AM-VPD09-016

e=MSC 2009VPD engineering. education. enterprise. virtual product development conference

Advanced Vehicle Dynamics: A Novel Experiment on Using MSC Products in the Classroom

Sangram Redkar, Arizona State University

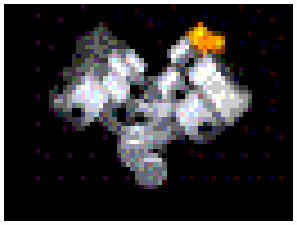
MSC Software

Introduction

ASU Arizona State University
POLYTECHNIC CAMPUS

Department of Engineering Technology- ASU Poly

- Analytical and mathematical concepts blended with practical 'hands on' training.
- Industry Driven
- Address today's needs but designed for future.
- Interdisciplinary



Automotive Technology:

- Design and Analysis of power-plants and power-trains
- Vehicle Dynamics, Automotive Electronics and Electrical Systems
- Human comfort and safety, System Integration

Curriculum Structure

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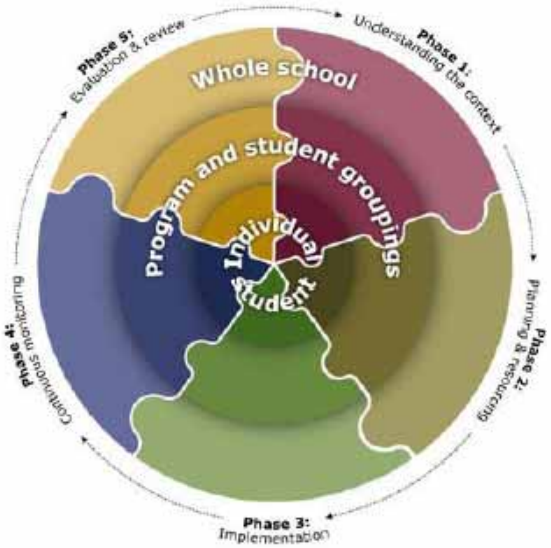
- **Concentration Model**
- 128 Credits Degree Program (Core 110+18 Concentration Credits)
- Concentration courses are 300, 400 level courses that build upon 100, 200 level ‘basic’ courses.
- **Current Concentrations**
- Mechanical Engineering Technology
- Automation Engineering Technology
- Aeronautical Engineering Technology
- Automotive Engineering Technology



Automotive Curriculum

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- **Traditional Approach**
- System-Subsystem Model
- Less emphasis on system integration
- More emphasis on analysis and mathematics
- **ASU ET Approach**
- Non-traditional
- Curriculum organization similar to Automotive company
- Emphasis on system integration
- More Flexible
- Equal emphasis on analysis ‘theory’ and practice

Course Development

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- **Design Process:**
- Design Group (Faculty, Automotive Engineers and IAB Members) voting results

1 credit 7 points	1. Vehicle Body: Exterior LLLLL M	2. Vehicle Body: Interior LLLLL M	1 credit 7 points
3 credits 15 points	3. Chassis HHH MMM	4. Thermal Design & Climate Control HHH MMM	2 credits 15 points
3 credits 18 points	5. Powertrain HHH HHM	6. Electrical Systems, Computer & Control Systems HHH HHH	3 credits 18 points
3 credits 15 points	7. System Integration HHH MMM	8. Vehicle Testing HHH MMM	2 credits 15 points
Plus a 6-credit Capstone Design sequence (easily could be an integrative project)			

Development Status

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Course	Developmental Status	Instruction Method
MET 321 – Introduction to Automotive Engineering	High	Lecture
MET 421 – Vehicle Powertrains	High	Lecture and Lab
MET 423 – Vehicle Chassis Design	High	Lecture and Lab
MET 424 – Vehicle Electrical & Control Systems	Low	Lecture and Lab
MET 426 – Vehicle Thermal Design	Medium	Lecture and Lab
MET 427 – Vehicle System Integration and Testing	Low	Lecture

MET 591: ADVANCED VEHICLE DYNAMICS

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Graduate Level Course in Vehicle Dynamics offered in Fall-2008.

Course Learning Objectives:

1. The students should be able to understand multi-body system approach to vehicle dynamics.
2. The student should be able to use multi-body computational software (ADAMS) to solve vehicle dynamics problems.

MET 591: Course Outline

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Topic No	Topic Name	Weeks	Focus Area
1	Introduction	1	Course Outline, Projects discussion and project assignments.
2	Kinematics and Dynamics of Rigid Bodies	2,3	Review of concepts in Dynamics of Multi-body systems
3	Multi-body Systems Simulation Software	4,5	Introduction to ADAMS-View, ADAMS-Car
4	Modeling and Analysis of Suspension Systems	6,7	Types of suspensions, suspension modeling and analysis using ADAMS-Car
5	Tire Characteristics and Modeling	8, 9	Introduction to tire models, applications of tire models, modeling tire in ADAMS-car
6	Modeling and the Assembly of the Full Vehicle	10, 11, 12	Modeling and assembling subsystems to create full vehicle
7	Simulation Output and Interpretation	13, 14	Virtual testing using ADAMS-Car
8	Project presentations	15,16	

MET 591: Advanced Vehicle Dynamics- Student Survey

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Question	Group A (>20 years of experience)	Group B (10-20 years of experience)	Group C (<3 years of experience)	Group D (<1 year of industrial experience)
(a) comfort level in analytical/theoretical dynamics	Low	Medium	High	Medium
(b) comfort level in math	Medium	Medium	Medium	Medium
(c) comfort level in modeling and drafting	Low	High	Medium	High
(d) understanding of practical problems	High	High	Medium	Low
(e)ability to correlate simulation results to actual experiment	High	High	Medium	Low
(f) experience with actual vehicle handing/dynamic testing	High	High	Low	Low

MET 591: Instruction Methodology

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- The course involved some theoretical material and hands on projects using MSC Software.
- MSC software provided the teaching material for ADAMS.
- This teaching material is based on ‘crawl-walk-run’ approach.
- Students build and analyze models of progressively complex assemblies and systems.

MET 591: Instruction Methodology

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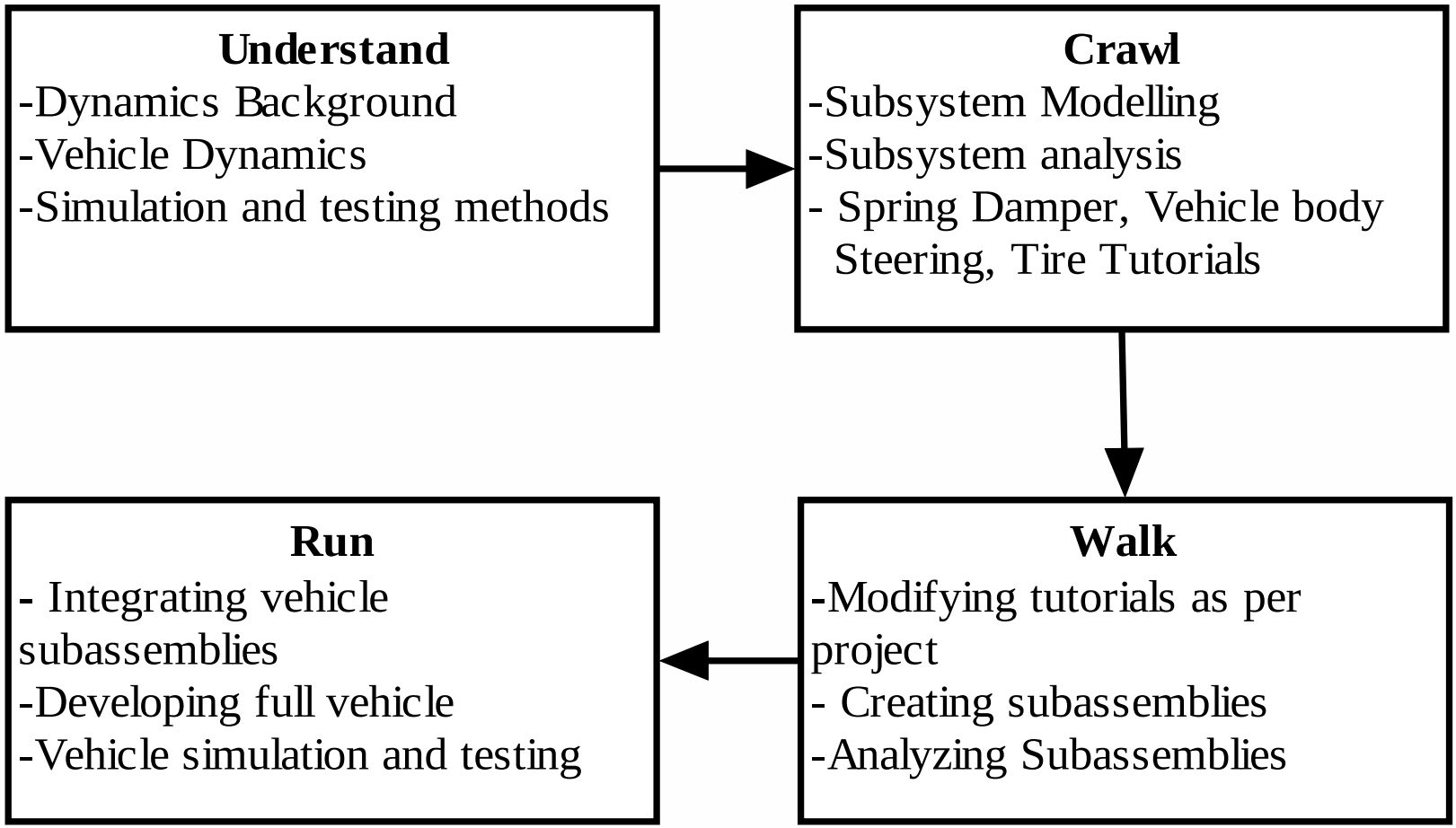
- **Understand-Crawl-Walk-Run Approach**



MET 591: Class Projects

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- **'Group A'(>20 yrs. of Exp)** proposed to work on a project on a practical subassembly problem instead of a full vehicle.
- '**Group B'(10-20 yrs. of Exp.)** proposed to model and analyze a vehicle dynamics problem for which experimental test data was available.
- **'Group C' (<3 yrs. of Exp.)** proposed to work on a vehicle subassembly-integration problem.
- **'Group D' (<1 yr. of Exp.)** wanted to work on modeling and analysis of 'SAE-Mini Baja' subsystem and vehicle assembly problem.

MET 591: Sample Projects

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- a) Trailer Suspension Analysis **('Group A').**
- b) Modeling and dynamic simulation of SUV-trailer combination **('Group B').**
- c) Dynamic analysis and testing of surge brake **('Group C').**
- d) Dynamic analysis of torsion bar system **('Group C').**
- e) Steering-Suspension system analysis SAE Mini Baja **('Group D').**

MET 591: Sample Project- Dynamic Analysis of Surge Brake Assembly

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- The surge brake assembly is a very critical component of trailer braking system that is actuated due to relative deceleration of the towing vehicle and trailer.

Courtesy: UHaul-International

MET 591: Sample Project- Dynamic Analysis of Surge Brake Assembly

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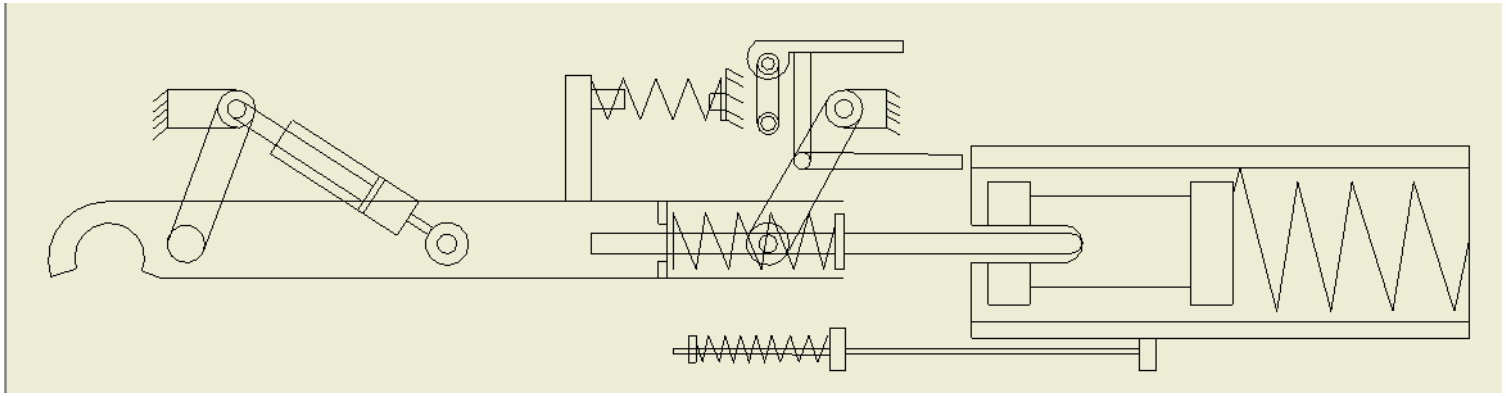
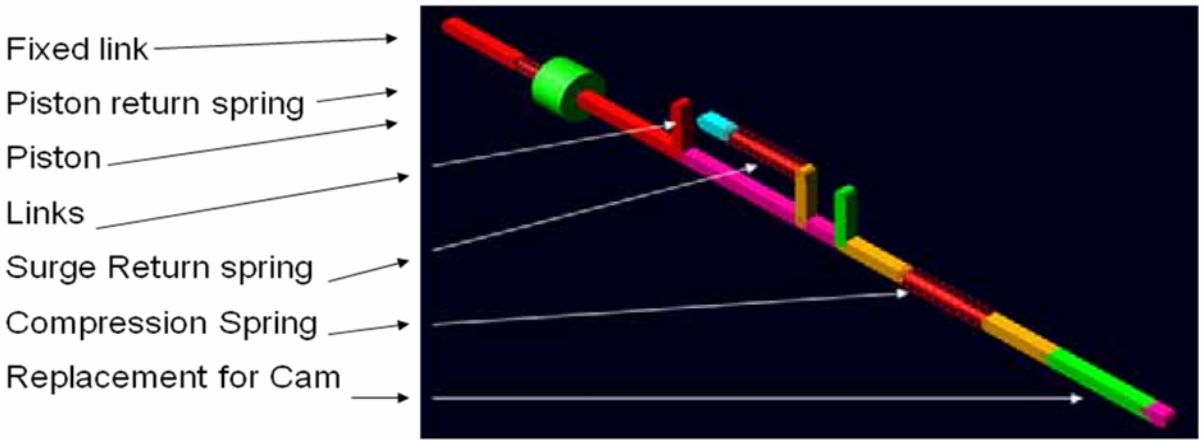
- Mechanism:



- ADAMS Model:



MET 591: Sample Project- Dynamic Analysis of Surge Brake Assembly- Simulation Results

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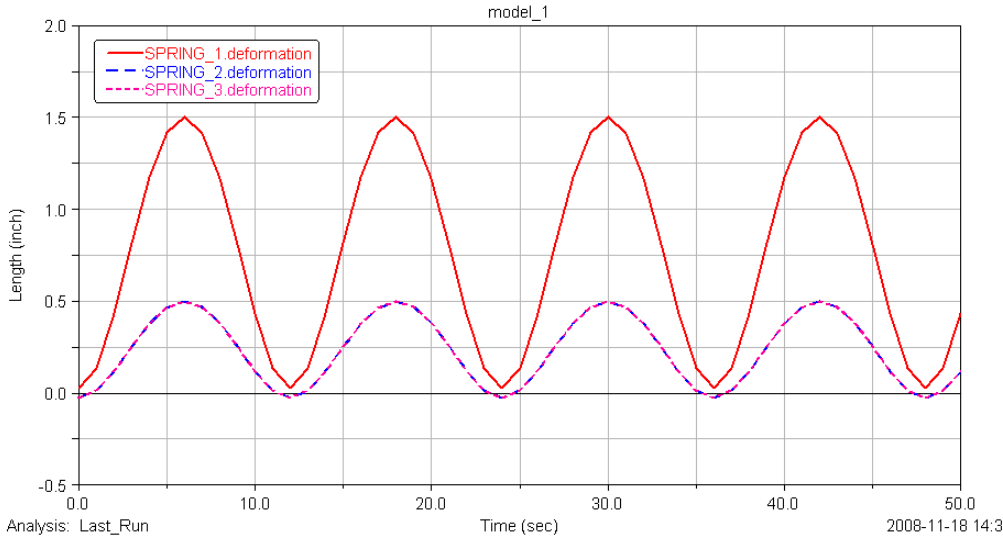
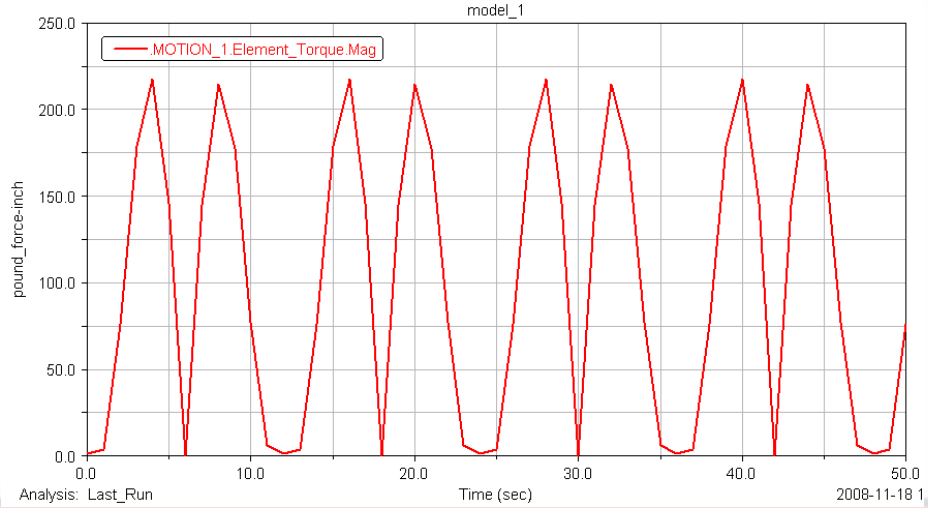
- Spring Deformation:



- Torque Requirement:



MET 591 Project-> Thesis-Design and Development of Durability testing Machine

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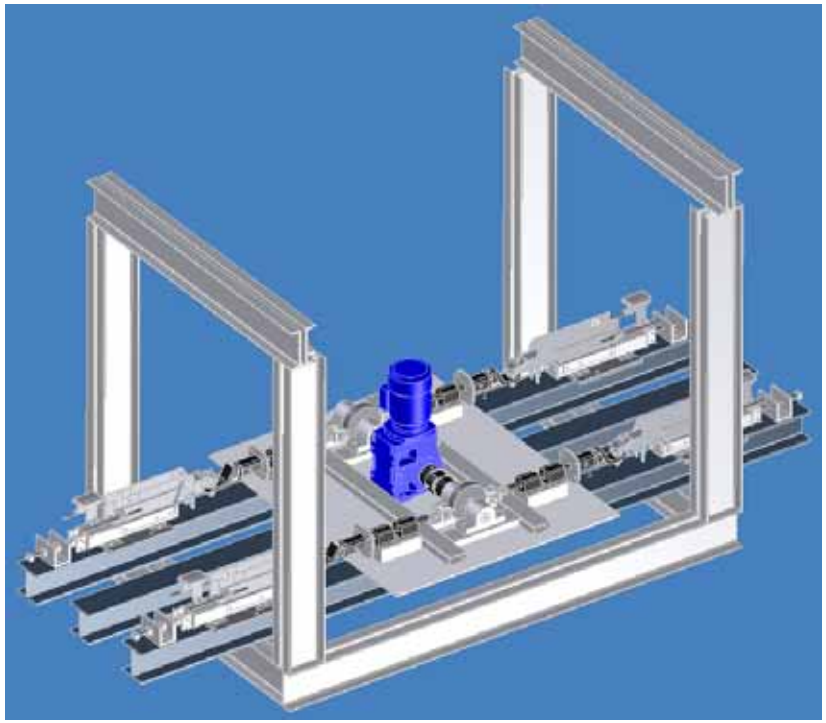
- The results from ADAMS Simulation were used to develop requirement specifications for Durability Testing Machine for surge brakes.

Courtesy: UHaul-International



MET 591: Seminar and MSC Software Hands-on Work Shop

- MSC Software hands-on workshop was organized by the Engineering Technology department and Advanced Technology Innovation Center (ATIC).
- The objective of this workshop was to introduce faculty, students and practicing engineers to MSC software products, discuss MSC university program, and explore opportunities to increase collaboration between MSC. Software Corporation, ASU and local business entities.
- Present two hands on sessions to familiarize participants with Virtual Product Development (VPD) technology.

MET 591: Seminar and MSC Software Hands-on Work Shop

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- Session I: ADAMS-Mechanical System Simulation
- Session-II: MSC.Nastran-Finite Element Analysis

MET 591: Class Evaluations/ Teaching Effectiveness

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EVALUATION OF THE COURSE *(exclusive of the instructor)*

1. Textbook/supplementary material in support of the course
2. Value of assigned homework in support of the course topics.
3. Value of laboratory assignments/projects in support of the course topics.
4. Reasonableness of exams and quizzes in covering course material.
5. Weight given to labs or projects, relative to exams and quizzes.
6. Weight given to homework assignments, relative to exams and quizzes.
7. Definition and application of criteria for grading.

MET 591: Class Evaluations / Teaching Effectiveness

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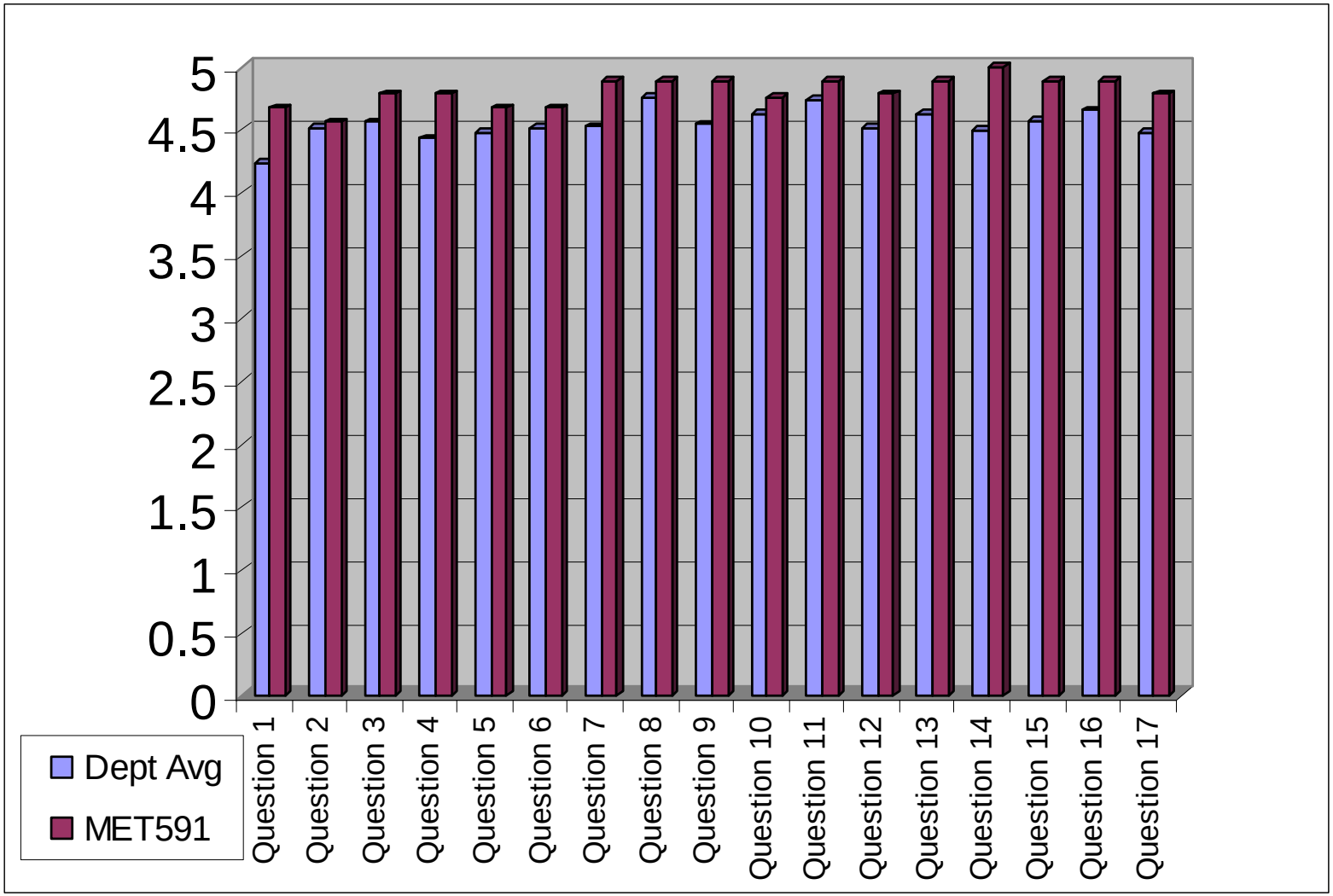
EVALUATION OF THE INSTRUCTOR

8. The instructor was well prepared.
9. The instructor communicated ideas clearly.
10. The instructor or assistants were available for outside assistance.
11. The instructor exhibited enthusiasm for the interest in the subject.
12. The instructor's approach stimulated student thinking.
13. The instructor related course material to its applications.
14. The instructor's methods of presentation supported student learning.
15. The instructor's grading was fair, impartial and adequate.
16. The instructor returned graded materials within a reasonable period.

MET 591: Class Evaluations / Teaching Effectiveness-Results



Conclusion:

- ASU, local industries and MSC software came together to offer students an excellent educational experience.
- The instructor adopted understand-crawl-walk-run type of teaching philosophy mixing theory and practice
- Project based learning approach.
- A hands on workshop was organized for the problems and questions that needed an ‘expert help’.

Acknowledgement and Thanks

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- Mr. Bhargav Shah (MS Student) working on Design and Development of Durability Testing Machine.

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