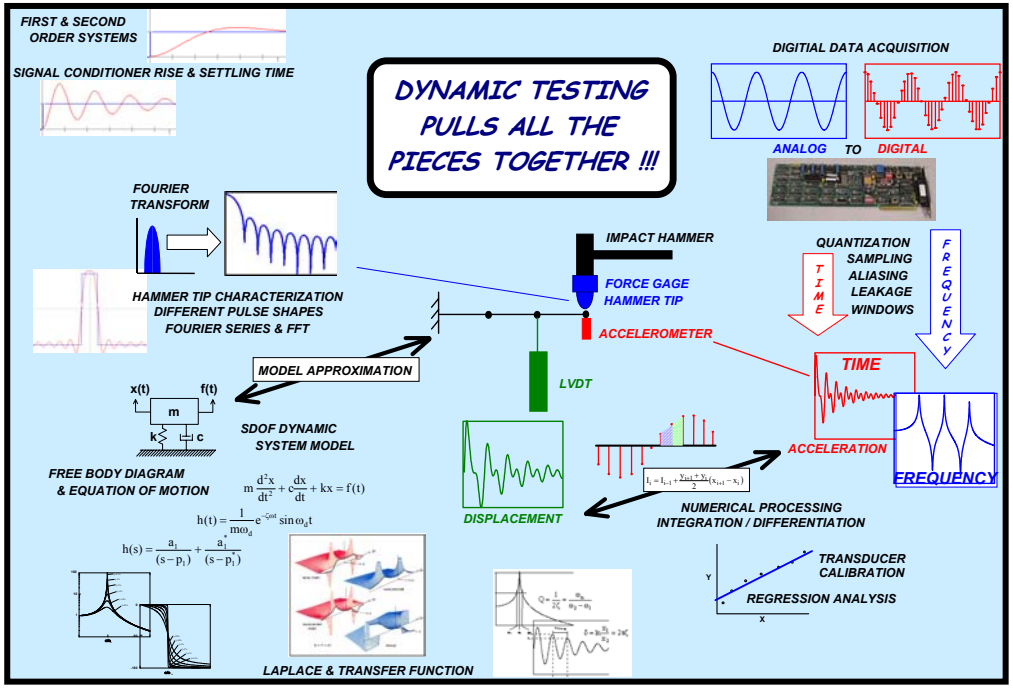
DYNamic SYStems

AN INTEGRATED UNDERGRADUATE DYNAMIC SYSTEMS TEACHING METHODOLOGY UTILIZING ANALYTICAL AND EXPERIMENTAL APPROACHES



Peter Avitabile
Mechanical Engineering Department
University of Massachusetts Lowell

UMASS LOWELL

The Problem

DYNamic SYStems

Students generally do not understand how basic STEM (Science, Technology, Engineering and Math) material fits into all of their engineering courses

Relationship of basic material to subsequent courses is unclear to the student.

Practical relevance of the material is not clear.

Students hit the "reset button" after each course not realizing the importance of STEM material

Reset

The Problem

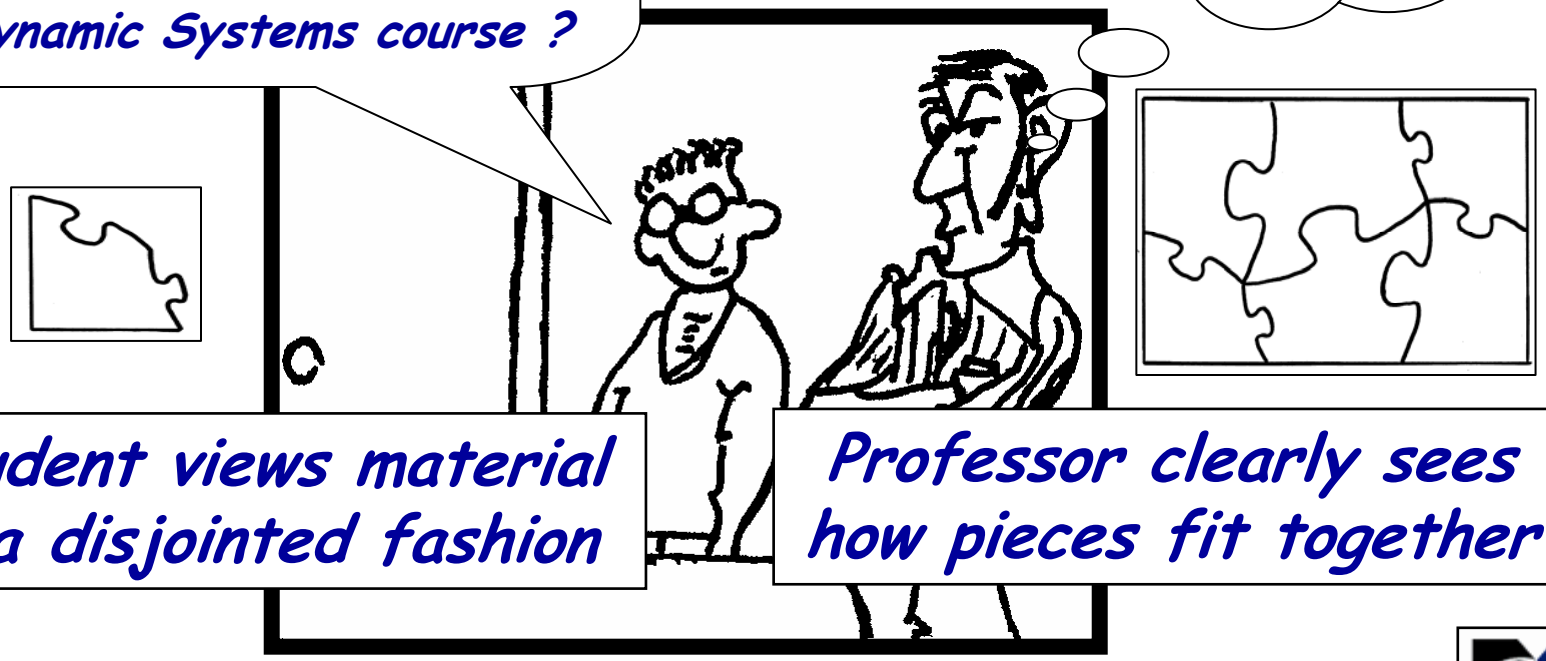
DYNamic SYStems

Student Comment:

Professor, why didn't you tell us that the material covered in other courses was going to be really important for the work we need to do in this Dynamic Systems course ?

Professor Thoughts:

Hmmmmm...



Student views material in a disjointed fashion

Professor clearly sees how pieces fit together

How to Solve the Problem

DYNamic SYStems

A new multisemester interwoven dynamic systems project has been initiated

This is to better integrate the material from differential equations, mathematical methods, laboratory measurements and dynamic systems

This is done across several semesters/courses to help students better understand the relationship of basic STEM material to an ongoing problem

Some Key Components of This Work

DYNamic SYStems

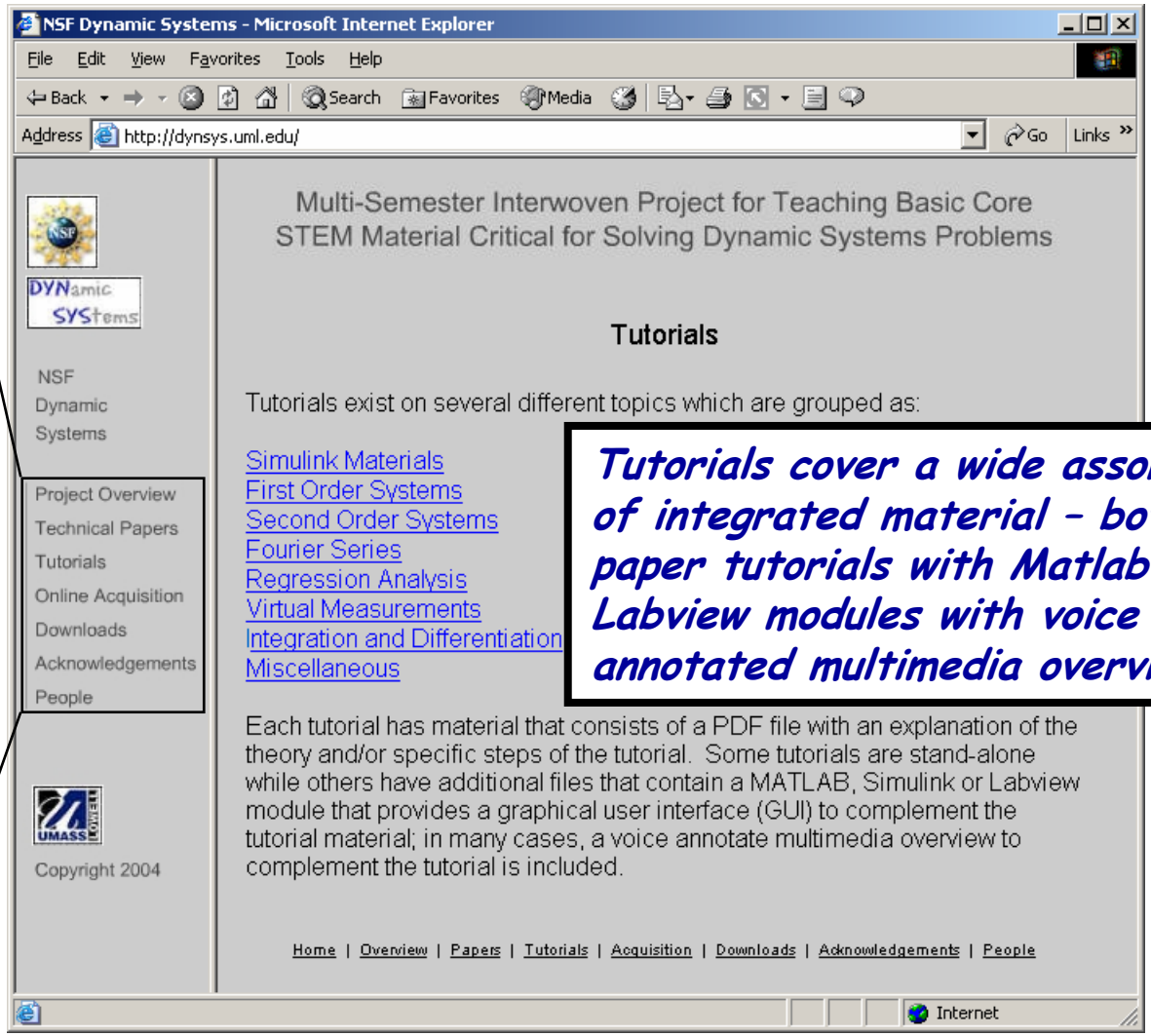
Analytical Modeling Tools/GUIs

Website and Online Acquisition System

Projects

- *Integration/Differentiation w/contaminants*
- *Fourier Series using LabVIEW*
- *Design of a Dynamic Measurement System*
- *1st and 2nd Order System Characterization*
- *(many additional smaller projects – see paper)*

Webpage --- dynsys.uml.edu



Project Overview

Technical Papers

Tutorials

Online Acquisition

Downloads

Acknowledgements

People

Tutorials cover a wide assortment of integrated material – both paper tutorials with Matlab and Labview modules with voice annotated multimedia overviews

Webpage --- dynsys.uml.edu

DYNamic SYStems

CLICK HERE FOR ERRATA		1st Order			2nd Order								Miscellaneous				
		RC Step	RC Filtering	Tank Problem	Initial Conditions	S-Plane	Step	Impulse	System Response	Complex FRF	Convolution: Arb.	Convolution: SDOF	Motor MDOF	Fourier	Regression	Int/Diff	Windowing and Leakage	VMS
General Theory	PDF	P			P													
Tutorial	PDF	P	P		P		P	P			P		P	P	P	P		
Block Diagram		P			P													
Matlab GUI	Tutorial	P	P	P	P	P	P	P		P				P	P	P		P
	Download	6 7	6 7	6 7	6 7	6 7	6 7	6 7		6 7				6 7	6 7	6 7		6 7
		MR	MR	MR	MR	MR	MR	MR		MR					MR	MR		
	Voice	F	F		F	F	F	F		F				F	F	F		F
		A	A		A	A	A	A		A				A	A	A		A
Excercise	PDF	P	P	P	P	P	P	P		P				P	P	P		P
	Voice	F	F		F	F	F	F		F				F	F	F		F
		A	A		A	A	A	A		A				A	A	A		A
LabVIEW GUI	Download	VR	VR		VR		VR	VR	VR		VR	VR	VR	VR			VR	
	Tutorial	P	P		P		P	P	P		P		P	P			P	
	Voice	F	F		F		F	F	F					F			F	
		A	A		A		A	A	A					A			A	
Excercise	PDF	P	P		P		P	P	P					P			P	
	Voice	F	F		F		F	F	F					F			F	
		A	A		A		A	A	A					A			A	

	Intro	GUI Instruction

Complete Imagemap of all materials available

Simulink	P	F	A		P	LTI Viewer and MUX Block	P	Block List	P	Modeling an Impulse	P	State Space and Transfer Function

	RUBE 1	RUBE 2
Overview	P	P
Pre-Recorded Data	R	R
Assignment	F	F
Online Acquisition	R	R

LEGEND			
P	PDF File (Requires Acrobat Reader)	VI	LabVIEW VI File (Requires LabVIEW 7.1)
6	MATLAB p File (Requires MATLAB 6.5)	VR	LabVIEW EXE File (Includes Runtime Engine)
7	MATLAB p File (Requires MATLAB 7.0)	F	Voice Annotated Flash (Requires Flash Plugin)
MR	MATLAB EXE (With Runtime Engine)	A	Voice Annotated AVI (NOT Streamed - Large
R	RUBE related material		

Analytical Modeling Tools/GUIs

DYNamic SYStems

Theoretical Aspects of First and Second Order Systems

First Order Systems

- *Modeling Step Response with ODE and Block Diagram*

Second Order Systems

- *Step, Impulse, Initial Condition with ODE and Block Diagrams*

Mathematical Modeling Considerations

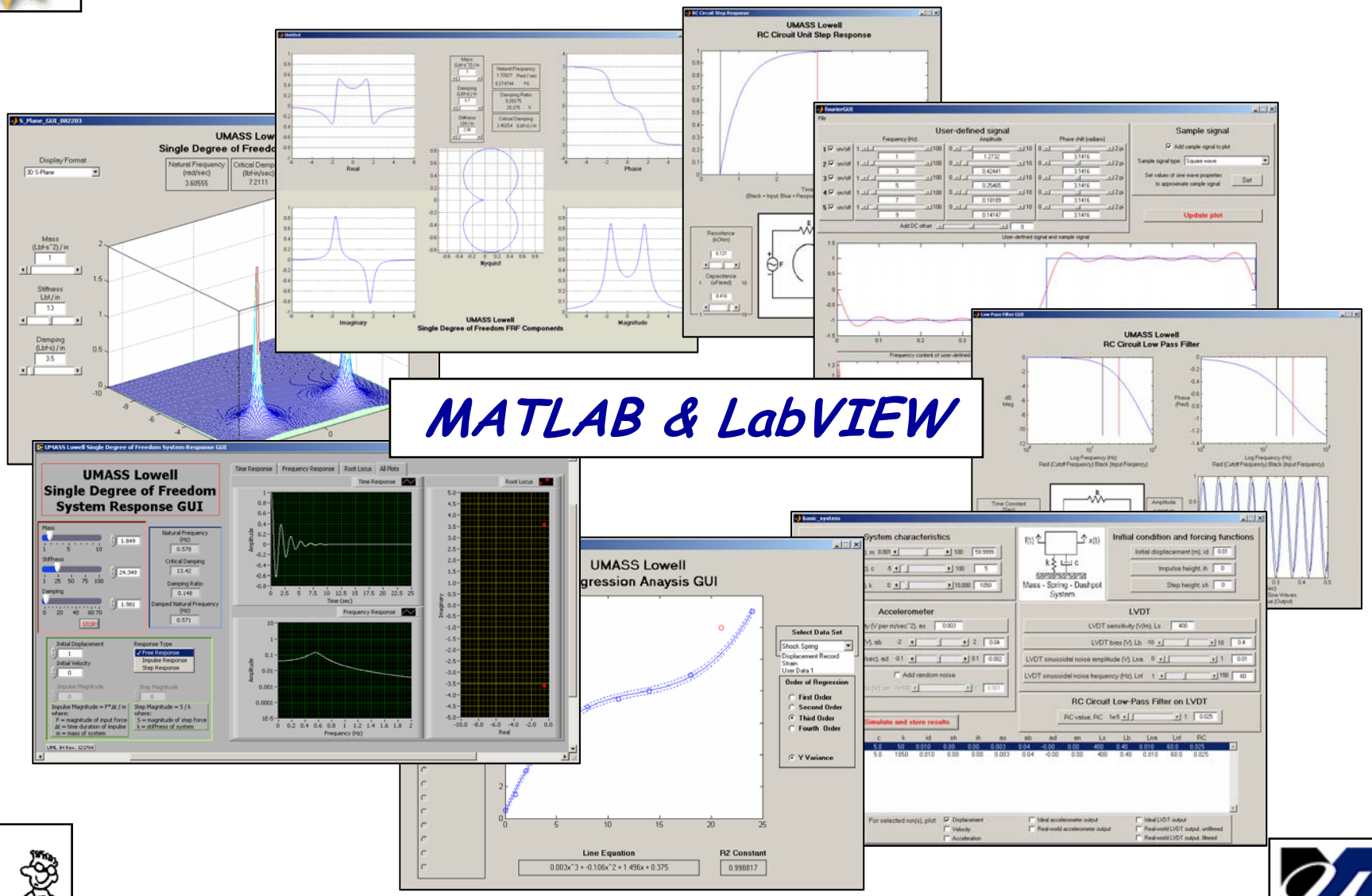
- *Fourier Series, Integration/Differentiation, Regression Analysis*

Miscellaneous Materials

- *Simulink and MATLAB Primer Materials*
- *LabVIEW Tutorial Materials*
- *Virtual Measurement Modeling Simulations*
- *Integration/Differentiation Considerations with Contamination*

Analytical Modeling Tools/GUIs

DYNamic SYStems

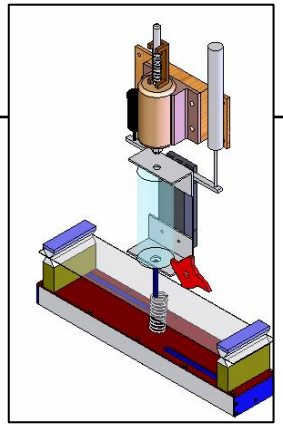


MATLAB & LabVIEW

UMASS LOWELL

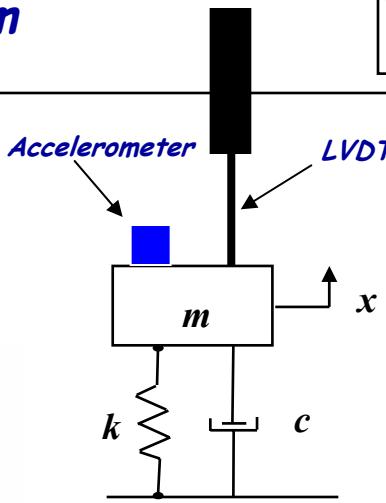
Online Measurement System

DYNamic SYStems



RUBE

Response Under Basic Excitation



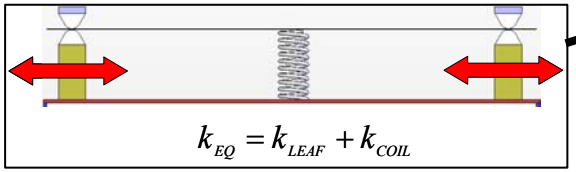
Measurement Devices

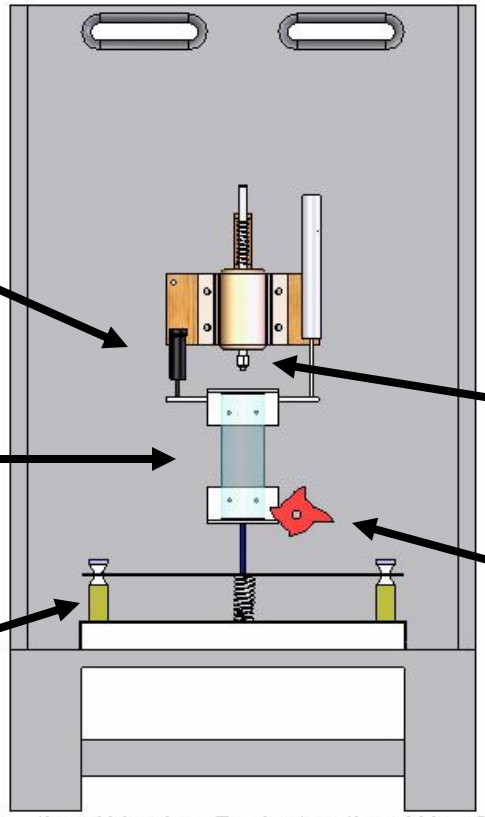
Variable Damping

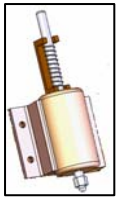
Variable Mass

System Characteristics

Variable Stiffness

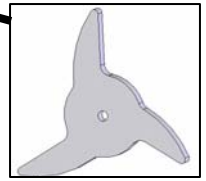






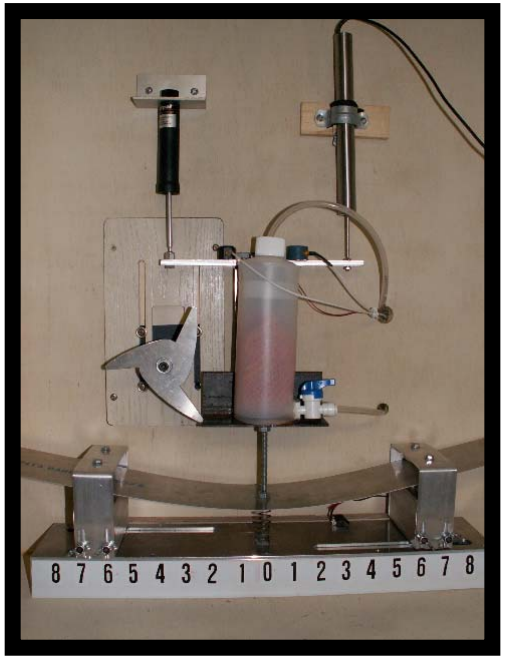
Excitation

Impact Force

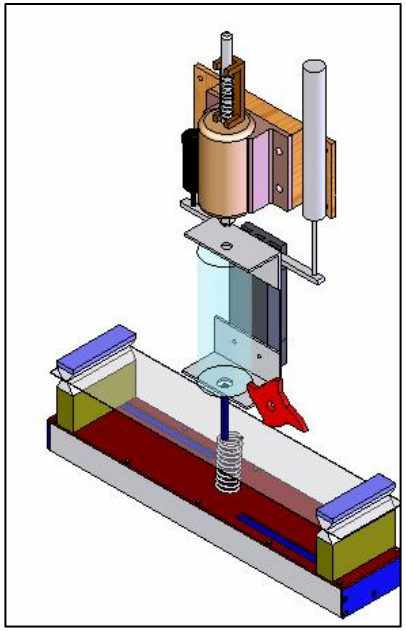


Initial Displacement

Online Measurement System



RUBE I



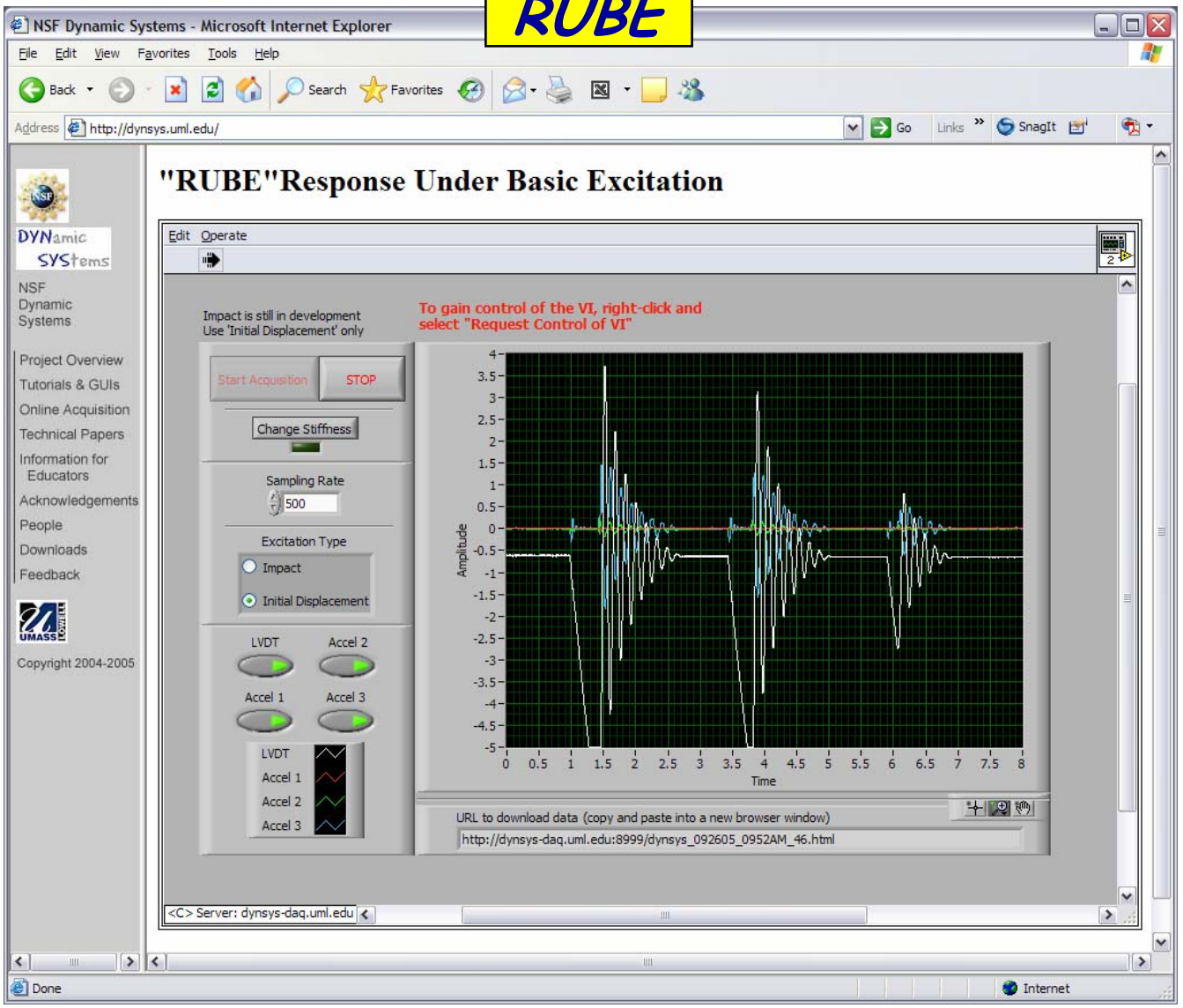
RUBE

Response Under Basic Excitation

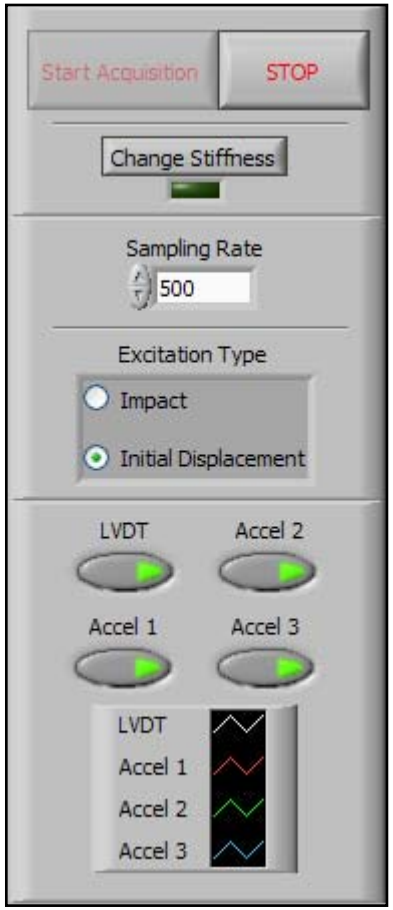
RUBE II

Online Measurement System

RUBE



RUBE



System can be remotely run

Stiffness is changed for each run

Sampling rate can be set

Impact is available
Initial displacements – three inputs

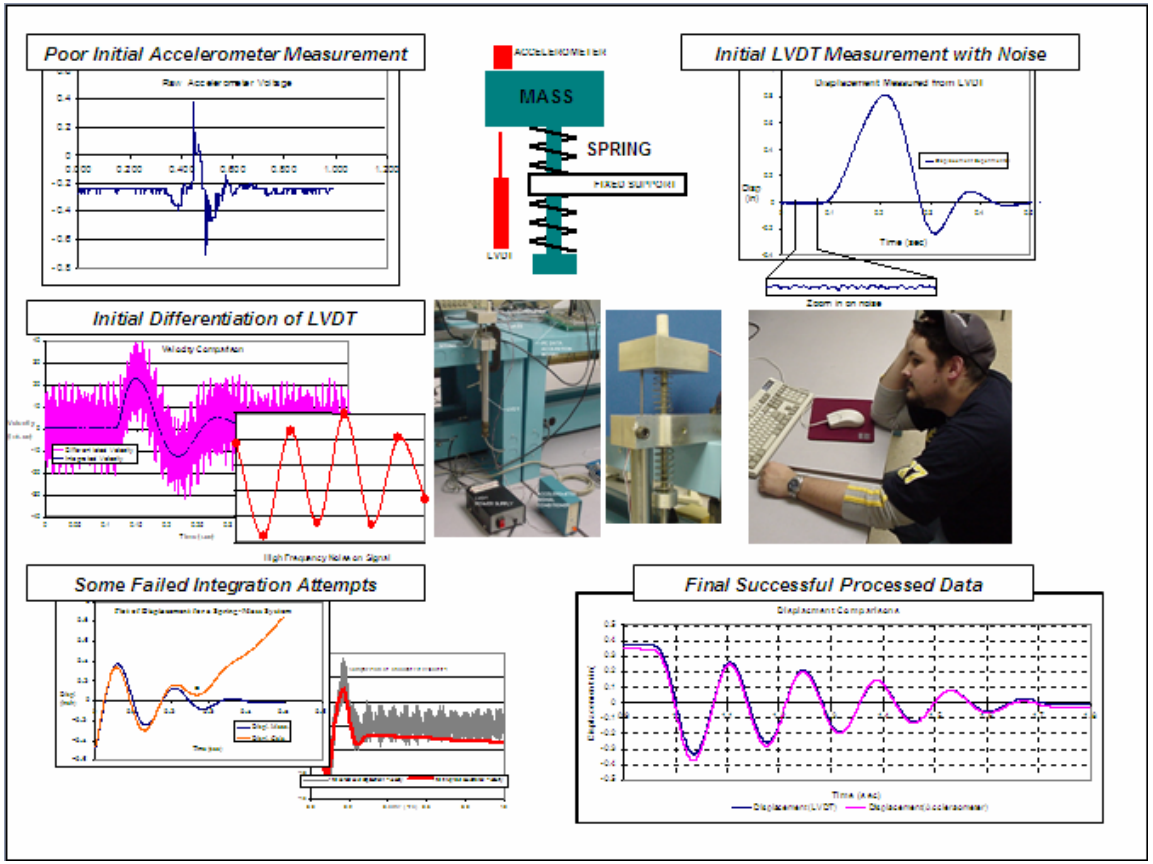
LVDT and accelerometers can be turned on and off as desired

Data saved and captured to browser

URL to download data (copy and paste into a new browser window)
http://dynsys-daq.uml.edu:8999/dynsys_092605_0952AM_46.html

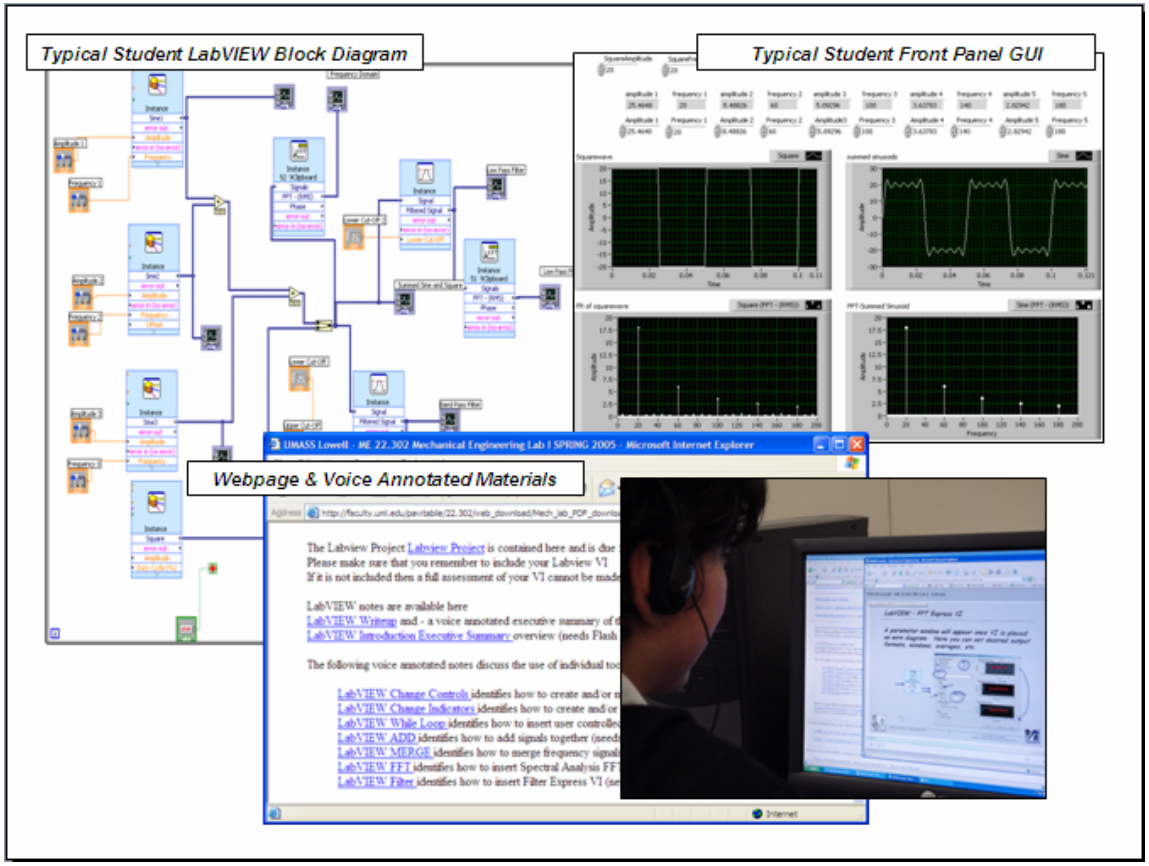
Contaminants Cause Difficulty

Students learn with problems that make them think



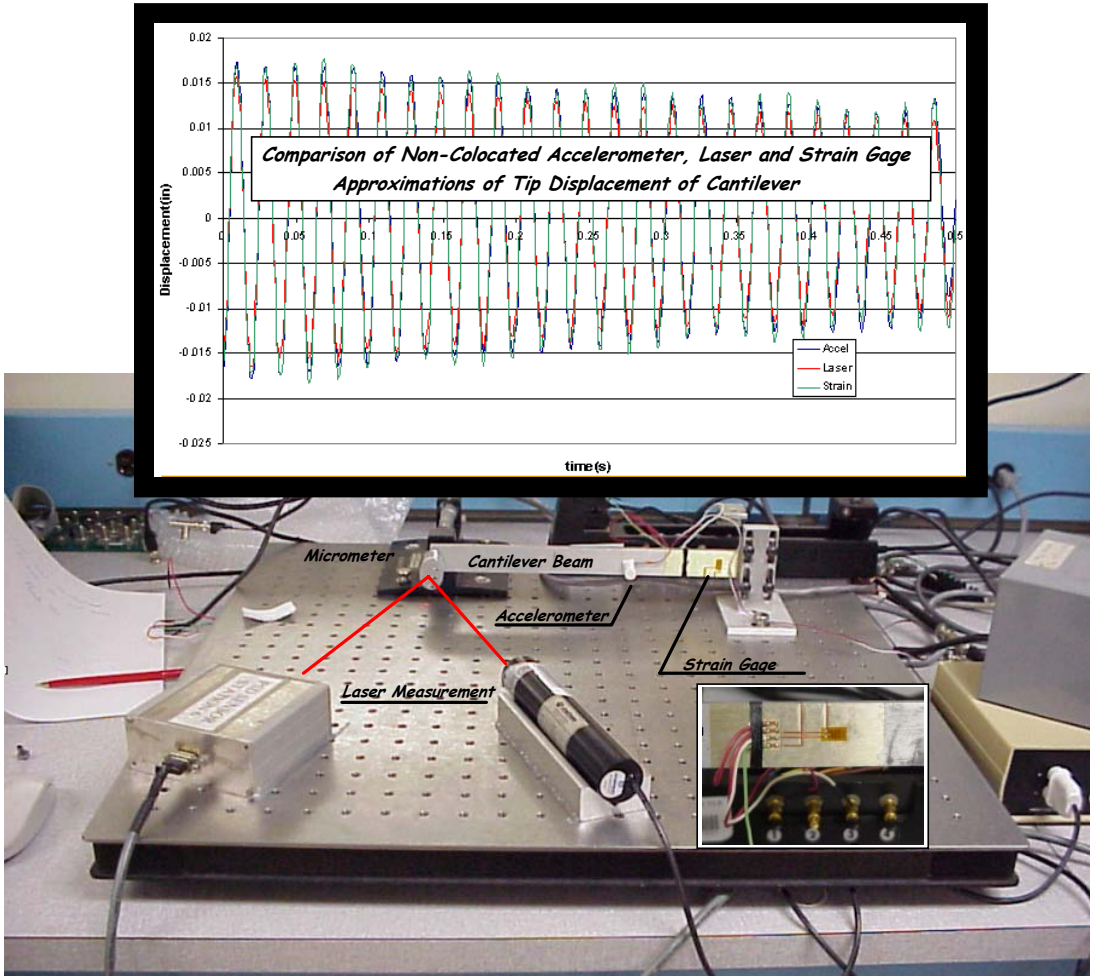
Learn by Doing (not Listening)

Fourier series come to life with LabVIEW



Dynamic Measurement System Design

Integration of all material to design system

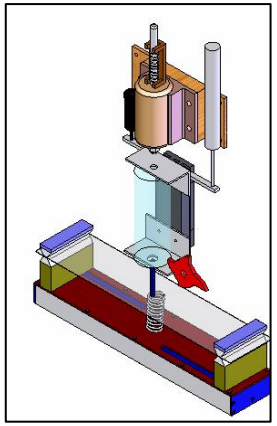


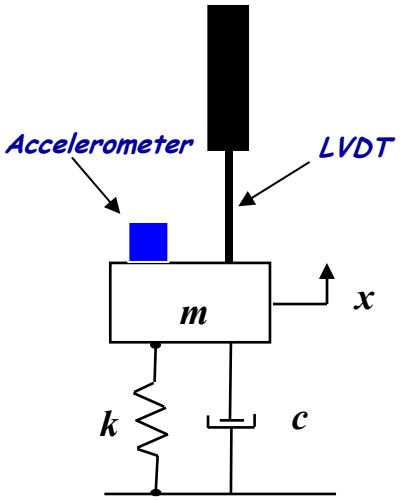
Dynamic Systems Projects

DYNamic SYStems

Projects integrated in with Lecture Material

- Analytical project to force understanding of ODE and Laplace along with MATLAB/Simulink
- RUBE used to strengthen understanding through system identification on less that perfect measurements
- Filtering data through 1st order RC filter in Simulink





Brief Summarizing Statements

Only a brief smattering of material presented here

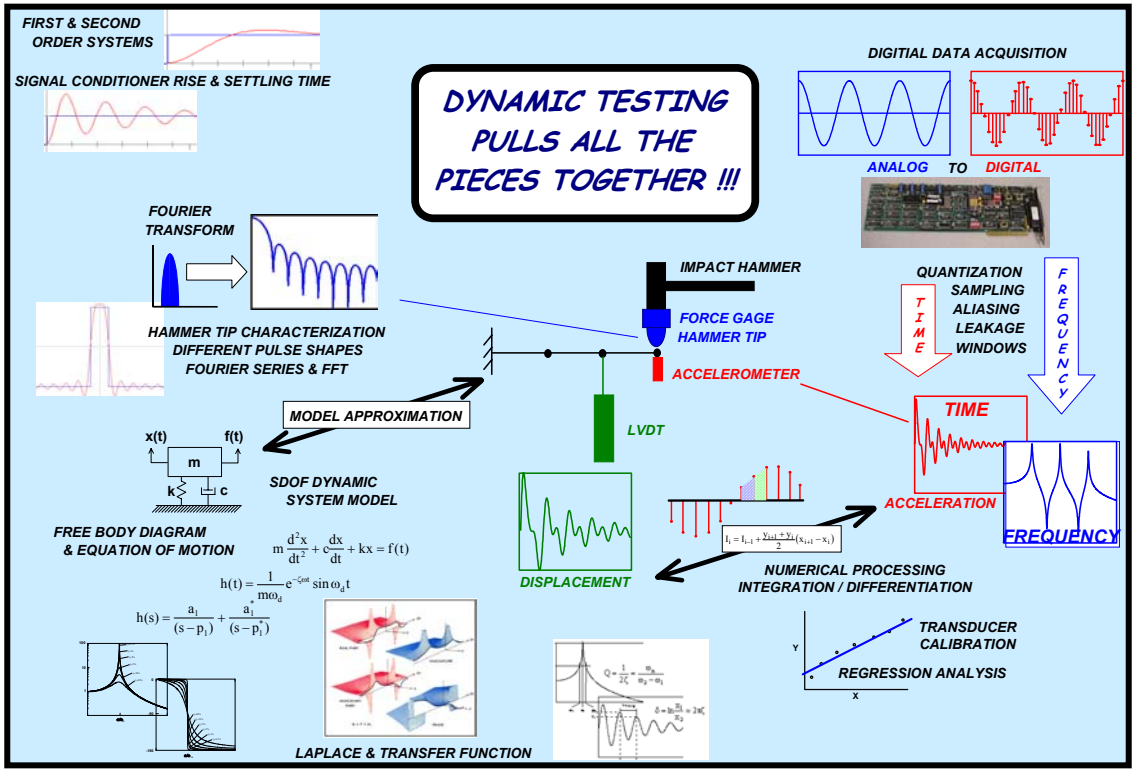
The 30 page paper has much more material.

The website has a significant amount of material (tutorials, exercises, GUIs, etc) along with the online measurement system

Acknowledgements

This project is partially supported by
NSF Engineering Education Division Grant EEC-0314875

Multi-Semester Interwoven Project for Teaching Basic Core STEM Material Critical for Solving Dynamic Systems Problems



Peter Avitabile, John White, Stephen Pennell

Acknowledgements

A special thanks to the students who have really been the driving force in making all this happen

Tracy Van Zandt, Nels Wirkkala, Wes Goodman and Jeffrey Hodgkins
Mechanical Engineering Department
University of Massachusetts Lowell

I could not have done any of this without their dedication and devotion to making this all happen

I have the pleasure of working with them and having them contribute to this effort

Acknowledgements

And to the additional students who have also participated during the final year of the project

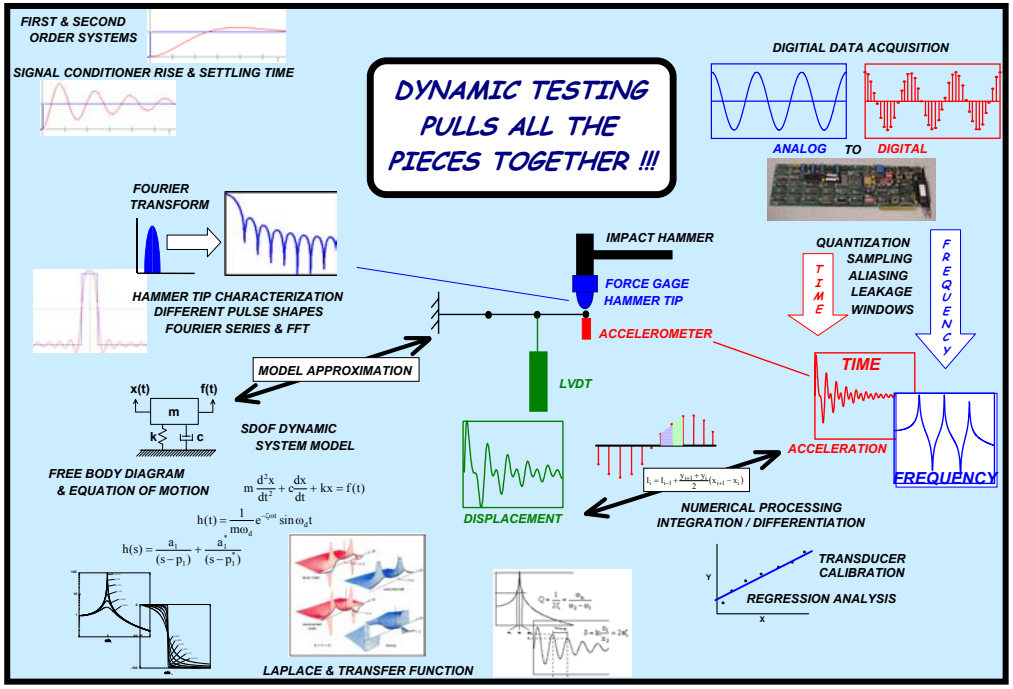
Adam Butland, Dana Nicgorski, Aaron Williams, Chris Chipman
Mechanical Engineering Department
University of Massachusetts Lowell

They have also made significant contributions to the overall project

I am very happy for their continued support and dedication

DYNamic SYStems

AN INTEGRATED UNDERGRADUATE DYNAMIC SYSTEMS TEACHING METHODOLOGY UTILIZING ANALYTICAL AND EXPERIMENTAL APPROACHES



Peter Avitabile
Mechanical Engineering Department
University of Massachusetts Lowell

UMASS LOWELL