



MULTIDISCIPLINARY
DESIGN PROGRAM

Experience. Innovation. Teams.

Program Overview

Multidisciplinary Design Program
University of Michigan

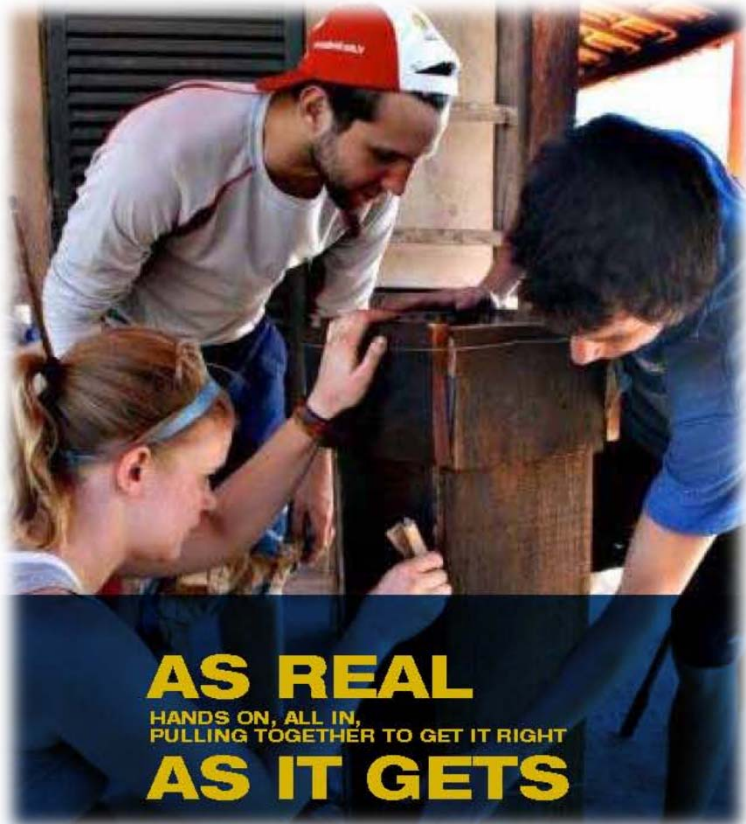
Multidisciplinary Design Program



■ Educational Outcome Goals

- Deeply technical, Systems thinkers
- Capable and skilled in bringing creativity and innovation to design and problem-solving
- Independent learners; Able to reinvent themselves
- Effective communicators and team players in professional and personal lives

Multidisciplinary Design Program



- “Operational” Goals
 - Enable multidisciplinary experiential opportunities in the engineering design process for students from across the university
 - Pilot new methods and models providing curricular instruction in engineering design process
 - Formally evaluate and assess new methods/models

Overview

- The MDP Program Activities
- Demographics
- MDP curriculum
 - MDP Minor
 - MDP Courses
- MDP student team projects models
 - Student Run Organization projects
 - Cross Department 1 semester Capstone Course
 - Externally sponsored projects
 - Faculty Research Design Teams / VIP
 - Cross College Capstone Course
 - Multidisciplinary Mobile Apps Projects
- Business Model, Logistics, and Support
- Research related to pedagogy of engineering design instruction

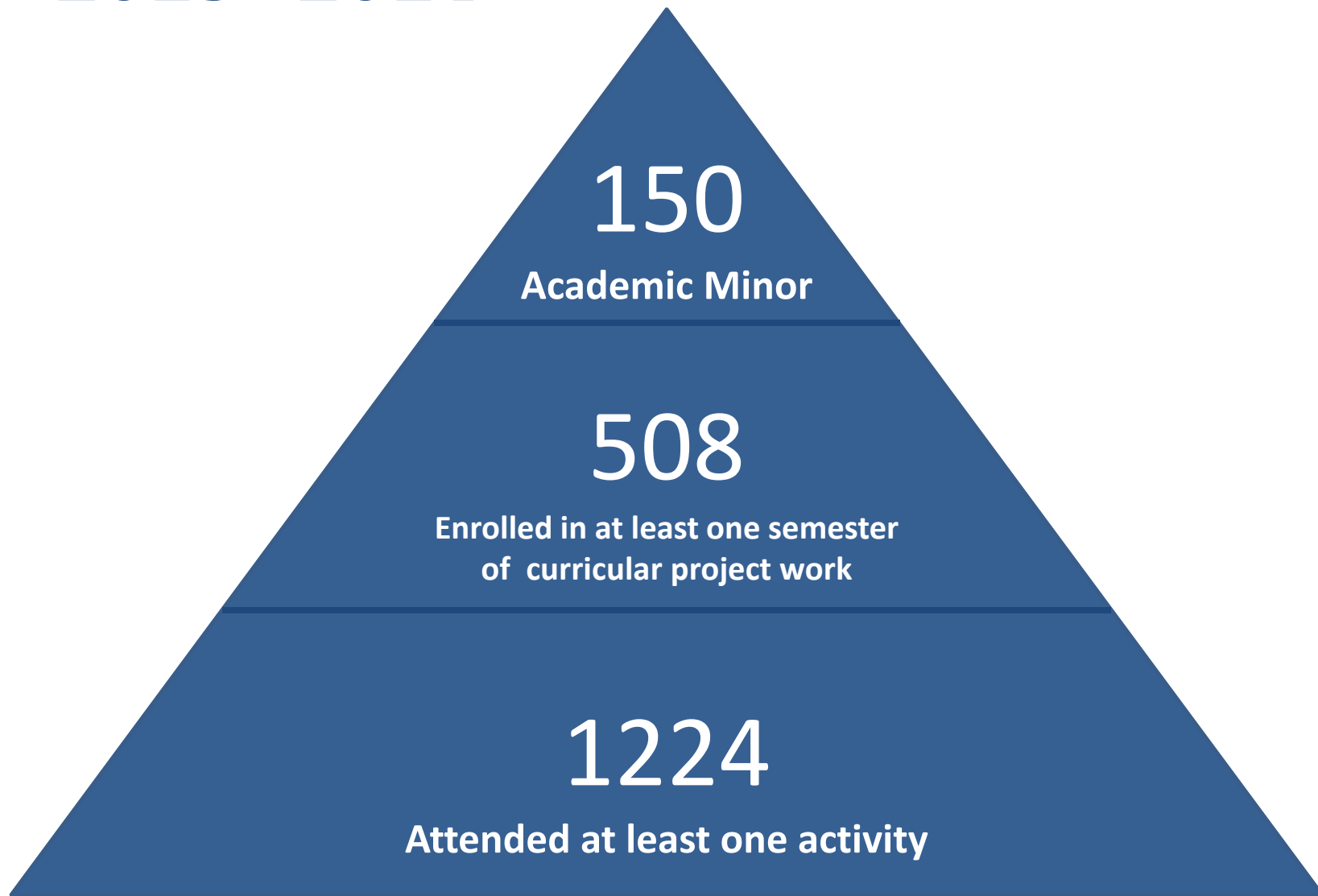


Student Program Activities

- Short Engagement Activities
(25 – 30 Events per year)
 - Professional Development Seminars
 - Workshops
 - Fieldtrips
- Student Project Activities
(roughly 50 Projects)
 - Significant, team-based, multidisciplinary
 - Piloting many modes of implementation



Student Participation 2013 - 2014








Program Participation 2013-2014

Aerospace Engineering	51	Financial Engineering	1	Naval Arch & Marine Engineering	33
Anthropology	1	Human Computer Interaction	5	Neuroscience	2
Applied Physics	1	Industrial & Operations Engineering	108	Nuclear Engineering and Radiological Sciences	15
Architecture	6	Informatics BA	2	Nursing	1
Art	3	Information Analysis and Retrieval	2	Performance: Music	2
Art and Design (BFA)	21	Information Economics for Management	2	Performing Arts Technology	4
Atmospheric, Oceanic and Space Sciences	27	Interarts Performance	1	Philosophy	2
Biomedical Engineering	38	Juris Doctor	1	Philosophy, Politics and Economics	1
Business Administration	17	Library and Information Science	2	Physiology	1
Cellular & Molecular Biology	1	Literature Science and the Arts: Undeclared	75	Plant Biology	1
Chemical Engineering	20	Materials Science and Engineering	58	Robotics and Autonomous Vehicles	4
Civil Engineering	22	Mathematics	4	Screen Arts and Cultures	3
Electrical Engineering and Computer Science	117	Mechanical Engineering	308	Sociology	1
Engineering Physics	3	Medicine MD	2	Spanish	1
Engineering: Undeclared	636	Movement Science	1	Statistics	3
Entrepreneurship MS	1	Natural Res & Environment	3		



Who Participates in Projects?

	Compared to All College of Engineering Undergraduates
Students with Full Financial Aid	
Students with Partial Financial Aid	
First Generation College	
Women	
Under Represented Minorities	





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MDP Curriculum

MDP Course Series x55: Multidisciplinary Design

MDP Minor

MDP Course Series

	<i>Academic Preparation/ Prerequisites</i>	<i>Project Content</i>	<i>Previous Design Process Experience</i>	<i>Professional Skills</i>
255 (1-3 Credits) Typically appropriate for advanced 1 st year students and 2 nd year students	general core class preparation, possibly 200 level domain specific beginning courses. beginning their university studies.	Limited or no previous experience in design process: Possibly completed ENGR 100, or other introductory project based course. Possibly has experience from High School (e.g., First Robotics)	Beginning to develop Executive Skills: personal management, team participation, project management and communications
355 (1-4 Credits) Typically appropriate for advanced 2 nd year students and 3 rd year students	completed at least 2, 200 level domain specific courses. Current registration in 300 level domain specific courses will be common. and should utilize and integrate (at least) 200 level domain specific knowledge and skills	Some previous experience design process. Completed ENGR 100, ENGR 255 or other introductory project based course (find list of other examples). Practical Co-curricular experience (e.g., BlueLab, S3FL, Program is Sustainable Engineering (PISE), Engineering Competition Teams, etc.)	Acquiring Executive Skills: personal management, team participation, project management and communications
455 (2-5 Credits) Typically appropriate for advanced 3 rd year students and 4 th year students	completed a number of 200 level and at least 1, 300 level domain specific courses. Current registration in 400 level domain specific courses will be common. and should utilize and integrate (at least) 300 level or higher domain specific knowledge and skills	Some previous experience in design process.	Practicing Executive Skills: Leadership, team participation, communications, project management



MDP Minor in Engineering Design

- 15 Credits
- 4 Requirements: Intro Project Course, Major Project Experience, Cornerstone Course, Leadership/Mentorship seminar
- Minor Approved Across Campus
 - College of Literature Science and the Arts
 - Ross Business School
 - School of Architecture
 - School of Kinesiology
 - College of Art and Design
 - School of Music, Theater and Dance



Development Activities

- Jump Start Boot Camp (2 Days before each cohort begins)
- Modern Design Process Lecture Series
- High-Functioning Teams
 - Gallup StrengthsFinder™
 - MBTI™ Assessments
 - Performance Appraisals
 - Individual Coaching
- Project Management – Menlo Innovations
- Technical Skill-Building Workshops
 - CAD, FEA, LabView, MathCAD, Composite Structures

Student Team Project Models

- Student Run Organization projects
- Cross Departmental, 1 semester, Senior Capstone Course
- Multidisciplinary Mobile Apps Senior Capstone Course
- Cross College Capstone Course
- Externally sponsored projects
- Faculty research sponsored projects

Student Run Organization projects (150 students per year)

- Independent, student run teams and clubs
- Enduring organizations – many 10 years old
 - e.g., Engineers without Borders, SAE Formula
- Sustained student participation (4+ semesters)
- Opportunity for individual students to curricularize significant participation on the team
 - “Independent” study model
 - Team Faculty Advisor as instructor
 - 1 semester minimum curricular commitment
- lowers the barriers to participation



Multidisciplinary Senior Capstone Pilot (Winter term 2014, 80+ Students)

- 2nd year of Pilot, EE/CE, ME, MSE
- 6-8 students/team, 4 faculty/1 TA
- External/internal customers, 16 projects
- Strong focus on learning modern design process
 - Voice of Customer; Requirements
 - Complete systems concept; Fabricated prototype
- Accommodates differing departmental educational outcomes (e.g. ABET A-K)
- Next year: Expand Pilot to 120 students, 4-5 depts, 6 faculty



Cross College Capstone (120 Students Winter 2014)

- Michigan Engaging Communities in the Classroom
- All courses work with the same customer/client base
 - Willow Run Factory Area
 - 7 Governmental Entities (State, County, School District, City)
 - Willow Run Neighborhood Association
 - RACER Trust
 - Willow Run Airport
- Parallel Courses / Shared Weekly Combined Seminar
 - Ford School of Public Policy – Masters Capstone Course
 - Urban Planning – Masters Capstone
 - Public Health/Medical School Epidemiology Course
 - Engineering
 - MDP Externally Sponsored Project
 - Operations Research Senior Capstone



Multidisciplinary Mobile App Senior Capstone Pilot

(Start Winter 2015, 90 students)

- CS faculty receives teaching credit
- 2 Semester Course
 - Externally Sponsored project with deliverable
 - Weekly sponsor mentor meetings
 - Small Team (4 CS students / 2 – 3 “Domain” students)
- Domain students (2 semesters ENGR x55 Multidisciplinary Design – 7 credits total)
- CS Students 8 credit course = software engineering tech elective 4 cr. + senior design 4 cr.
 - All assignments based on sponsored project



Externally Sponsored Projects (170 Students on 26 projects calendar 2014)

- External Sponsor provides
 - Carefully vetted, real project that will be implemented if successful
 - Sponsor Mentor that meets with the team 1 hour per week
 - Optional paid summer internship OR on campus summer stipend
 - Typically requires IP/NDA agreement
- 5-7 Students chosen for the team (Freshman – Masters)
 - 2 semester / 7 credits
- Faculty Mentor (2 hour meeting per week)
- Technical Communications Faculty (3 meetings per semester)
- MDP requirements: Jumpstart boot camp, 6-lecture series, weekly reports, performance appraisals, formal design reviews, visits to sponsors location



Stryker Medical Post Operative Monitoring Device



ProQuest Elementary Library Sciences Product Redesign

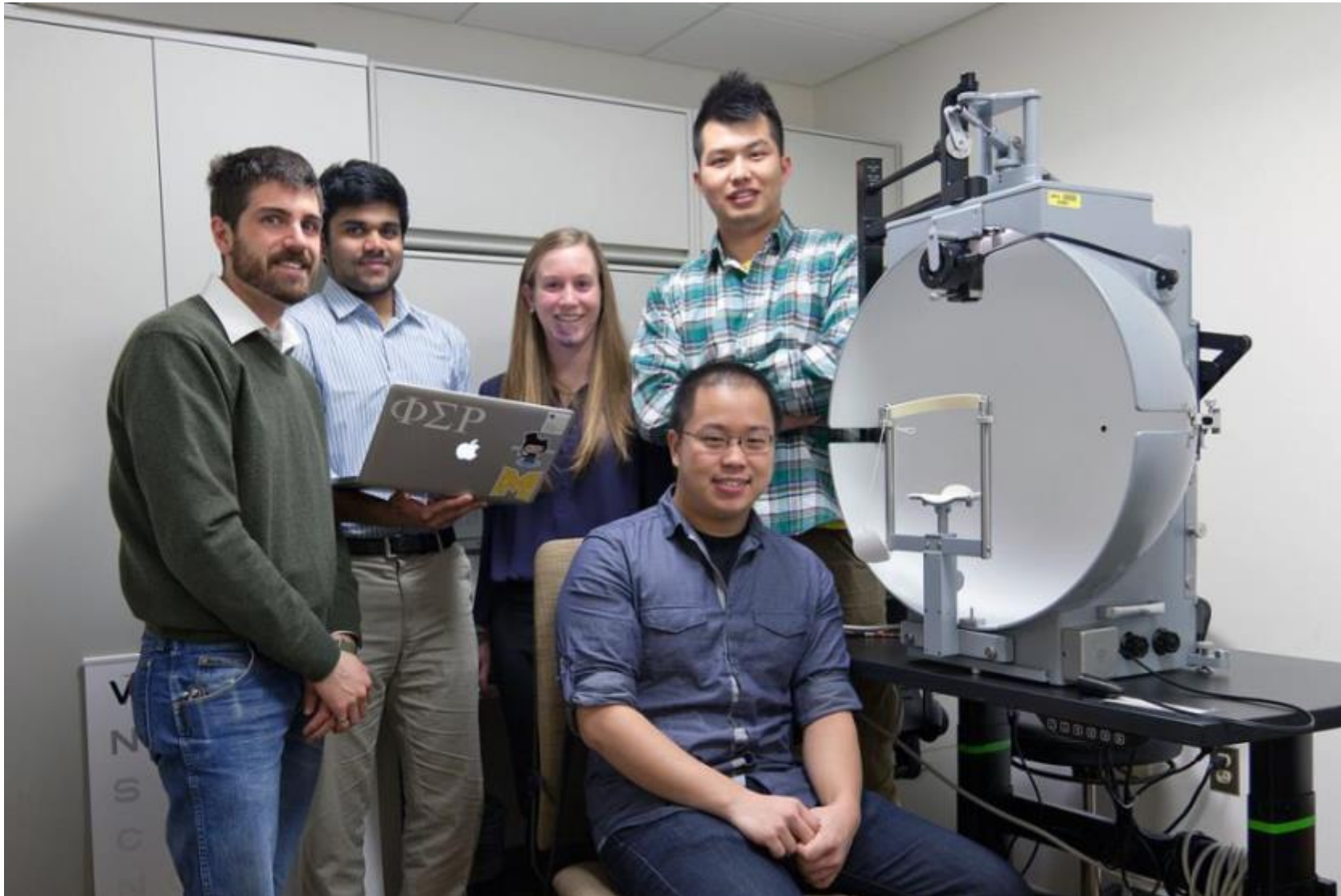


Research Design Teams/ VIP (60 Students on 7 teams, Calendar 2014)

- Long Term Projects (Currently in “establish” mode)
- 10 Students in seed groups / increasing each year
- Faculty Research as Customer/Client
- Faculty as PI (possibly with PhD student PI)
- Student self organization to lower faculty supervision requirements
- Multi-cohort teams (freshman – senior, professional masters)
- 2 credits per semester / 2 semester minimum commitment



Kellogg Eye Center – Ophthalmology Data Visualization Tool





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Nuts and Bolts -

How do you execute the program?

Competitive Student Project Selection (externally sponsored and RDT/VIP)

- Project Fair – External sponsors / faculty research groups present their projects
- Projects are defined in terms of skill sets required
- Students apply to as many projects as they wish
 - Application includes (1) resume, (2) transcript and (3) short personal statement
 - Rank projects they would accept by desirability 1 N
- External Sponsors / Faculty rank applicants 1 ... K
- Utilize Roth-Shapley matching algorithm to maximize happiness in assigned projects

Scheduling Meeting Times

- Project Meeting Times are scheduled PRIOR to semester registration – students schedule around their ES/RDT/VIP projects
- Optimization program
 - Hard constraints
 - Faculty availability
 - Required Courses for each team member
 - Room Availability
 - Soft Constraints
 - Preferred sections
 - Other Activities

Space – Where does all this interesting project work happen?

- Wilson Student Team Center (Pilot / Fabrication Facility)
- Faculty Research Lab Space
- Laboratory / Pilot Plants at Sponsor's Facilities
- Library Design Lab facilities



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Research

What has impact?

What could we be doing better?

Reflective Milestones

(work in progress)

- Preliminary study based on 1 hour interviews with 7 students
- Final assignment of Leadership/Mentorship Seminar
- Student identified 5 most significant “turning point” Milestones in their project experience
 - Calendar with timetable of events
 - Short Paragraph explaining the situation and impact of each Milestone
- Current status coding and analyzing responses from 300 students
 - Most Common Milestones include: Teamwork Issues (good and bad), Technical Challenges, Project Management

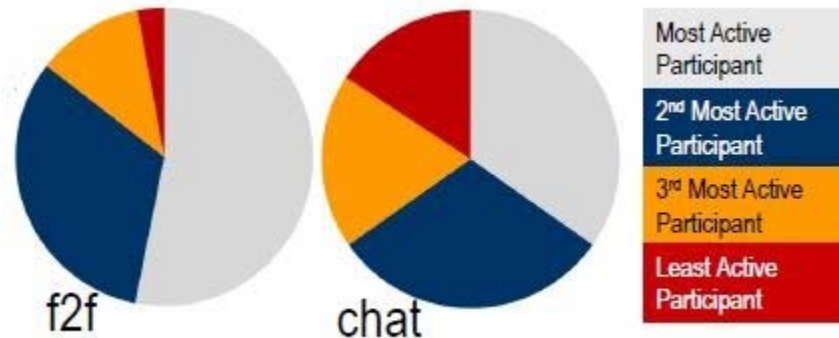
Utilizing Electronic Platform in Student Team Design Ideation Sessions

In face-to-face team conversations (ideation in front of a white board), contributions are often skewed, with a few members speaking a lot and others speaking very little. The “silenced” members are more often women, minorities and non-native speakers.

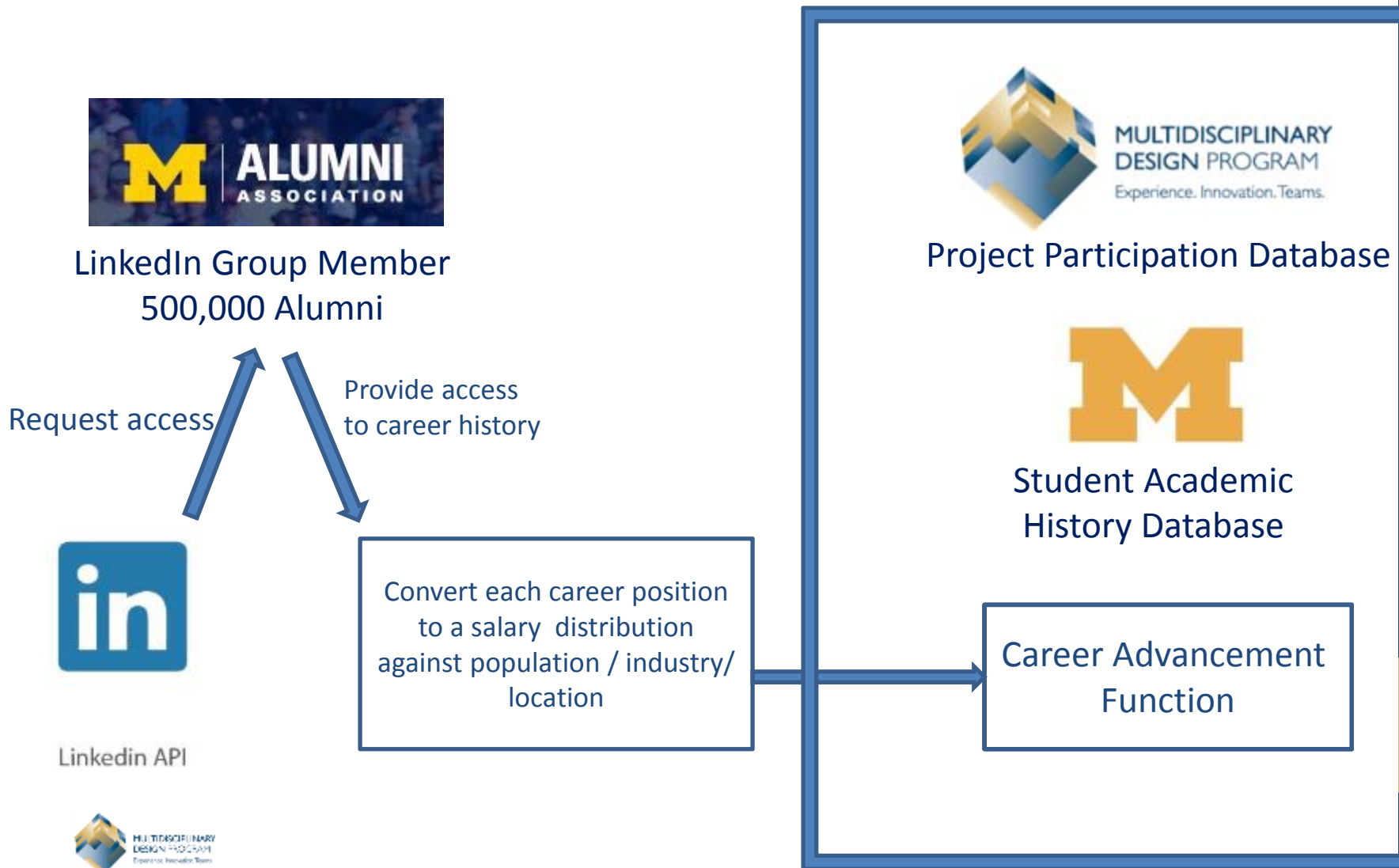
Different methods of interacting can shift the “percentage of voice” to a more balanced participation: google chat; webex; screen shares

Why does this happen?

- Less synchronous
- Text-based
- Lower social presence



Impact of Project Experience on Post Graduate Career



Student team performance appraisals

- *2 Response Tools*
 - *CATME – Validated Instrument, Likert scale online tool*
 - *Short Answer “praise statement” and “improvement statement”*
 - *Specific Example – times, situations and details*
 - *Actionable*
- *Once per semester*
- *Anonymized Feedback provided to individuals and shared with faculty mentor*
- *Utilized as early warning for team dysfunction*
- *Individual coaching is offered for students having difficulties*



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Where Next? How to make the most of VIP Opportunity

Thoughts on Implementing VIP

- Establish a Premiere Program known for excellence in its educational outcomes.
 - Rigorous, not soft
 - Innovative in integrating faculty research with student learning
 - Benefit to faculty research
 - No faculty “burn-out”
 - Quantifiable in assessing student outcomes
 - Maximizes synergistic (efficient) learning with other degree relevant learning goals

Achieving “Premiere Status” for VIP (p1)

- Establish:
 - High quality educational content leveraging VIP Consortium “Best-of-the-Best,” e.g. Voice of Customer, Concept generation/selection, System Engineering, Design Reviews, Multidisciplinary teams, Leadership, IP, Patents, etc. (Don’t reinvent the wheel)
 - Prepared for multiple levels (freshman through masters)
 - Efficient student professional development methods and resources
 - Sustainable educational outcome measurements
 - For ABET level evaluation (silence the “hand-ringers”)
 - Against bench-marks (silence the “nay-sayers”, satisfy the skeptics)
 - and, ...
- Commitment to sharing and training among partner schools



Achieving “Premiere Status” for VIP (p2)

- Commit resources to
 - Coherently integrate VIP in to degree program curriculum
 - Change enough degree programs at school/college to reach “tipping point”
 - Integrate VIP educational outcome experiences throughout degree program, i.e. earlier courses, special training mini-courses
 - If it is important, students should be exposed to it at least twice
- Establish Funding for students in need




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Additional Slides

MDP Program Staffing Levels

- Academic Directors
- Managing Director
- Program Manager (External Projects) – funded from sponsor fees
- ½ time Academic Advisor
- Administrative Assistant

2014 Externally Sponsored Projects

- Amway Medical Device Prototype
- AXS Wear RFID Clothing/Wear
- General Motors Transmission Efficiency
- HATCI Innovation System Design
- John Deere Vision System for Consumer Autonomous Mower(CAM)
- John Deere Gator Adaptive Suspension
- JP Morgan Chase and Co. Real Time Volume Monitor and Projection
- Kellogg Eye Center Retinal Scan Diagnostic Tool Database
- Kellogg Eye Center 3D Data Visualization
- North American Bancard Mobile Application, Website and Support Services
- Navistar Fuel Economy Route Optimizer
- NTVB Media Mobile Application Development
- Pillar technology Micro-controller Lab and Development Ops Platform
- Procter & Gamble Design of Paper-Web Handling Airfoil
- Proquest Web Product Portfolio Analysis
- Racer Trust Sustainable Wetlands Environment
- Reverie Not Your Grandfather's Adjustable Chair
- Stryker Bariatric Cot
- Stryker Post-Operative-Monitoring Device
- UM Credit Union Online Loan Application System
-  Union Pacific Locomotive Safety Couplings
- A&D Professor Joseph Trumpey Domestic Solar Sustainability

Current MDP External Sponsors



JPMORGAN CHASE & CO.



University of Michigan
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Hyundai KIA America Technical Center, Inc.

