BOARD OF TRUSTEES

Academic & Student Affairs Committee Meeting Agenda

November 6, 2023
10:30 AM – 12:00 PM

Florida Polytechnic University
VIRTUAL VIA MICROSOFT TEAMS

Dial in: 1-863-225-2351 | Conference ID: 373 999 519#

MEMBERS

Dr. David Williams, Chair	Dr. Narendra Kini, Vice Chair	Dr. Laine Powell
Lyn Stanfield	Dr. Ajeet Kaushik	Melia Rodriguez

AGENDA

I.	Call to Order	Dr. David Williams Committee Chair
II.	Roll Call	Kristen Wharton Corporate Secretary
III.	Public Comment	Dr. David Williams
IV.	Approval of the September 21, 2023 Minutes *Action Required*	Dr. David Williams
V.	2022-24 Academic & Student Affairs Committee Work Plan Review	Dr. Terry Parker EVP & Provost
VI.	Provost's Report	Dr. Terry Parker
	A. M.S. in Electrical and Computer Engineering Program *Action Required*	
	B. Florida Industrial and Phosphate Research Institute (FIPR) Annual Report FY23 *Action Required*	
	C. Advanced Mobility Institute (AMI) Annual Report FY23 *Action Required*	Dr. Randy Avent President
VII.	Closing Remarks and Adjournment	Dr. David Williams

BOARD OF TRUSTEES

Academic & Student Affairs Committee Meeting Minutes

DRAFT MEETING MINUTES

September 21, 2023
3:30 PM – 5:00 PM

Florida Polytechnic University
VIRTUAL VIA MICROSOFT TEAMS

I. Call to Order

Committee Chair David Williams called the Academic and Student Affairs Committee meeting to order at 3:30 p.m.

II. Roll Call

Kristen Wharton called the roll: Committee Chair David Williams, Committee Vice Chair Narendra Kini, Trustee Melia Rodriguez, Trustee Laine Powell, and Trustee Lyn Stanfield were present (Quorum)

Committee members not present: Trustee Ajeet Kaushik

Other Trustees Present: Board Chair Cliff Otto, Board Vice Chair Beth Kigel, Trustee Gary Wendt, Trustee Mark Bostick

Staff Present: President Randy Avent, Provost Terry Parker, Dr. Allen Bottorff, David Fugett, David Blanton, Mike Dieckmann, Kristen Wharton, Melaine Schmiz, Maggie Mariucci, Kevin Calkins, and Dr. Kathryn Miller

III. Public Comment

There were no requests received for public comment.

IV. Approval of the June 7, 2023, Minutes

Trustee Narendra Kini motioned to approve the Academic and Student Affairs Committee meeting minutes of April 27, 2023. Trustee Laine Powell seconded the motion; a vote was taken, and the motion passed unanimously.

V. Work Plan

Committee Chair David Williams noted several updated items in the Committee's annual work plan, including the addition of one item pertaining to SB 266 – "Review and Approve General Education Course Requirements." There were no questions by the Committee.

A motion was made by Trustee Melia Rodriguez to approve the revised 2022-2024 Academic and Student Affairs Committee Work Plan. Trustee Lyn Stanfield seconded the motion; a vote was taken, and the motion passed unanimously.

VI. Provost's Report

Provost Terry Parker began his report by reviewing the recently released US News and World Report rankings. He then reviewed the textbook affordability report, stating the percentage of course sections meeting the statute requirement for fall 2022 was 99.3% and 100% for spring 2023. There were no questions on this item.

A motion was made by Trustee Melia Rodriguez to recommend approval of the Annual Textbook and Instructional Materials Affordability Report for academic year 2023 to the Board of Trustees. Trustee Laine Powell seconded the motion; a vote was taken, and the motion passed unanimously.

Provost Parker reviewed the University's activities in support of civil discourse, including the newly formed Office of Public Policy Events. Additionally, he covered accreditation activity stating the University enters ABET reaccreditation in four academic programs this year.

Trustee Gary Wendt asked what Provost Parker attributes the YOY decline in admissions to, to which Provost Parker replied lack of on-campus housing as the primary cause. Provost Parker stated the University is making a strategic shift in enrollment strategies which includes a change in leadership, different marketing approaches, and increased brand awareness campaigns. As a result, early trends in fall 2024 FTIC applications show a significant increase.

Provost Parker reviewed improvements made in housing leasing operations, career services, on-campus activities, and the four-year graduation rate improvement plan.

Regarding faculty, Provost Parker noted that the University hired 21 new faculty in the past year; he also presented the faculty population by department, rank, and the incoming faculty population in terms of diversity. Based on employment availability versus the faculty the University onboards, Trustee Lyn Stanfield inquired if the University is recruiting and interviewing diverse talent and if the University is missing potential applicants. Discussion occurred between Trustee Stanfield, Provost Parker and President Avent on branding and marketing the University in such a way that is attractive to all potential applicants.

The University developed a 4+1 program which is an entry path for Florida Poly's graduate programs. Currently, ten students are enrolled in one graduate course per semester in their senior year, earning six of their 36 graduate degree hours as an undergraduate student.

Trustee Melia Rodriguez asked Provost Parker to explain the engagement sequence referenced earlier in his presentation. Provost Parker shared how it addresses retention rates by injecting a project-based learning experience within a targeted class in each semester from freshman to senior year. Trustee Rodriguez asked what the major shortfalls in retention are and what the University is doing to address them; Provost Parker responded, 1) disengaged students (particularly freshman year), 2) poorly prepared students, and 3) instruction quality. He reviewed actions that have been taken to address all three of these issues, such as implementing the engagement sequence, providing additional learning support, and adding additional faculty training.

VII. Closing Remarks and Adjournment

With no further business to discuss the meeting adjourned at 4:42 p.m.

Respectfully submitted:
Kristen J. Wharton
Corporate Secretary

AGENDA ITEM: V.

Florida Polytechnic University
Academic and Student Affairs Committee
Board of Trustees
November 6, 2023

Subject: 2022-2024 Academic and Student Affairs Committee Work Plan

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Proposed Committee Action

Review only. No action required.

Background Information

Provost Terry Parker will review the Committee's 2022-2024 Work Plan.

Supporting Documentation: Academic and Student Affairs Committee Work Plan 2022-2024

Prepared by: Dr. Terry Parker, Provost and Executive Vice President

ACADEMIC & STUDENT AFFAIRS

Committee Work Plan

Academic & Student Affairs Committee Work Plan
2022-2024

SEPTEMBER

- Academic & Student Affairs Committee Charter *(review and approve every two years – due September 2022)*
- Civil Discourse: Review of student orientation programming and student code of conduct *(completed - September 2022)*
- Annual Textbook and Instructional Materials Affordability Report *(review and approve)*
- Renewal of Out of State Fee Waiver *(review and approve as needed)*
- Institutional Accreditation Activity *(review as needed)*
- Admissions and Financial Aid *(review as needed)*
- Student Affairs *(review as needed)*
- Four-year graduation improvement plan *(review as needed)*
- Degree Program Additions and Faculty Hiring *(review as needed)*
- Student and Faculty Demographics *(review as needed)*
- Graduate programs *(review as needed)*
- Technology and Pedagogy *(review as needed)*

NOVEMBER

- Advanced Mobility Institute Annual Report *(review and approve)*
- FIPR Institute Annual Report *(review and approve)*
- FIPR Institute Seven-Year Review *(completed – November 2022)*
- SB266: Review and Approve General Education Course Requirements
- Institutional Accreditation Activity *(review as needed)*
- Admissions and Financial Aid *(review as needed)*
- Student Affairs (review as needed)
- Four-year graduation improvement plan *(review as needed)*
- Degree Program Additions and Faculty Hiring *(review as needed)*
- Student and Faculty Demographics *(review as needed)*
- Graduate programs *(review as needed)*
- Technology and Pedagogy *(review as needed)*

FEBRUARY

- CITF Increase, Inc. to Existing Fees or New Fees *(review and approve only if changes are proposed)*
- Academic Calendar (AY+1 and AY+2) *(review and approve)*
- Institutional Accreditation Activity *(review as needed)*
- Admissions and Financial Aid *(review as needed)*
- Student Affairs (review as needed)
- Four-year graduation improvement plan *(review as needed)*
- Degree Program Additions and Faculty Hiring *(review as needed)*
- Student and Faculty Demographics *(review as needed)*
- Graduate programs *(review as needed)*
- Technology and Pedagogy *(review as needed)*

APRIL

- University Accountability Report *(review and approve)*

JUNE

- Institutional Accreditation Activity *(review as needed)*
- Admissions and Financial Aid *(review as needed)*
- Student Affairs (review as needed)
- Four-year graduation improvement plan *(review as needed)*
- Degree Program Additions and Faculty Hiring *(review as needed)*
- Student and Faculty Demographics *(review as needed)*
- Graduate programs *(review as needed)*
- Technology and Pedagogy *(review as needed)*

FLORIDA POLYTECHNIC UNIVERSITY

Provost's Report

Terry Parker

Provost & Executive VP

Contributions from Dr. K. Miller, K. Calkins, N. Tardiff, D. Voss, P. Zhang

November 6, 2023

Today there are requests for approval, information review, and reporting

- **Approvals Required:**
  - Masters of Science Degree development for Electrical and Computer Engineering
  - Florida Industrial and Phosphate Research Institute Annual Report
  - Advanced Mobility Institute Report
- **Information review, no approval required:**
  - Institutional Accreditation Activity (SACSCOC and ABET)
- **Typical Reporting to the ASA Committee:**
  - Admissions and Financial Aid
  - Student Affairs
  - Four-year graduation improvement plan
  - Degree Program Additions and Faculty Hiring
  - Student and Faculty Demographics
  - Graduate programs
  - Technology and Pedagogy

Grey font indicates no report for this meeting

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Performance Based Funding motivates a change in our Graduate Programs

Graduate Degree Name and CIP	2022-23 and before: On the Programs of Strategic Emphasis List?	2023-24 and after: On the Programs of Strategic Emphasis List?
M. S. Computer Science (11.0101)	Yes	Yes
M.S. Data Science (30.7001)	Yes	Yes
Engineering Management (15.1501)	Yes	Yes
Engineering (14.0101)	Yes	**No**
Electrical Engineering (14.1001)	Yes	Yes
Mechanical Engineering (14.1901)	Yes	Yes

The MS Engineering currently operates as two tracks: Mechanical and Electrical and Computer Engineering. Our proposal is to split these programs into traditional named degrees aligned with the PSE list.

Metric 8 awards points based on the fraction of our graduate degrees that are on the "Programs of Strategic Emphasis" list. This list has recently changed.

Degree approval is a multi-step process

- **The process is:**
  - Declaration of intent to develop degrees in accountability plan which is BOT approved
  - Submission of preproposal to Council Of Academic Vice Presidents for consideration
  - Proposal development for degree
  - Submission of formal proposal to BOT for approval
  - Submission of approved degree proposal to Board of Governors staff for adoption
- **Our 2023 Accountability plan stated:**
  - "*Additional Master's programs will be investigated and developed to build upon Florida Polytechnic's STEM-focused mission. These degrees will fully consider the market needs, the resources required in delivering the degrees, and be compatible with the System's Strategic Plan*."
  - **Using this language, we are asking for board approval of:**
    - **The development of a Masters of Science in Electrical and Computer Engineering degree program (14.1001)**
    - **Concurrent with adoption, we will move the existing Engineering MS program to Mechanical (14.1901)**

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Request for Motion

- **The Current Engineering Masters program operates with**
  - Two tracks: Mechanical, and, Electrical and Computer Engineering
  - Both tracks operate with a thesis option, and a course only option
  - The two tracks share a common set of two technical classes
- **Separating the programs will not require new academic resources, it is a change in name only**

Motion to recommend to the Board of Trustees approval of the development of a Masters of Science in Electrical and Computer Engineering degree program, CIP code (14.1001).

FIPR Annual Report Approval

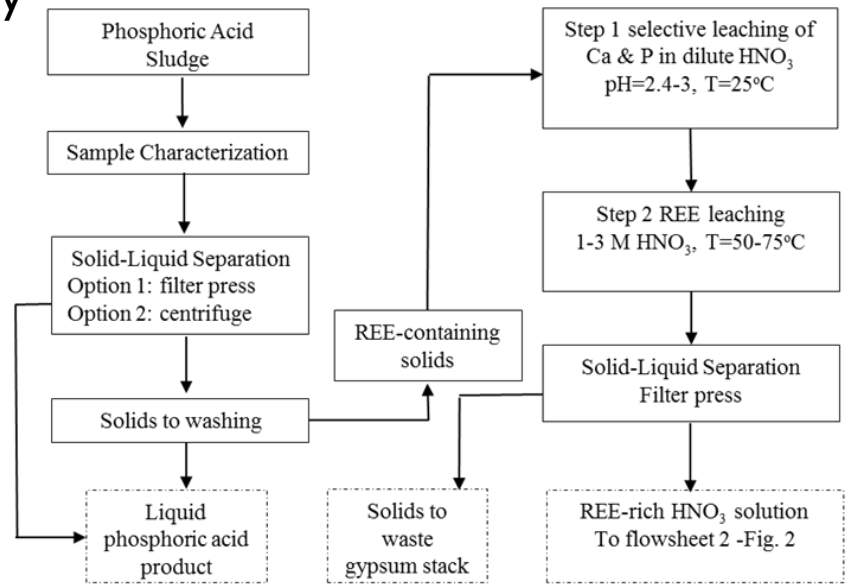
- **Four Research Areas for Focus:**
  - Minerals processing / rare earth elements (REE's)
  - Phosphogypsum (PG) stacks and PG utilization
  - Water, including process / industrial wastewater
  - Phosphatic clay
- **Augmentation of staff capability with research work from three environmental engineering faculty**
- **Highlights for the year**
  - Ten years as a member of the Critical Materials Institute (a US DOE Energy Innovation Hub)
    - Focus on production of Rare Earth Elements (REE) associated with the Phosphate Industry
    - Other DOE sponsored effort leading to potential for federal funding of a pilot facility for REE extraction
    - Lab Testing of Phosphosgypsum stack material as road base and new approaches for reducing radioactivity in PG
    - Pilot Scale demonstration of water-based separation of dolomite from phosphate ore: expands phosphate reserves
    - Nascent efforts from environmental engineering supporting water quality, phosphogypsum stack material use as road base

FIPR-led CMI Phase III Project

- **Project title: Total Utilization of Phosphogypsum Waste for Production of Rare Earth Element (REEs), Fertilizers, and Construction Materials**
- **Partners:**
  - FIPR and Rutgers University
  - Pacific Northwest and Oak Ridge National Laboratories
  - Florida International University and Mosaic
- **Project Objectives**
  - Reduce radionuclides in Phosphogypsum (PG)
  - Maximize REE leaching recovery from PG
  - Develop technologies for REE production using PG
  - Combine PG use with significant CO2 sequestration
  - Produce low-cost cement and concrete using PG as raw material with dramatic reduction in carbon footprint compared to the current commercial operations

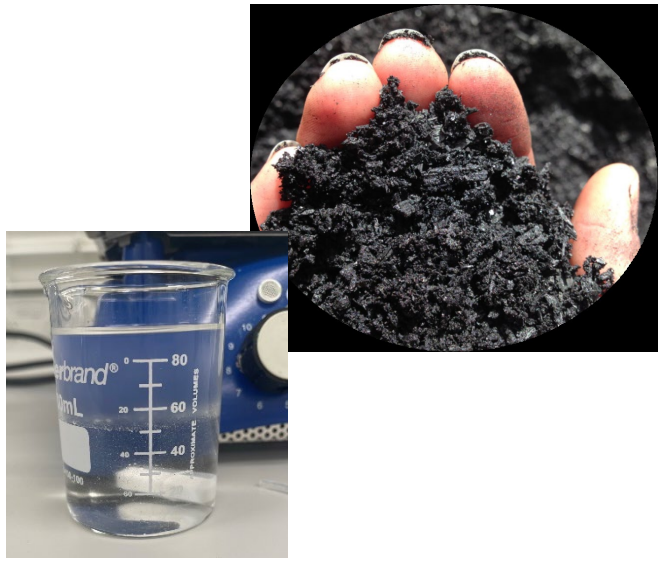
Effort Toward Commercialization of FIPR-developed Technology for REE Production

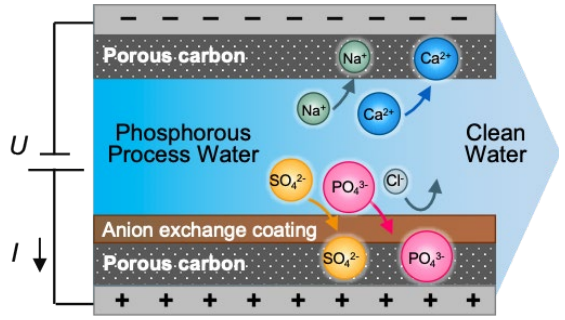
- **New Grant Proposal title: Optimization of Continuous Process Flowsheet Towards Mass Production of High-Purity REE from a Phosphate Mining Byproduct Partners:**
  - Florida Poly
  - Pacific Northwest and Oak Ridge National Laboratories
  - Florida International University
  - K-Technologies Inc, Rare Earth Salts, Rare Earth Technologies, and Mosaic
- **Grant size: $2-3 million**
- **Duration: 2 years**



FIPR Financials

- **Severance Tax Income has been falling**
  - 2021-22: $1,329,029
  - 2020-21: $1,591,280
  - 2019-20: $1,646,375
- **Income (2022-2023):**
  - Severance Tax: $1,193,161
  - Contracts and Grants: $498,624
  - Auxiliaries: $16,015
- **Expenses:**
  - Total: $1,686,668
- **Net:**
  - $21,132





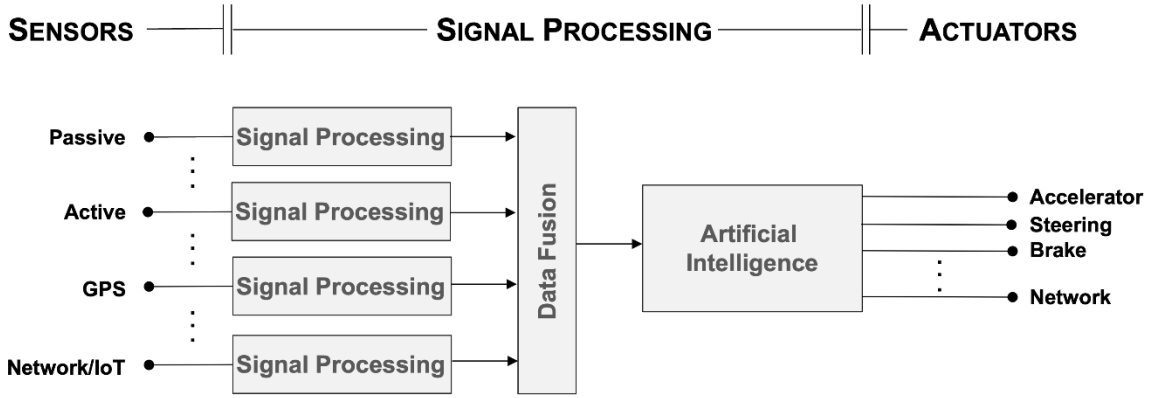
Top: biochar for Phosphate cleanup
Middle: Ionic liquid after leaching
Bottom: Capacitive deionization concept

Request for Motion

- **Annually, the Board of Trustees reviews and (potentially) approves the financial report for FIPR**
- **Key elements and financials were provided in the previous slides and in board materials**

Motion to recommend approval of the Florida Industrial and Phosphate Institute annual report for fiscal year 2023 to the Board of Trustees.

Advanced Mobility Institute Annual Report



- **Strategic partnership with SunTrax to focus on Validation and Verification**
- **Build infrastructure to support full spectrum testing**
  - Open-road testing is realistic but lacks repeatability and controllability
  - Digital twins incorporate physics-based simulations that provide repeatability and controllability to achieve AI Validation & Verification for AV applications
- **AMI focus has been on building an open-source digital twin for AV**
  - PolyVerif was substantially completed in FY23 and delivered to several university, government, and industry partners
  - Community interest in PolyVerif continues to grow (IAMTS, Autoware, SAE, …)

Advanced Mobility Institute Financials

Trial Balance		
Organization	Florida Polytechnic University	
Periods	FY2022-23 : Jul - Jun	
Ledger	Actuals	
Display Worktag Type	Cost Center	
Accounting Worktag	1056 Advanced Mobility Institute (AMI)1095 AMI 2	
Run	11/1/23 15:46	
Consolidation Data		
Ledger Account	**Cost Center**	
	Balance 6/30/2022	**339,705.12**
71101:In-State Travel	1056 Advanced Mobility Institute (AMI)	6,563.16
71102:Out-of-State Travel	1056 Advanced Mobility Institute (AMI)	1,320.20
77111:Salaries - AMP and Executive Service Group	1056 Advanced Mobility Institute (AMI)	77,597.80
77141:Fringe Benefit Expense - AMP and Executive Service Group	1056 Advanced Mobility Institute (AMI)	26,150.43
77200:Contractual Services	1056 Advanced Mobility Institute (AMI)	33,160.00
77300:Materials & Supplies	1056 Advanced Mobility Institute (AMI)	72.00
77300:Materials & Supplies	1095 AMI 2	4,350.00
		149,213.59
	Balance 6/30/2023	**190,491.53**
	Expenses, Commitments and Obligations for FY24	(151,085.70)
	Remaining balance 10/31/23	39,405.83

Request for Motion

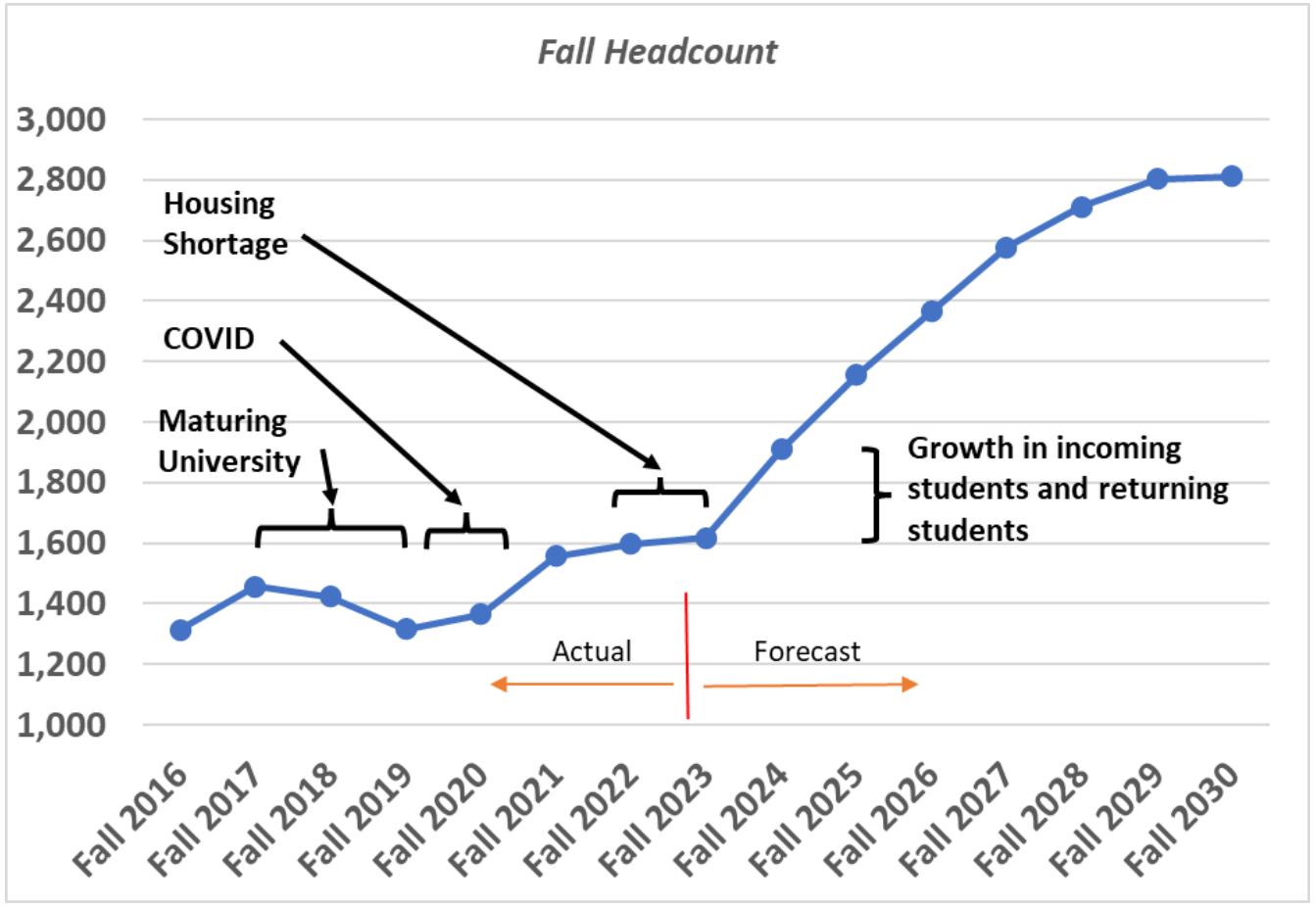
- **Annually, the Board of Trustees reviews and (potentially) approves the financial report for AMI**
- **Key elements and financials were provided in the previous slides and in board materials**

Motion to recommend approval of the Advanced Mobility Institute annual report for fiscal year 2023 to the Board of Trustees.

Accreditation Activity

- **SUS and FCS institutions must change institutional accrediting agencies (SB 7044, effective 7/1/2022)**
- **Formal request made to US Dept. of Education (USDE)**
  - March 2023
  - Change accrediting agency from SACSCOC to HLC
  - Current status is that all information requested by USDE has been provided to them
  - Institution accreditation activity: maintain activity to support SACSCOC accreditation, consider activity required for change
- **ABET accreditation activity**
  - Four programs are up for reaccreditation this year (Computer Engineering, Computer Science, Electrical Engineering, Mechanical Engineering)
  - Two programs where we will seek initial accreditation: Environmental Engineering and Data Science
  - Activity throughout the year, each program requires a self-study report to be submitted before July 01, 2024

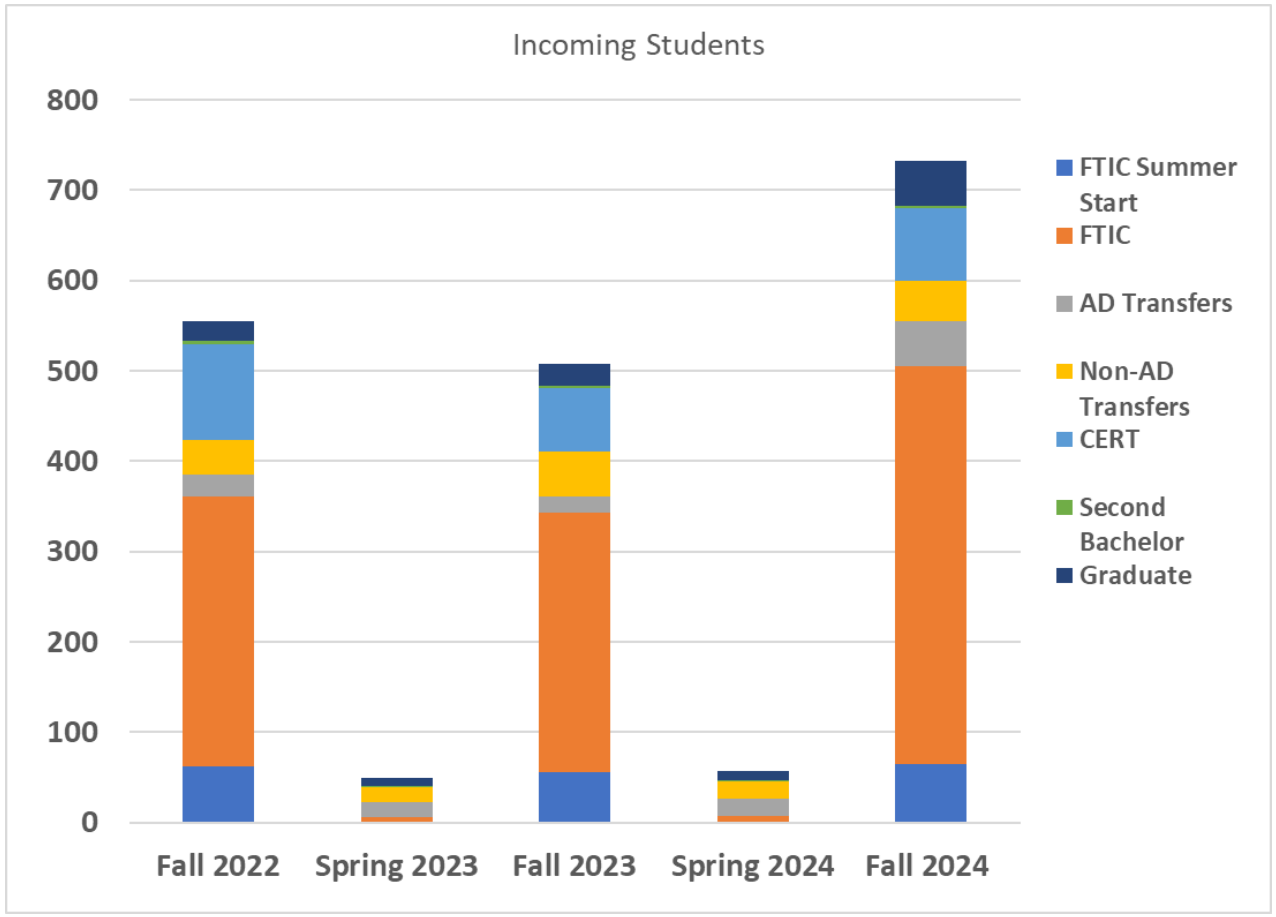
Florida Poly is working actively to grow its student population



The addition of the new residence hall is the key to our next phase of growth

Admissions uses a range of "entry paths" to bring students to Florida Poly

- **FTIC: First Time in College**
- **FTIC Summer start: lower entry metrics**
- **Transfers: with and without Associates Degrees**
- **Cert: Challenge program**



Growth in Fall 2024 entering class enabled by a range of proactive measures

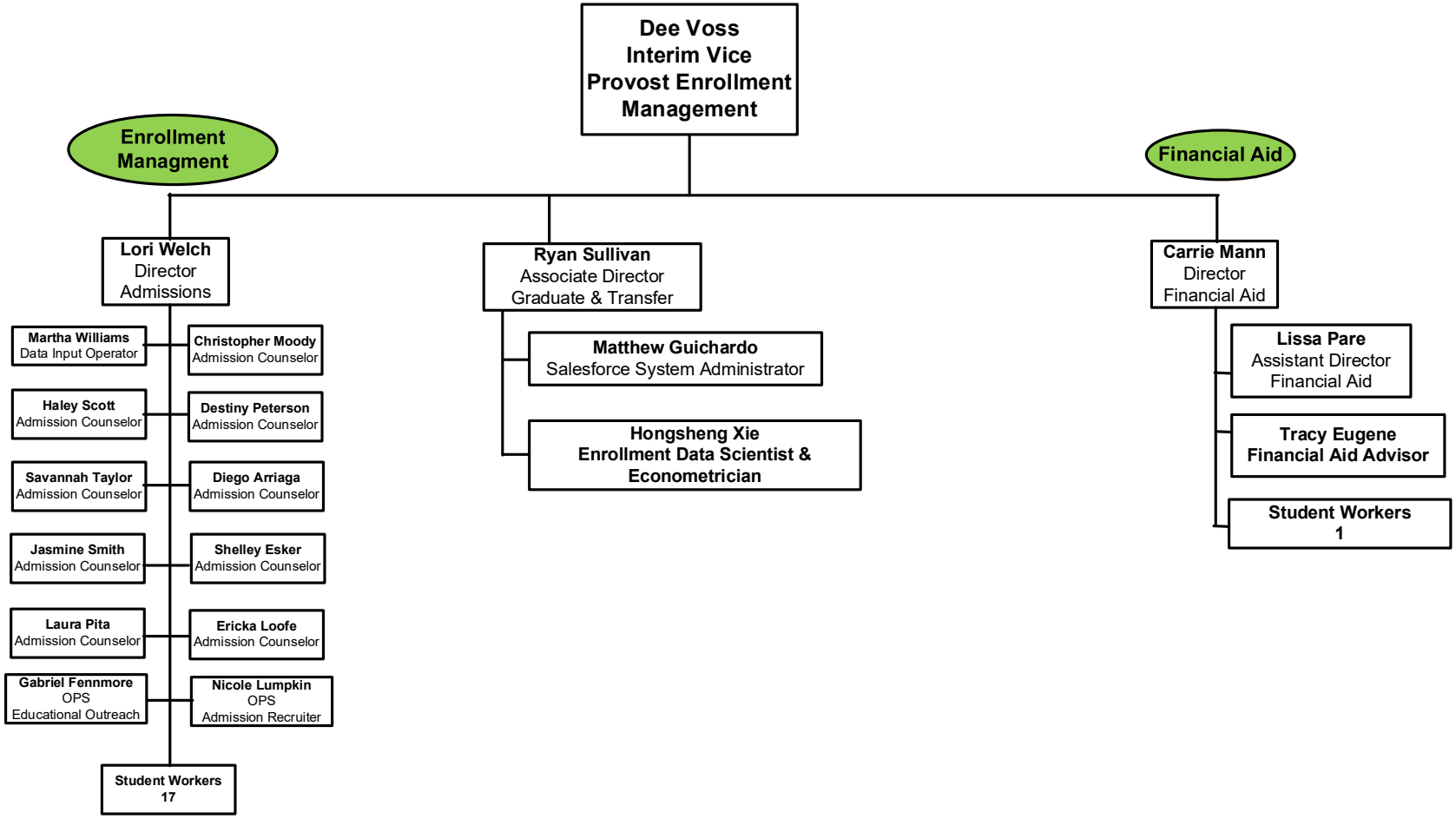
Strategic Shift in Enrollment for Fall 2024 and Beyond

- **Change in Leadership**
  - Dee Voss, Interim Vice Provost Enrollment Management
  - 20+ years in Florida Admissions, 3 major institutions, 4 years with Education Advisory Board
- **Shift in Academic Year 2022-23 to marketing to High School Juniors, Sophomores, Freshman**
- **Move to market majors and not focus on concentrations**
  - Started last January with a shift in website, emphasize Degree offering (note expansion of degrees)
  - Focus freshmen marketing messages on majors, STEM demand, Florida Poly proven outcomes, and affordability
- **Creating strong partnerships and data sharing with academic departments and key partner offices within the University**
  - Recruitment events have faculty strongly embedded within them

Results as of 10/27/2023:

- *Applications up by 83%, up in all geographic areas, average admit SAT 1351*
- *~300 positive admission and merit aid decisions released to prospective students*
- *Housing options will open to new students ~December 1*

Enrollment Management includes Admissions and Financial Aid



Enrollment Management is fully staffed and contributes actively to retention and graduation efforts

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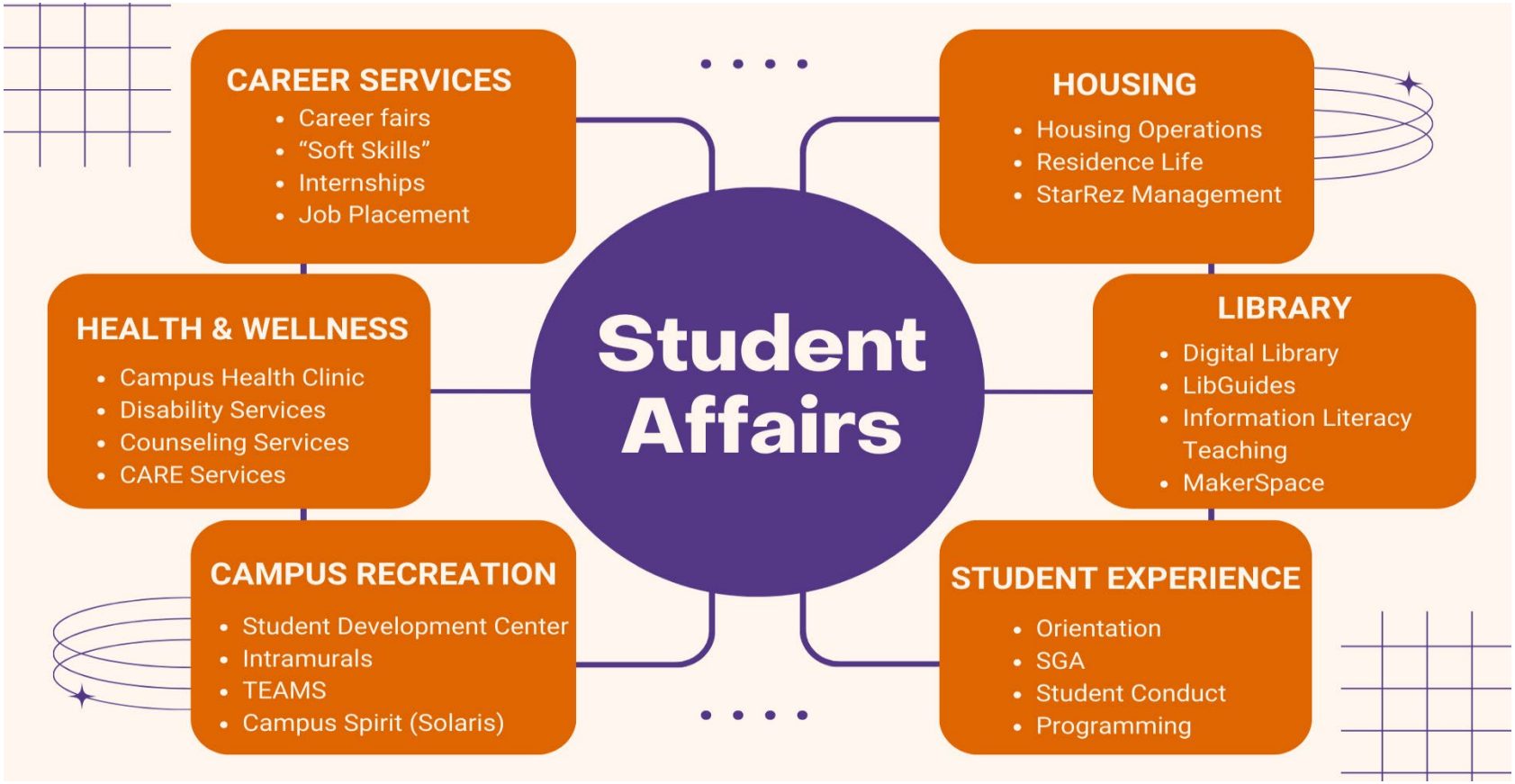
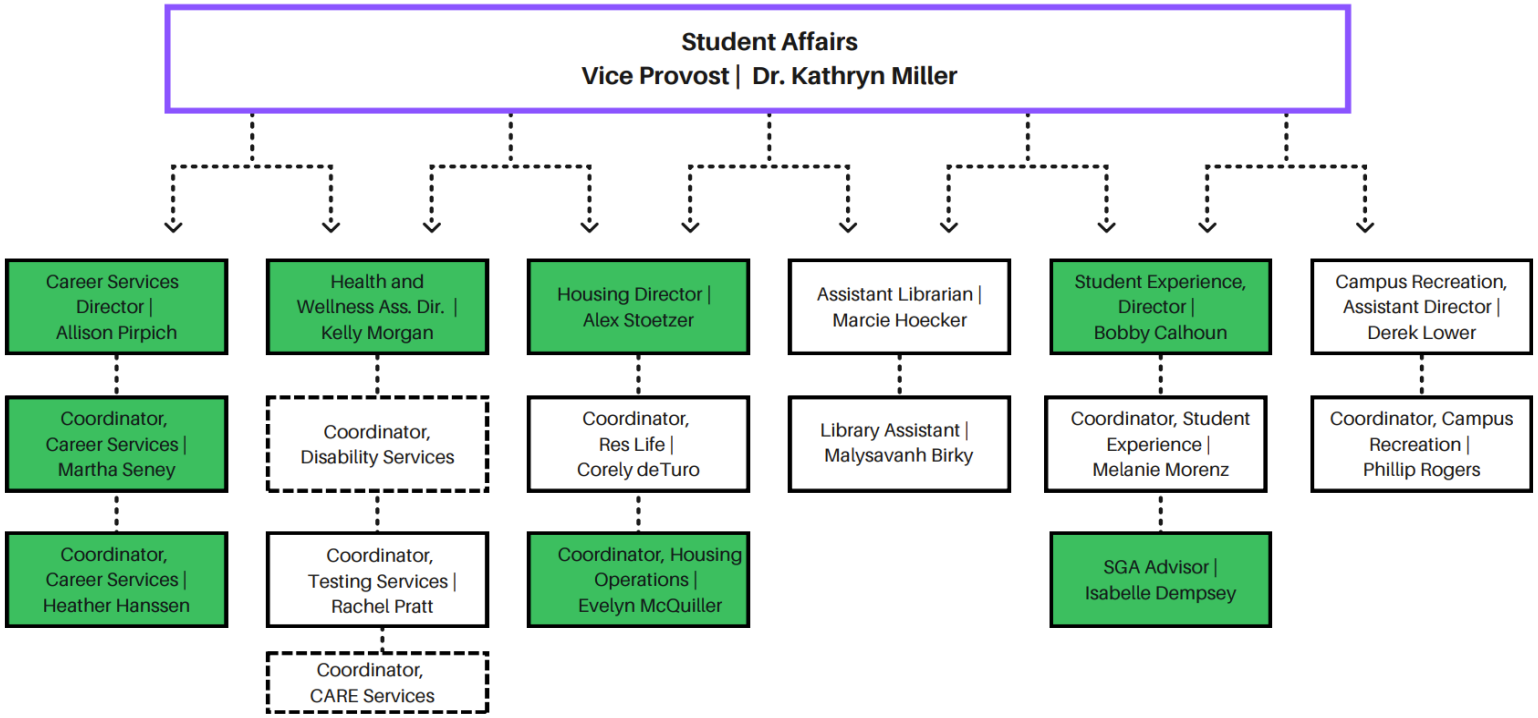
Learning Beyond the Classroom



Student Affairs is committed to student engagement and learning beyond the classroom. The department fosters student growth through personal development, interpersonal skills, and civil discourse.

Student Affairs



Green: New and Notable. Dotted Border: Open Position.

- **Career Services**—January 2023—Fully rebuilt to focus on student internship and career outcomes
- **Health and Wellness**—Fall 2023—New Associate Director and focus on process. Note continued relationships with Lakeland Regional and BayCare. Case management system for mental health support
- **Housing**—January 2023—Opened new Housing Operations Office. StarRez implementation and successful AY 2023-2024 leasing
- **Student Experience**—March 2023—New Director and management of SGA activities and Registered Student Organizations

Student Experience Continues to Evolve

- New Student Convocation
- Growth of ULead Program
- Usage of Student Development Center has doubled
- Number of intramural activities has doubled
- New frisbee golf course
- MakerSpace
- Resume Books for company recruitment
- Solaris named
- Alma Mater and Fight Song
- Band participation in local parades
- Leadership Council

LEADERSHIP IS DEFINED AS BEHAVIORS WHICH EMPOWER ACTIONS THAT INSPIRE PERSONAL RESPONSIBILITY, COLLABORATION, AND SHARED WORK TOWARD A COMMON GOAL.

CURRICULUM

ALL STUDENTS

Leadership skills that are acquired through in-class projects and curricular requirements add the important element of disciplinary application and facilitate the student's maturation to a STEM professional.

EMERGING

SELECT STUDENTS

Emerging Leader programs are guided by a faculty or staff leader, emerging leader programs support students in becoming self-aware of how to effectively grow and use their personal leadership potential.

EXTRA

STUDENTS OPT-IN

Extracurricular Leadership. Students to gain valuable experience in student organizations through a portfolio of outside of the classroom opportunities.

LEADERSHIP PROGRAMS OPERATE WITH GRATITUDE TO GARY C. WENDT FOR HIS GENEROUS GIFT AND COMMITMENT TO THE DEVELOPMENT OF STUDENT LEADERSHIP SKILLS

Housing

Phase 3 Residence Hall

The Residential Campus

- Campus Living as a key yield tool
- Community atmosphere
- Learning beyond the classroom
- Connection to campus
- Access to campus resources
- Opportunities for personal growth
- Introducing Themed Learning Communities

With the University-owned res hall buildings we are able to work with a housing agreement structure, implement housing agreement timelines and strategy that align with Enrollment Management and continue the training and daily use of our campus safety net.

Campus Community: The Importance and Value of Traditions

- New Student Move-In
- New Student Orientation—PlayFair
- Convocation
- The Bridge Crossing
- Purple Fire Week
- Class Color
- Family Day/Solaris' Birthday
- Fall Fest
- Club Row
- Humans vs. Zombies
- Florida PolyCon
- Intramural Competitions and Winners
- Gingerbread Contest
- Career—Ringing of the bell
- Faculty and Staff vs. Students competitions
- Florida Poly Pi Run
- Moonlight Breakfast
- Floor Wars
- Spring Fest
- U Lead Selection and Training
- Fight Song
- Alma Mater
- TEAMS—Purple and White games
- Tailgates
- Degree Programs:
  - First Year Hack-A-Thons
  - Capstone Showcase
  - Ring Ceremonies

Ever Forward
Florida Poly
University we adore.
Innovation is our history
From all those who came before.
Knowledge, passion, and with purpose
We soar higher than before.
Alma Mater, strength and honor
Florida Poly ever more.

"Performance Based Funding" sets common metrics to measure performance

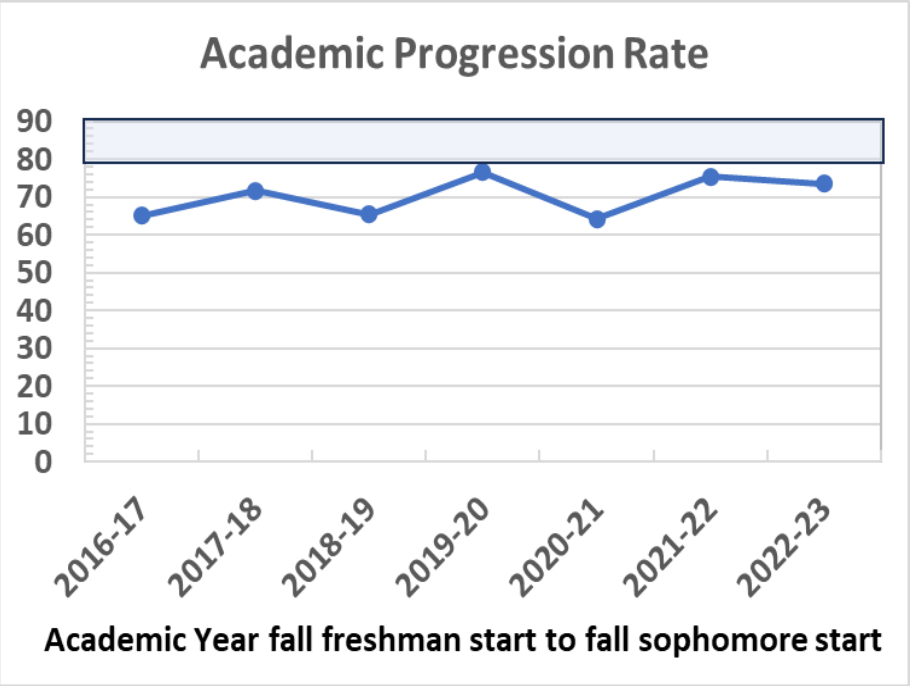
	Performance Funding Metric	FY21	FY22	FY23*	
1	% BS Graduate Employed	10	9	10	
2	Median Wages BS Graduates	10	10	10	
3	Average Cost to Student	10	10	10	
4	FTIC 4-yr Graduation Rate	0	7	5	
5	Academic Progress Rate	10	0	10	
6	% BS Degrees in Strategic Emphasis	10	10	10	
7	University Access Rate	8	7	7	
8	% Graduate Degrees in Strategic Emphasis	10	3	10	
9a	FCS Transfer 2-yr Graduation Rate	0	0	0	
9b	Pell Recipient Retention Rate	5	0	5	
10	% BS Graduates with 2+ Workforce Experience	10	10	10	
		83	66	87	

Red text denotes metrics unique to Florida Poly

Metrics that are difficult for Florida Poly

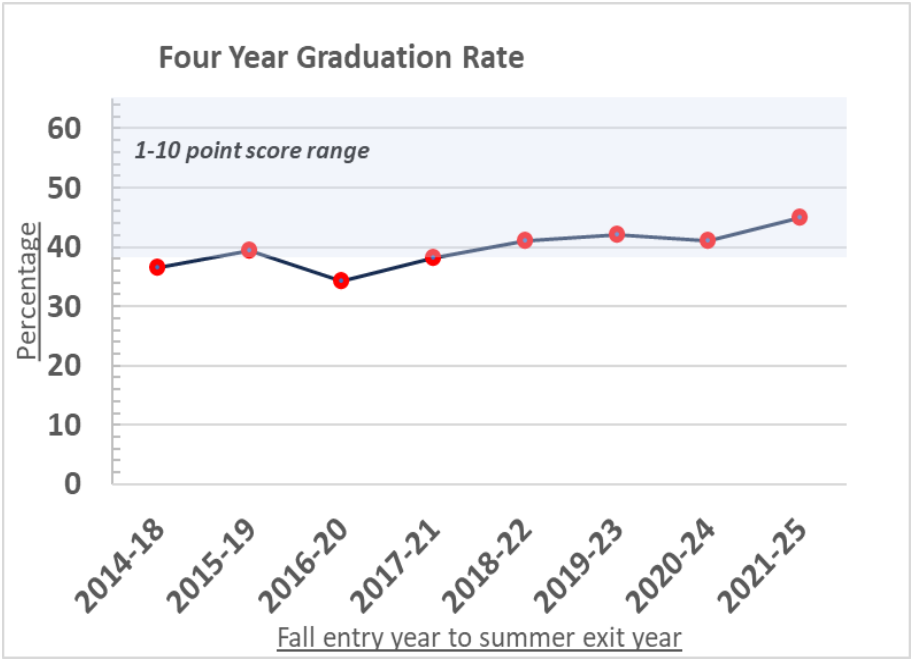
The university implements programs to improve Academic Progression Rate

- **Academic Year 2021-22**
  - Schedules determined by student entrance metrics
  - Peer Learning Strategist (PLS)program in key freshman courses
- **Academic Year 2022-23**
  - Student Success Center
  - Freshman Council
  - Courses added to Peer Learning program
- **Academic Year 2023-24**
  - Teaching Workshops for ALL faculty
  - Admissions: emphasis on degree requirements
  - Further expansion of Peer Learning program
  - Expansion of student life opportunities



Four-year graduation rate is a second metric that is difficult for Florida Poly

- **Efforts at improving Academic Progression Rate also support increases in four-year graduation rate**
- **Additional efforts**
  - Stronger degree pathways with thoughtful prerequisite structures (2017 and onward)
  - Degree progression policy – courses are repeated immediately (2021)
  - Summer repair courses (2018 and onward)
  - Course planning through graduation software (2023)
  - Sophomore year courses added to peer learning program (2023)
  - Teaching workshops for faculty (2023)



Critical Metric Comparisons with the SUS and STEM Peers

Key Factors:

- Students that are not successful with Calculus end up leaving the university
- We do not have a degree progression pathway that is "easy"
- Our focus has been on promoting student success in foundational freshman courses
- Conclusion is both metrics can be improved, the focus must be on Academic Progression

Comparison of Critical Metric Averages for Florida Poly to the SUS and Peer Institutions

	APR or Retention	Four Year Grad Rate
State University System (comprehensive universities)	83.50%	53.80%
Aspirational Peer Instituions	90%	72%
Peer Instituions	82%	41%
Florida Poly	75.30%	41%

Aspirational Peers: Stevens Institute of Technology, Rose Hulman, US Navy Academy, US Military Academy, Lafayette College, Colorado School of Mines, US Air Force Academy, Bucknell, Cal Poly San Luis Obispo, Union College

Peers: Missouri University of Science and Technology, Milwaukee School of Engineering, New Mexico Tech, Kettering, Gonzaga, Michigan Tech, Clarkson, Florida Institute of Technology, Embry-Riddle Prescott

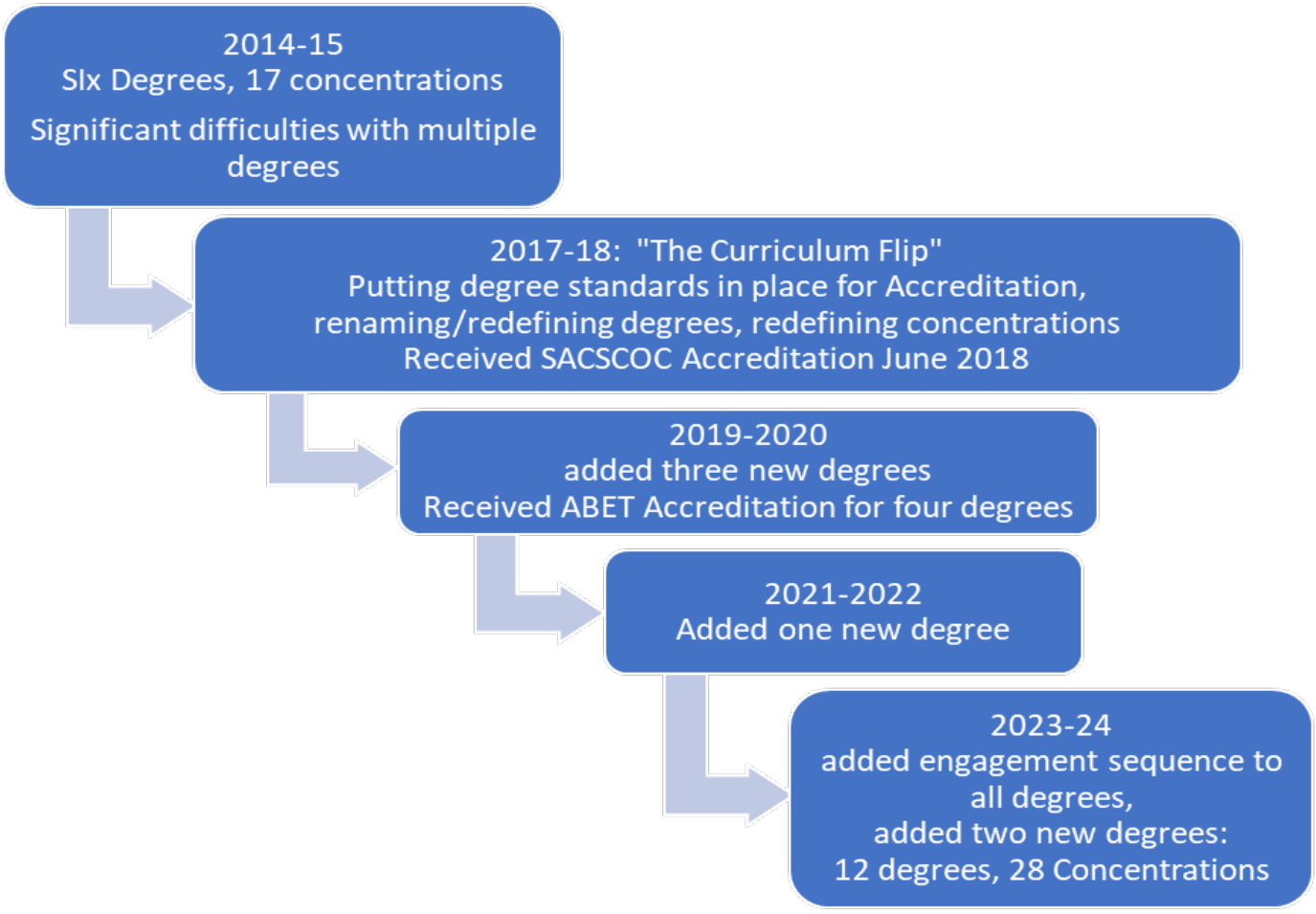
Data Source is IPEDS and SUS PBF data, note retention is typically 3 to 6 percent higher than APR

The Anatomy of a Florida Poly Degree

- **State requirements for Bachelors are 120 credit hour maximum and must meet the 36 credits of General Education Requirements**
  - 18 credits of Communication, Humanities and Social Sciences*
- **Common Freshman Year Supported by STEM Core**
- **Professional Internship as a Graduation Requirement**
- **Technical Coursework to support ABET accreditation or best practice for the degree**
  - Carefully sequenced courses across and within the home department (defined by degree standards such as ABET)
  - Two Semester Capstone Design Sequence in senior year
  - The Engagement (or Design) Sequence (new this year, special thanks to Trustee Wendt)
  - Technical Electives packaged as Concentrations
  - Focus area within the degree program

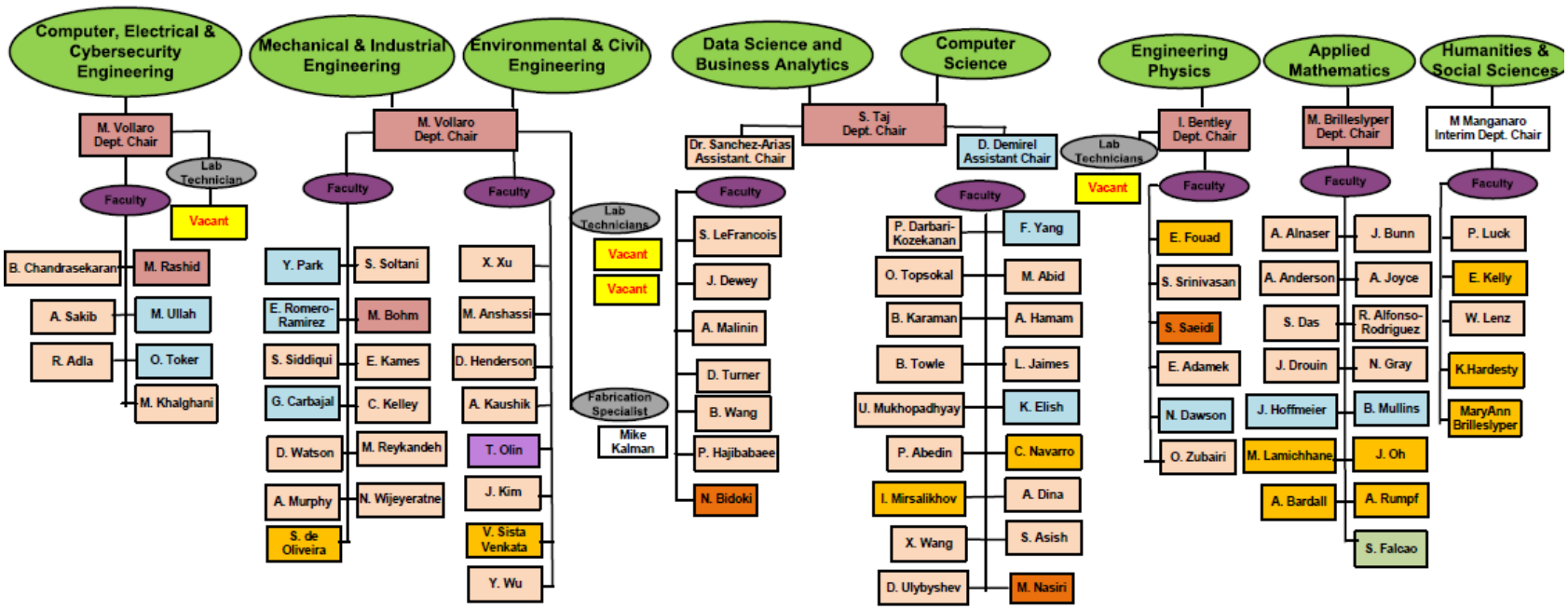
also state requirements of foreign language, summer residency and civic literacy

Our Undergraduate Degree Offering has evolved quickly



FLORIDAPOLY

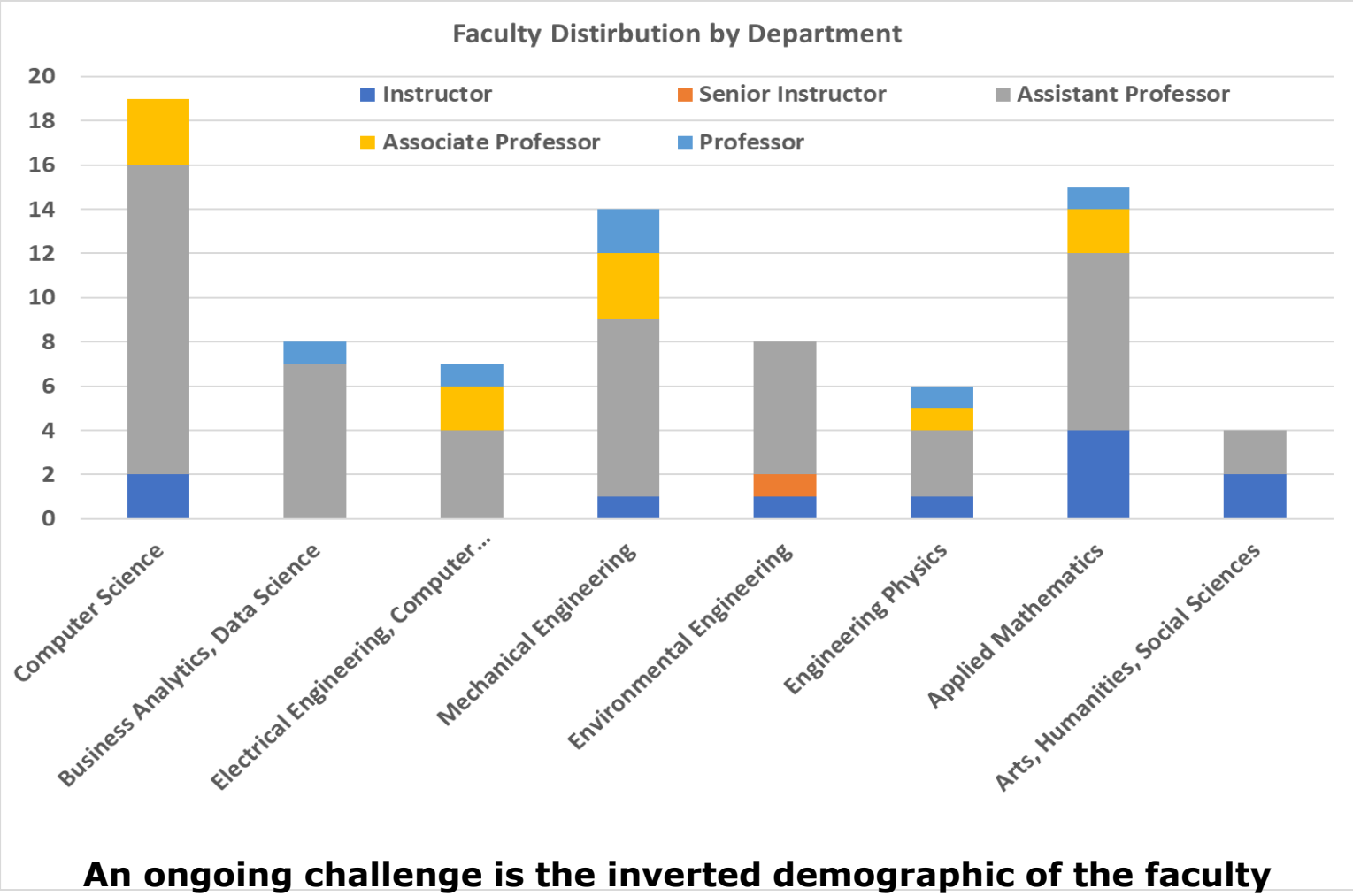
Degrees are delivered by the academic departments



Fall 2023

Professor	Associate Professor	Assistant Professor	
Senior Instructor	Instructor	Visiting Assistant	Visiting Instructor

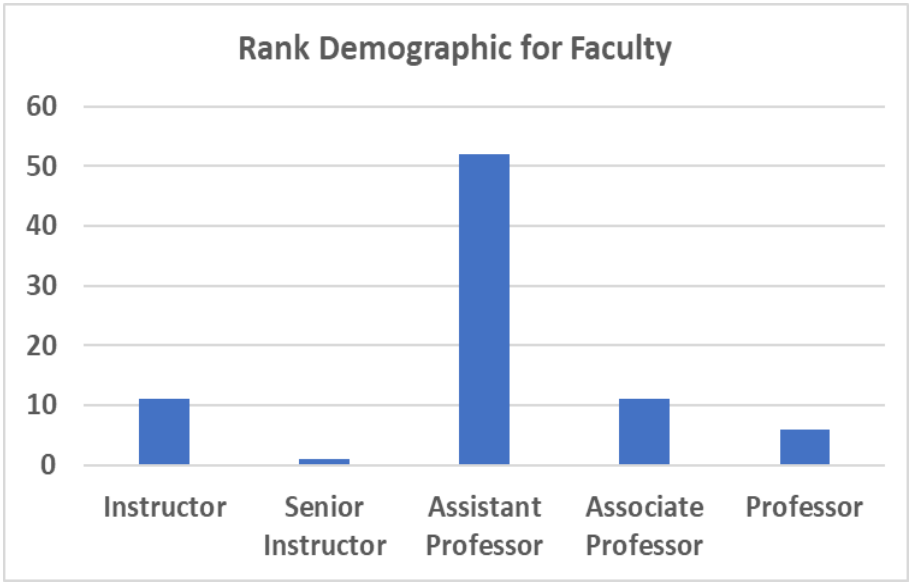
Faculty are distributed in departments to meet delivery needs



An ongoing challenge is the inverted demographic of the faculty

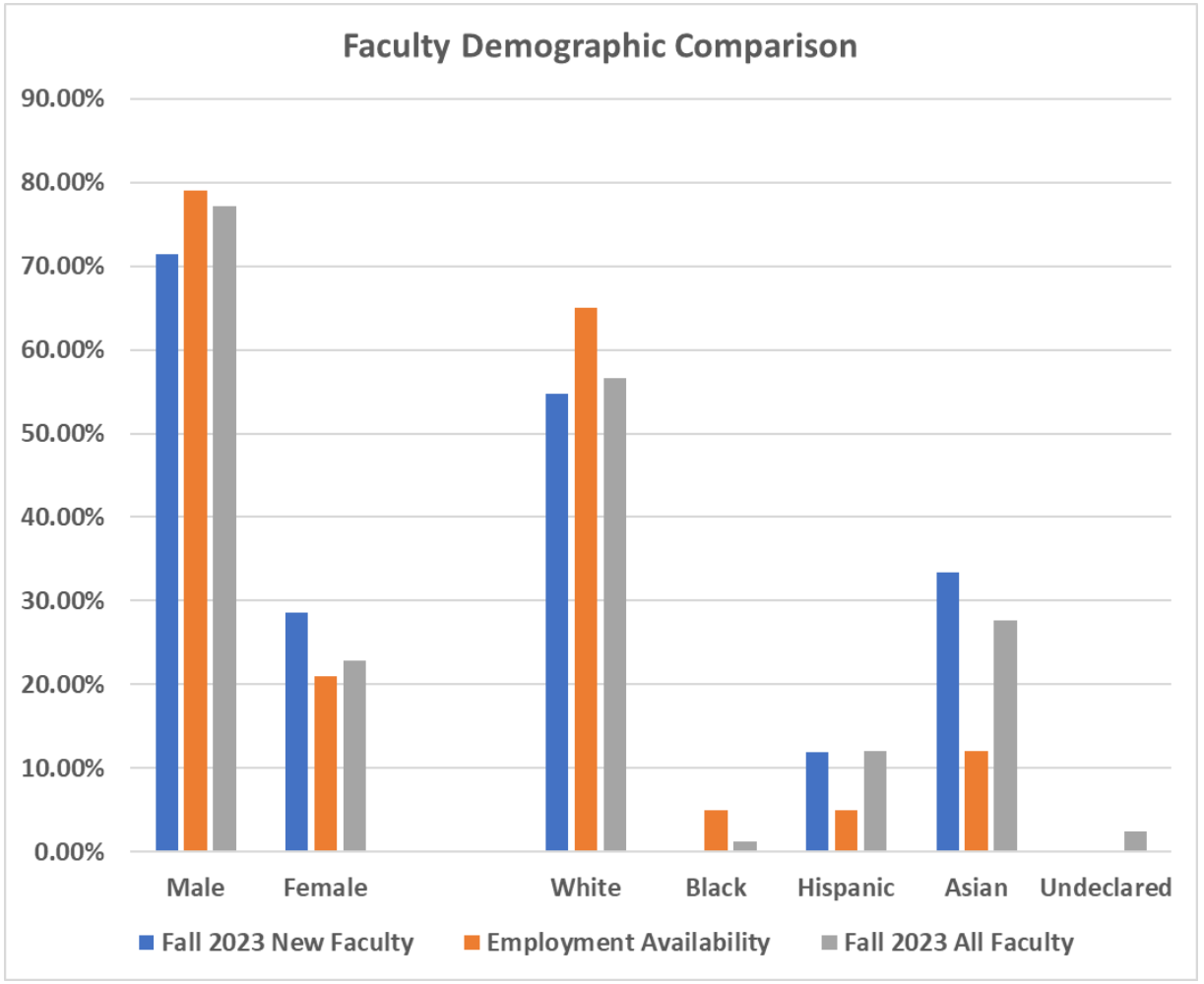
Faculty hiring for the year is underway

- **Identified need for ~20 new faculty**
  - **Meet growth needs, new degree needs, replacement for attrition**
- **16 faculty are up for reappointment or promotion this year**
- **The combined "load" to staff searches and reappointment and promotion is significant**



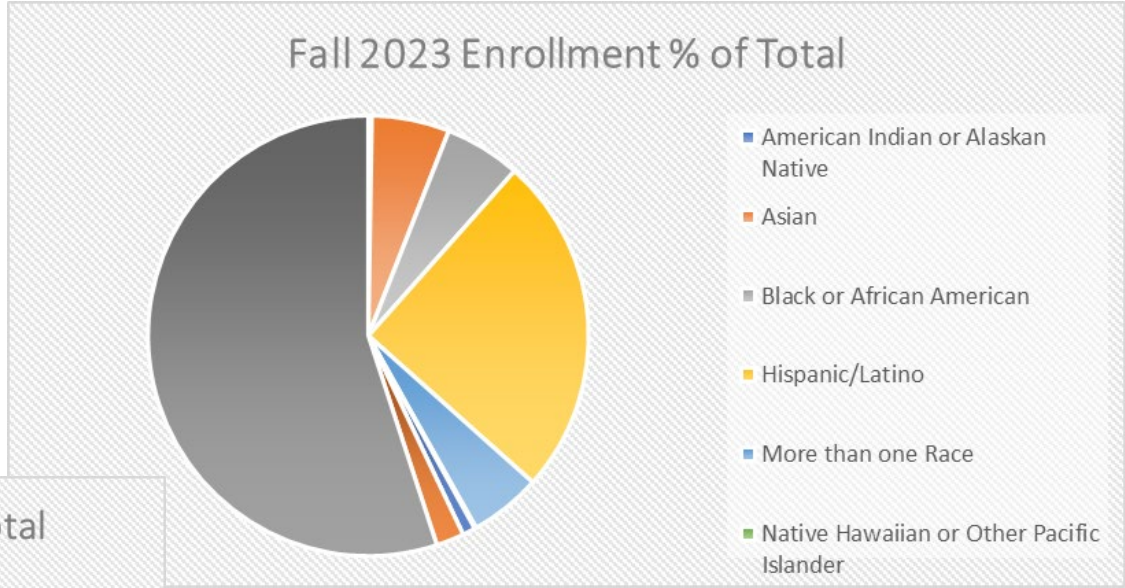
The faculty at Florida Poly are dominantly Assistant Professors. This reflects the youth of the institution and the difficulty with hiring mid or late career individuals

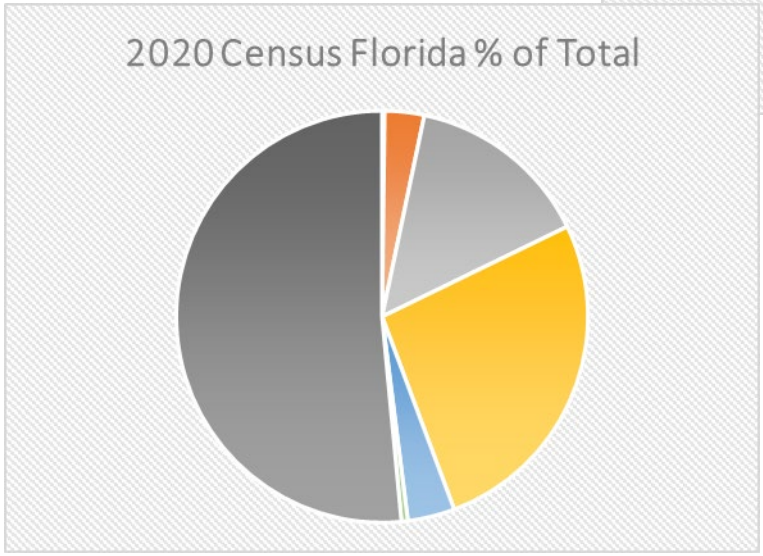
Faculty Demographics for new faculty, all faculty, and employment availability



- **Our faculty demographic is strongly influenced by the demographic of our application pools**

Student population and Florida demographic are similar





- ***The university does NOT reflect the state gender demographic; the student body is currently 19.4% female***

Technology and Pedagogy

- **During COVID, the campus "flipped the switch" and went to remote and hybrid delivery**
- **From this experience:**
  - **Our new infrastructure facilitated the move to Hybrid with little difficulty**
    - Network infrastructure that is up to date, classroom cameras that are available, the use of laptop cameras to facilitate delivery, all made this possible
    - Results were not good and demonstrated that we can do this but outcomes were poor student engagement and learning results overall
    - We do use hybrid in targeted ways for courses that are appropriate (mixed online and in person classes)
- **Our emphasis now:**
  - **Developing an excellence in teaching culture in the faculty**
    - Onsite and external faculty workshops

FLORIDAPOLY

Key Messages for Today

- **Approvals**
  - Electrical and Computer Engineering degree development
  - FIPR annual financial report
  - AMI annual financial report
- **Accreditation Activity**
  - Regional Accreditation we await notification, ABET effort is underway
- **Admissions and Financial Aid**
  - Significant changes in positioning and processes, early indicators positive
- **Student Affairs**
  - Strong growth of activity on campus in support of our students
- **Four-year Graduation Improvement Plan**
  - Discussion of critical metrics for PBF and Florida Poly
- **Degree Program Additions and Faculty Hiring**
  - Review of undergraduate degree history,
  - Faculty hiring plans and note on faculty rank demographic
- **Student and Faculty Demographics**
- **Technology and Pedagogy**
  - Current focus is on teaching excellence

AGENDA ITEM: VI.A.

Florida Polytechnic University

Academic and Student Affairs Committee

Board of Trustees

November 6, 2023

Subject: M.S. in Electrical and Computer Engineering Program

Proposed Committee Action

Recommend to the Board of Trustees approval of the development of a Masters of Science in Electrical and Computer Engineering degree program, CIP code (14.1001).

Background Information

Currently the Engineering Master's program has two tracks: Mechanical, and Electrical and Computer Engineering. Both operate with a thesis option and a course only option, with a common set of two technical classes. Separating these two tracks into distinct programs will not require additional academic resources.

The 2023 Accountability Plan provided language that supports the development of a Master of Science in Electrical and Computer Engineering degree program (CIP code: 14.1001) and the concurrent adoption of moving the existing Engineering MS program to Mechanical (14.1901).

Supporting Documentation: N/A

Prepared by: Dr. Terry Parker, Provost, and Executive Vice President

AGENDA ITEM: VI.B.

Florida Polytechnic University

Academic and Student Affairs Committee

Board of Trustees

November 6, 2023

Subject: Florida Institute of Phosphate Research (FIPR) Institute Annual Report FY23

Proposed Committee Action

Recommend approval of the Florida Institute of Phosphate Research Annual report for fiscal year 2023 to the Board of Trustees.

Background Information

FIPR was established as a University Center in August of 2020 following a long history as a state research enterprise. The Board of Governors requires annual reporting by December of each year of the expenditures during the prior fiscal year using the mandated BOG format.

Highlights for the year include:

- Ten years as a member of the Critical Materials Institute (a US DOE Energy Innovation Hub)
- Focus on production of Rare Earth Elements (REE) associated with the Phosphate Industry
- Other DOE sponsored effort leading to potential for federal funding of a pilot facility for REE extraction
- Lab Testing of Phosphosgypsum stack material as road base and new approaches for reducing radioactivity in PG
- Pilot Scale demonstration of water-based separation of dolomite from phosphate ore: expands phosphate reserves
- Nascent efforts from environmental engineering supporting water quality, phosphogypsum stack material use as road base

The report follows the format required by the Board of Governors.

Supporting Documentation: FIPR Financial and Annual Reports for FY23

Prepared by: Dr. Terry Parker, Provost and Executive Vice President

Fiscal Year 2022/2023 Annual Report

Florida Industrial and Phosphate Research Institute

Contents

Phosphate Research and Activities Board Members

Robert Fredere, Jr., The Mosaic Company, Chair

To be Named, Florida Department of Environmental Protection, (Vishwas Sathe retired from the board fall 2022, new member to be named by Department of Environmental Protection)

Randy Avent, Ph.D., Florida Polytechnic University, President

Environmental Community Member, Awaiting Appointment

Industry Member, Awaiting Appointment

Florida Industrial and Phosphate Research Institute Technical Staff

Terry Parker, Ph.D., Executive Director and University Provost

Patrick Zhang, Ph.D., Research Director, Mining and Beneficiation

Aaron Medley, B.S. Laboratory Manager

Florida Polytechnic University Environmental Engineering Faculty contributing to FIPR.

Mary Vollaro, Ph.D., Department Chair

Jun Kim, Ph.D., Assistant Professor

Derek Henderson, Ph.D., Assistant Professor

Xiaofan (Caleb) Xu, Ph.D., Assistant Professor

Executive Director's Message – Dr. Terry Parker

FIPR has transformed itself from a standalone, state-funded research center to a university research institute that is fully embedded within Florida Polytechnic University. FIPR's core funding is a small fraction of the Florida state severance tax on phosphate rock product, which provides between $1.2M and $1.5M in support for research operations; multiple research grants and testing services provide important augmentation to these funds. As a research institute, FIPR has continued to focus on four critical areas that are consistent with its statutory mission:

- Minerals processing / rare earth elements (REE's)
- Phosphogypsum (PG) stacks and PG utilization
- Water, including process / industrial wastewater
- Phosphatic clay

In order to augment operations in these areas and to bring new ideas and viewpoints to FIPR, the University has created a strong alignment between the Environmental Engineering Department and FIPR. This partnership brings the inherent strength of the environmental engineering department in water and water quality to FIPR. A critical area for the phosphate industry in the future is water with problems ranging from managing process water to very broad effects of the industry on water in the environment.

FIPR is an internationally recognized institution of excellence in the global phosphate realm and has been leveraging this expertise to gain prominence in addressing the needs of our nation's security and economic independence based on efforts that support domestic production of critical rare earth elements. FIPR continues to be a unique contributor to the United States' efforts to ensure a domestic supply chain of these materials. This role was formalized 10 years ago as it became a founding member of the Critical Material Institute. FIPR has maintained its presence in this effort over the last decade. At this time, the effort has expanded into other grant opportunities where FIPR is looking to develop methods to exploit Florida's vast phosphate resources to meet the challenges of ensuring a domestic supply of critical rare earth elements. FIPR's ongoing efforts in the Critical Materials Institute and within other federally funded grants is a clear indication of our federal government's acknowledgement of FIPR's unique capabilities.

Since its creation in 2013, the USDOE's Critical Materials Institute has consistently supported FIPR's research in exploring the viability of phosphate deposits as a potential source of a domestic supply of rare earth elements. The 10-year funding program, with FIPR as a founding member, has made great progress in developing methods of REE extraction from all phosphate processing streams. The Critical Materials Institute has been renewed at the federal level, and FIPR remains a vital and active part of this national effort.

Significant progress has also been made toward realizing the capability to economically separate phosphate from dolomite in the vast high-magnesium phosphate pebble resources in Florida. FIPR's pilot plant at Mosaic's South Pasture facility has demonstrated that this recovery can be accomplished. This will greatly expand Florida's phosphate reserves well into the future. FIPR is investigating how to apply this technology so that the economics are favorable to the overall industry

The goal of finding high-volume uses for phosphogypsum was also addressed with the development of a novel road base technology through FIPR's Smart Road research project. The technology demonstrated load bearing strengths with Phosophgypsum as a road base that exceeded the state's standards with competitive economics to conventional methods. FIPR's intent is to identify pathways for using this material as a way of limiting, and potentially decreasing the amount of phosphogypsum stacked in Florida. To move this forward, we will continue to test the material as a road base, and work with the phosphate industry as a partner to identify regulatory barriers to adopting this as a roadbase.

Seamless integration of FIPR's efforts and capabilities with those of Florida Poly has made great strides during the past year. FIPR directorial staff served on committees to select the University's Environmental Engineering faculty. Environmental Engineering faculty have embarked upon new phosphate research projects that draw upon their individual areas of expertise with FIPR's support.

FIPR's laboratory services capabilities continue to be recognized by industry as providing high-quality, high-value results. This business center's activity has continued to be robust in its service to industry and academia. FIPR laboratory instrumentation will also be employed to enhance Florida Poly faculty research moving forward. FIPR and Florida Poly look forward to enhancing these partnerships as the University grows well into the future.

I am pleased to present this report of the Institute's activities and accomplishments during the 2022-2023 fiscal year and look forward to the challenges and achievements to come in the year ahead.

Summary of Core FIPR Activities (Contributed by Dr. Patrick Zhang, A. Medley)

Recovery of Critical Materials from Phosphate

CMI Phase II

FIPR is one of the founding members of the Critical Materials Institute (CMI) and has secured about $2 million CMI funding during Phases I and II for research on recovery of critical rare earth elements (REE) from byproducts and wastes generated during phosphate mining and processing. On July 1, 2023, CMI Phase II officially concluded and began its new phase. FIPR's achievements under CMI Phase II reached a new level during the current year by meeting all the milestones and filling two provisional patents. In a patent titled System and Method for Recovery of Rare Earth Elements and Phosphate from Byproduct Materials (US patent 63/465,121, May 9, 2023), FIPR disclosed a physical treatment method that can enhance REE leaching from phosphate byproducts achieving higher recovery with reduced leaching time and acid consumption. The other innovation involves thermal cracking of REE in phosphoric acid sludge achieving over 95% REE recovery while recovering the phosphate as high-value elemental phosphorus. (System and Method for Recovery of Rare Earth Elements and Phosphate from Phosphoric Acid Sludge, US patent 63/466,858, May 26, 2023).

CMI 2023 Phosphate Workshop

As a Florida Poly News post summarized, “Research scientists and industry leaders from across the country converged at Florida Polytechnic University to learn about research around rare earth element (REE) extraction at the CMI 2023 Phosphate Workshop”. FIPR organized this workshop to present our recent developments in collaboration with national labs in REE recovery from phosphate and to seek technical input from experts in the field. This two-day event also featured presentations by three technology companies on separation and purification of REE metals in the forefront of technology development by US scientists.

Workshop participants engaging in discussion with an industry representative during coffee break.

Successful REE Project Funded by US Department of Energy (DOE)

In collaboration with Pacific Northwest National Laboratory (PNNL), Oak Ridge National Laboratory (ORNL), Florida International University and Mosaic, FIPR Institute successfully concluded a new REE recovery project funded by the DOE (DE-FE0032123, 01/01/2022 to 09/30/2023). The project was titled “Technology Development and Integration for Volume Production of High Purity Rare Earth Metals from Phosphate Processing”. The research team developed a promising processing flowsheet (Figure 1) for production of high purity mixed rare earth oxide and rare earth metals. Considering this achievement, we are collaborating with the team members and preparing a new ($2-3 million) grant proposal for continuous testing of the processing technology to bring it one step closer to commercialization. The proposal is titled Optimization of Continuous Process Flowsheet Towards Mass Production of High-Purity REE from a Phosphate Mining Byproduct.

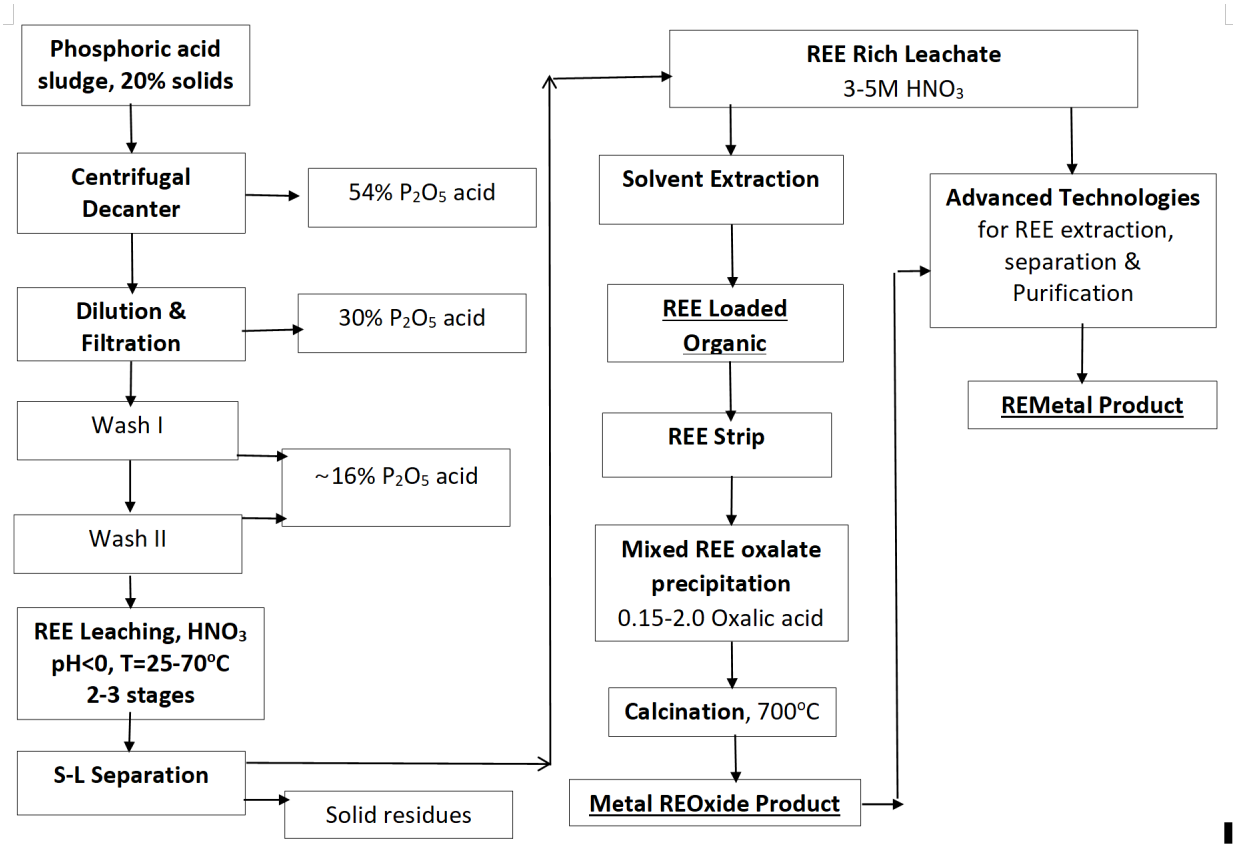


Figure 1. Overall processing flowsheet developed by FIPR and collaborators for production of high-purity MREO and REE metals using phosphoric acid sludge as feedstock.

CMI Phase III

FIPR led a five-member team in submitting a proposal to compete for CMI Phase III projects and succeeded in securing funding for the proposal in the amount of about $800K ($250K for FIPR) per year, likely for 5 years. The project is titled “Total Utilization of Phosphogypsum Waste for Production of REEs, Fertilizers, and Construction Materials”. Team members include Rutgers University, PNNL, ORNL, FIU and Florida Poly. The research project is designed to integrate recovery of critical elements into total utilization of the huge amount of PG generated from phosphoric acid manufacturing with five major objectives:

1. Reduce radionuclides in PG thus removing a hurdle to its use
2. Maximize REE leaching recovery from PG
3. Develop technologies for REE extraction from the PG leachate and production of mixed rare earth oxide/salt or individual rare earth metals (MREO/MRES/REMs)
4. Combine PG use with significant CO_2 sequestration.
5. Produce low-cost cement and concrete using PG as raw material with dramatic reduction in carbon footprint compared to the current commercial operations.

Collaboration with CF Technologies

FIPR collaborated with CF Technologies, a technology startup, in securing a research grant under DOE's Small Business Innovation Research (SBIR) program to evaluate CF Technologies' supercritical fluid process for extracting and purifying REEs using leachate from phosphate byproducts and wastes. The project demonstrated the feasibility of supercritical extraction technology. Preliminary economic analysis shows profitable scenarios using phosphoric acid sludge as feedstock, as shown in the table below.

• Acid Sludge tons/yr	50,000	400,000
• Extractor Diameter (m)	0.15	0.2
• Capital Cost Estimate	$1.3 M	$2.4M
• Operating Rate (hrs/yr)	2000	8000
• Operating Cost ($/yr)	$0.7M	$4.2M
• Annual Revenue ($/yr)	$1.6M	$13M
• Net ($/yr)	$0.9M	$8.8M
• Payback (yr)	<2	<1

Phosphogypsum Research

PG Use for Road Construction

In collaboration with Madrid Engineering, FIPR research produced an innovative road base composition and method of construction. The road base mixture incorporates varying quantities of by-product phosphogypsum (PG) from phosphate fertilizer production, sand, clayey sand and CONSOLID additive. The resultant mixtures impart strength and resilience properties into the road base when compared to traditional road construction methods. Additionally, the mix also has been demonstrated to be hydrophobic, thus improving moisture resistance and long-term durability under wet conditions.

Extensive PG Characterization

Recently, Mosaic undertook a major effort to establish a database of PG characteristics both chemically and physically. Lots of samples were collected under that effort, including many core samples from different depths and horizontal directions in a stack, fresh PG from the pan filter, and PG samples from different acid plants. FIPR participated in that program and analyzed numerous samples for rare earths and heavy metals, physical properties, and SEM/EDS maps. The information generated from this program can serve as a useful guide for developing methods for REE extraction, reduction of radioactivity, and PG purification for different uses.

Technology Development for Reducing Radioactivity in PG

As discussed above, removal of radionuclides from PG is a research component of the CMI Phase III project. Since PG contains a low concentration of radium-226 in a complex matrix, it is extremely challenging to develop an economically feasible process for reducing the radioactivity level to meet the current regulatory limit. During this year, FIPR ran radioactivity analysis of sieved fractions from three PG samples. Results indicate that a large portion of radionuclides may be eliminated from PG by removing a small fraction of material within a certain size range using physical methods.

Research to Improve Phosphate Industry Efficiency

Packed Column Jig (PCJ) for Removing Dolomite

Since late 2021, FIPR has conducted several pilot testing campaigns to demonstrate the feasibility of PCJ for removing dolomite from high-Mg phosphate pebbles achieving encouraging results. Based on the test results, operating parameters, mass balance information and equipment prices, KEMWorks Technology Inc (a Lakeland-based engineering firm) conducted a feasibility study on a PCJ plant, which shows rapid return on investment for commercialization of this technology. KEMWorks summarized the main conclusions of the study as follows: "The operating cost for this process is estimated to be ≈$20 per short ton of product material. The economics of the process will be predominately dependent on the values assigned to the low-quality pebble feed and the higher quality product. With current rock prices around $300/mt, this project becomes very economically attractive." Compared to flotation process for dolomite removal from dolomitic phosphate pebbles, PCJ has the following advantages:

- "Operating Cost – the Jig Column Process had a significantly lower operating cost
- Capital Cost – the Jig Column Process had a significantly lower (≈24%) capital cost
- Phosphate Recovery – the Jig Column Process recovery was at least comparable, if not better."

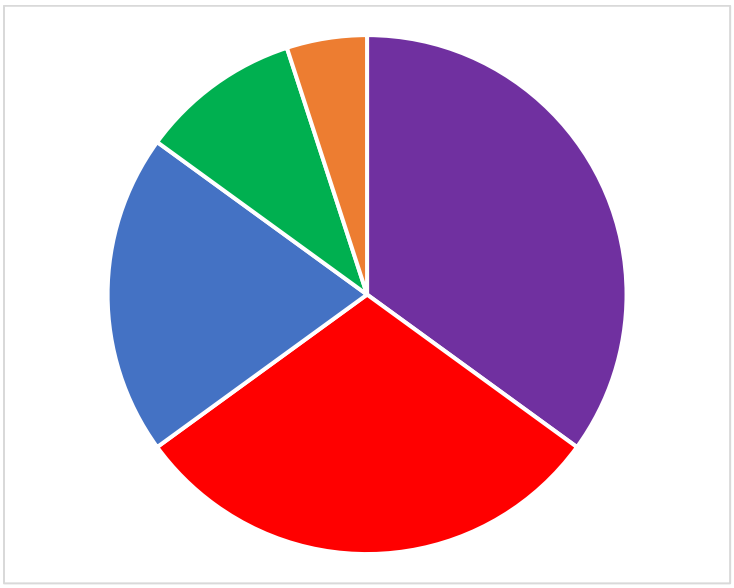
Considering these encouraging results and the market potential for PCJ, FIPR filed a provisional PCJ-based patent (System and Method for Separating Carbonaceous and Siliceous Materials from Phosphate Via Gravity Separation, US Patent 63/468,413, May 23, 2023).

Recovery of Phosphate from PG

A recent PG characterization study showed that a small fraction of PG contains as high as 15% P_2O_5. This fraction is quite easy to separate from the bulk PG. With some minor treatment, this fraction could be used as a feed for phosphoric acid manufacturing, since it contains low concentrations of minor elements (Mg, Fe, and Al). FIPR is investigating strategies for utilizing this phosphate resource within the acid plant before PG is pumped into the stack that is subject to environmental regulations.

FIPR Laboratory 2022-2023 AR

The FIPR analytical and metallurgical testing laboratories play a vital role in both our internal research programs and key research projects funded by the federal government and industries In addition, these labs provide quality analytical, testing and consulting services to external research institutions, engineering firms and industrial companies. The FIPR labs have developed specialized capability for tests associated with phosphate chemistry. This capability includes specific processes and analytical methods such as flotation, grinding, screening, particle size analysis, solvent extraction, thermal analysis, colorimetric testing, optical emission spectroscopy and mass spectroscopy. The combination of state-of-the-art instrumentation with a laboratory staff dedicated to providing impeccable quality standards has led to industrial recognition of the FIPR analytical lab as a leader in phosphate-related analyses.



35% = Phosphate Analysis Big 6 (P_2O_5, Insol, MgO, Al_2O_3, Fe_2O_3, CaO)
30% = Individual Metal Analysis (Cd, Co, Ni, Cu, Zn, Au, Ag, Li, Na, Mn)
20% = Rare Earth Elements + Th and U
10% = Water Analysis (P_2O_5, MgO, Al_2O_3, Fe_2O_3, CaO, SO_4, F, TDS, pH, ORP, DO, Conductivity)
5% = Particle Size Analysis, Sample Preparation

Categorization of Laboratory Services Analyses (Source: FIPR Institute Analytical Laboratory).

In Fiscal Year 2022-2023, the FIPR Institute laboratories provided analytical services to fourteen (14) different entities in multiple work efforts totaling more than $113,000. Laboratory Services has had an increase in internal research and analysis of Rare Earth Elements and Lithium recovery from the last fiscal year. FIPR analytical laboratory equipment includes: ICP-OES, ICP-MS, Lachat QuickChem P_2O_5 analyzer, Astoria Pacific rAPID-T water analyzer, Horiba Particle Size Distribution Analyzer, and Orion pH/ISE meters.

The FIPR laboratories have worked closely with Florida Polytechnic's Environmental Engineering program supplying them with samples and analyses. The FIPR Institute looks forward to collaborating with them even more on several of their research projects.

Environmental Engineering Projects

Application of biochar to phosphorus control in phosphogypsum process water treatment

Principal Investigator: Dr. Xiaofan (Caleb) Xu, xxu@floridapoly.edu

Abstract: As a byproduct of phosphate mining, phosphogypsum (PG) is usually managed in large stacks due to its weak radioactivity. The process water stored at the PG stacks poses a risk of leakage, potentially contaminating nearby surface water and groundwater. Of particular concern is the presence of elevated levels of nitrogen and phosphorus in the process water, which can lead to water eutrophication. Compared to nitrogen, is recognized as the limiting nutrient in freshwater bodies, contributing to harmful algae blooms (HABs). Nevertheless, research on phosphorus control in PG process water treatment has been limited, with most related technologies remaining at the lab scale due to economic feasibility constraints. Biochar, a form of black carbon derived from biomass sources, has gained prominence in wastewater treatment as an effective and cost-efficient adsorbent, owing to its porous structure. This study employed biochar in the treatment of PG process water to mitigate HABs through phosphorus management, and evaluated the technological performance and life-cycle environmental impacts of biochar relative to its phosphorus management capability. Three commercial biochar products of varying particle sizes—medium (>25 mesh), small (26-50 mesh), and powder (<50 mesh)—were mechanically mixed with two process water samples provided by the Mosaic Company. The mixture comprised 5g of biochar and 100mL of the sample, maintained at a constant temperature of 22 ℃. Over a span of five days, phosphate concentration in the six groups was monitored, with removal efficiency peaking at 33% to 41% within three days. It's worth noting that the low pH in the process water was identified as a limiting factor affecting biochar performance. To comprehensively evaluate the environmental impacts, a life cycle assessment (LCA) was conducted using SimaPro PhD software for the biochar application in PG process water treatment. Three different end-of-life (EOL) strategies were considered, including landfill, incineration, and composting. Coal-based granular activated carbon (GAC) with thermal regeneration was used as a benchmark for comparison. Six categories of environmental impacts were assessed using the Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI) v2.1 developed by the US EPA. Notably, biochar exhibited fewer environmental impacts compared to GAC. Among the various strategies considered, biochar with a composting EOL approach was found to be the most sustainable option, yielding the lowest impacts in eutrophication potential, global warming potential, and human toxicity.

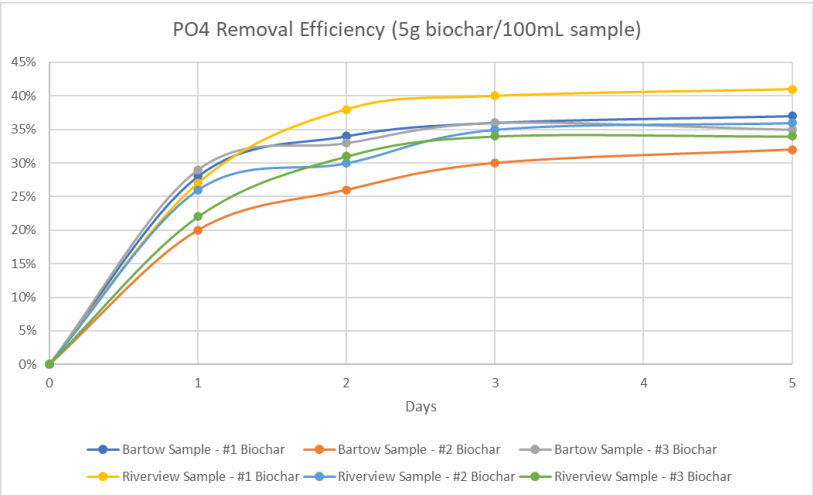
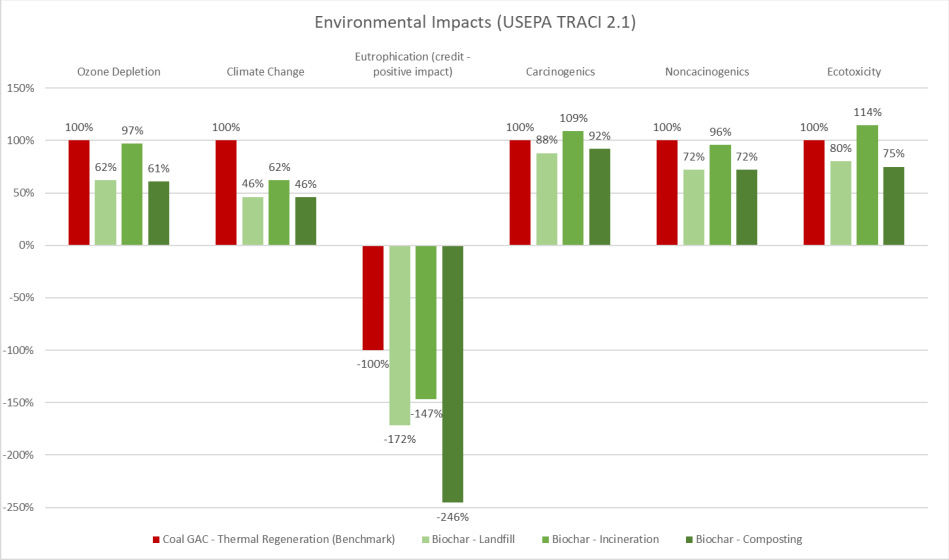


Figure 1. Phosphate removal efficiency of three biochar products for two process water samples.

Figure 2. Environmental Impacts of biochar and with different strategies relative to process water treatment.



GAC EOL

Purification of Phosphoric Acid Manufacturing Process Water with Recovery of Critical Materials via Ion-selective Capacitive Deionization

Jun Kim[1], Patrick Zhang[2]

[1]Dept. of Environmental Engineering, Florida Polytechnic University
[2]Florida Industrial and Phosphate Research Institute, Florida Polytechnic University

I. INTRODUCTION

Every year, the United States consumes more than 20 million tons of phosphate rock mainly for producing fertilizers. Phosphoric acid is also used in everything from food and cosmetics to animal feed and electronics. During the phosphate mining process, the production of highly saline process water with phosphate ion (PO_4^{3-}) is inevitable. Meanwhile, the process water contains an appreciable amount of critical rare earth elements (REEs), such as Y, Dy, Gd, Pr, and Nd[1]. The extraction of REEs has great potential economic benefits when properly recovered from the process water. Membrane capacitive deionization (MCDI) is an ion-selective electrochemical water treatment process for various hazardous contaminants and targeted elements using microporous carbon electrodes and ion-exchange membranes[2]. Kim et al. demonstrated a higher adsorption rate of multi-valent cations and anions, thus MCDI can be further used for resource recovery, especially for trivalent REEs (3+) and phosphate (3-) ions.

II. MATERIALS AND METHODS

A. MCDI reactor

In this study, the membrane capacitive deionization (MCDI) reactor is composed of supercapacitor carbon supercapacitor electrodes on titanium (Ti) substrates, a cation and anion exchange membrane (CEM and

AEM) with a spacer in-between. DC 1.2V is applied for electrosorption and reversed-voltage (DC -1.2V) is for complete discharge and electrode regeneration.

B. Measurement

A UV-Vis spectrophotometer (Agilent, Cary 60) and a quadrupole inductively coupled plasma - mass spectrometry (ICP-MS, PerkinElmer, NexION 350X) is utilized for the analysis of water samples.

C. Ion-selectivity

The performance of the MCDI is under evaluation in a flow-through cell using binary electrolyte solutions. The total ion adsorption capacity of the electrode remains the same with and without the nanocomposite coating. However, the MCDI reactor can demonstrates selectiv-electrosorption towards trivalent cations and anions over the monovalent cations and anions, respectively.

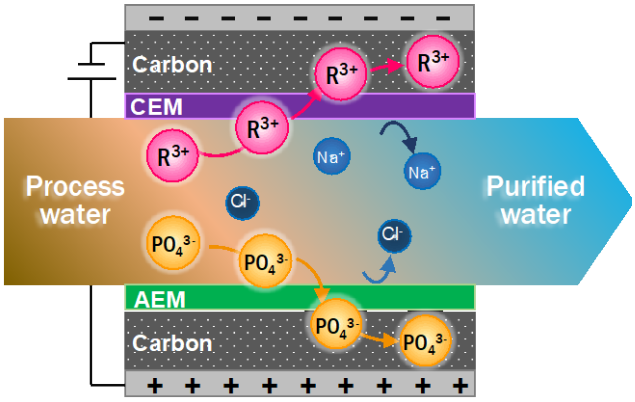


Figure 1: Membrane capacitive deionization process diagram

D. Performance Evaluation

Total amount of target (T) ions adsorbed (meq) during electrosorption can be calculated by

$$q_T = \int_0^{t_{ad}} Q \sum \left(C_{i,inf} - C_{i,eff}\right) dt$$

Selectivity for the target (T) ions (Nd^{3+}, PO_4^{3-}) over the competing (C) ions (Na^+, Cl^-) can be written as

$$Selectivity_t = \frac{q_{T,t}}{q_{T,c}} \Big/ \frac{C_{in,t}}{C_{in,c}}$$

ACKNOWLEDGEMENTS

This research is part of the Florida Industrial and Phosphate Research (FIPR) Institute projects.

REFERENCES

1. Zhang et al., “The ultimate mineral processing challenge: Recovery of rare earths, phosphorus and uranium from Florida phosphatic clay”, Minerals & Metallurgical Processing, 34, 183-188, 2017.
2. Kim et al., “Selective Removal of Calcium Ions from Water Using Target-ion Specific Capacitive Deionization”, Water Research, 160, 445-453, 2019.

[Supporting Information]

Figure S1. Electrosorption test-set up

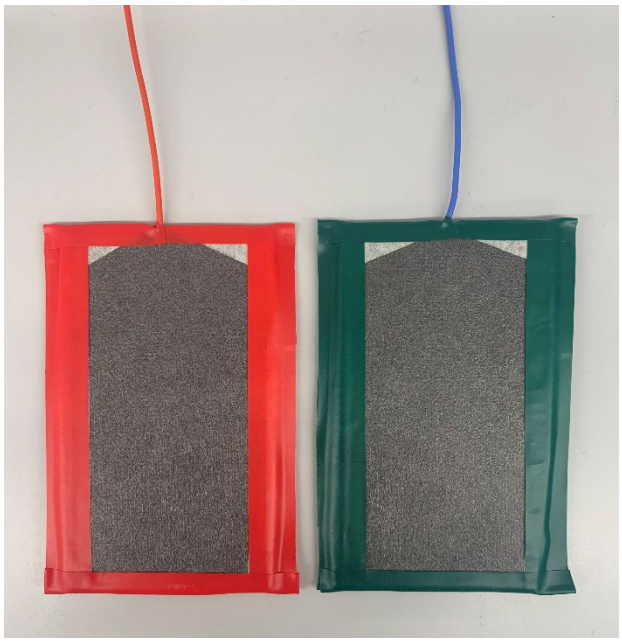
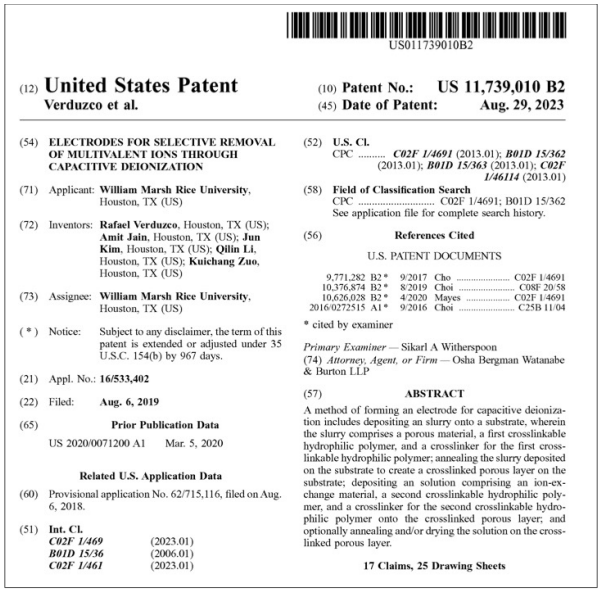


Figure S2. Supercapacitor electrodes

[Technological Advantages]

- High-selectivity
- Regeneratable electrodes
- Easily scalable
- Easy operation & maintenance
- No pressure-driven process
- No chemical usage (hazardous waste)
- Patented process (US 11,739,010)



US011739010B2

(12) **United States Patent**
Verduzco et al.

(10) **Patent No.: US 11,739,010 B2**
(45) **Date of Patent: Aug. 29, 2023**

(54) **ELECTRODES FOR SELECTIVE REMOVAL OF MULTIVALENT IONS THROUGH CAPACITIVE DEIONIZATION**

(71) Applicant: **William Marsh Rice University**, Houston, TX (US)

(72) Inventors: **Rafael Verduzco**, Houston, TX (US); **Amit Jain**, Houston, TX (US); **Jun Kim**, Houston, TX (US); **Qilin Li**, Houston, TX (US); **Kuichang Zuo**, Houston, TX (US)

(73) Assignee: **William Marsh Rice University**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 967 days.

(21) Appl. No.: **16/533,402**

(22) Filed: **Aug. 6, 2019**

(65) **Prior Publication Data**

US 2020/0071200 A1 Mar. 5, 2020

Related U.S. Application Data

(60) Provisional application No. 62/715,116, filed on Aug. 6, 2018.

(51) **Int. Cl.**
C02F 1/469 (2023.01)
B01D 15/36 (2006.01)
C02F 1/461 (2023.01)

(52) **U.S. Cl.**
CPC ***C02F 1/4691*** (2013.01); ***B01D 15/362*** (2013.01); ***B01D 15/363*** (2013.01); ***C02F 1/46114*** (2013.01)

(58) **Field of Classification Search**
CPC C02F 1/4691; B01D 15/362
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,771,282	B2 *	9/2017	Cho	C02F 1/4691
10,376,874	B2 *	8/2019	Choi	C08F 20/58
10,626,028	B2 *	4/2020	Mayes	C02F 1/4691
2016/0272515	A1 *	9/2016	Choi	C25B 11/04

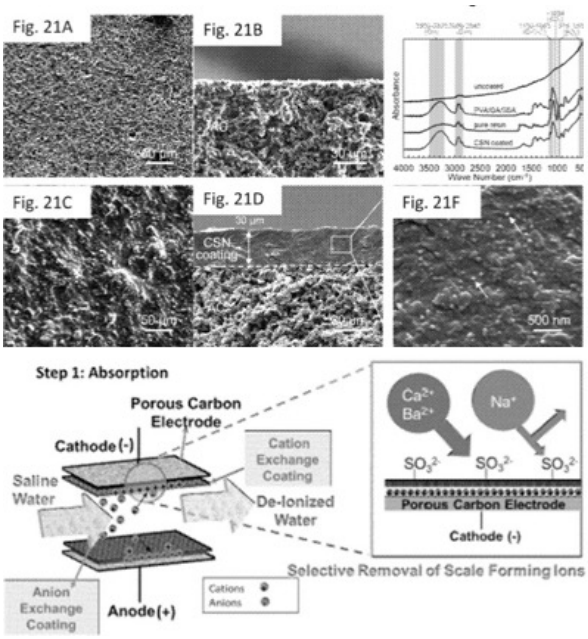
* cited by examiner

Primary Examiner — Sikarl A Witherspoon
(74) *Attorney, Agent, or Firm* — Osha Bergman Watanabe & Burton LLP

(57) **ABSTRACT**

A method of forming an electrode for capacitive deionization includes depositing an slurry onto a substrate, wherein the slurry comprises a porous material, a first crosslinkable hydrophilic polymer, and a crosslinker for the first crosslinkable hydrophilic polymer; annealing the slurry deposited on the substrate to create a crosslinked porous layer on the substrate; depositing an solution comprising an ion-exchange material, a second crosslinkable hydrophilic polymer, and a crosslinker for the second crosslinkable hydrophilic polymer onto the crosslinked porous layer; and optionally annealing and/or drying the solution on the crosslinked porous layer.

17 Claims, 25 Drawing Sheets



Phosphogypsum Road Base and REE/RN Extraction Research

Derek Henderson, Florida Polytechnic University

Introduction

PG road base:

The use of existing phosphogypsum (PG) stack material as a road base material has been considered by various entities, however, the long-term performance of a road constructed with a PG road base under simulated road loading and environmental conditions is not well understood. The selection of a binder-PG-additive mixture, tested under simulated environmental conditions, will be an important component of successful PG road base implementation. Furthermore, the monitoring of synthetic stormwater runoff from a PG based test road will likely be necessary for public and regulatory acceptance and will reveal what, if any, mitigation systems may be needed for stormwater runoff management of a PG based road.

REE/RN extraction:

Due to rapidly increasing demand for REE materials, their importance as critical materials, and their role in national security, securing domestic sources and processing methods of REEs is of great interest. Additionally, the processed PG may be used as an additional resource if radioactivity levels are sufficiently reduced, reducing liabilities related to phosphate production.

Research Goals

PG road base research goals:

Initial research goals of the PG road base study are the development and optimization of the road base test apparatus (RBTA) used to determine the long-term performance of PG road base. The design and development of the RBTA is currently underway with the construction of the steel frame currently in progress.

Following completion of the RBTA, an indoor asphalt surfaced, PG base test road will be examined for long term performance and durability under simulated road loading and environmental conditions. In addition, synthetic runoff samples will be collected and analyzed for indications of road degradation or material release. If necessary and feasible, mitigation systems will be designed and implemented into the RBTA. Methodology details can be found below.

The road base binder and mixture will be determined/improved by a series of cube tests of various binder-PG-additive mixtures and tested for compression strength by standard compression testing. In addition, prepared cube samples will be subjected to simulated environmental conditions such as extended contact with synthetic road runoff and high intensity UV. The synthetic road runoff used in these experiments will also be analyzed for water quality impacts as an indicator of material degradation or release.

REE and radionuclide extraction research goals:

Ionic liquids have gained some interest as a greener and recyclable alternative extraction solvent over concentrated, high temperature acids. The ionic liquid betainium bis(triflouromethylsulfonyl)imide, commonly referred to as [Hbet][Tf2N], was synthesized in lab and used an extraction solvent for REEs and RNs. REEs and RNs were quantified in the aqueous phase of the solvent mixture and low-strength acid used to strip the ionic liquid for reuse. Method details may be found below. The use of a group of more affordable and even greener solvents known as deep eutectic solvents may prove to provide similar results but at a more feasible cost based on further studies. Extraction of REE/RN from the insoluble clays are a potential study due to the high solubility of both phosphogypsum and acid sludge.

Rotary extraction was used to determine basic extraction characteristics of phosphogypsum as well as to create phosphogypsum nutrient extractions used in algal extraction experiments. Three conditions were selected for analysis: extraction kinetics, effect of solvent pH on extraction, and solid to solvent mass ratio. Method details are found below.

Following a series of solid-liquid and liquid-liquid REE and radionuclide extraction experiments, vegetative and algal extraction studies are already in progress to determine feasible plant species and ideal soil to PG ratios or phosphogypsum based nutrient solution for a hydroponic growth system which allow for rapid growth rates and high percentage of accumulation. These studies are of interest as a potential method to further isolate REE and RN from dissolved PG material found in liquid-liquid extraction. Although mass transfer from soil to plant is typically low, some species have been found to be high accumulators (Tyler 2004) which could then be processed for additional concentration through digestion or combustion and ash extraction. A column study of various plant species' potential for accumulation would be conducted for their feasibility as a viable extraction technology. The REE and RN mass stored in vegetative matter will be recovered using solid-liquid and liquid-liquid extraction methods on vegetative ash. This method potentially results in recovery of REE and/or RN while minimizing dissolution of PG

which contributes to dissolved calcium and sulfate contamination. This study also examines the potential for accumulation of REE and RN by specific algal species. Although a pure phosphogypsum based nutrient solution has failed to support algal growth, possibly due to low pH of the nutrient solution, a commercial nutrient solution used with the rotary extraction method to extract REE/RN has successfully supported algal growth. Future research will include the comparison of initial REE/RN concentrations to post-growth concentrations to determine the biological assimilation of REE/RN and potential for remediation of contaminated process waters and extraction of critical materials.

Methodology

PG road base methodology:

The RBTA is currently designed as an eight by four-foot test bed enclosed within steel plating and supported by a steel tube frame to prevent any flexing of the test road during loading. The entire apparatus is suspended above a steel frame platform to allow for mechanical and sampling equipment to be located below the test road. The test road is designed to be as much as 12 inches of PG/binder road base with a two inch, cold applied asphalt surface.

Figure 1: Steel support frame for road base test apparatus

Long term performance of PG road base will be determined by fatigue testing in conjunction with simulated environmental conditions. Loading will be applied by a tire on a motorized track and adjustable by a series of hydraulic or mechanical presses located in the track system. Loading and fatigue will be measured through a combination of embedded strain gauges and loading cells. Deformation will be tracked with digital images and physical measurements of the road surface.

To better understand performance under typical road conditions, environmental conditions will be simulated by periodic application of synthetic stormwater road runoff through a series of sprayers. Road runoff will be recollected through a curb and gutters system for analysis. Infiltrated stormwater will be collected through an underdrain pipe system and an embedded

“monitoring well”. Changes in moisture content of the road base will be analyzed using embedded moisture sensors.

Stormwater runoff and infiltrate will be analyzed to ensure there are no adverse environmental impacts. If potential environmental impacts are discovered, mitigation measures will be designed and, cost and scope permitting, implemented into the test apparatus.

Potential lanthanides and radionuclides will be analyzed using ICP-MS to determine if stormwater infiltrate has any potential to release heavy metals due to desorption or dissolution of PG material. Dissolved calcium will be analyzed using ICP-OES or ion chromatography as an indicator of dissolution of PG material which may lead to voids within the road base, road cracking, or road subsidence. Sulfate potentially released due to PG dissolution will be analyzed either through sulfate turbidity method using barium chloride or ion chromatography. All runoff samples will be analyzed for total suspended solids to determine if or to what extent solid particles are migrating from the road surface or road base using standard filtration and gravimetric determination. Samples will be analyzed for phosphate to determine potential for nutrient loading to receiving waters either by spectrometry or ion chromatography. Finally, the presence of polymers will be quantified by FTIR to determine potential degradation of the polymer binder. Particle emitters may be determined in future sampling by liquid scintillation counting, depending on equipment availability. Liquid scintillation would provide a sensitive and accurate method of determining particle emitters released either as dissolved ions or sorbed to other migrating solid particles.

Approximately 6000 pounds of phosphogypsum material has been secured through Mosaic for use in the road base testing and is currently stored on-site at Florida Polytechnic University. Approximately ten gallons of dry application Consolid polymer binder has been secured through FIPR for testing as a suitable binder material to increase the compression strength of the phosphogypsum and create a durable road base.

REE/RN extraction methodology:

Extraction experiments are already underway using various solid-liquid and liquid-liquid extraction methods. These methods include ionic liquid extraction, rotary leaching, vegetative extraction, and algal extraction. Liquid-liquid extractions are performed using a recyclable, synthesized, thermomorphic ionic and aqueous liquid solution. 50 mg of phosphogypsum or acid sludge were used for extraction with equal volumes of an aqueous nitrate solution and ionic liquid. The solution is heated to 50 degrees Celsius for one hour which creates a single-phase solvent. The solution is allowed to cool overnight which results in the solvent returning to a two-phase liquid (aqueous and ionic liquid) and partitions REE/RN and other dissolved ions between the resulting two phases. Recycling is done using a 1.5 M hydrochloric acid stripping process to extract REE/RN species from the ionic liquid phase.

Additional planned experiments include deep eutectic liquids and sonication extraction, as well as multi-step extraction processes aimed at further isolating REE/RN species of interest from common ions, particularly dissolved calcium and sulfate. For example, liquid-liquid extraction using thermomorphic liquids in combination with high REE aqueous solution produced from rotary leaching.

Rotary extraction was performed using a Thermofisher rotator with 15 mL centrifuge tubes for times ranging from 5 minutes to 108 hours with the same aqueous nitrate solution used with ionic liquid extraction at range of pH values from 1.0 to 11.0. The remaining planned experiment will examine the optimization of the solid phosphogypsum to solvent mass ratio.

Vegetative extraction, including algal extraction, will include flaming vegetative mass in a muffle furnace and using previously described extraction methods to preferentially extract REE/RN species. This is expected to provide isolated REE/RN species in solution at the expense of some extraction efficiency.

The isolated liquid extracts are examined for REE/RN using ICP-MS while dissolved calcium and sulfate are currently determined using ICP-OES. Future analysis of sulfate may be performed using ion chromatography depending on equipment availability.

Results:

Ionic Liquid Extraction of REE/RN

Concentrations of REE/RN were seen to range from 18.58 ppm from 50 mg of phosphogypsum to 25.91 ppm from 50 mg of acid sludge. Although some clarification is needed from the analytical lab, the sample volumes used for analysis were 1 mL when available. The phosphogypsum was analyzed for REE/RN and was determined to have 459.8 mg REE/RN per kg of phosphogypsum. This would equate to a mass of 22.99 mg of REE/RN for a 50 mg sample of phosphogypsum. This results in extraction efficiencies of 80.8% to 108.3% for phosphogypsum. There seems to be a large (unquantified) degree of variance between duplicate samples within the PG and acid sludge material, despite being dried and ground into a relatively fine powder. One current challenge is the isolation of REE/RN from other ions, particularly the calcium and sulfate dissolved from the phosphogypsum during extraction. The highest concentrations of these two ions are in the aqueous phase, which is also where the highest concentrations of REE/RN are found. Ionic liquid extraction was performed twice on the same samples in an attempt to separate the ions of interest, but no additional separation was observed. Although additional testing has been performed, only early results are presented here for brevity.

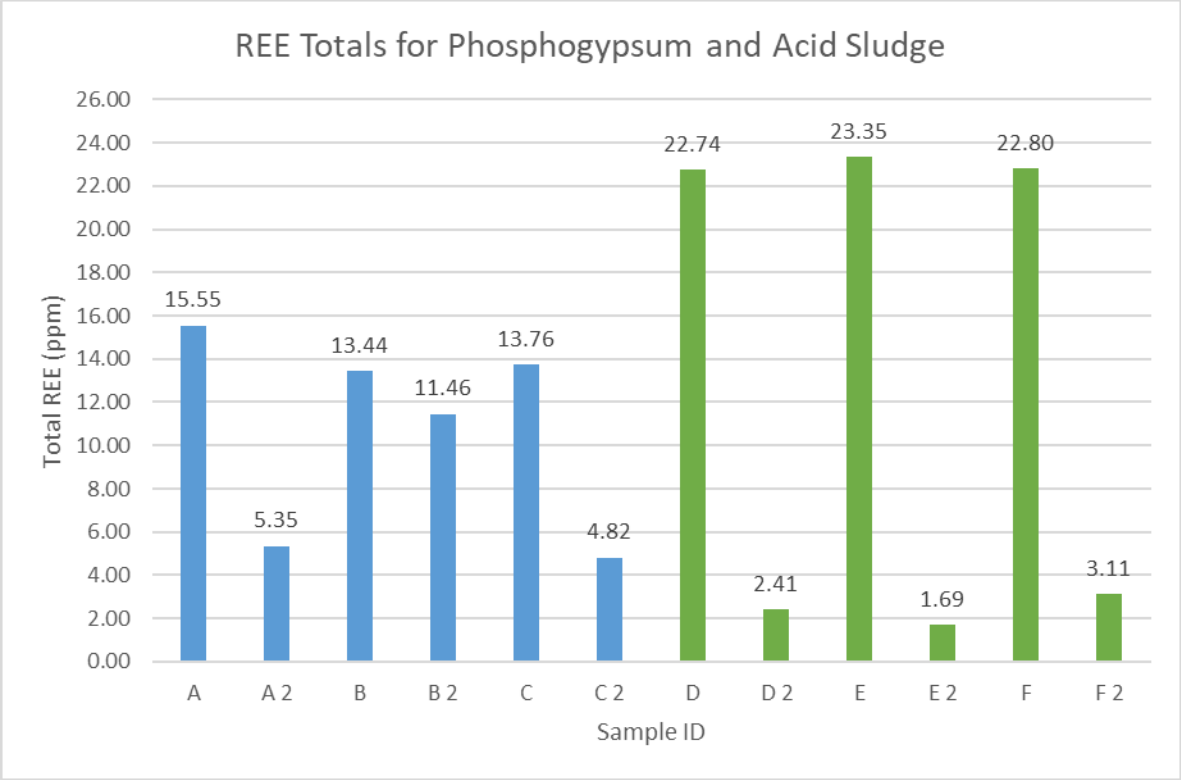


Figure 2: Total REE/RN concentrations for each sample of initial ionic liquid extraction from phosphogypsum and acid sludge experiments. Samples in green denote acid sludge. Each sample was tested for REEs in the aqueous solution and acid stripping solution.

Rotary extraction was used to optimize extraction times and pH values. The extraction times can be seen in Figure 3, below, truncated at 600 minutes for clarity.

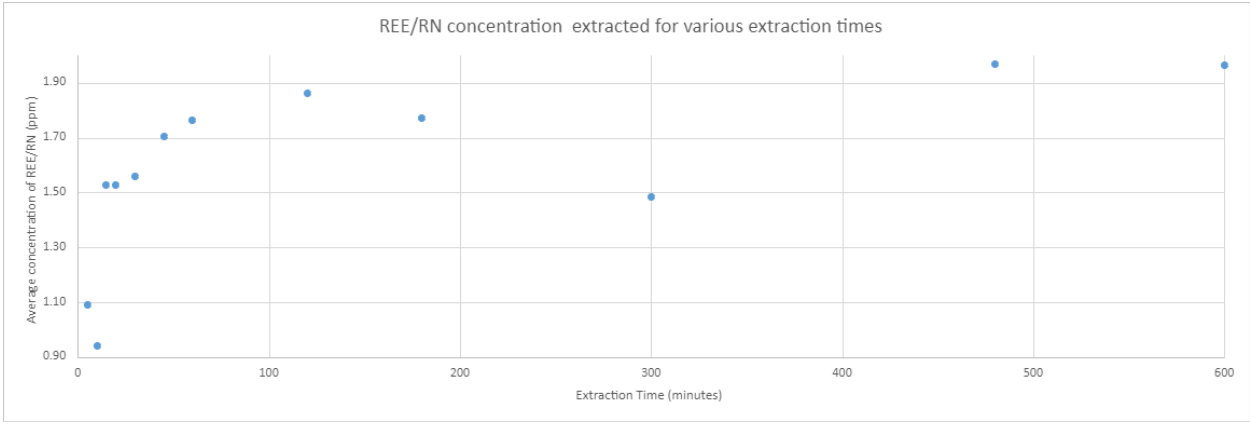


Figure 3: REE/RN average concentrations at extraction times from 5 minutes to 600 minutes.

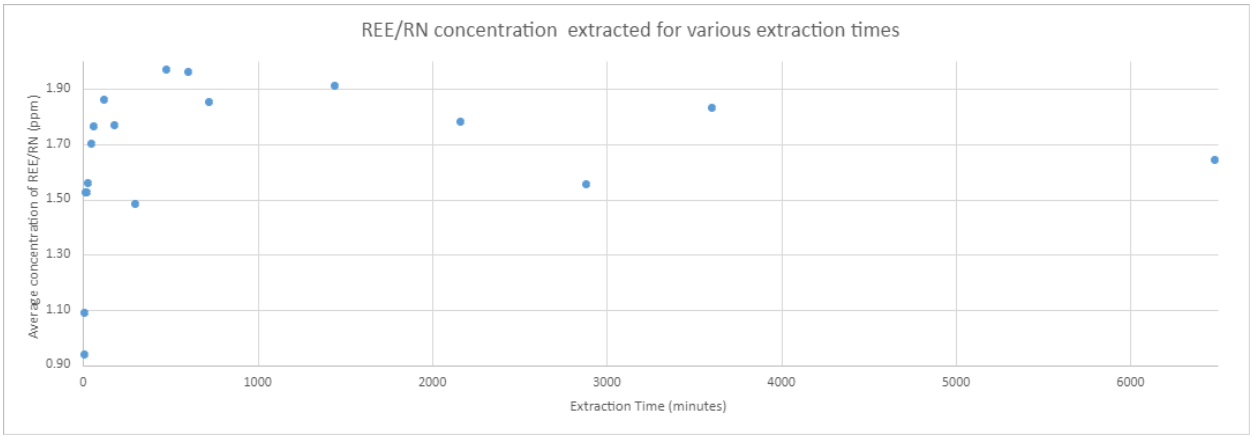


Figure 4: REE/RN average concentrations at extraction times from 5 minutes to 6480 minutes.

The maximum concentration of 1.97 ppm was observed at 480 minutes of extraction while a concentration of 1.86 ppm was seen at only 120 minutes of extraction time. It is noted that concentrations beyond 480 minutes did decrease in some cases. Additionally, the reported concentrations are averaged from duplicate samples.

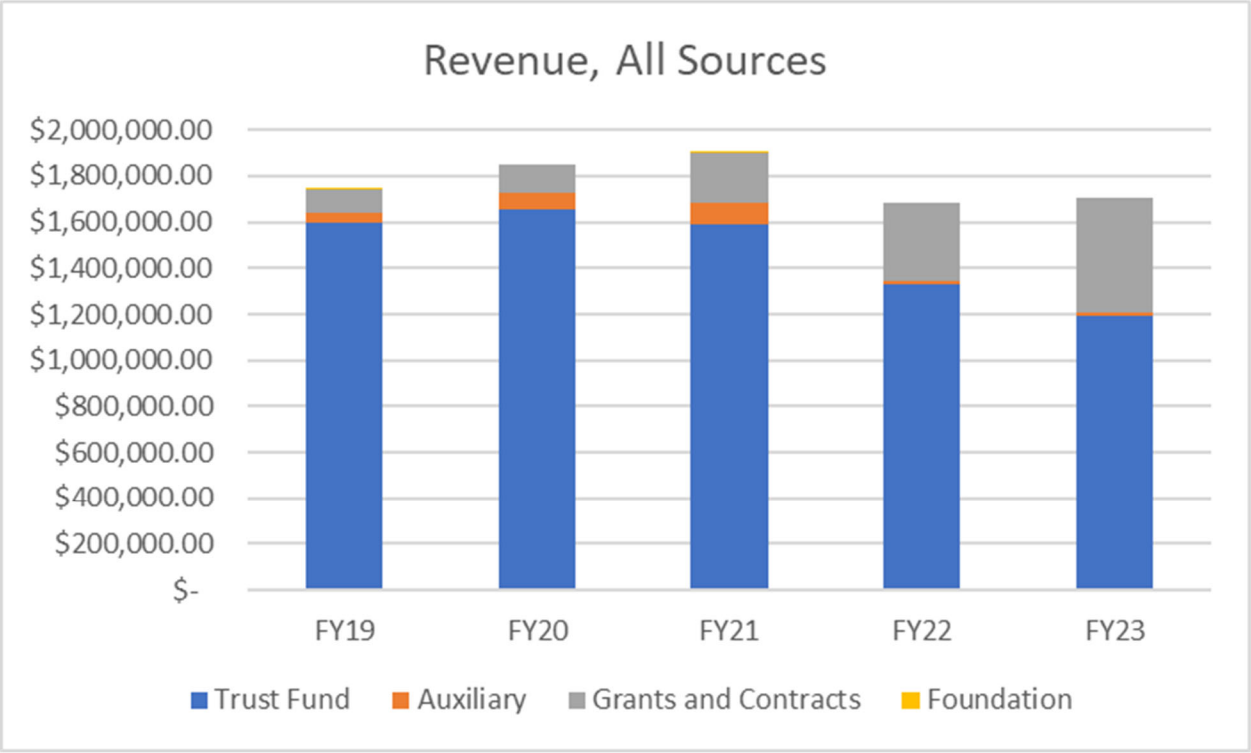
pH ranging from 1 to 11 were extracted in duplicate for 120 minutes and 480 minutes. Results indicate that extraction done at 1 pH resulted in an average concentration of 1.49 for both extraction times. Concentrations dropped off quickly with an average concentration of 3.5 ppm at a pH of 2 and 120 minutes and 0.25 ppm at a pH of 2 and 480 minutes.

Fiscal Year 2022/2023 Financial Report

Florida Industrial and Phosphate Research Institute

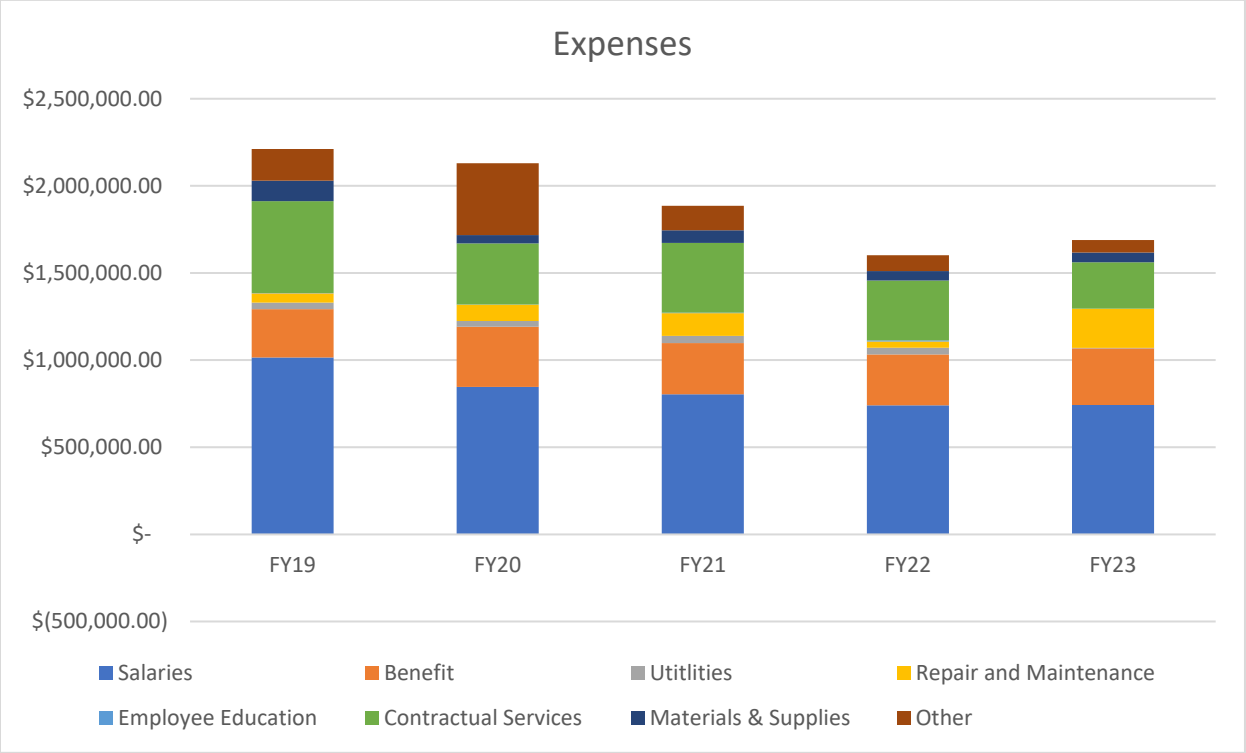
FIPR Institute revenue, all sources.

	FY19	FY20	FY21	FY22	FY23
Trust Fund	$ 1,598,967.65	$ 1,651,677.76	$ 1,591,279.81	$ 1,329,029.12	$ 1,193,160.53
Auxiliary	$ 43,559.69	$ 79,153.48	$ 90,776.68	$ 15,974.77	$ 16,015.48
Grants and Contracts	$ 97,580.55	$ 119,566.23	$ 217,188.10	$ 336,495.91	$ 498,624.38
Foundation	$ 209.60	$ -	$ 58.73		



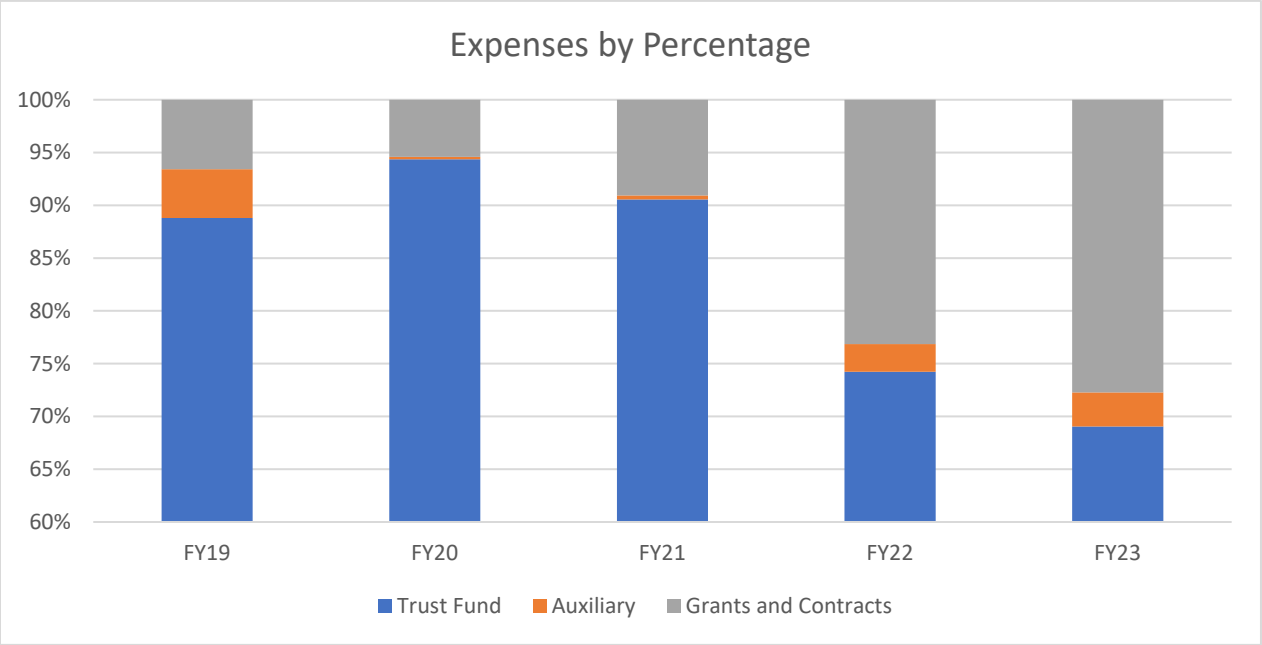
FIPR institution-wide expenses, listed in “typical” expense categories.

	FY19	FY20	FY21	FY22	FY23
Salaries	$1,014,884.84	$ 845,902.87	$ 804,142.42	$ 740,203.93	$ 741,775.92
Benefit	$ 277,306.26	$ 345,710.38	$ 293,034.45	$ 291,814.57	$ 325,123.85
Utilities	$ 37,348.82	$ 33,127.39	$ 41,904.56	$ 38,940.27	$ 2,725.16
Repair and Maintenance	$ 53,682.86	$ 93,009.39	$ 130,507.70	$ 36,107.78	$ 225,114.04
Employee Education	$ 1,422.00	$ 1,246.00	$ 2,418.76	$ 5,938.79	$ (3,464.00)
Contractual Services	$ 527,264.29	$ 350,764.74	$ 400,095.90	$ 343,569.02	$ 266,426.18
Materials & Supplies	$ 118,196.96	$ 47,442.08	$ 73,015.87	$ 54,510.76	$ 56,232.09
Other	$ 181,352.77	$ 412,254.09	$ 140,690.33	$ 90,269.03	$ 72,014.09



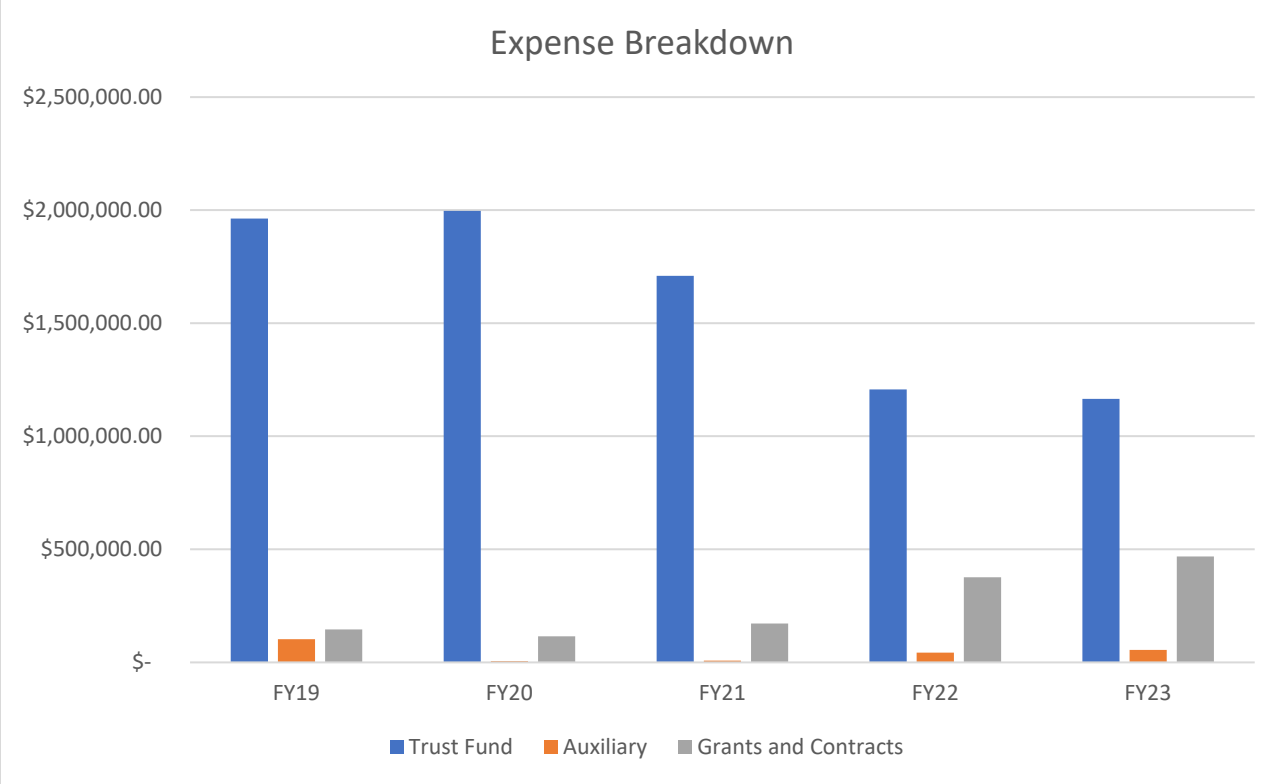
FIPR Institute expense percentages

	FY19	FY20	FY21	FY22	FY23
Trust Fund	89%	94%	91%	74%	69%
Auxiliary	5%	0%	0%	3%	3%
Grants and Contracts	7%	5%	9%	23%	28%



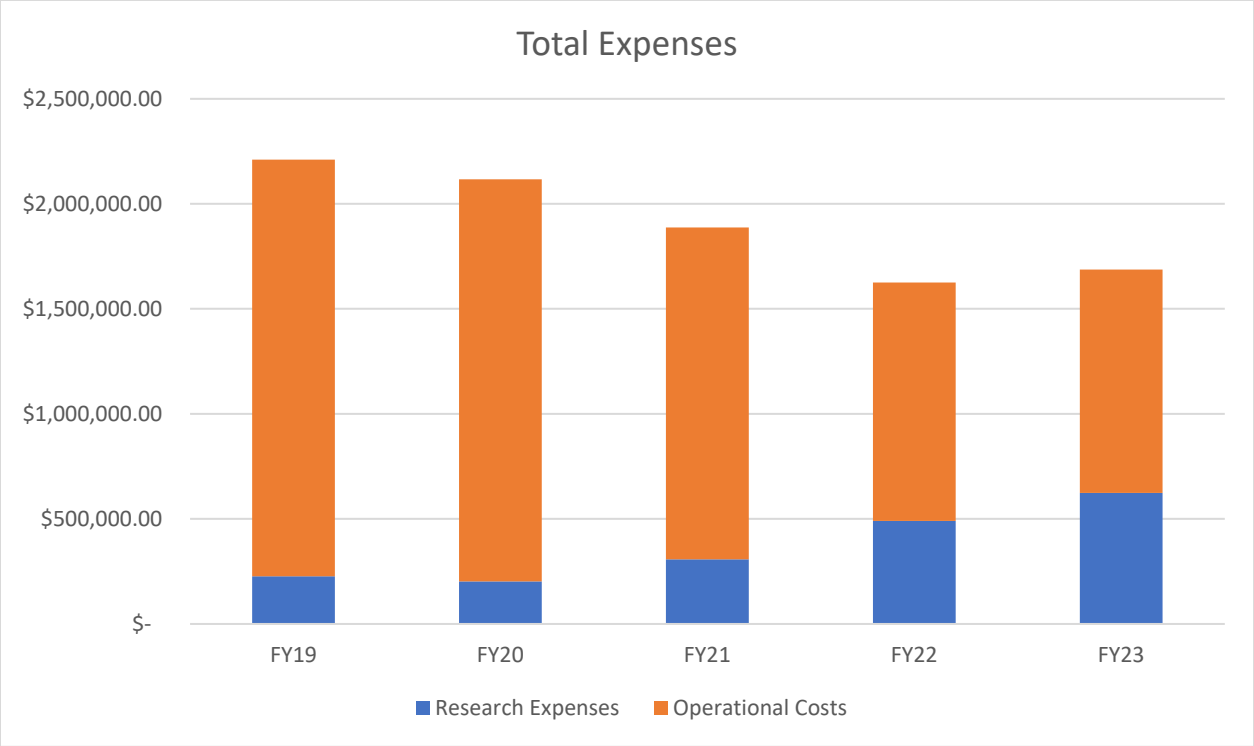
FIPR Institute expense break-down.

	FY19	FY20	FY21	FY22	FY23
Trust Fund	$ 1,962,502.42	$ 1,996,914.18	$ 1,709,131.73	$ 1,206,652.00	$ 1,164,881.41
Auxiliary	$ 102,168.32	$ 4,743.63	$ 6,938.52	$ 42,618.14	$ 54,458.76
Grants and Contracts	$ 145,202.73	$ 114,652.08	$ 171,140.92	$ 376,100.91	$ 467,767.32
Total	$ 2,209,873.47	$ 2,116,309.89	$ 1,887,211.17	$ 1,625,371.05	$ 1,687,107.49



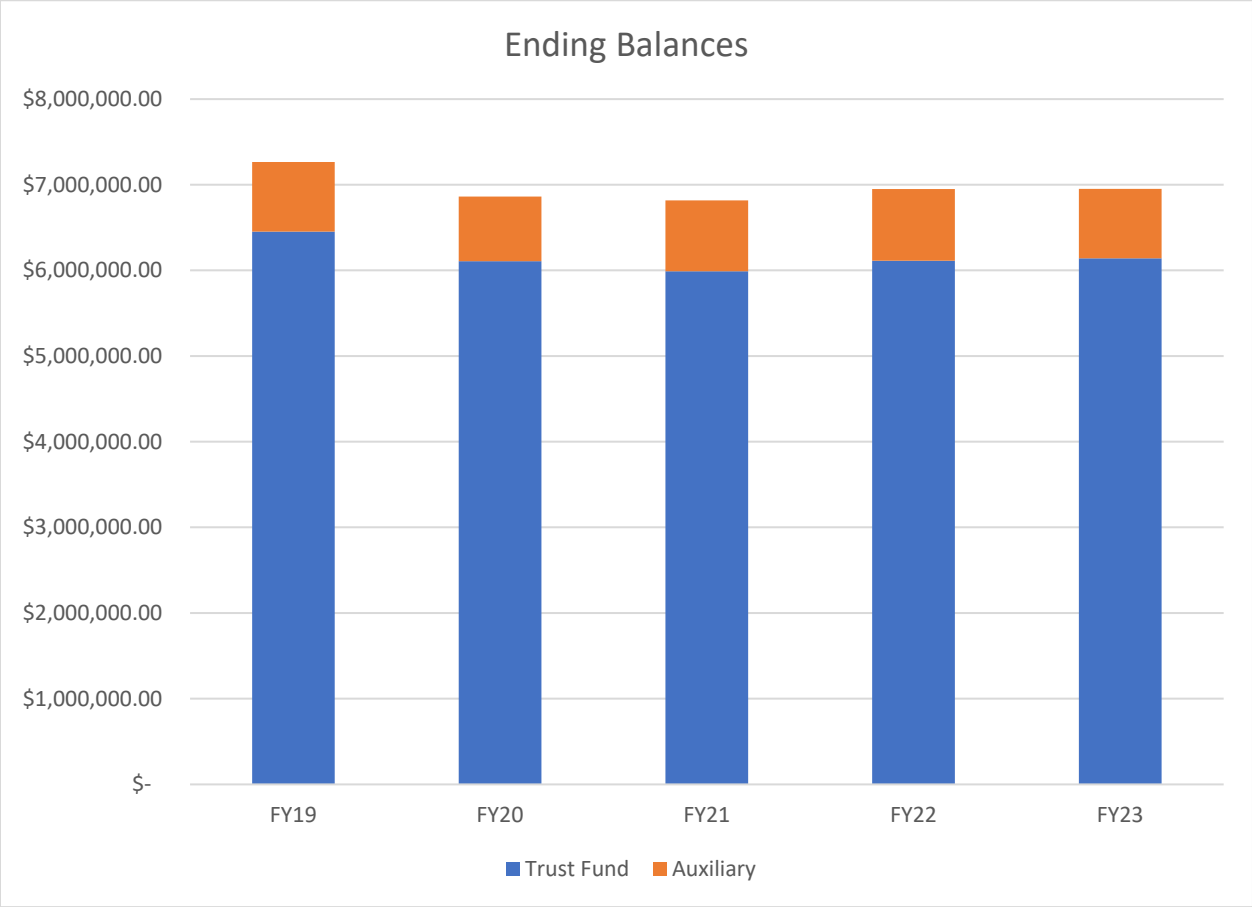
FIPR Institute research expenses versus total expenses.

	FY19	FY20	FY21	FY22	FY23
Research Expenses	$ 226,563.13	$ 202,401.30	$ 307,364.28	$ 490,623.25	$ 623,399.07
Operational Costs	$1,983,310.34	$1,913,908.59	$1,579,846.89	$1,134,747.80	$1,063,708.42
Total Expenses	$2,209,873.47	$2,116,309.89	$1,887,211.17	$1,625,371.05	$1,687,107.49



FIPR Institute ending balances

	FY19	FY20	FY21	FY22	FY23
Trust Fund	$ 6,453,304.34	$ 6,108,067.92	$ 5,990,216.00	$6,112,593.33	$6,140,872.45
Auxiliary	$ 811,623.16	$ 753,014.53	$ 827,424.38	$ 836,852.69	$ 810,209.32



AGENDA ITEM: VI.C.

Florida Polytechnic University

Academic and Student Affairs Committee

Board of Trustees

November 6, 2023

Subject: Advanced Mobility Institute (AMI) Annual Report FY23

Proposed Committee Action

Recommend approval of the Advanced Mobility Institute Annual report for fiscal year 2023 to the Board of Trustees.

Background Information

AMI was established as a University Institute in May of 2018 with a mission to provide university-affiliated applied research and development of autonomous systems and technologies. The Institute also provides a rich educational experience for students across multiple disciplines. The Board of Governors requires annual reporting by December of each year of the expenditures during the prior fiscal year using the mandated BOG format.

Supporting Documentation: Advanced Mobility Institute (AMI) Annual Report FYE23

Prepared by: Dr. Rahul Razdan, Senior Director, Special Projects; Dr. Randy K. Avent, President

Advanced Mobility Institute (AMI) Report

November 2023

ADVANCED MOBILITY INSTITUTE

FLORIDA POLYTECHNIC UNIVERSITY

Executive Summary

Artificial Intelligence (AI) is a breakthrough technology that impacts nearly every facet of life. One of its key applications is in Autonomous Vehicles, where the Validation and Verification (V&V) issue must be solved to address critical safety concerns. Florida Polytechnic University's Advanced Mobility Institute (AMI) was created to address this issue and this report summarizes its progress and accomplishments as of November 2023.

1. Publications

1.1. Journals

1) Razdan, R, MI Akbas, R Sell, M Bellone, M Menase and M Malayjerdi, "PolyVerif: An Open-Source Environment for Autonomous Vehicle Validation and Verification Research Acceleration," in IEEE Access, vol. 11, pp. 28343-28354, 2023.
2) Akbas, MI, M Menase and R Razdan, "Demo: Modular Test Frameworks for PolyVerif Autonomous Vehicle Validation Environment," 2023 IEEE 48th Conference on Local Computer Networks (LCN), Daytona Beach, FL, USA, 2023.
3) Q. Goss, L. Crump and M. I. Akbas. "SUMO Traffic Simulator Interface for Scenic." In the ERAU Discovery Day, March, 2022.
4) Mokhtari, Sohrab and Abbaspour, Alireza and Yen, Kang and Sargolzaei, Arman, “A machine learning approach for anomaly detection in industrial control systems based on measurement data,” Electronics, vol. 10, no. 4, p. 407, 2021.
5) Alnaser, Ala Jamil and Akbas, Mustafa and Sargolzaei, Arman, “Autonomous Vehicles Scenario Testing Framework and Model of Computation: Generation of Equivalence Classes and Coverage” IEEE Access, vol. 9, pp. 60617-60628, 2021, doi:10.1109/ACCESS.2021.3074062
6) Vargas, Jorge and Alsweiss, Suleiman and Toker, Onur and Razdan, Rahul and Santos, Joshua, “An Overview of Autonomous Vehicles Sensors and Their Vulnerability to Weather Conditions," Sensors (2021). https://doi.org/10.3390/s21165397
7) Khoshavi, Navid and Tristani, Gabrielle and Sargolzaei, Arman, “Blockchain applications to improve operation and security of transportation systems: A survey,” Electronics, vol. 10, no. 5, p. 629, 2021.
8) Victorio, Mario and Sargolzaei, Arman and Khalghani, Reza, “A secure control design for networked control systems with linear dynamics under a time-delay switch attack,” Electronics, vol. 10, no. 3, p. 322, 2021.
9) Saleem, Sahawneh and Alnaser, Ala’ J “The Ecosystem of the Next-Generation Autonomous Vehicle”, Advances in Science, Technology and Engineering Systems Journal, vol. 6, no. 1, pp. 1264-1272 (2021). https://astesj.com/v06/i01/p144/.
10) Alnaser, Ala' J., et al. “Autonomous Vehicles Scenario Testing Framework and Model of Computation: On Generation and Coverage.” IEEE Access, vol. 9, 2021, pp. 60617–60628., https://doi.org/10.1109/access.2021.3074062.
11) Chakeri, Alireza, et al. “A Platform-Based Incentive Mechanism for Autonomous Vehicle Crowdsensing.” IEEE Open Journal of Intelligent Transportation Systems, vol. 2, 2021, pp. 13–23., https://doi.org/10.1109/ojits.2021.3056925.

12) Vargas, Jorge, et al. “An Overview of Autonomous Vehicles Sensors and Their Vulnerability to Weather Conditions.” *Sensors 2021*, vol. 21, no. 16, 2021, p. 5397., https://doi.org/10.3390/s21165397.
13) Toker, Onur and Alsweiss, Suleiman, "Design of a Cyberattack Resilient 77 GHz Automotive Radar Sensor" Electronics, v.9, 2020 10.3390/electronics9040573
14) Toker, Onur, “Physical-layer Cyberattack and Interference Resilient Automotive Radar Systems," IEEE Access, 2020. https://ieeexplore.ieee.org/document/9274416
15) Medrano-Berumen, Christopher, and Mustafa İlhan Akbaş. “Scenario Generation for Validating Artificial Intelligence Based Autonomous Vehicles.” Intelligent Information and Database Systems, 2020, pp. 481–492., https://doi.org/10.1007/978-3-030-42058-1_40.
16) Medrano-Berumen, Christopher, and Mustafa İlhan Akbaş. “Validation of Decision-Making in Artificial Intelligence-Based Autonomous Vehicles.” Journal of Information and Telecommunication, vol. 5, no. 1, 2020, pp. 83–103., https://doi.org/10.1080/24751839.2020.1824154.
17) Alnaser, Ala Jamil and Akbas, Mustafa Ilhan and Sargolzaei, Arman and Razdan, Rahul, "Autonomous Vehicles Scenario Testing Framework and Model of Computation" SAE International Journal of Connected and Automated Vehicles, v.2, 2019 10.4271/12-02-04-0015
18) Akbas, Mustafa Ilhan and Sargolzaei, Arman and Razdan, Rahul, “Unsettled technology areas in autonomous vehicle test and validation,” tech. rep., SAE Technical Paper, 2019.

1.2. Conference Proceedings

1) O. Toker, “Performance Bounds for Cyberattack Detectors Using Multiple Observations,” IEEE SoutheastCon 2022, 104-109.
2) Dubs, V. Correa Andrade, M. Ellis, B. Karaman, D. Demirel, A.J. Alnaser, O. Toker, “Drive a Vehicle by Head Movements: An Advanced Driver Assistance System Using Facial Landmarks and Pose,” International Conference on Human-Computer Interaction 2022, pp. 502-505.
3) Dubs, V. Correa Andrade, O. Toker, M. Ellis, S. Ganley, B. Karaman, “A Photo-Realistic Simulation and Test Platform for Autonomous Vehicles Research,” Proceedings of the 7th North American International Conference on Industrial Engineering and Operations Management, Orlando, Florida, USA, June 12-14, 2022.
4) A.J. Alnaser, O. Toker, A. Bowers, “Modelling of a Hybrid Vehicle for Autonomous Vehicles Research,” Proceedings of the 7th North American International Conference on Industrial Engineering and Operations Management, Orlando, Florida, USA, June 12-14, 2022.
5) Toker, Onur “An FPGA Based 24 GHz Radar System for Physical-layer Cyberattack Research," IEEE Radar Conference 2021.
6) Tremura, Heitor and Toker, Onur, “Vehicle Level Software Design of the Florida Polytechnic Autonomous Golf-Cart'," IEEE SouthEastCon 2021.

7) Toker, Onur and Ozdemir, Ozgur, “Physical-Layer Cyberattack Resilient OFDM Automotive Radars," IEEE Vehicular Networking Conference 2020.
8) Toker, Onur and Ozdemir, Ozgur “A Synthetic Wide-Bandwidth Radar System Using USRPs," 7th International Electronic Conference on Sensors and Applications, 2020. https://doi.org/10.3390/ecsa-7-08174
9) Toker, Onur, and Adla, Rawa, “A Sub-6 GHz Vital Signs Sensor Using Software Defined Radios," 7th International Electronic Conference on Sensors and Applications, 2020. https://doi.org/10.3390/ecsa-7-08197
10) Toker, Onur, and Alsweiss, Suleiman and Abid, “A Computer Vision Based Testbed for 77 GHz mmWave Radar Sensors," IEEE SouthEastCon 2020, Raleigh, NC (2020).
11) Toker, Onur, and Alsweiss, Suleiman, “mmWave Radar Based Approach for Pedestrian Identification in Autonomous Vehicles," IEEE SouthEast 2020, Raleigh, NC (2020).
12) Toker, Onur, Alsweiss, Suleiman, Vargas, Jorge, Razdan, Rahul, “Design of an Automotive Radar Sensor Firmware Resilient to Cyberattacks," IEEE SouthEastCon 2020, Raleigh, NC (2020).
13) Holland, James and Sargolzaei, Arman, “Verification of autonomous vehicles: Scenario generation based on real world accidents,” in 2020 IEEE SoutheastCon, vol. 2, pp. 1–7, 2020.
14) O. Toker, B. Karaman, D. Demirel, “A Paper-Based Keyboard Using ArUco Codes: ArUco Keyboard,” International Conference on Human-Computer Interaction, 195-208
15) Sahawneh, Saleem and Alnaser, Ala' J. and Akbas, Mustafa Ilhan and Sargolzaei, Arman and Razdan, Rahul, "Requirements for the Next-Generation Autonomous Vehicle Ecosystem," IEEE SoutheastCon 2019, 10.1109/SoutheastCon42311.2019.9020400

1.3. Thesis

1) Tremura, Heitor. Hardware Software Codesign Approach for an Autonomous Vehicles Research Testbed. MS Thesis, Florida Polytechnic University 2021.
2) Islam, Foredul. Design and Performance Analysis of Vehicle to Everything Communication System with SDRs. MS Thesis, Florida Polytechnic University 2021.

1.4. Trade Publications

1) Razdan, Rahul, et al. “Unsettled Issues Regarding Autonomous Vehicles and Open-Source Software.” SAE International, 2021, https://doi.org/10.4271/epr2021009
2) Razdan, Rahul, et al. “Unsettled Topics Concerning Automated Driving Systems and the Development Ecosystem.” *SAE International*, 2020, https://doi.org/10.4271/epr2020004.
3) Razdan, Rahul, et al. “Unsettled Topics Concerning Autonomous Public Transportation Systems.” *SAE International*, 2020, https://doi.org/10.4271/epr2020020.
4) Razdan, Rahul, et al. “Unsettled Topics Concerning Human and Autonomous Vehicle Interaction.” *SAE International*, 2020, https://doi.org/10.4271/epr2020025

5) Razdan, Rahul, et al . "Unsettled Technology Areas in Autonomous Vehicle Test and Validation." *SAE International*, 2019, https://doi.org/10.4271/epr2019001.
6) Book: Autonomous Vehicle QuickStart Primer - A Business and Technology Survey of the Autonomous Vehicle Space
7) Online Course: Autonomous Vehicles for Transportation Professionals

2. Grants and Partnerships

2.1. Grants

1) NSF Major Research Instrumentation (MRI) grant, Award number: 1919855, Starting Date: October 1, 2019, End Date: Ongoing: Total budget: $350,137.00
2) Two state grants were provided through our Legislative Budget Request

2.2. Partnerships

1) FTE/Suntrax (Scientific Advisor and MOU): We maintain strong relationships with the CEO of FTE/Suntrax, Secretary of FDOT (past and present), and all the major FDOT civil engineering consultants.
2) Tallen Institute of Technology (Taltech/MOU): Initiated by an MOU in 2018, the partnership has continued to grow in the last four years. Indications of progress include BAFF (Fulbright for baltic region) reward for Taltech Director to visit Florida Poly, numerous joint publications, and partnership with the PolyVerif Open-Source V&V Framework.
3) Jacksonville Transit Authority (JTA): Initiated with an MOU in 2018, JTA is building an AV shuttle. Poly has worked with JTA to provide feedback on the JTA buildout and most recently JTA/Poly have built a digital twin for JTA AV routes in the PolyVerif Open-Source V&V system.
4) IAMTS (member agreement): Florida Poly is a founding member of International Alliance for Mobility Testing and Validation (IAMTS). Dr. Razdan worked with SAE, IEEE, and industry leaders in automotive test and validation such as TUV Sud and United Laboratories to architect the structure of this worldwide organization.
5) Autoware (member agreement): Florida Poly is a member of a significant open-source AV stack originally started as a part of Nagoya University.
6) **Academic Partners:** Taltech, Embry-Riddle, UF, MIT, Nagoya University, UC Berkeley
7) **Industrial Partners:** Ansys, IBM, Cadence, National Instruments, Continental, Cerebellum, Beep, BlackBerry, Otonomo
8) **Government/Non-profits/Associations:** Insurance Institute for Highway Safety, NOAA, FDOT, JTA, IAMTS, Singapore, Linux Foundation, Autoware Foundation

3. Research and Student Projects

An Autonomous and Electric Vehicle (AV/EV) capability was built in the Applied Research Center (ARC) that includes a laboratory with equipment and infrastructure for conducting research and student projects. Three testbed systems were completed as part of this laboratory and are summarized below:

3.1. **Driving Simulator:** The goal of this program was to build a driving simulation testbed that allows users (faculty and students) to test their research rapidly and safely before deploying it in a live vehicle. The system provides a simulation capability designed in MATLAB that includes a mock car cockpit with a seat, steering wheel, and display. It provides the ability to simulate driving scenarios in a laboratory environment with customizable parameters.

3.2. AV/EV Golf Cart Project: A "Drive-by-Wire" electric golf cart project was designed and built to allow faculty and students to transition projects out of the simulated environment and into a small-scale realistic environment before moving to full-sized vehicles. The resulting golf cart includes a drive-by-wire interface that allows it to be controlled in normal manual operations, through an x-box controller, through a touchscreen, or through a USB connection. This project also redesigned the solar charging subsystem to include four solar panels. Together, this vehicle provides the ability to do student and faculty projects in both Autonomous and Electric Vehicles.

3.3. AV Testbed: Finally, a Ford Fusion Plugin Hybrid was purchased and is being constructed to provide a vehicle-based platform for developing new sensors, signal processing, AI, and communications for Autonomous Vehicles. To this end, we have developed the software that controls the steering, throttle, and brakes. We have also built interfaces that allow us to capture the current sensor data, visualize it in real-time, and save it to files for future analysis or to provide scenarios for our simulator. We have also started working on new AI-based steering tests that use different semantic segmentation algorithms for autonomous steering.

3.4. PolyVerif: We substantially completed an open-source Validation & Verification (V&V) environment called PolyVerif (www.avvc.net). PolyVerif is the result of a deep collaboration between Taltech, UC Berkeley, Embry-Riddle University, and Nagoya University. As an open-source project, PolyVerif allows Florida Poly to have a worldwide impact without the need for a PhD program. To date, PolyVerif has built digital twins of the Taltech campus, Jacksonville Transit Authority (JTA) AV routes, and modeled all the AV accidents in the NHTSA database for use by researchers worldwide. Our eventual ambition is for PolyVerif to have the level of impact of other open-source platforms such as Linux, Wordpress, or Spice.

The adoption of PolyVerif continues to grow as discussions are now in place with the International Alliance for Mobility Testing & Standardization (IAMTS), which is a broad AV testing consortium made up of leaders in the field. The largest open-source AV stack in the world is the Autoware Reference Design, and they have also expressed an

interest in including PolyVerif into their core reference design. Finally, there are discussions with the Baltic Atlantic Freedom Foundation (BAFF) on developing a full-year AV course that is based on PolyVerif.

4. Future Work

Beyond these projects, AMI will focus deeper research on three topics connected to PolyVerif in cooperation with research teams from other R1 universities.

1) The first will be AI component validation in conjunction with Embry-Riddle and L3Harris. With a focus on AI training validation, this work, likely in cooperation with L3Harris for the airborne space, can be directly applied to AVs.
2) System Design Coverage in conjunction with UC Berkeley. This effort addresses how much verification and testing is needed to build a system that is sufficient and has reduced legal liability. It will also examine the decomposition of a system into its parts where each of the parts are validated.
3) Human Machine Language (UF Linguistics): Humans operate with a non-verbal language when driving. Defining this language formally so that AVs can use it is the focus of this research.

5. Financials

Trial Balance		
Organization	Florida Polytechnic University	
Periods	FY2022-23 : Jul - Jun	
Ledger	Actuals	
Display Worktag Type	Cost Center	
Accounting Worktag	1056 Advanced Mobility Institute (AMI)1095 AMI 2	
Run	11/1/23 15:46	
Consolidation Data		
Ledger Account	**Cost Center**	
	Balance 6/30/2022	**339,705.12**
71101:In-State Travel	1056 Advanced Mobility Institute (AMI)	6,563.16
71102:Out-of-State Travel	1056 Advanced Mobility Institute (AMI)	1,320.20
77111:Salaries - AMP and Executive Service Group	1056 Advanced Mobility Institute (AMI)	77,597.80
77141:Fringe Benefit Expense - AMP and Executive Service Group	1056 Advanced Mobility Institute (AMI)	26,150.43
77200:Contractual Services	1056 Advanced Mobility Institute (AMI)	33,160.00
77300:Materials & Supplies	1056 Advanced Mobility Institute (AMI)	72.00
77300:Materials & Supplies	1095 AMI 2	4,350.00
		149,213.59
	Balance 6/30/2023	**190,491.53**
	Expenses, Commitments and Obligations for FY24	(151,085.70)
	Remaining balance 10/31/23	39,405.83