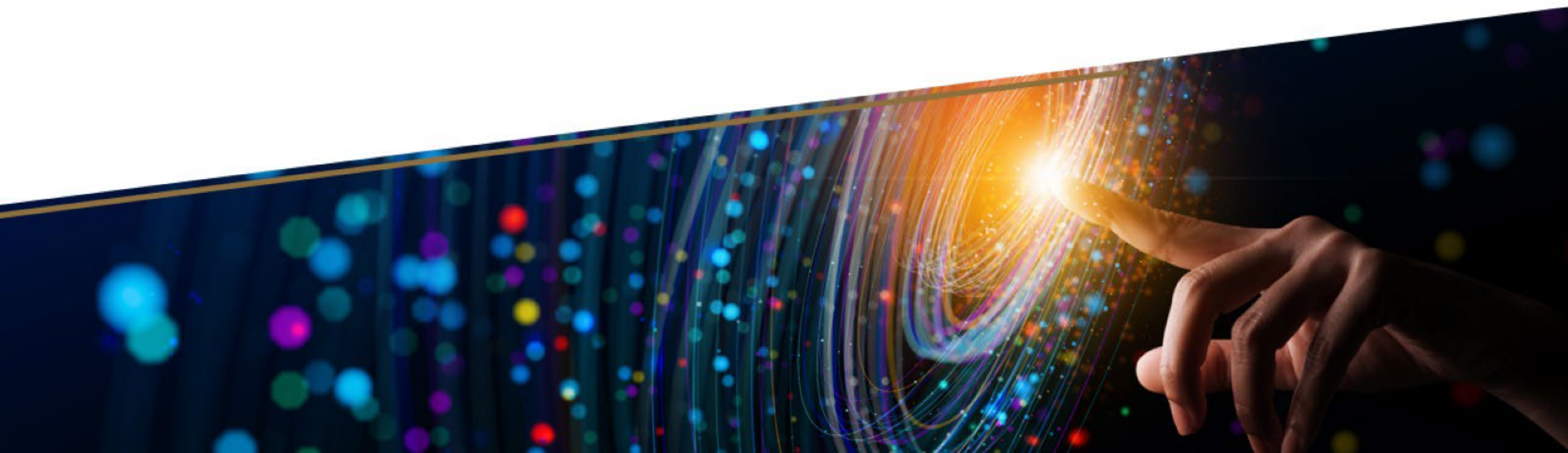


Building a Digital Thread Discipline at Purdue

Travis Fuerst & Angshuman 'Moz' Mazumdar

Tuesday, May 3rd, 2023



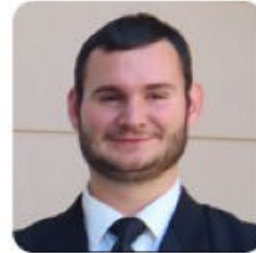
Introductions



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Purdue University



Indiana's Land-Grant University



Senator Justin Morrill
The Morrill Act 1862



Purdue founded 1869



John Purdue

Introduction to Product Data Management

Indiana's Land-Grant University



Purdue West Lafayette

Fall 2022 enrollment = 50,884

Undergraduate	37,949
Graduate	12,017
Professional	918

Purdue University Northwest

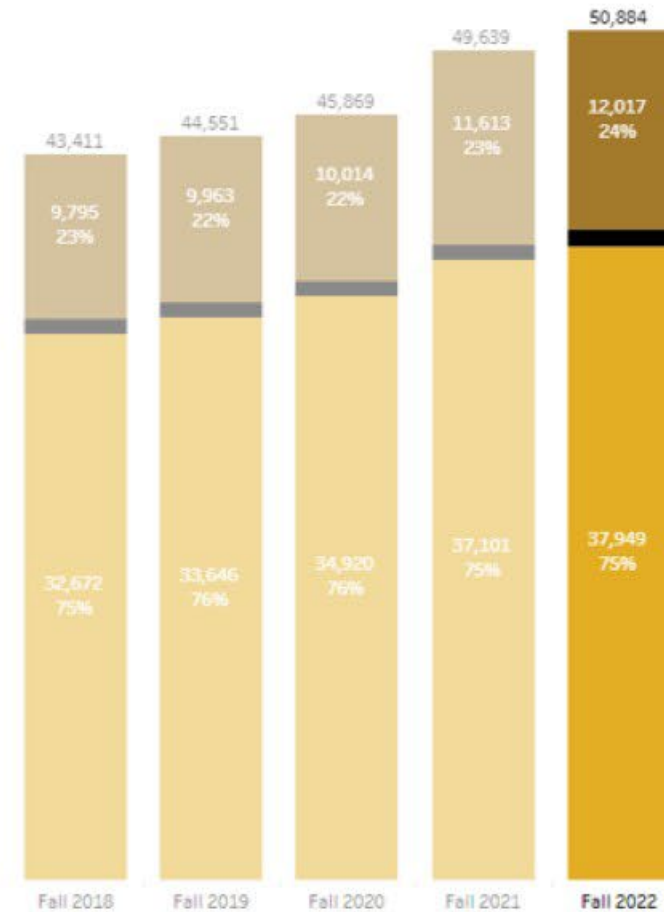
Fall 2022 enrollment = 8,911

Purdue University Fort Wayne

Fall 2022 enrollment = 9,069

Statewide Technology

Fall 2022 enrollment = 646



Purdue Colleges and Key Units



- Agriculture
- Education
- Engineering
- Health & Human Sciences
- Liberal Arts
- Krannert/Management
- Pharmacy
- Science
- **Purdue Polytechnic**
- Veterinary Medicine
- Libraries
- Honors College
- Graduate School

Purdue Polytechnic Institute

- 
- Aviation and Transportation Technology
 - Computer and Information Technology
 - Computer Graphics Technology
 - Construction Management Technology
 - Division of Military Science and Technology
 - **School of Engineering Technology**
 - Technology Leadership and Innovation

Programs:

- Electrical Engineering Technology
- Industrial Engineering Technology
- **Manufacturing Engineering Technology**
- Mechanical Engineering Technology

Majors:

- Automation & Systems Integration Engineering Technology
- **Digital Enterprise Systems**
- Mechatronics Engineering Technology
- Robotics Engineering Technology
- Smart Manufacturing Industrial Informatics

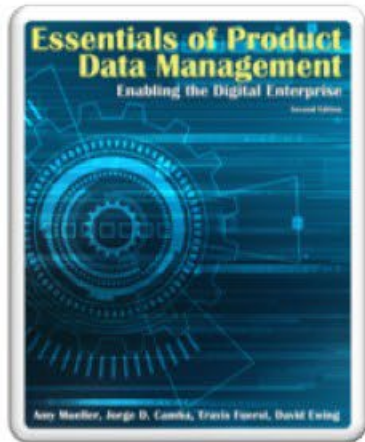
- Only PLM academic program in the U.S. since 2001
- PLM Minor
- Service courses for Engineering

Curriculum Topics

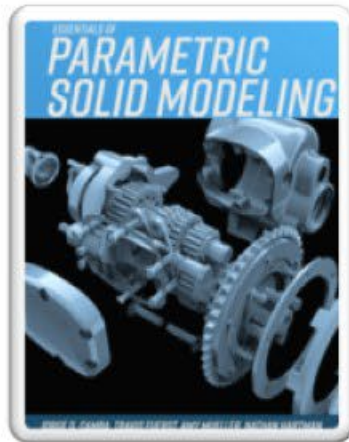
- 3D Modeling
- Analysis and simulation
- Product data management
- Product lifecycle management
- Virtual collaboration
- Standards/interoperability
- Web development/front-end & back-end infrastructure
- Machine-tool manufacturing
- Additive manufacturing
- Manufacturing process planning
- Quality management/LEAN
- Supply-chain modeling and development
- Maintenance/MRO
- Sustainability

Undergraduate Implementation of PDM

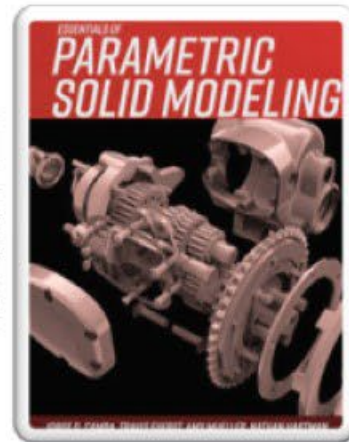
- Aras Innovator implemented in four undergraduate Courses
 - MFET 10301 - Geometric Modeling Applications (~300 Students)
 - MFET 16300 – Graphic Communication & Spatial Analysis (~1200 Students)
 - MFET 11301 – Product Data Management (~30 Students)
 - MFET 20301 – Model Based Definition (~20 Students)
 - MFET 31301 – Business of Managing Product Data (~20 Students)



Essentials of PDM



Essentials of
Parametric Solid
Modeling (NX)



Essentials of
Parametric Solid
Modeling (SW)



MBD in the Product
Lifecycle

Graduate and Professional Education

Master of Science degree

- CGT 514: Product Lifecycle Management
- CGT 534: Technical Documentation in the Digital Thread
- CGT 554: Model-Based Definition
- CGT 564: Configuration Management (CM2)
- CGT 634: Automation of Digital Product Development Processes

Certificate Programs (Delivered online: instructor-led or self-paced)

- PLM Certificate, established in 2006 with Boeing
- MBD Certificate, in 2014
- TDP Certificate, in 2018

• TDP Certificate, in 2018

• MBD Certificate, in 2014

• PLM Certificate, established in 2006 with Boeing

Graduate and Professional Education

PLM Certificate

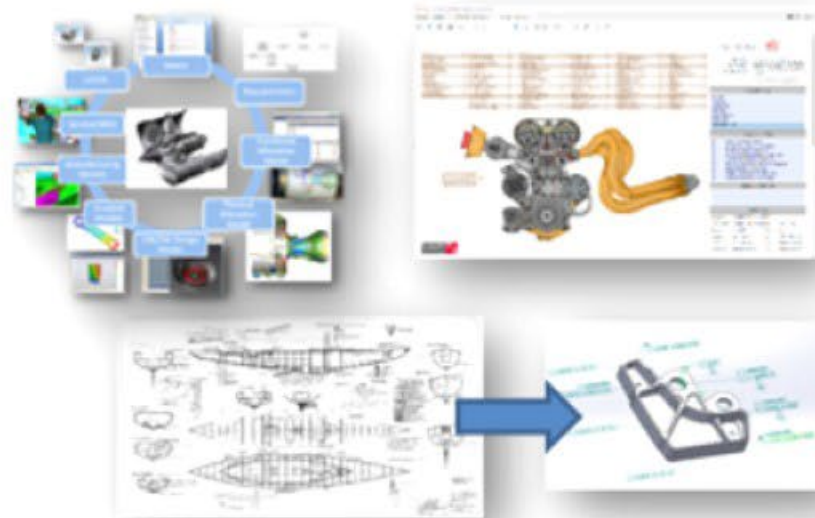
1. Digital Product Definition in PLM Environments
2. Product Data and Configuration Management in PLM Environments
3. PLM Across the Enterprise

MBD Certificate

1. Overview of MBD and PMI
2. Transformation from 2D to 3D Product Data
3. Model-based Data Exchange and Geometry Reuse
4. Guided Practice for Creating MBD

TDP Certificate

1. Introduction to Technical Data Packages
2. 3Di PDF TDP Background & Process
3. Guided Practice
4. The Future



<https://polytechnic.purdue.edu/digital-enterprise-center>

Background

Education

- Successfully deployed Aras Innovator as a Learning Management System (LMS) in five engineering and technology courses at Purdue University (~1,300/semester).
- Worked with Purdue's SAE teams (EV and Baja) to implement Aras Innovator in their workflows (Pre-COVID).
- Partnerships with companies like CADENA PART Solutions, ANARK, CAPVIDIDA, Hexagon, ITI, and CAPVIDIA to bring technologies into the classroom.

PURDUE
UNIVERSITY



Essig PLM Solutions



Educational Research

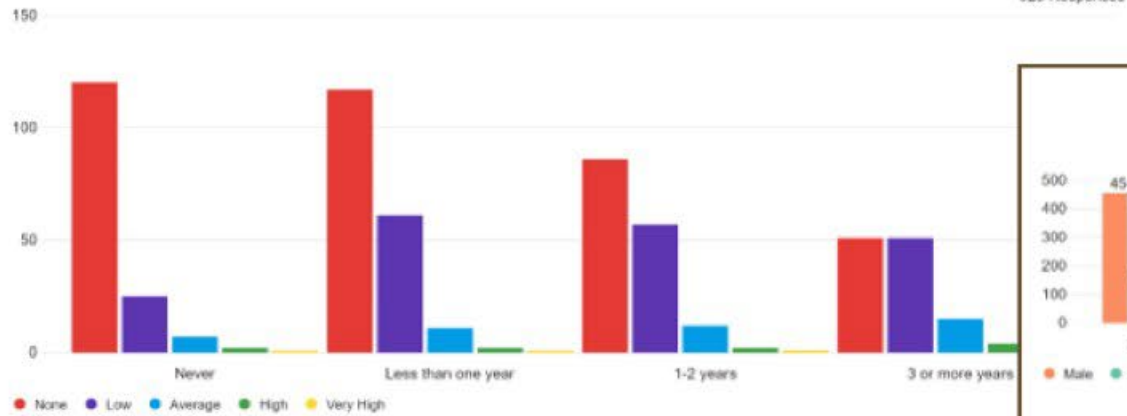
Research papers

- Fuerst, T., Zhou, J., Graton, S., Rudd, K., Camba, J.D. (2020). **A Case Study on Product Lifecycle Management in SAE (Society of Automotive Engineers) Collegiate Design Teams.** 2020 American Society for Engineering Education (ASEE) Annual Conference & Exposition, Montreal, Quebec, Canada, June 21-24 (accepted).
- Astheimer, R., Fuerst, T., Camba, J.D. (2020). **Work-In-Progress: Product Data Management to Promote Higher Order Thinking.** IEEE Global Engineering Education Conference (EDUCON 2020). Porto, Portugal, April 27-30 (under review).
- Del Re, K. J., Yun, S., Kozikowski, E. J., Fuerst, T. & Camba, J. D. (2019), **Integrating a Product Life-Cycle Management System into a Freshman Level Classroom Environment.** 2019 American Society for Engineering Education (ASEE) Annual Conference & Exposition, Tampa, Florida, June 16-19.
- Mueller, A., Camba, J.D., Hartman, N., Fuerst, T. & Astheimer, R. (2019). **Development and Application of PDM Curriculum in Undergraduate Engineering and Technology Coursework.** 11th International Conference on Engineering and Computer Education, ICECE 2019. Guimarães, Portugal. September 8 -11.

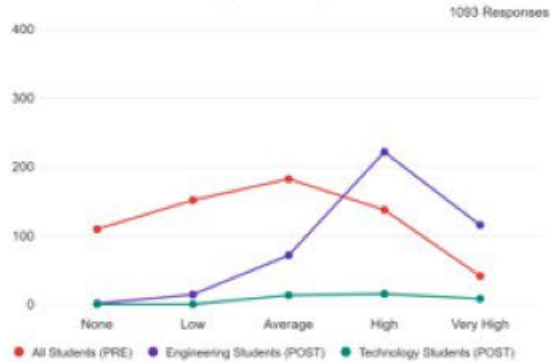


Educational Research

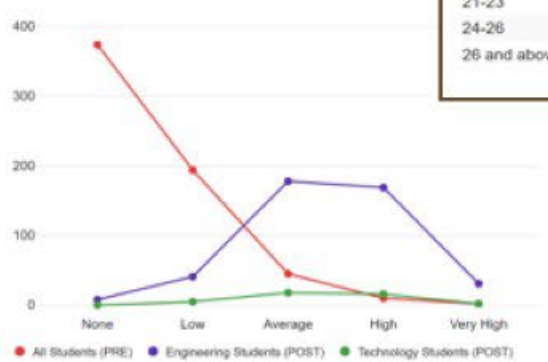
Prior CAD Experience (in years) vs. Familiarity Level with PDM (Likert Scale)
PRE-Course Survey



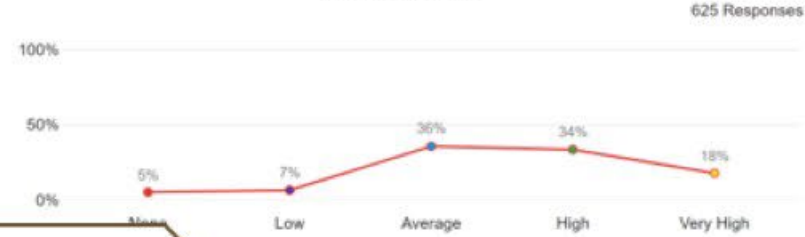
Q13. Familiarity Level with CAD
[PRE vs. POST]



Q17. Familiarity with a PDM system
[PRE vs. POST]



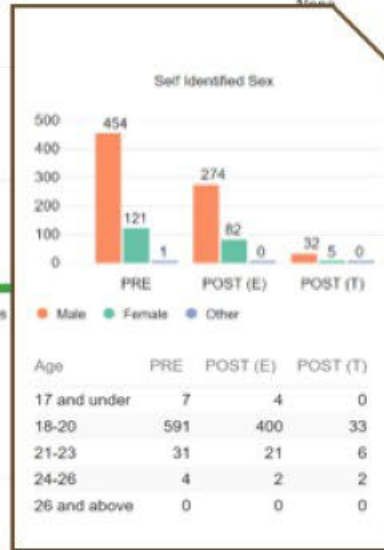
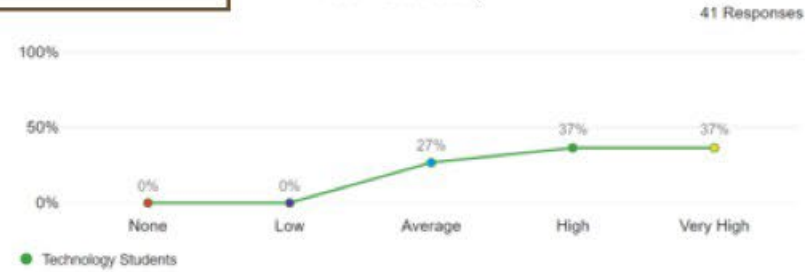
Q19. Perception of importance of PDM with CAD
PRE - Course Survey



Q19. Perception of importance of PDM with CAD
POST - Course Survey



Q19. Perception of importance of PDM with CAD
POST - Course Survey



Age	PRE	POST (E)	POST (T)
17 and under	7	4	0
18-20	591	400	33
21-23	31	21	6
24-26	4	2	2
26 and above	0	0	0

[Full Results](#)



Student Club Implementation of Aras Innovator

Purdue Pullers - Quarter Scale Tractor



Background

- Team size: 10-15 Students
- Majors
 - Ag Engineering
 - Ag Systems Management
 - Design Systems Management
 - Digital Enterprise Systems
- Competition(s)
 - Three North America events held in June
- Goal
 - Design a tractor that can pull farthest while also being able to turn well, and not fall apart going over large bumps



Purdue Pullers - Quarter Scale Tractor



Product Data Management – Current State

- **Current State**

- Shared file system on Purdue server
- Each tractor design in own directory with sub-folders

- **Pain Points**

- Finding correct parts
- Managing test data
- Ensuring design meets requirements

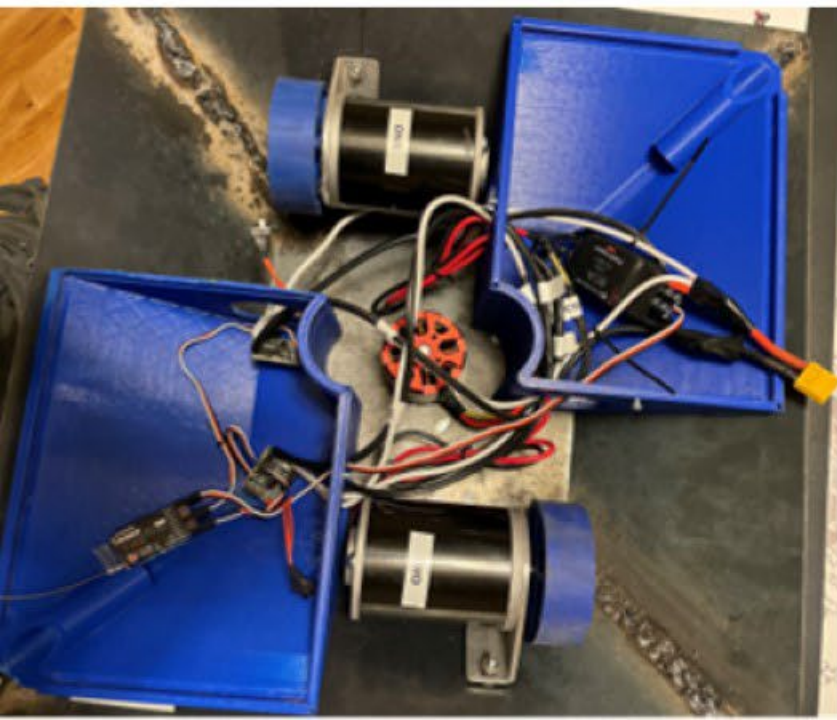
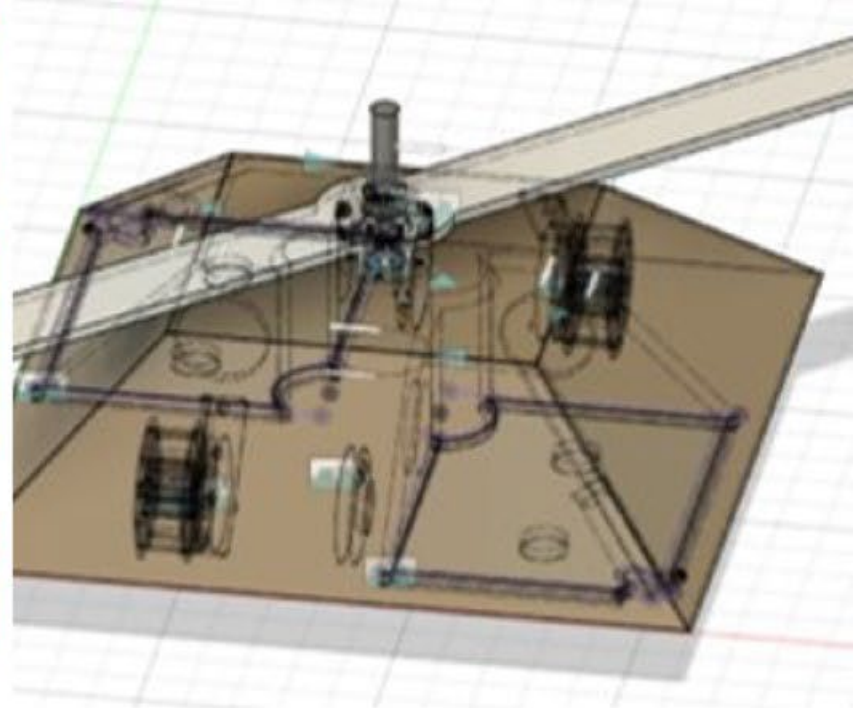
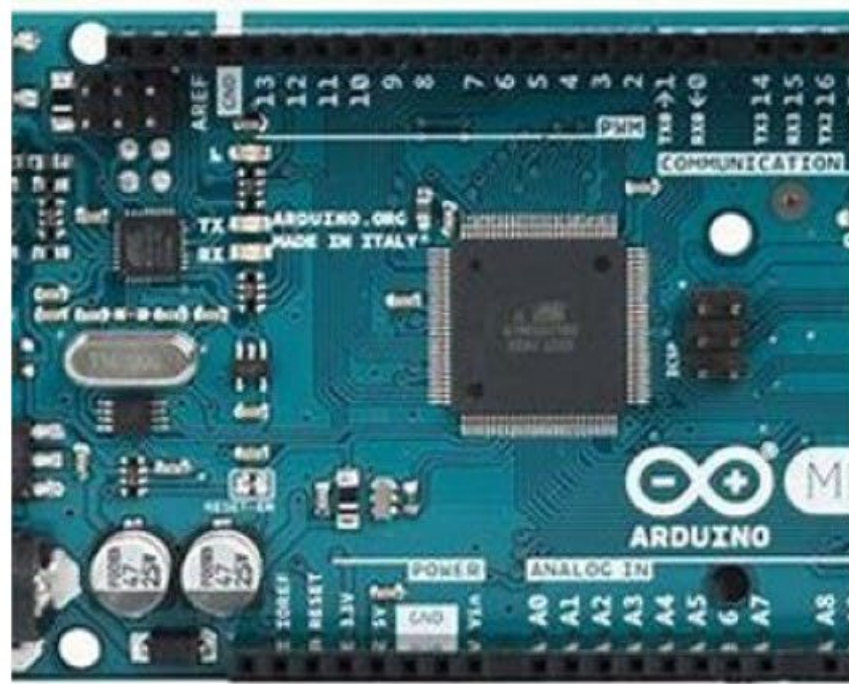


Railside Robotics – Battle Bots

Background

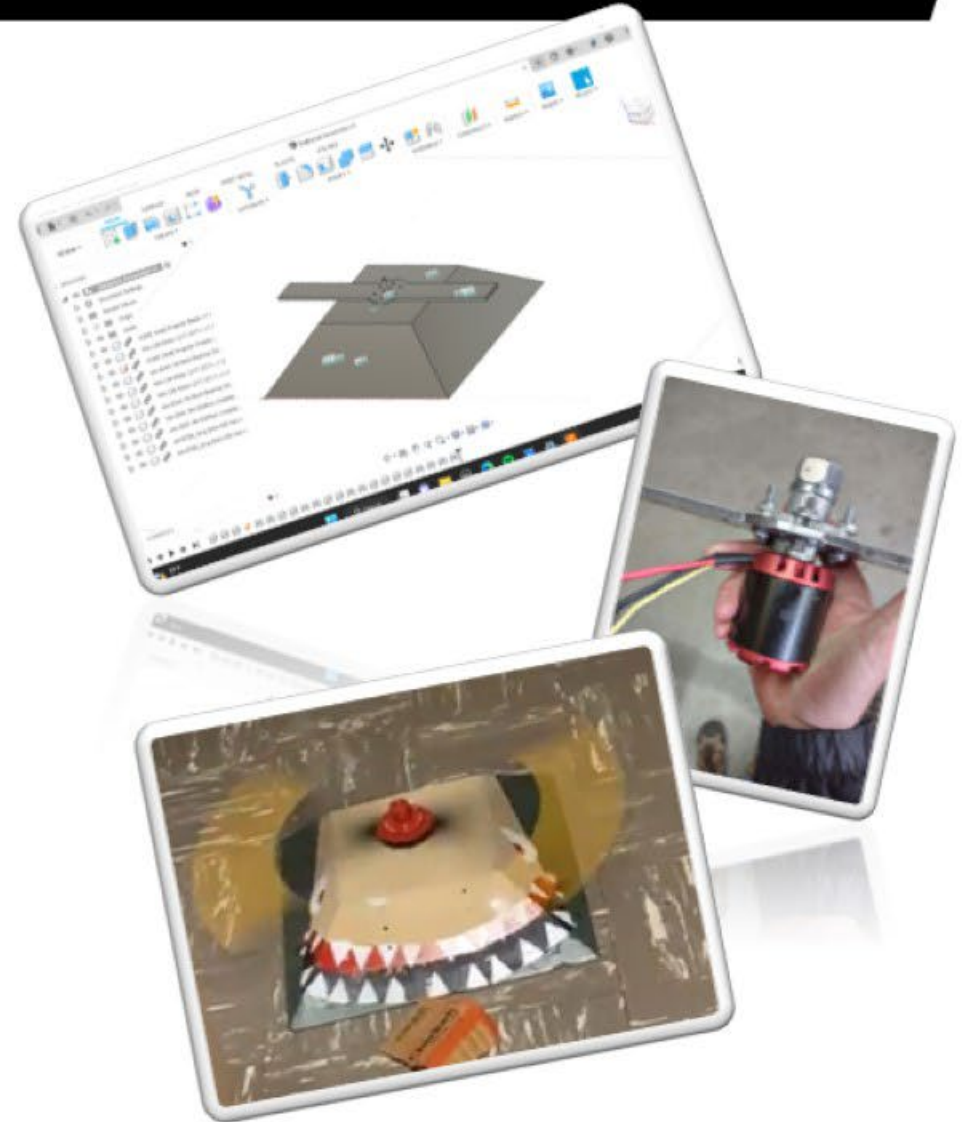
- Team size: ~60 Students
- Majors
 - Mechanical Engineering
 - Electrical Engineering
 - Open to all majors
- Competition(s)
 - UIUC Robobrawl – 30lb
 - Xtreme BOTS: Collegiate Clash – 15lb hobbyweight
 - Engineered for Destruction – 3lb beetleweight
 - Chicago Robotics Combat Association – All weight classes
- Goal
 - Fostering innovation and instilling technical skills within the Purdue community in order to design and manufacture robots that can disable or control other robots





Product Data Management – Future State

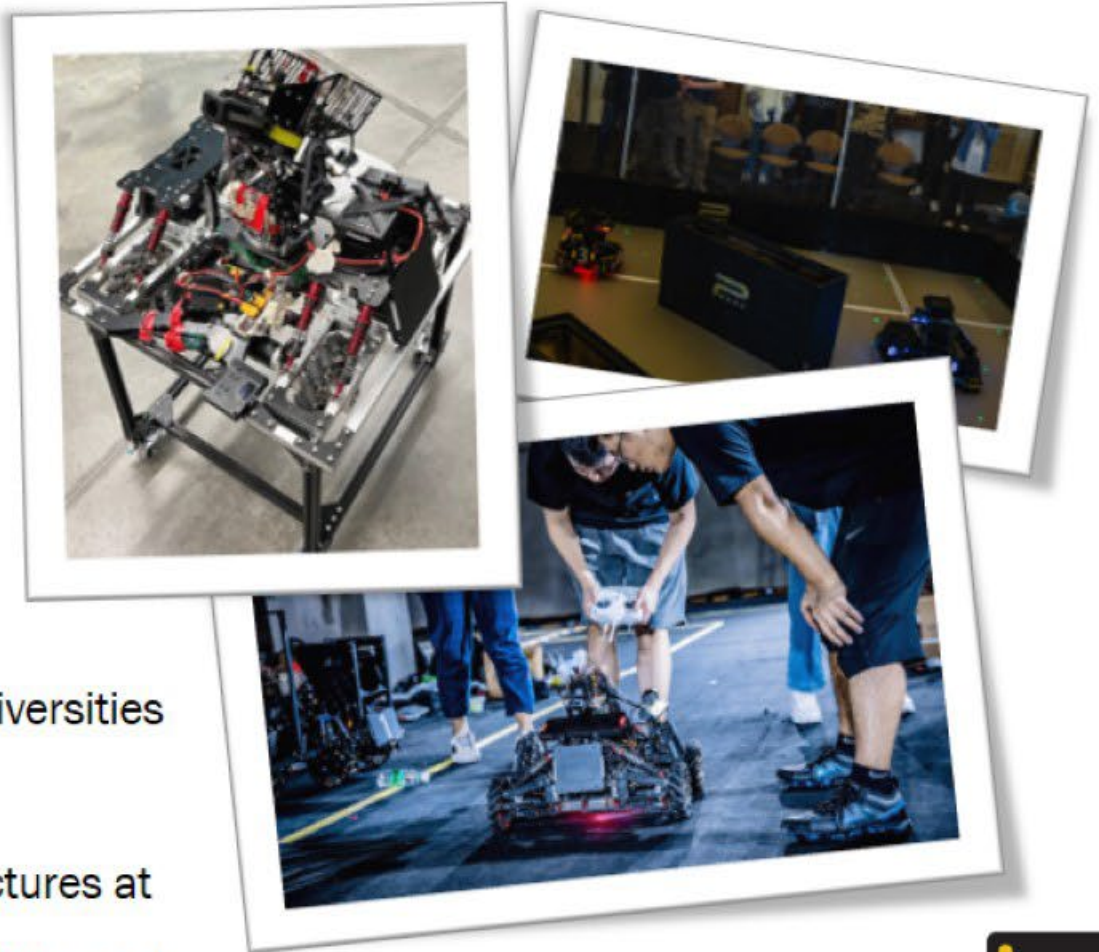
- **Current State**
 - Greenfield implementation (new club)
 - Current PDM done using Google Drive cloud storage
 - Communication on Slack
- **Pain Points**
 - Unable to schedule milestone deadlines
 - Limited & unreliable access to up-to-date CAD files
 - General members have very limited access to files





Background

- Team size: 50-100 Students
- Majors
 - Computer Science
 - Data Science
 - Electrical Engineering
 - Computer Engineering
 - Mechanical Engineering
 - Mechatronics
 - Robotics Engineering Technology
- Competition(s)
 - Hosted annually in Shenzhen China & various U.S. universities
 - 2023 – University of Washington (Seattle)
- Goal
 - Design 7 robots with different requirements and structures at different levels of autonomy.
 - Robots includes include Engineer, Sentry, Standard, Hero, and Drone





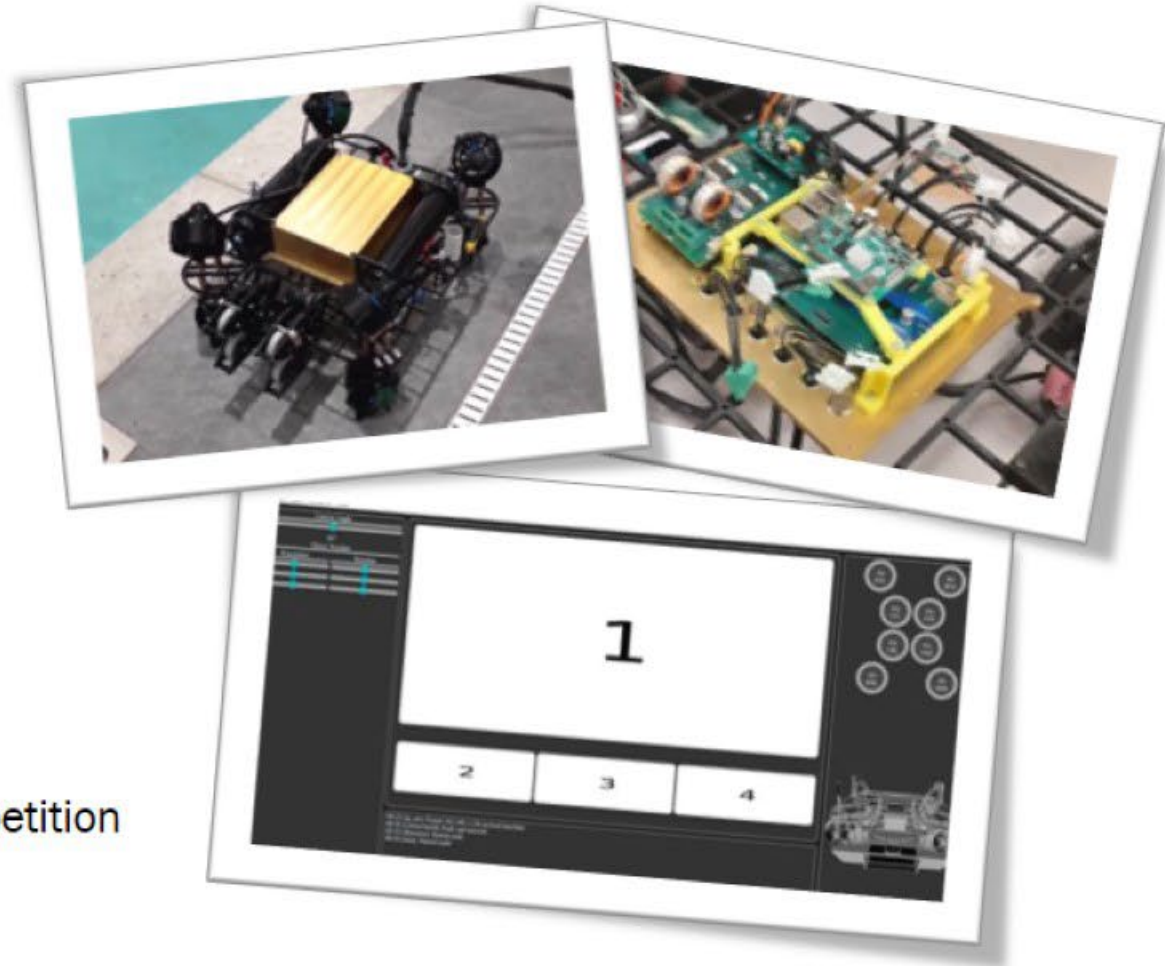
Product Data Management – Current State

- **Current State**
 - Google Drive, Onedrive and file servers
 - Project management via Trello
- **Pain Points**
 - Data scattered between storage locations
 - Version control executed via Zip files
 - Frequent CAD dependency issues



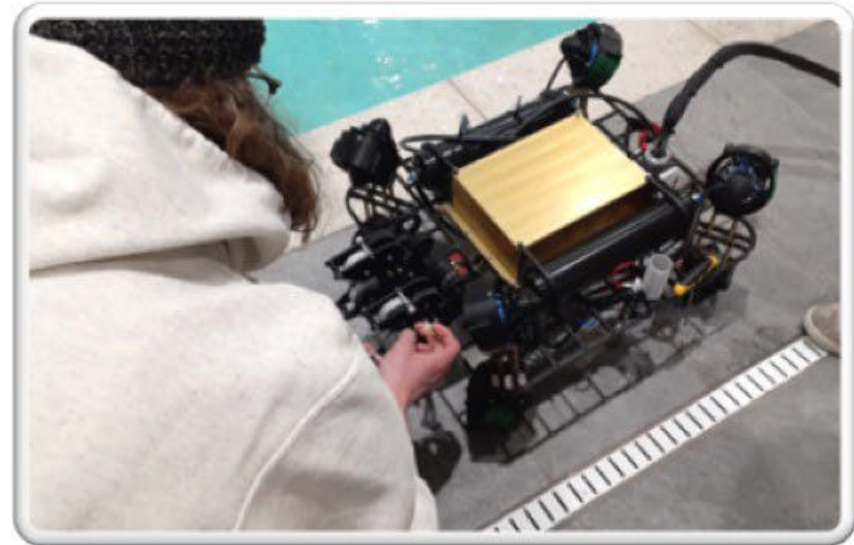
Background

- Team size: 45 Students
- Majors
 - Computer Science
 - Data Science
 - Electrical Engineering
 - Mechanical Engineering
 - Mechanical Engineering Technology
 - Mechatronics
 - Aeronautical Engineering
- Competition(s)
 - MATE ROV World Championship
- Goal
 - The ROV must do a variety of tasks to succeed in competition
 - lifting heavy tanks under water
 - retrieving objects
 - creating models autonomously with computer vision



Product Data Management – Current State

- **Current State**
 - GrabCAD Workbench
 - Project management via Trello
- **Pain Points**
 - Syncing issues
 - No one has access to entire ROV product



Contact Information
rov@purdueieee.org
Jorge Varela (varela4@purdue.edu)

Purdue Space Programs Hybrids

Background

- Team size: 31 Students
- Majors
 - Mechanical Engineering
 - Aeronautical Engineering
 - Chemical Engineering
 - Others...
- Goal
 - Design, Build, and Fly Experimental Hybrid Rocket of 120lbs to 10,000ft
 - Carry and operate scientific payloads



Product Data Management – Current State

- **Current State**
 - Data stored on Confluence server
- **Pain Points**
 - Master is handed between team leads
 - No revision control
 - Difficult to access data



Background (Newly Conceptualized)

- Team size: ~5 Students
- Majors
 - Digital Enterprise Systems
- Competition(s)
 - Support DES & processes for tenant teams
- Goal
 - Document DES processes
 - Coordinate with tenant teams for processes changes
 - Assist tenant teams with training an onboarding
 - Administer systems
 - Provide helpdesk support
 - Ensure sustainability of DES implementation



Thank you for your time, and Boiler Up!

Any Questions?