



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

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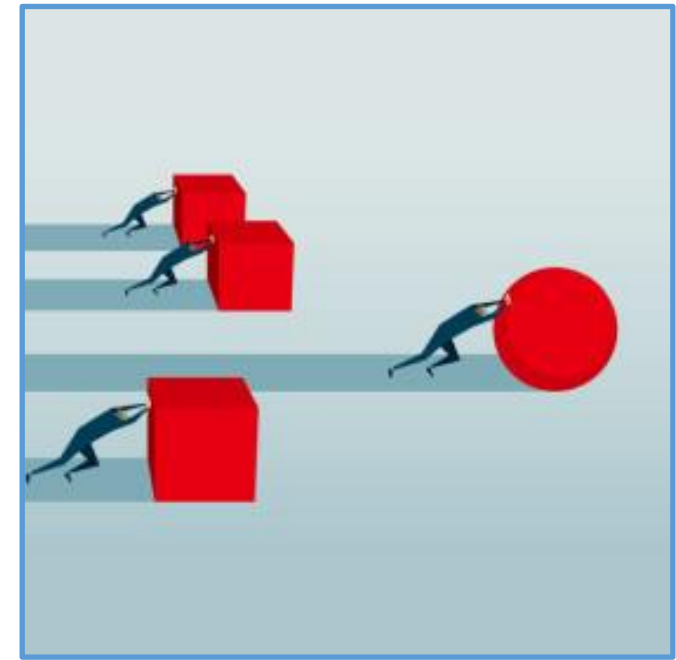
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Program Manager: Chris Malbrue

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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VIP 2.0: Vertically Integrated Projects (VIP) in ECE

VIP Teams embedded in Faculty Scholarship and Exploration in ECE

Fragmentation By Discipline

Affects Everyone

The “Thinkings,” Budget Lines, Culture

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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



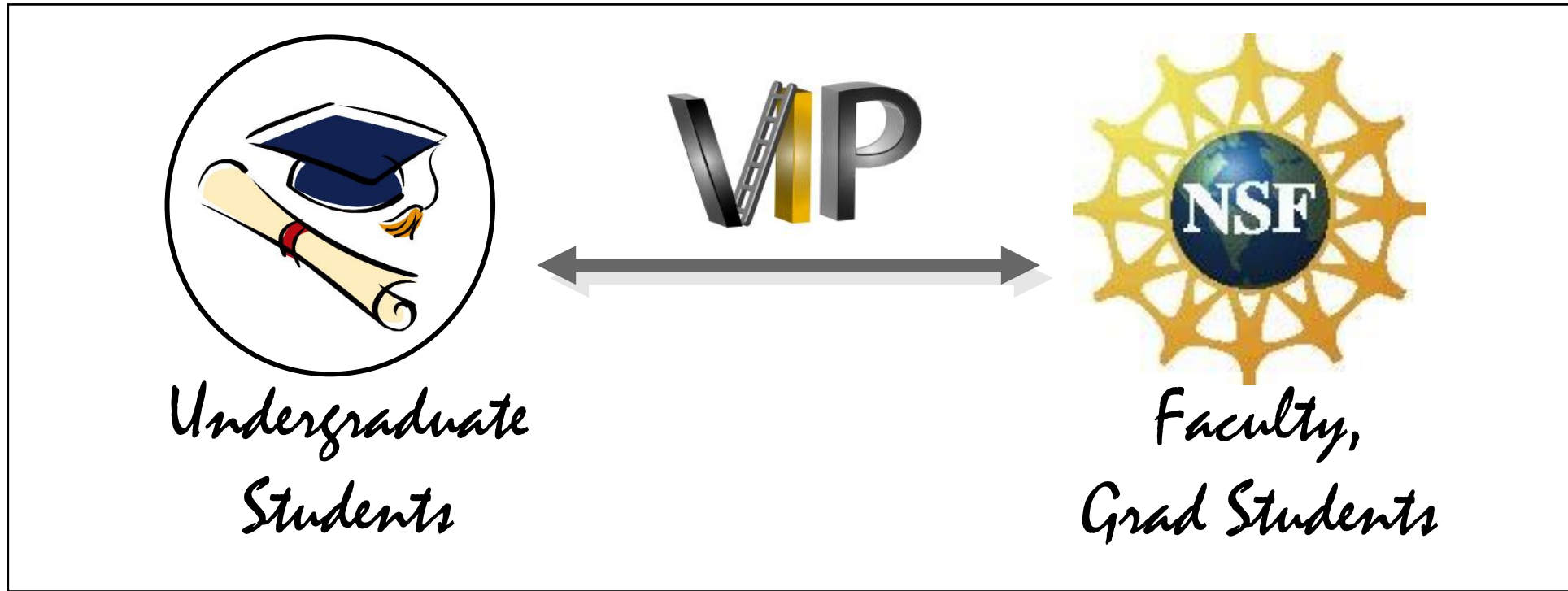
Context



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

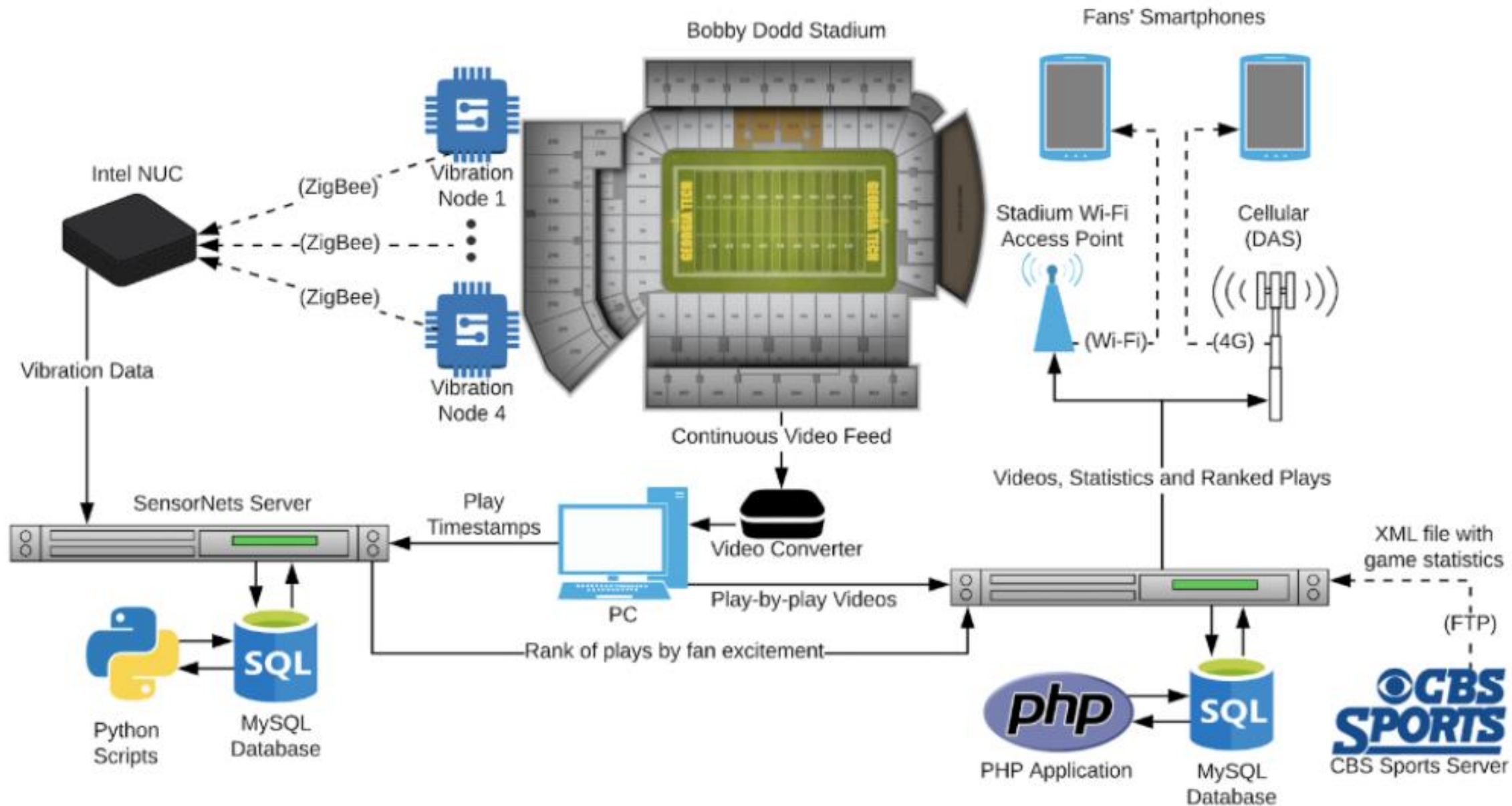
Example: The 19-year-old Stadium-IoPT Team



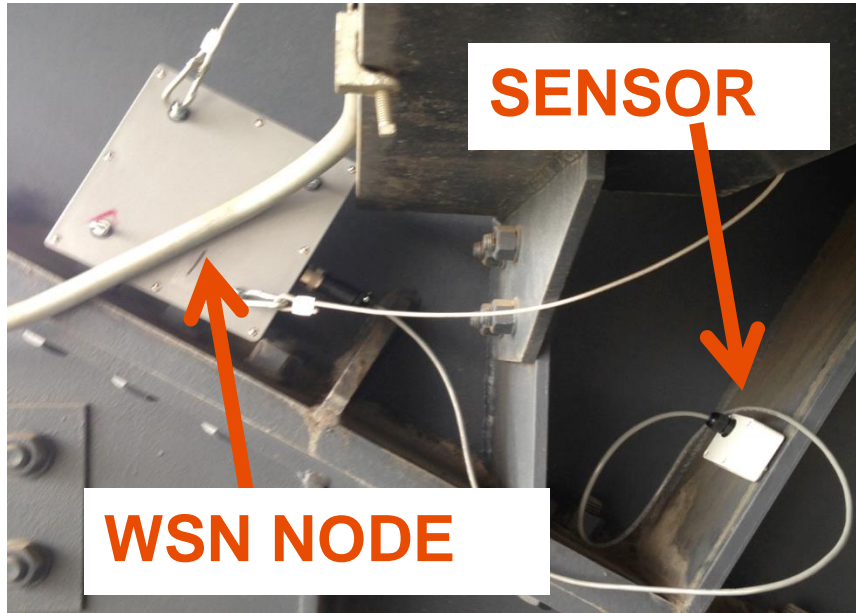
The Stadium-IoPT Team's Testbed: Bobby Dodd Stadium



The Stadium-IoPT System as of 2019



Stadium-IoPT: Sensor Net Subproject

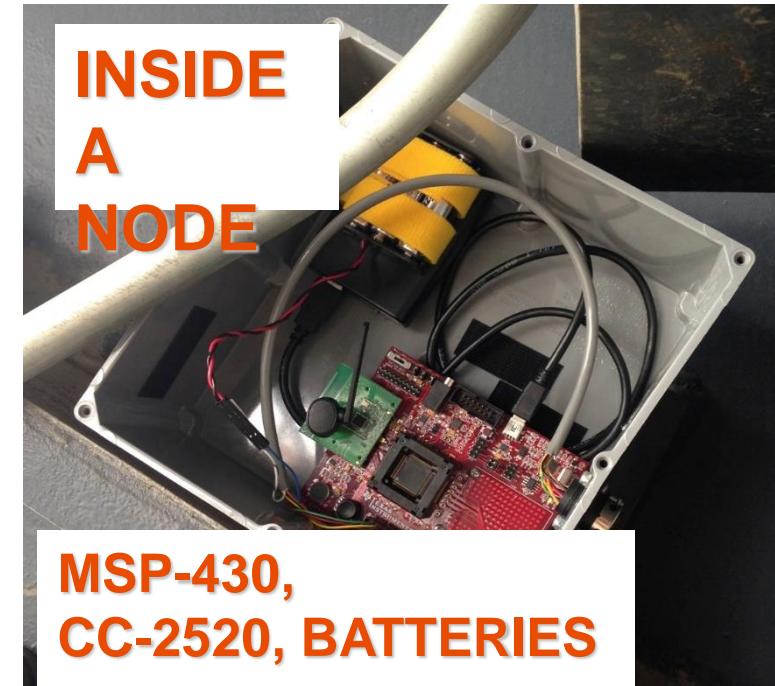


Sensing Tasks:

- 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



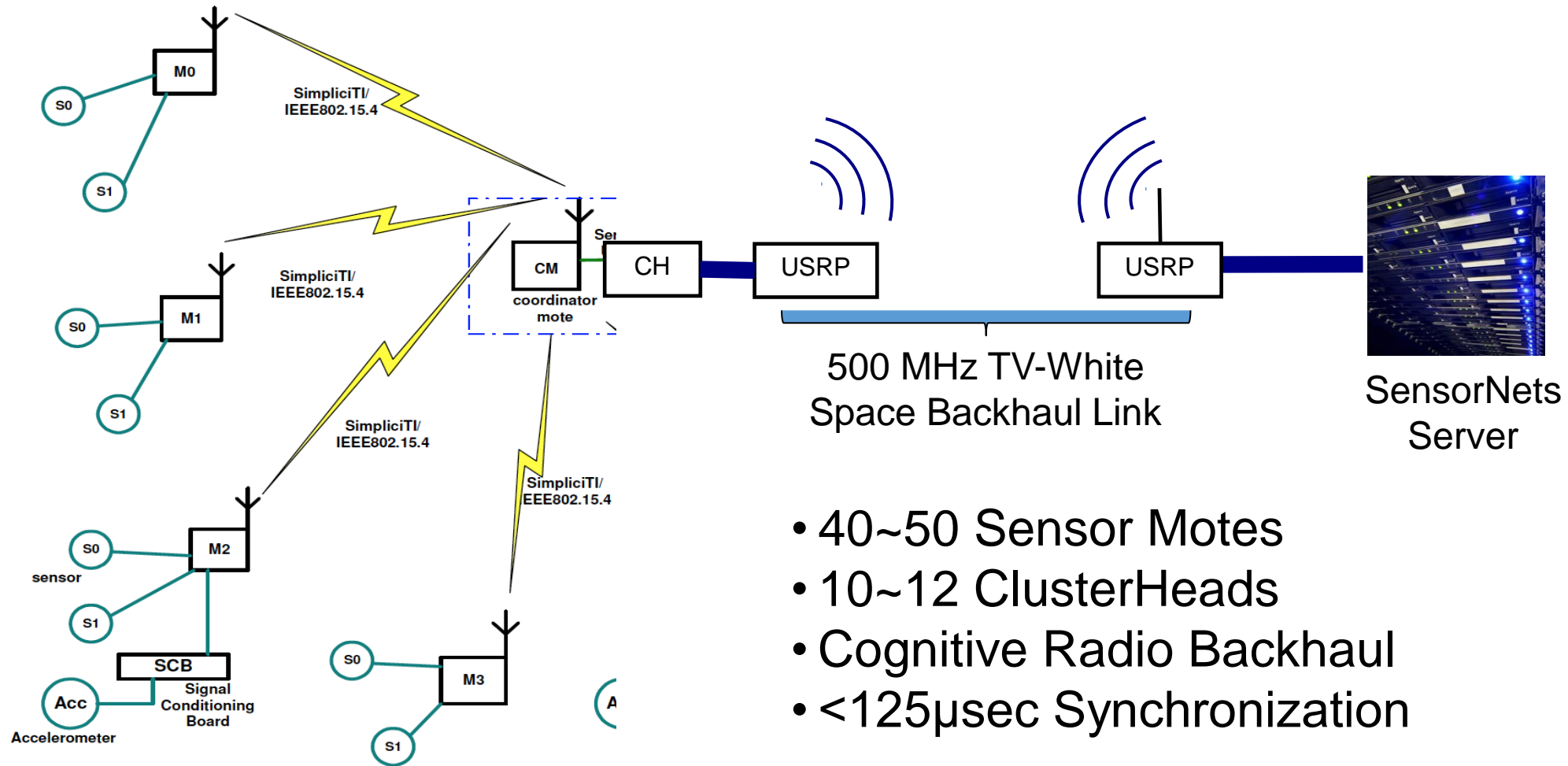
Stadium-IoPT: Sensor Net Subproject



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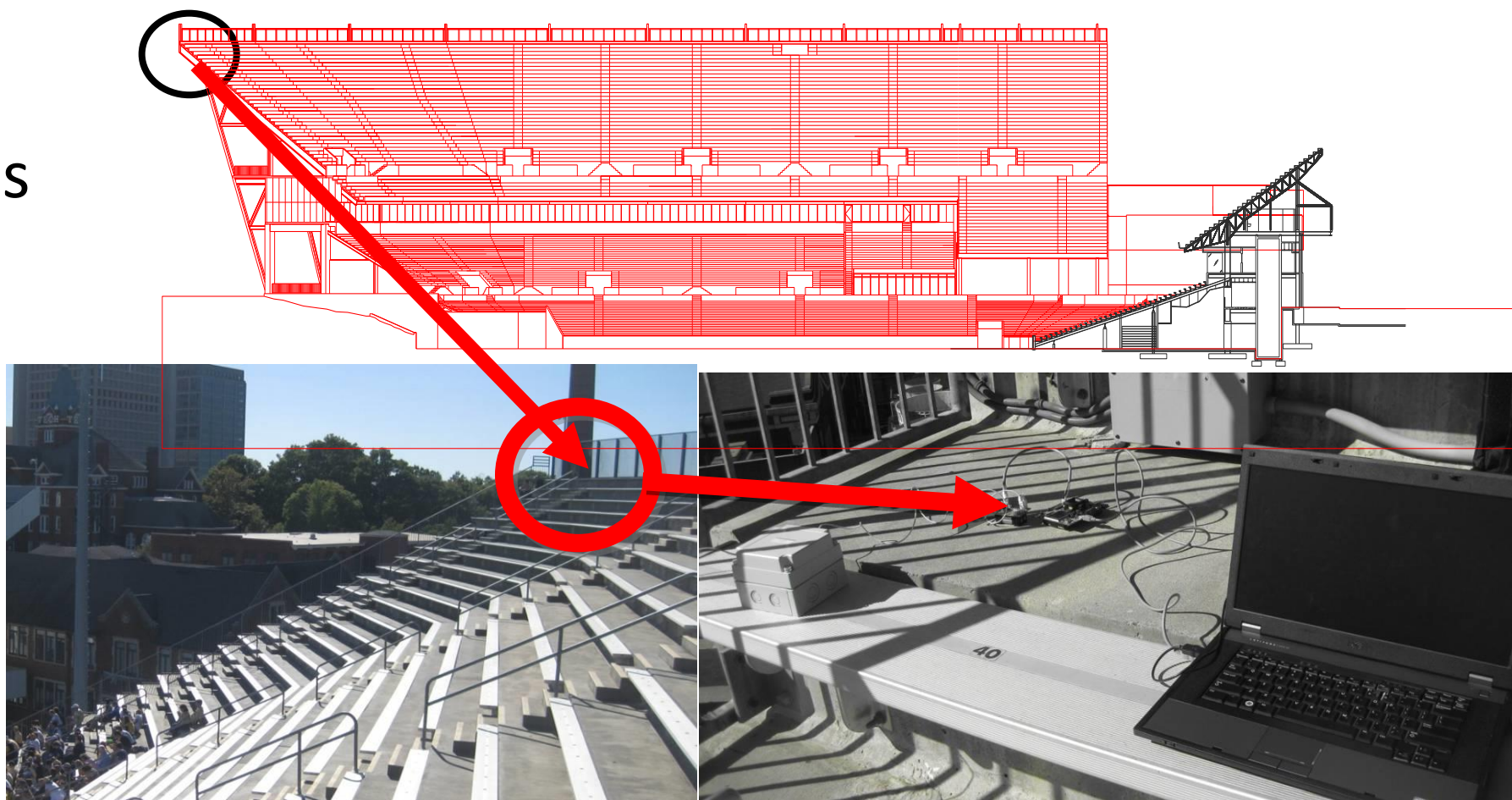


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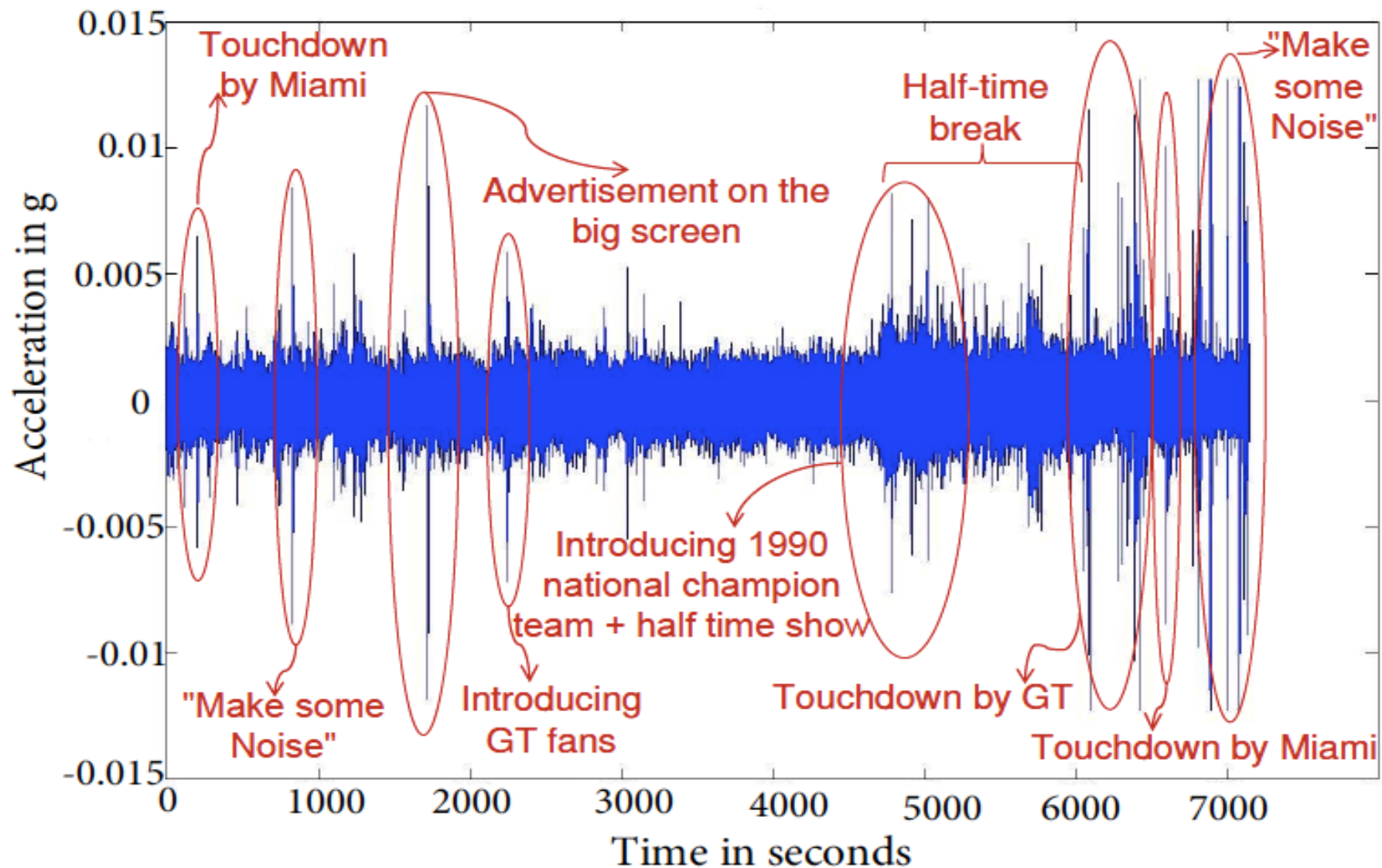


Stadium-IoPT: Sensor Net Subproject

Sensing
Vibrations



Stadium-IoPT: Game Vibrations

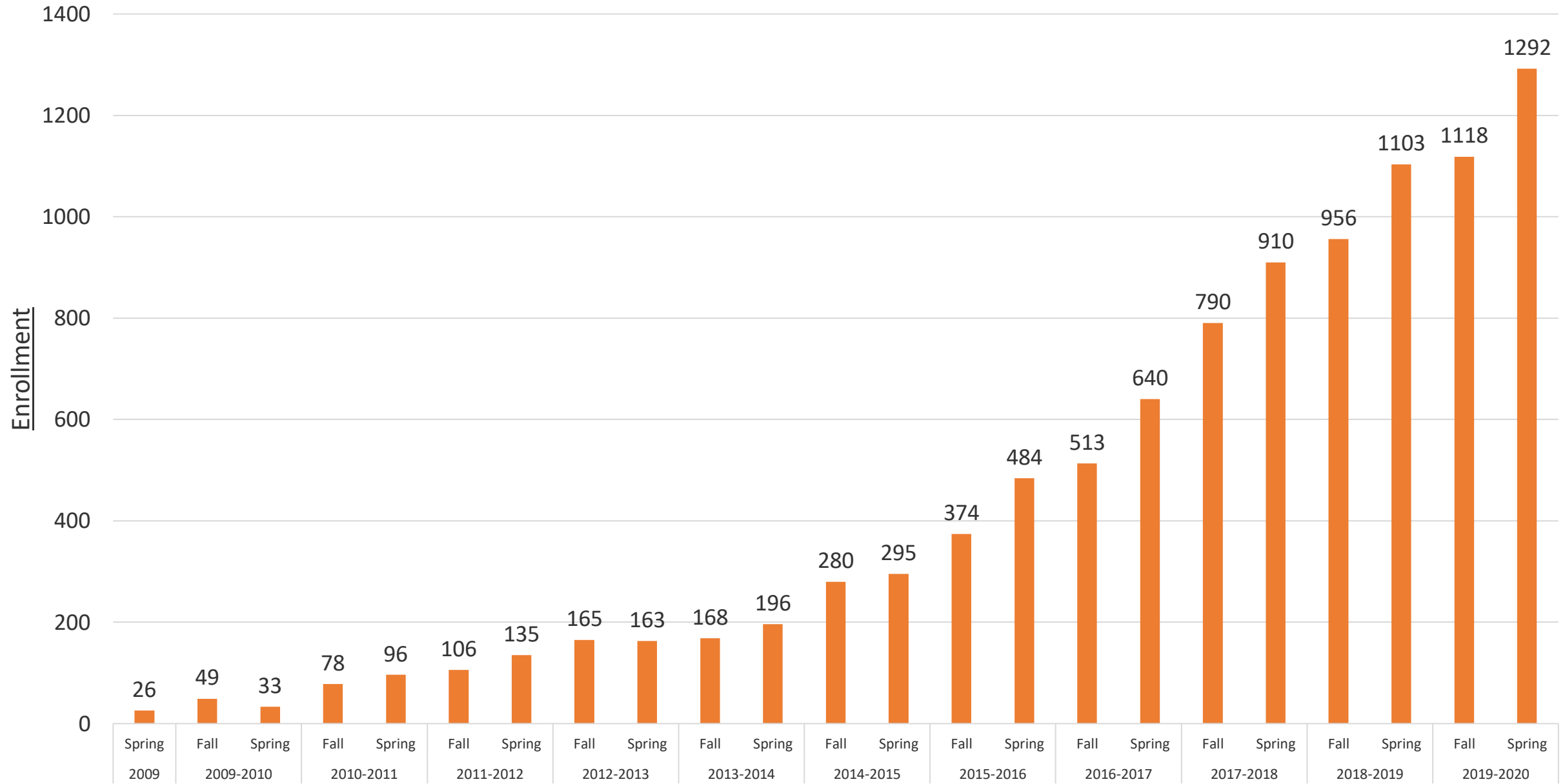


Georgia Tech VIP Teams: Spring 2020

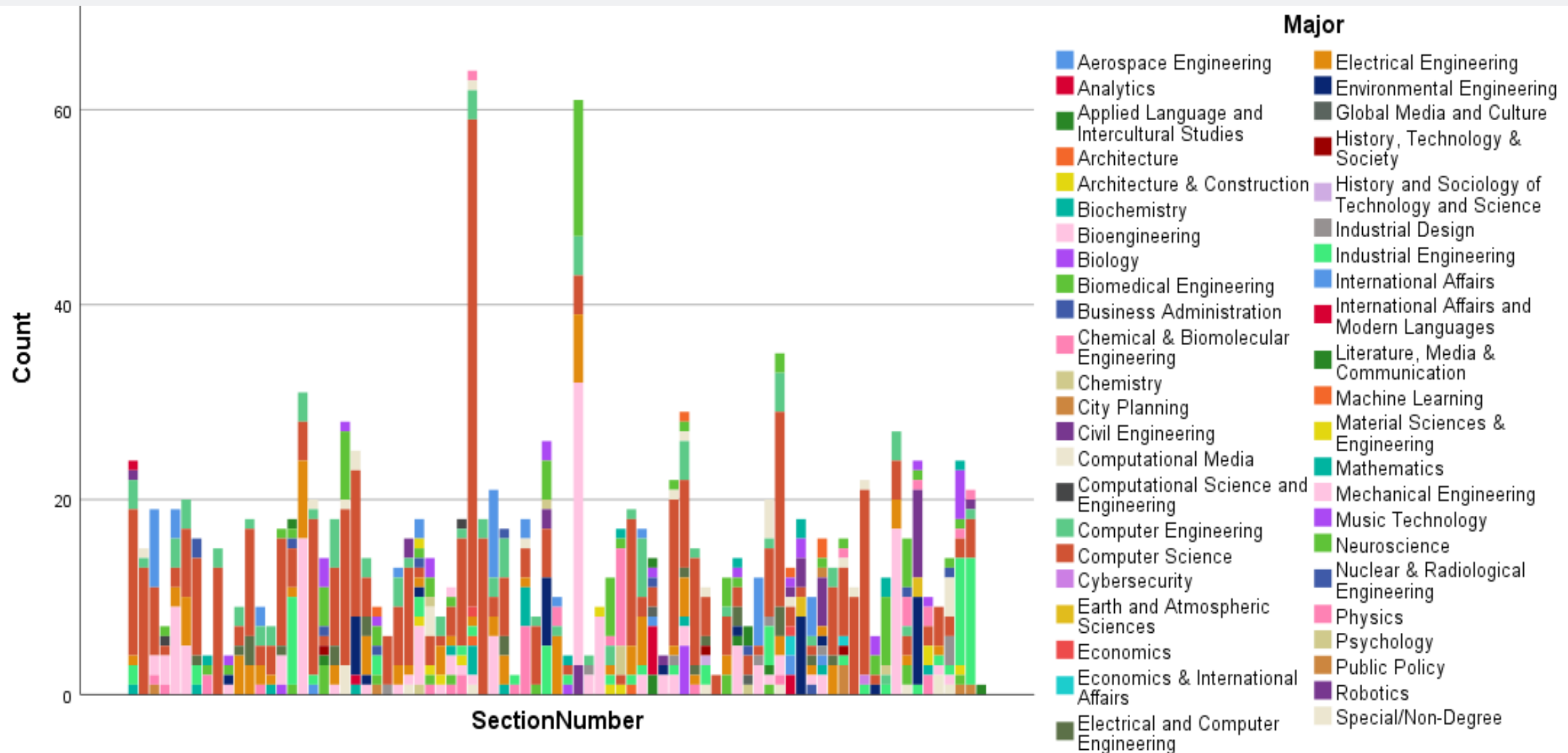
- 81 Teams; 1300 Undergraduates Enrolled
- Students and Faculty from all colleges: Business, Computing, Design, Engineering, Liberal Arts, and Science
- List of GT VIP teams. Click on any team's icon to see a one-page description of that team and the list disciplines from which that team is seeking students:

<http://www.vip.gatech.edu/teams>

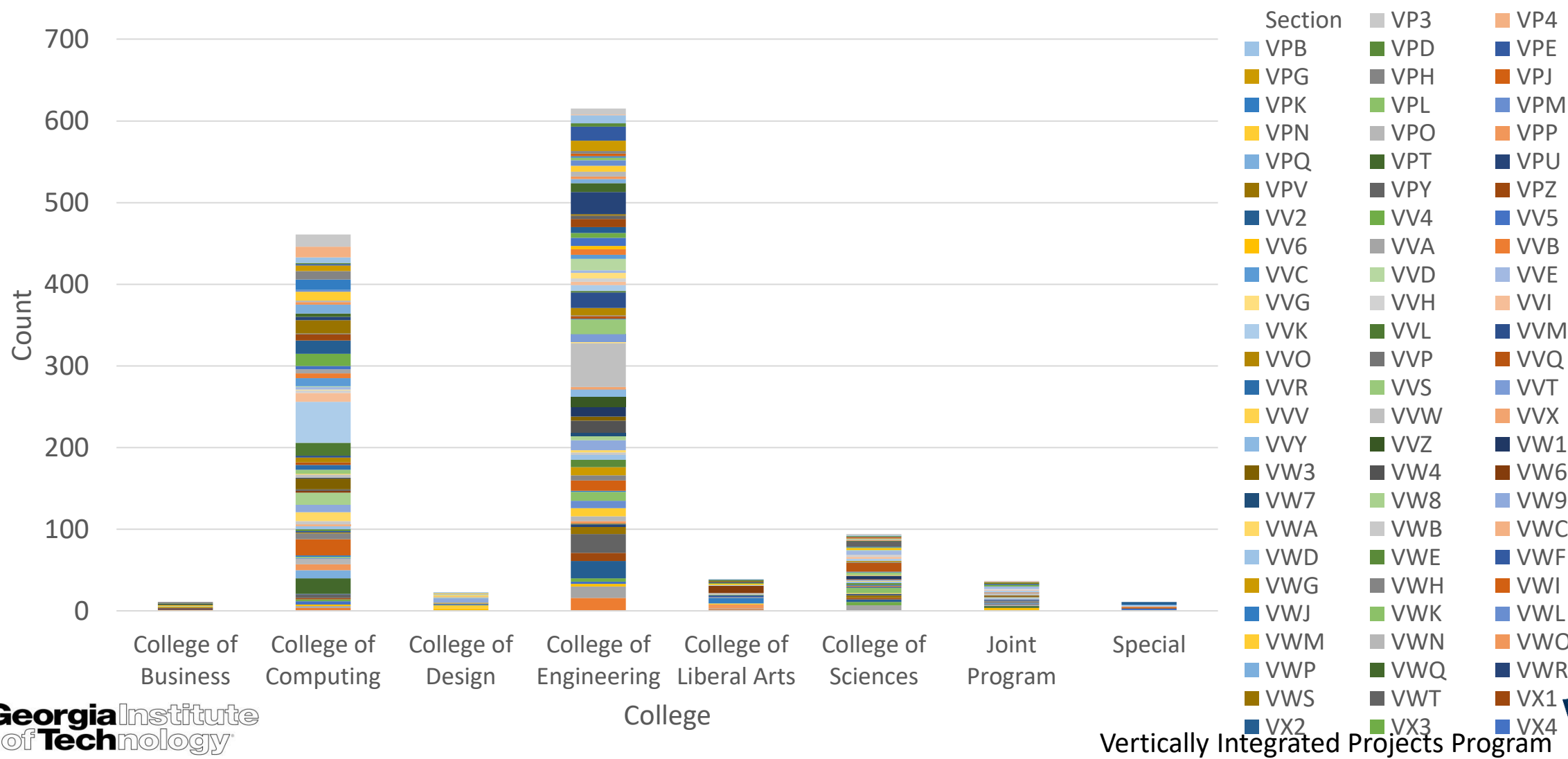
VIP@GT Enrollment: Spring 2009 - Spring 2020



VIP Enrollment Spr 2020: Team Size + Majors

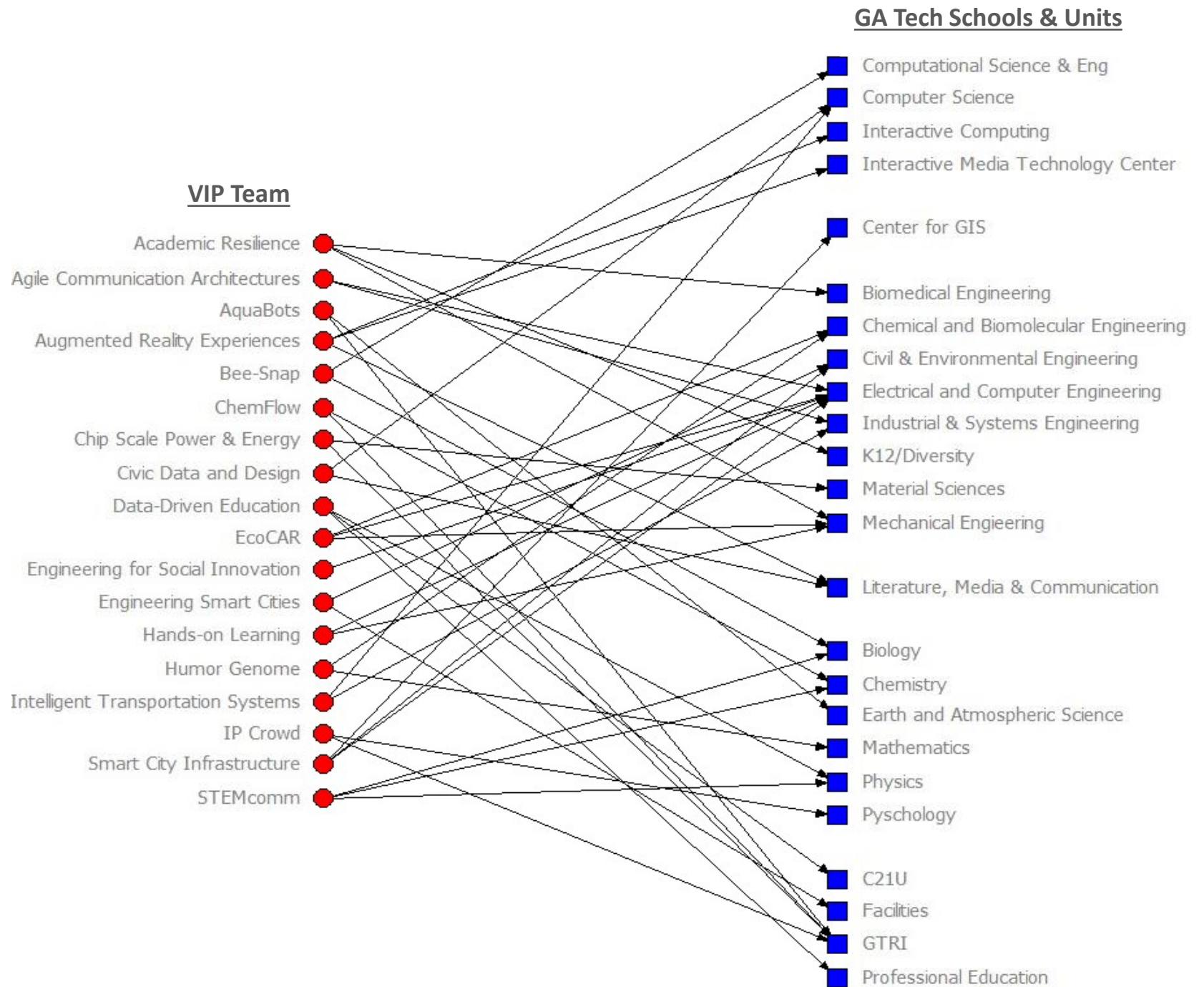


VIP Enrollment by College & Team

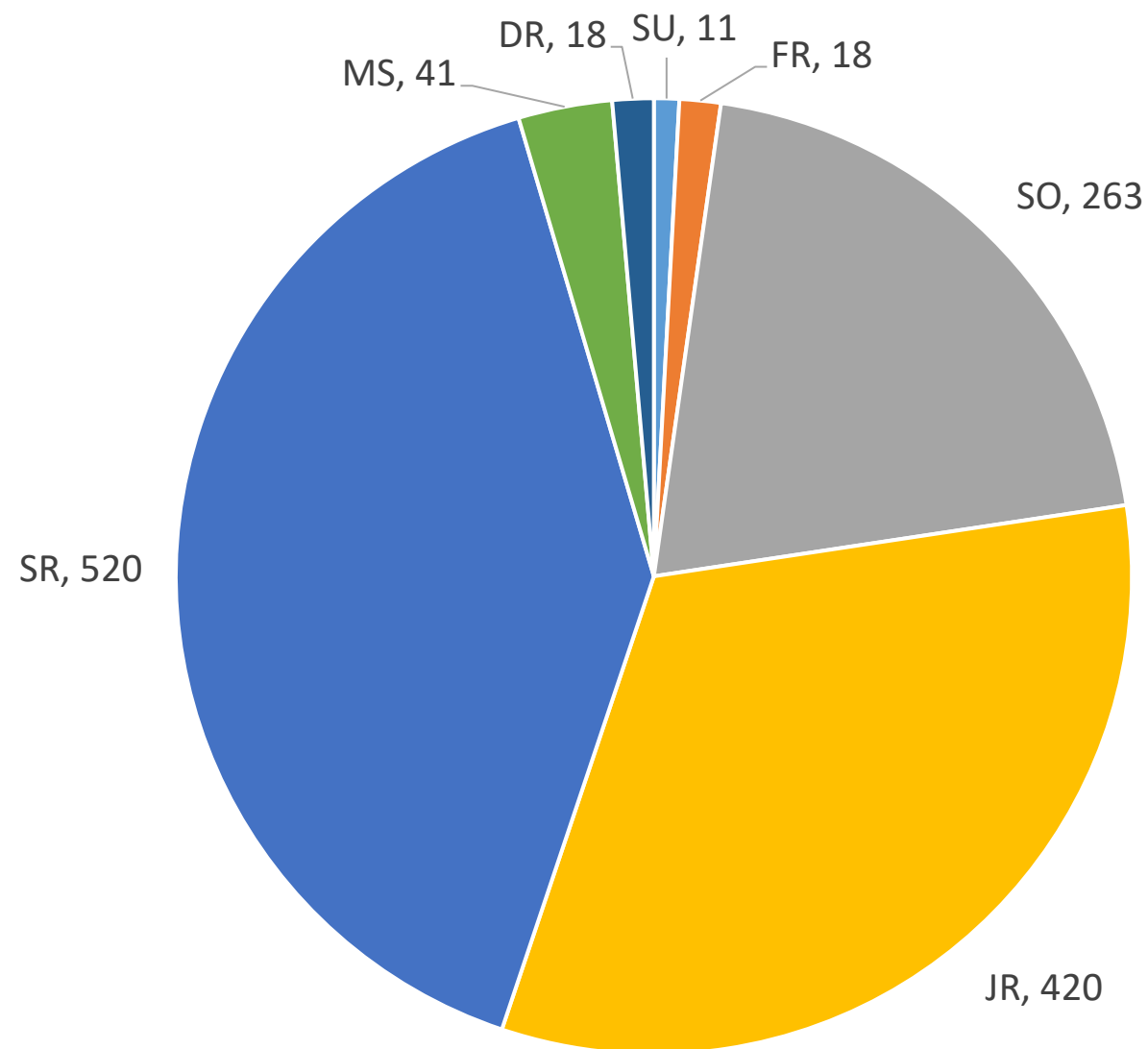


Cross-Campus Collaboration, GT

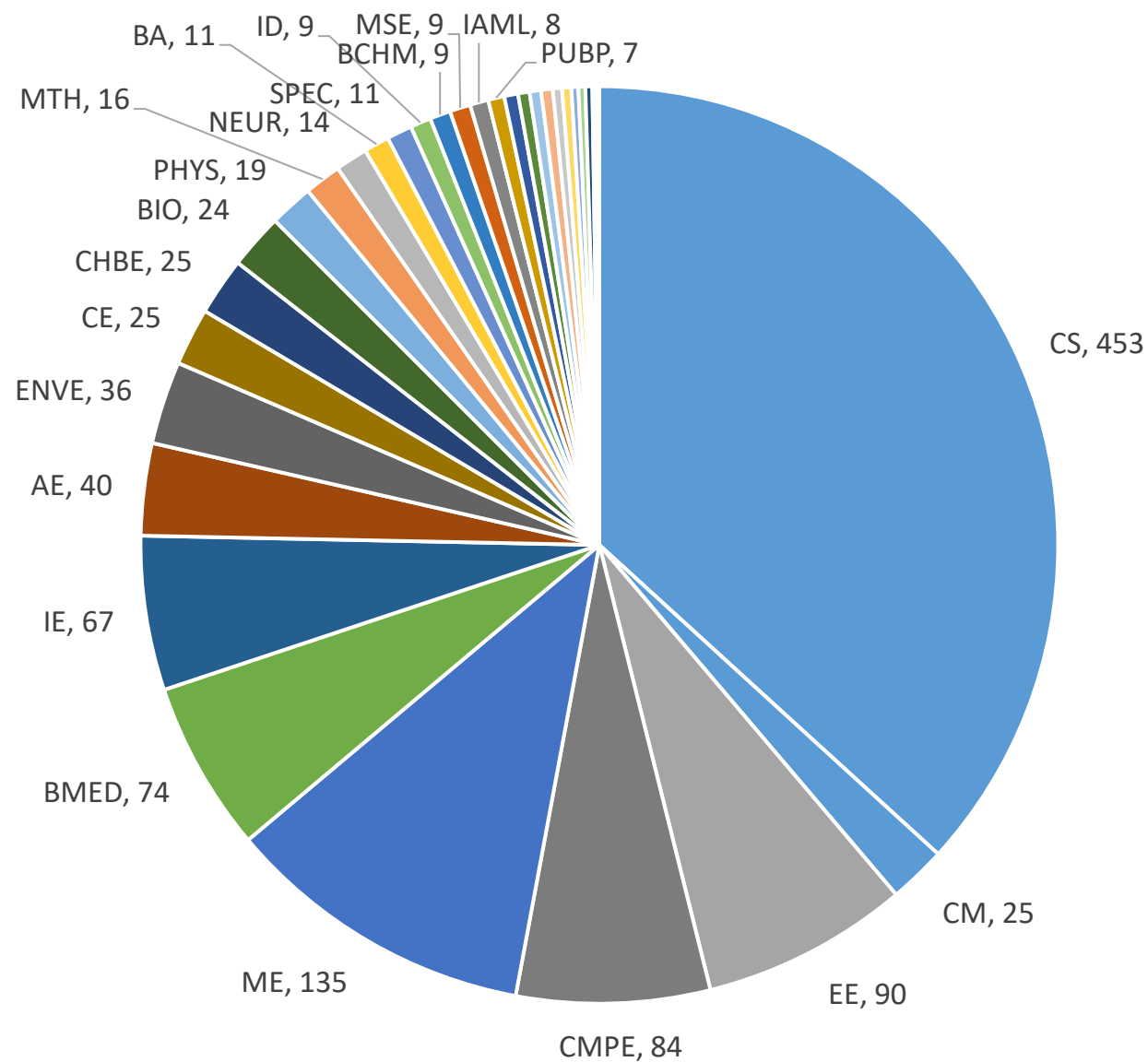
1/3 of VIP teams
draw instructors
from more than
one GT Unit.



VIP Team Composition: By Academic Rank, Spr 2020

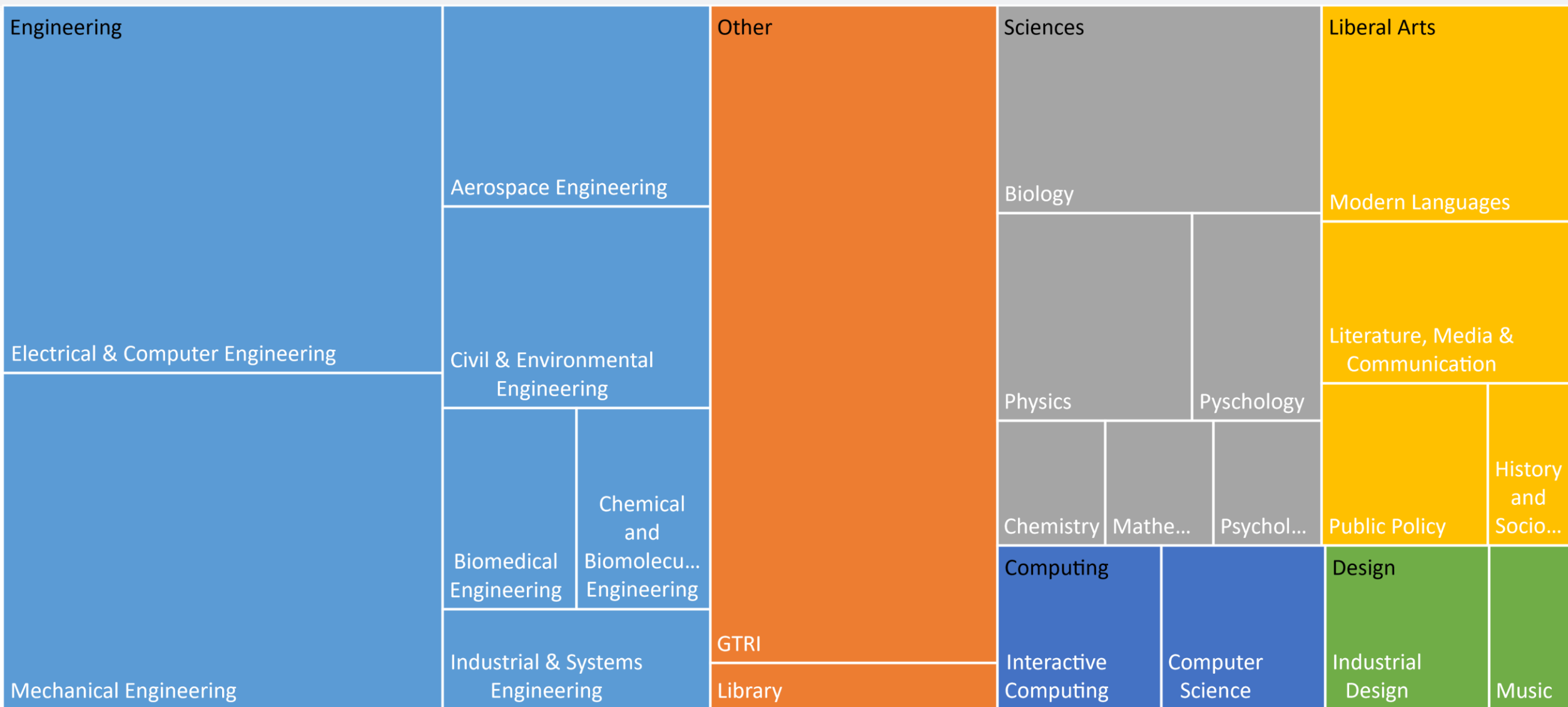


VIP Enrollment: By Major, Spring 2020



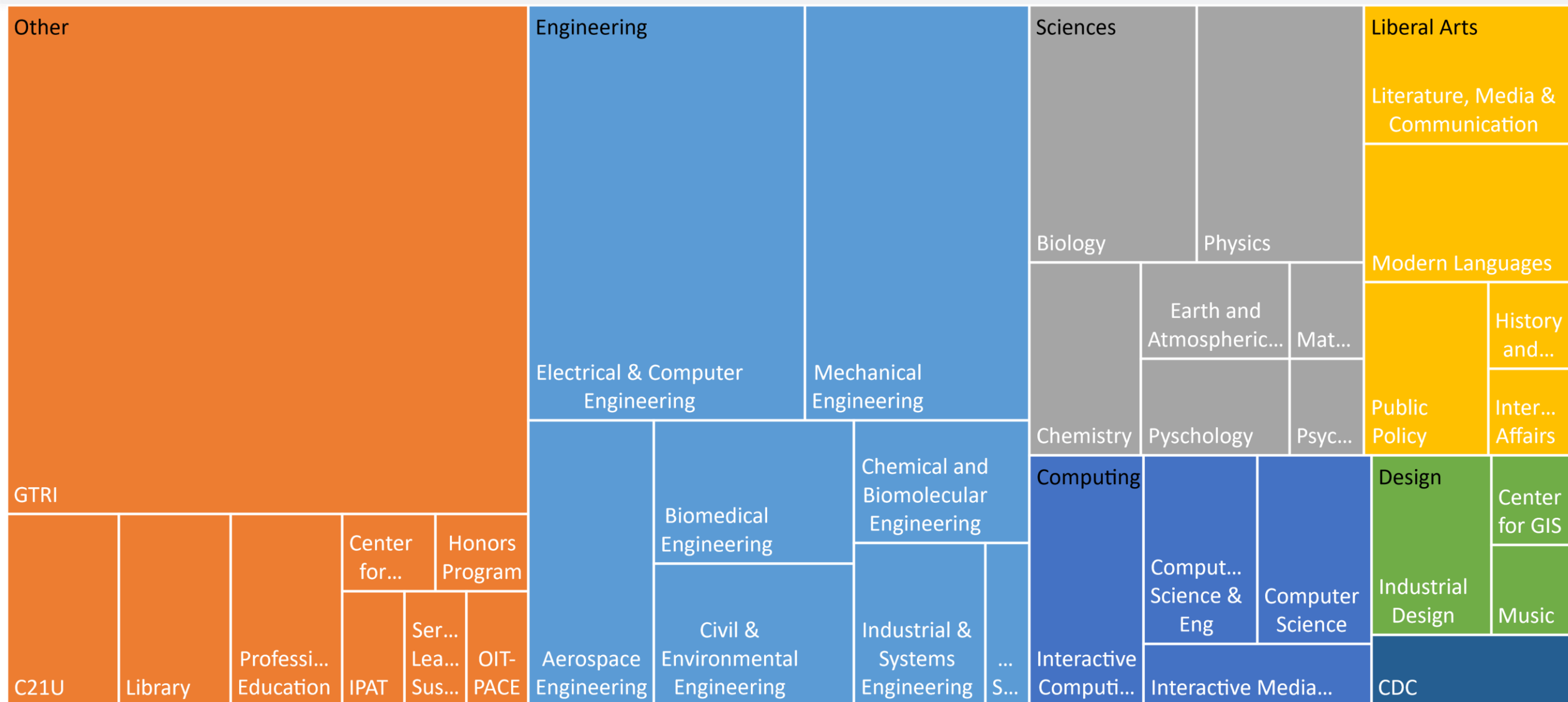
Lead VIP Instructors by Home Department, Spring 2020

■ Engineering ■ Other ■ Sciences ■ Liberal Arts ■ Computing ■ Design



Instructors & Co-Instructors by College & Department, Spring 2020

■ Engineering ■ Other ■ Sciences ■ Liberal Arts ■ Computing ■ Design ■ External



VIP@GT Course Structure: Campus-wide Courses

	1 credit	2 credits	3 credits	For pay (0 credits)
2nd Year	VIP 2601			
3rd Year	VIP 3601	VIP 3602	VIP 3603 by dept. request	VIP 3600
4th+ Year	VIP 4601	VIP 4602	VIP 4603 by dept. request VIP 4983 capstone	VIP 4600
Graduate	VIP 6601	VIP 6602	VIP 6603	VIP 6600

- 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

Grading Interface for Instructors

Credits	Class	Major	Semesters	Email	wiki	Midterm		
						Peer Eval	Enter Grades	Release Student Grade
1	JR	CMPE	1		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
1	SR	CS	2		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
1	JR	CS	1		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
2	SR	CMPE	3		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
2	JR	EE	2		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
2	SR	CMPE	3		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
2	JR	CS	2		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
1	SR	EE	5		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
1	SO	CMPE	2		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>
2	SR	EE	2		Wiki	of / by	Edit / View	<input checked="" type="checkbox"/>

Grading Form: Categories

Credits: 2 **Class:** SR
Major: CMPE
Evaluation: Mid-term
Total semesters registered : 3

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
B Focuses effort on achieving goals
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 [REDACTED] 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 [REDACTED] graduated. I like that you volunteered to meet with your team's customer, the [REDACTED] 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 [REDACTED] 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

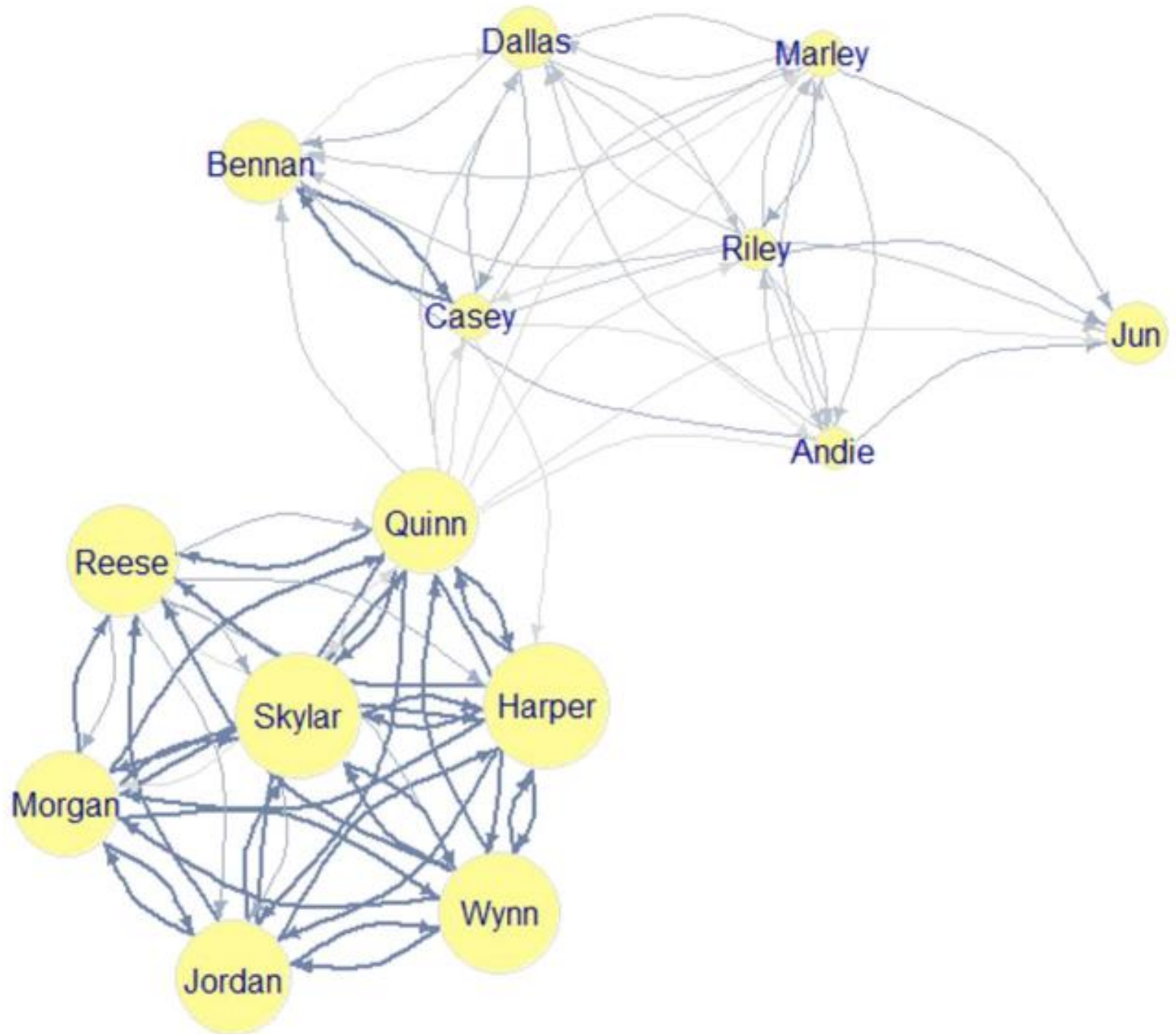
1. How often do you interact with each person below? ⓘ	5 / 5	5 / 5	5 / 5
2. How often do you get suggestions/advice from each person below? ⓘ	5 / 4.7	5 / 4.7	4 / 4.7
3. How often do you give suggestions/advice to each person? ⓘ	4 / 4.7	5 / 4.7	5 / 4.7
4. Participation in team meetings/class: ⓘ	5 / 3.7	4 / 3.7	2 / 3.7
5. Participation in subteam meetings or breakout discussions: ⓘ	5 / 4	4 / 4	3 / 4
6. Documentation: ⓘ	4 / 4	4 / 4	4 / 4
7. Quality of work: ⓘ	4 / 4.7	5 / 4.7	5 / 4.7
8. Communication: ⓘ	5 / 4	5 / 4	2 / 4
9. Dependability: ⓘ	5 / 4.3	4 / 4.3	4 / 4.3
10. When encountering obstacles, how does each person react? ⓘ	5 / 5	5 / 5	5 / 5
11. Independent Learning: ⓘ	5 / 5	5 / 5	5 / 5
12. Team management ability: ⓘ	5 / 4	4 / 4	3 / 4
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. ⓘ	4000 / 3333.3	4000 / 3333.3	2000 / 3333.3
14. Comments: Please leave comments on each person below for your instructor(s). Constructive criticism is especially helpful. ⓘ	Very passionate about the team.	Very dedicated to learning what is needed for the team. Could participate in discussion more.	Very knowledgeable on the material related to the team. Needs to be more committed.

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** AAU,1
- Howard University MSI
- Iowa State University AAU
- **Morehouse College** MSI,1
- New York University AAU
- Notre Dame
- Polytechnic Univ. of Puerto Rico MSI
- Purdue University AAU,1
- Rice University AAU
- Stony Brook University AAU
- Texas A&M University AAU,MSI, 1

- UC Davis AAU,MSI
- University of Delaware
- **University of Georgia**
- University of Hawaii MSI
- University of Michigan AAU, 1
- University of Washington AAU
- VA Commonwealth University
- Virginia Tech

LEGEND:

AAU: Member of the AAU (10)

MSI: Minority Serving Institution (7)

1: Pre-Consortium Programs (6)

Bold: State of Georgia Institutions (4)

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 Strathclyde¹ (Scotland)
- UNICAMP (Brazil)

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)

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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