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

150
Academic Minor

508
Enrolled in at least one semester of curricular project work

1224
Attended at least one activity
### Program Participation 2013-2014

<table>
<thead>
<tr>
<th>Program</th>
<th>Participation</th>
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<tbody>
<tr>
<td>Aerospace Engineering</td>
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<td>Anthropology</td>
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<td>Cellular &amp; Molecular Biology</td>
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<td>Medicine MD</td>
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<td>Natural Res &amp; Environment</td>
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<td>Naval Arch &amp; Marine Engineering</td>
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<td>Neuroscience</td>
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<td>Robotics and Autonomous Vehicles</td>
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<td>Entrepreneurship: MS</td>
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<td>Natural Res &amp; Environment</td>
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## Who Participates in Projects?

<table>
<thead>
<tr>
<th>Compared to All College of Engineering Undergraduates</th>
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<tbody>
<tr>
<td>Students with Full Financial Aid</td>
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<tr>
<td>Students with Partial Financial Aid</td>
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<tr>
<td>First Generation College</td>
</tr>
<tr>
<td>Women</td>
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<td>Under Represented Minorities</td>
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</table>
MDP Curriculum

MDP Course Series x55: Multidisciplinary Design
MDP Minor
## MDP Course Series

<table>
<thead>
<tr>
<th>Academic Preparation/Prerequisites</th>
<th>Project Content</th>
<th>Previous Design Process Experience</th>
<th>Professional Skills</th>
</tr>
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<tbody>
<tr>
<td><strong>255 (1-3 Credits)</strong>&lt;br&gt;Typically appropriate for advanced 1st year students and 2nd year students</td>
<td>general core class preparation, possibly 200 level domain specific beginning courses.</td>
<td>... beginning their university studies.</td>
<td>Beginning to develop Executive Skills: personal management, team participation, project management and communications</td>
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<tr>
<td><strong>355 (1-4 Credits)</strong>&lt;br&gt;Typically appropriate for advanced 2nd year students and 3rd year students</td>
<td>completed at least 2, 200 level domain specific courses. Current registration in 300 level domain specific courses will be common.</td>
<td>... and should utilize and integrate (at least) 200 level domain specific knowledge and skills</td>
<td>Acquiring Executive Skills: personal management, team participation, project management and communications</td>
</tr>
<tr>
<td><strong>455 (2-5 Credits)</strong>&lt;br&gt;Typically appropriate for advanced 3rd year students and 4th year students</td>
<td>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.</td>
<td>... and should utilize and integrate (at least) 300 level or higher domain specific knowledge and skills</td>
<td>Practicing Executive Skills: Leadership, team participation, communications, project management</td>
</tr>
</tbody>
</table>
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
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
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

LinkedIn Group Member
500,000 Alumni

Request access

Provide access to career history

LinkedIn API

Convert each career position to a salary distribution against population / industry / location

Project Participation Database

Student Academic History Database

Career Advancement Function
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
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 into degree program curriculum
    - Change enough degree programs at school/college to reach “tipping point”
  - Integrate VIP educational outcomes 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
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

- Harris
- DMS
- ProQuest
- P&G
- Amway
- JPMorgan Chase & Co.
- Pillar
- Eaton
- Union Pacific
- University of Michigan Kellogg Eye Center
- Navistar
- North American Bancard
- Hyundai KIA America Technical Center, Inc.
- GM
- Stryker
- John Deere
- Racer
- NTMB Media
- AXS Wear Connected Apparel