

# Managing a Multidisciplinary Experiential Program









#### **UTDesign**<sup>®</sup>

INNOVATIVE DESIGN FOR REAL-WORLD ENGINEERING PROBLEMS

#### **Presenters**



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#### Acknowledgements

- Much of the work to be presented is based on capstone programs at other universities
- We gratefully acknowledge their contributions and appreciate the discussions we have had with them
- We would also like to acknowledge the contributions and support of all the UTDesign staff and UTD administration.

#### **Overview**

- Capstone at UT Dallas
  - Bringing real-world to the classroom
  - Course framework
  - Managing projects
  - Multidisciplinary aspects

# **Engineering at UT Dallas**

- Undergraduate degrees
  - Biomedical Engineering
  - Mechanical Engineering
  - Electrical Engineering
  - Computer Engineering
  - Software Engineering
  - Computer Science
- Engineering students complete a two-semester senior (capstone) design course
  - Team-based project
  - Many teams are multidisciplinary





#### **Capstone Course Overview**

- Our goal is to help students make the transition from their academic career into their professional career
- Most projects are industry-sponsored
  - Give students an opportunity to learn how to manage a project with realistic constraints and complexities
- Key policies
  - \$15K sponsorship fee (includes materials and services)
  - IP owned by sponsor; no university involvement
  - Funding provided as a gift and there is no contractual relationship



## What is UTDesign?

- UTDesign is a collaborative program involving all engineering departments (started in 2009)
  - Provides the facilities and administrative functions needed for capstone courses
  - Academic aspects of capstone remain under control of individual departments
- Advantages
  - Resource sharing
  - Facilitates multidisciplinary projects and attitude
  - Encourages faculty collaboration
  - Single interface for corporate involvement (Give us your problem and we will build a team to solve it!)

#### **UTDesign Studio**

- 30,000 sq. ft. of space
- Students have 24/7 access to open lab (after on-line safety training)
- Shop access requires additional training





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Design®

#### Organization



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## **Finding Real World Problems**

- Project recruiting is done by UTDesign staff and capstone instructors
- Look for sponsors that can clearly articulate project purpose and goals
- Some strategies
  - Build personal relationships
  - Reach out to alumni
  - Hold information sessions
  - Promote to trade and professional organizations
  - Look beyond traditional "industry"- medical schools, non-engineering companies, museums, etc.



## **Establishing the Mindset**

- Our motto: Welcome to the Real World!
- It is critical to set the right expectations from the beginning
- In the first class we make it clear to students
  - You are no longer a student consider yourself a new employee at the company; we will treat you as such
  - You will work as part of a team to manage a realistic engineering project from beginning to end
  - This is a serious project for a client that has a stake in the outcome; it is not a lab or class project

### **Use of Industry Terminology**

Academic	Industry
BMEN 4388/MECH 4381	UTDesign (the company name)
Student	Engineer
Course Instructor	Engineering Director
Faculty Advisor	Technical Manager
TA	Technical Assistant
Sponsor/Corporate Mentor	Customer/Corporate Mentor
Team Leader	Engineering Team Leader
Class	Company Meeting
Assignment	Project Deliverable
Due Date	Deadline
Lecture	Training
Parts Ordering	Procurement

#### Presenter



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# **UTDesign Curriculum**

- Emphasis is on non-technical, professional topics
  - Professional skills (emails, meetings, ethics, etc.)
  - Teamwork skills & conflict management
  - Engineering design process
  - Practical considerations in design
  - Innovation and idea generation
  - Project management (scope, cost, scheduling, risk)
  - Safety
  - Standards & regulation
- We have frequent guest speakers
- Training sessions not scheduled on several weeks throughout the first semester and most of the second semester



#### **Active Learning Strategies**

- Clicker quizzes
  - Turning Point Technologies ResponseWare
- Team activities
  - Agendas and Minutes
  - WBS
  - FMEA
- Classroom discussions
  - Require participation by calling on teams to answer – keep list of teams that have been called on in previous classes



#### **Guest Lecture Training Sessions**

- Professional Communication and Teamwork
  - Collaboration with Business Communication instructors from School of Management at UTD
  - Specially developed curriculum
    - Team charter
    - Conflict resolution
    - Leadership training
    - Presentation skills
- External guest lecturers
  - Topics covered: Innovation, Real-World Project Management, Ethics
  - Lectures are well received by students
  - Guest lecture topics help to reinforce topics covered by instructors



#### **UTDesign Schedule and Deliverables**



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#### **Recent Additions**



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## **Engineering Directors**

- Oversee the entire UTDesign program
- Conduct training
- Set the schedule and deliverables
- Evaluate all deliverables
- Review all evaluations from your peers, Technical Manager and sponsor
- Teaching capstone takes a lot more time than a typical class, so it is important that faculty be given adequate time



# The Technical Manager (TM)

- TMs are an internal resource for the teams
- Team are expected to meet weekly with their TM
- Roles:
  - Review progress
  - Provide oversight & guidance
  - Connect the team to technical resources and experts
  - Available to help with any questions (technical or otherwise)
- Key Point: TMs <u>do not</u> direct the project work
- TM training is held at the beginning of the project

# The Corporate Mentor (CM)

- CM has two roles
  - Customer that establishes requirements and provides feedback on concepts to establish project direction
  - Help the team understand the company's technology involved in the project
- Team are expected to meet weekly with their CM (separate from TM meeting)
- CM orientation session is held at the beginning of the project



#### **Team Formation**

- All projects are entered into EduSourced by sponsors
- Time is provided in first class for students to review projects and ask questions
  - Give anticipated team makeup (e.g., 3 BMEN + 3 ME)
- Students are given a few days to complete their bid
  - Done individually using the EduSourced tool
  - Rank top projects
  - Describe relevant qualifications and skills
  - Upload resume
  - "Sell" why they should be placed on top 3 choices
  - Indicate preferred team member(s) & preference for team or top-ranked project
- A summary sheet is generated for each student and teams are formed manually by instructors

Last, First					Biomedical Engineering			
NDA/IP	Yes							
Role	No p	refere	nce					
Preference	Proje	ects						
Conflicts	No							
	_							
LabVIEW	Cou	irse ex	perienc	e	Expertise Explai needle hub applic	nation: I used So sator for a potent	olidWorks to create a	
Matlab	Cou	irse ex	cperienc	e	with Epimed.	ator tor a potent		
РСВ	Cou	irse ex	perienc	е				
Soldering	Cou	irse ex	perienc	е				
uController	Cou	irse ex	perienc	е				
Mobile app	Nor	e						
SolidWorks	Bey	ond c	ourse ex	perience	Completed Elect	tives: BMEN 4V	95 : material science	
ProE/Creo	Nor	ie						
FEA	Nor	ne			Currently Enrolled Electives:BMEN 4V95 : material			
CFD	None				science			
Machine shop Very little, the last time I us constructing our ping pong					ed machine shop ball launcher. for Dr. Cogan res	tools was fresh	man year of college logical effects of differen	
Internship	nternship sciatic nerve electrode size treadmill. Analysis of the ra			es in rats. I researched papers, as well as ran rats on a ats was also done to see the different gait patterns in				
Work as a pharmacy techn Relevant skills time management, as well				armacy techr ment, as well	ician which provid as problem solvin	les excellent skil Ig.	lls in organization and	
Rank 1-3		Ran	k 4-6	Rank 7-9	Rank 10-12	Rank 13-15	Prefer NOT	
Wearable Orth	0 E	nhance	d Desi	Orthosis and Pr	DESIGN CHAL	Endoscopy Pro	CortiWATCH: Wrist-worn	
REBOA Traine	er S	uper he	ero pow	Pulsed Electrica Medical Imaging	aSound Localiza Rapidly Securin	DESIGN CHAL Clinical Tane !	Spectral Tissue Analyzer Real-time Video Analytics	
		sposa	and definit		g aprory occolini	onnour rupe En.	int of the state o	
Reason for first choice: I think my knowledge in material science could help with the polymer adhesive aspects of this project. I also have experience with CAD and 3D printing. I have a strong interest in orthotics and orthotic research once I have graduated with my undergraduate degree.						with the polymer ting. I have a strong rgraduate degree.		
Reason for second choice: I think many years of Matlab and a few years with C ar programming skills required for this project. I also have an interest in the human boo taking advanced physiology next spring.					h C and C++ help my an body, and plan on			
Reason for third choice: I think my knowledge in material science could help with the polymer adhesive aspects of this project. I also have experience with CAD and 3D printing. I am also currently taking biomechanics and took statics which could help with this project as well.								



#### Presenter



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# **Managing Project Teams**

- Use a set of tools to identify those teams or individuals in need of help
  - Weekly communication
    - Hours Worked
    - Meeting Held and Attended
    - Minutes and Agendas
  - Using Milestones and Deliverables
  - Peer evaluations (4 total)
  - Technical Manager evaluations
    - Team based (4 total)
    - Individual based (3 total)
  - Corporate Mentor evaluations
    - Team based (2 total)

		First Se	emester	Second Semester		
		Middle	End	Middle	End	
,	Peer Eval.	Х	Х	Х	Х	
	TM - Team	Х	Х	Х	Х	
	TM - Individual		Х	Х	Х	
	CM		Х		Х	



# Weekly Communication Overview

#### • Motivation

- Ensure that all teams are communicating on a regular basis with their Technical Managers, Corporate Mentors, and each other
- One weekly communication grade per team
  - Based on simple rubric on quality of Minutes and Agendas -- graded by teaching assistants
  - If an individual fails to submit their own hours or attendance at meetings their individual weekly communication grade is a 0



# Weekly CommunicationTime Sheet

#### • Motivation

- Tracking hours creates accountability for students to the course and to their teammates
- Enables instructors to gauge level of commitment to project
- Data Collection Methods
  - Previous: One team member submits hours for all members once per week (using Qualtrics surveys)
  - Current: Individuals submit their own hours on a rolling basis (using EduSourced)

#### **Hour Tracking Metrics**

- Two key hour tracking metrics
  - Average hours worked per week for each team member (our target is 10)
  - Contribution ratio (individual hours/avg. hours per team member)

flag students below contribution: 0.8 (APPLY)					
Team	Metrics (contribution   avg   total) 08/28/17 - 09/24/17	Week 1 (contribution   total)	Week 2 (contribution   total)	Week 3 (contribution   total)	Week 4 (contribution   total)
Team 534: Wearable Orthotic for Resto	-   21.06   84.25	<b>8/28/2017</b> -   0	<b>9/4/2017</b> - 33.5	<b>9/11/2017</b> - 25.75	<b>9/18/2017</b> - 25
Student 1	1.28   3   12	0 0	1.61   6	0.52   1.5	1.62   4.5
Student 2	1.07   2.5   10	0 0	0.74   2.75	1.49   4.25	1.08   3
Student 3	0 0 0	0 0	0 0	010	0 0

# Weekly CommunicationTM and CM Meetings

#### • Motivation

- Tracking teams' meeting with their CM and TMs help instructors identify teams potentially lacking guidance
- Tracking individual team members attendance at meetings creates accountability
- Data Collection Methods
  - Previous: One team member submits meetings held and attendance for whole team (using Qualtrics survey)
  - Current: Individuals submit their own meeting attending (using an EduSourced surveys)



#### Deliverables

- Guidelines for each deliverable posted on EduSourced and discussed in training sessions
- Deliverables submitted to Milestones in EduSourced
- Rubrics used to evaluate deliverables
  - Use of rubrics aids in ABET assessment

UTDesign (edit milestones)								
			Conceptual Design					
Project Name	Team Profile ≟	Kickoff Meeting ≟	Team Charter	Project Definition (for TM review)	Project Definition	Preliminary Design Review (PDR) Meeting 🛓	Project Plan	
Team 535: Bio-Inspired Soft Robot	0	0	0	0	0	0	0	
Team 536: Clinical Tape Ladder Project	0	0	0	0	0	0	0	

#### **Peer Evaluation**

• Utilize questions from The Comprehensive Assessment of Team-Member Effectiveness (CATME)\*



• Customized survey for UTD (not part of standard EduSourced product)

\* Ohland, M. W *et al*, "The comprehensive assessment of team member effectiveness: Development of a behaviorally anchored rating scale for self and peer evaluation," **Academy of Management Learning & Education**, 11 (4), 609-630, 2012.

\* Website: http://www.catme.org



#### **Technical Manager Evaluation**

- Technical Managers are asked to provide a performance evaluation for the team as a whole and for each individual member of the team
  - Evaluations completed in EduSourced
  - Mid-term and end of each semester team evaluations
  - End of first semester and mid-term and end of second semester individual evaluations
  - Team Evaluation Areas of Focus
    - Technical Work
    - Deliverables
    - Meetings
    - Teamwork
    - Professionalism

- Individual Evaluation Areas of Focus
  - Technical Ability and Effectiveness
  - Communication & Contributions to meetings
  - Attitude

#### **Corporate Mentor Evaluation**

- Corporate Mentors are asked to provide a performance evaluation for the team as a whole
- Evaluations completed in EduSourced at the end of each semester
- Team Evaluation Areas of Focus
  - Technical Work
  - Meetings
  - Attitude
  - Professionalism
  - Sponsor satisfaction

#### **Continuous Monitoring**

- Engineering Directors meet regularly to review all teams and engineers
  - Hours worked
  - Evaluations
- Take action as needed
  - Meet with individuals or teams
  - Discuss issues
  - Require written improvement plans when needed
  - Follow-up to ensure goals are met
- Dismiss students from teams in extreme situations



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#### **Multidisciplinary Capstone**

- Beginning in 2014, Hart (ME) and Polk (BE) began collaborating on capstone
  - ME had one cohort completed
  - BE was preparing for their first cohort
- Department capstone courses taught separately for 2 years but using the same material
- In the Fall of 2016 the BE and ME capstone courses were merged and taught together by Hart, Polk and Pacheco (BE – joined team in 2016)
- One combined cohort completed, second is nearing halfway point



#### **Multidisciplinary Success**

- All BE and ME capstone students are together in the same training (class)
  - EE and CS have provided students to BE and ME teams
- Hart, Pacheco and Polk meet outside of class for 5-10 hours weekly to plan and continually evolve the capstone program at UT Dallas
  - Critical review and improvement of material presented in training
  - Review and updating of guidelines for deliverables
  - Development of rubrics for evaluating deliverables

#### Want to Learn More about Capstone?

- Attend the 2018 Capstone Design Conference
  - More information at <u>www.capstoneconf.org</u>





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# Thank you!

# Questions?



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