse College \(\text{MSI,1}\)
- New York University \(\text{AAU}\)
- Notre Dame
- Polytechnic Univ. of Puerto Rico \(\text{MSI}\)
- Purdue University \(\text{AAU,1}\)
- Rice University \(\text{AAU}\)
- Stony Brook University \(\text{AAU}\)
- Texas A&M University \(\text{AAU,MSI,1}\)
- UC Davis \(\text{AAU,MSI}\)
- University of Delaware
- **University of Georgia**
- University of Hawaii \(\text{MSI}\)
- University of Michigan \(\text{AAU,1}\)
- University of Washington \(\text{AAU}\)
- VA Commonwealth University
- Virginia Tech

**International (12):**
- Inha University (Korea)
- Malmö University (Sweden)
- Natn’l Dong Hwa University (Taiwan)
- Natn’l Ilan University (Taiwan)
- Riga Technical University (Latvia)
- Universidad del Norte (Colombia)
- Universidad ICESI (Colombia)
- Universidad Mayor (Chile)
- Univ. of New South Wales (Australia)
- University of Pretoria (South Africa)
- University of Strathclyde \(\text{1}\) (Scotland)
- UNICAMP (Brazil)

**Legend:**
- **AAU**: Member of the AAU \(10\)
- **MSI**: Minority Serving Institution \(7\)
- 1: Pre-Consortium Programs \(6\)
- **Bold**: State of Georgia Institutions \(4\)
The VIP Consortium: Pending/Potential Members

**US Pending (15):**
- University of Arizona AAU
- Clemson University
- The Cooper Union
- Duke University
- Florida Atlantic Univ.
- Florida Inst. of Tech.
- Loyola Univ. – Chicago
- **Kennesaw State Univ.**
- Minnesota State Univ.
- NCA&T University MSI
- NC State University
- University of Memphis
- Univ. of Texas - Austin AAU
- Tuskegee University MSI
- Western New England Univ.

**LEGEND:**
- **AAU:** Member of the AAU (1)
- **MSI:** Minority Serving Institution Institution (2)
- **Bold:** State of Georgia (1)

**Int’l Pending (15):**
- Beijing Inst. Of Technology (China)
- Univ. of St. Andrews (Scotland)
- University of Bath (UK)
- Universidad de Antofagasta (Chile)
- Universidad de Aysen (Chile)
- Universidad de Chile (Chile)
- Univ. Catolica del Norte
- Univ. de Concepción (Chile)
- Univ. of Dubai (Dubai)
- American Univ. of Lebanon
- Lebanese American Univ. (Lebanon)
- National Taiwan University
- Riga Stradins Univ. (Latvia)
- Univ. of Waikato (New Zealand)
- Universidad de Chile (Chile)
The VIP Consortium: 2019 Annual Meeting
The VIP Program: Essential Characteristics

• 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 Disciplinary and Professional Skills
The VIP Consortium: Essential Characteristics

- All Institutions Have a Professor-Led VIP Program
- Program Must Have Essential Elements of VIP but Adapt as needed 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://www.vip.gatech.edu

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