



The Design, Development, and Assessment of the Vibrating Beam Experiment Multimedia Instructional Courseware

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Vibrating Beam Experiment Instructional Courseware

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Lab
Room

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Next

Introduction

- **Goals and Objectives**
- **Design Process: Fall 1993 to Spring 1995**
- **Vibrating Beam Experiment Instructional Courseware Version 1.0**
- **Data Collection**
- **Survey and Usage Results**
- **Suggested Improvements**
- **Summary**

Overall Goal

- **Assist Students in Conducting and Understanding the *Vibrating Beam Experiment***
 - Senior, Mechanical Engineering Laboratory
 - Open-ended problems that require teamwork
- **Courseware Should**
 - Integrate information from multiple disciplinary classes
 - Provide framework to understand fundamental principles and lab procedures
 - Combine theory with system behavior

Pedagogical Objectives

- **Goal: Aid Students' Ability to Integrate and Understand Multidisciplinary Material Needed to Complete the Experiment**
- **Improve Students' Understanding by Providing a Centralized Source of Information at a Greater Depth of Material than is Usually Available**
- **Enhance Students' Physical Understanding of the Experiment by Providing Visualizations**
- **Provide Students with Guided Learning Opportunities without Providing a 'Cookbook' Approach**

Design Objectives

- **Goal: Design for Ease of Use**
- **Provide Access to Information Through the Careful Design of the User Interface**
- **Provide Multiple Navigation Schemes to Address the Diversity of Information Retrieval Styles**
- **Provide a Structure that Assists Students in Seeing Connections Between the Breadth of Material while Enabling Easy Access to a Greater Depth of Material**

Courseware Development Process

Version	Semester	Courseware Development	Assessment & User Feedback
Alpha 0	Fall 93	General content set	Survey
Apha 1	Spring 94	Change in focus, new user-interface	
Beta 1	Summer 94	Refinement of content and user-interface	
Beta 2	Fall 94	Refinement of content and user-interface	Survey, Usage Log
Final Beta	Spring 95	Usability and installation testing	Survey, Usage Log
Production	Spring 95	Version 1.0 Release	



3.2 Modeling Vibrating Beams

k

M

 ζ ω_n ω_d ω_r

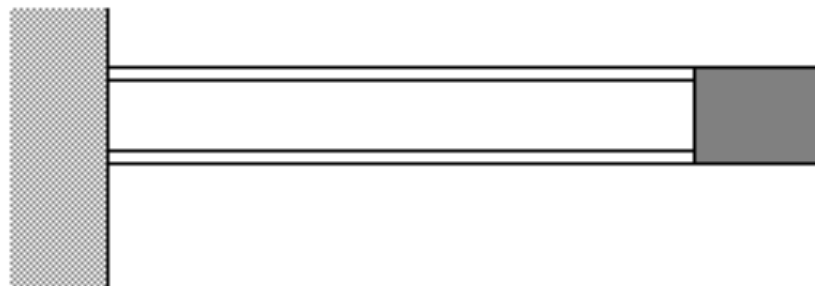
Approximating

k

M

 ζ ω_n ω_d τ ω_r

Measuring



The non-dimensional system parameters that define vibrating systems are:

ω_n = natural frequency

ζ = damping ratio.

These non-dimensional parameters are determined by the physical parameters: **spring constant**, **damping constant**, and **effective end mass** for our vibrating beam case.

*Note: The following discussion assumes a familiarity with 2nd Order Dynamic Response of systems. For more information press the 2nd Order Button.

[2nd Order Response](#)

Fall 1993 Survey Results

- **Structure and Content Not Clear**
- **Wanted “Additional Source” of Material**
 - “Extra description”
 - “More examples”
 - “Derivations”
 - Interactive simulations / “Mock experiment”
- **Wanted Prioritized Information**
 - “Bullet” items
 - “What’s Important” screens
- **Wanted Self-Assessment to Understand “Overall Picture”**
 - “Quizzes”
 - “Review pages”

Vibrating Beam Experiment Instructional Courseware

Version 1.0

- **Structure**
 - Graphical maps
 - *Lab Room* metaphor
- **Content**
 - Breadth similar to previous version
 - Added multiple layers of material and additional depth of material
- **User-Interface**
 - Multiple navigation schemes
 - Improve information access
- ***Quick Look***

Map

Lab Room



Lab Room

Assignment



Apparatus Map

Map



Theory Map



Section



Strain
Gauges



LVDT



Accel-
erometer



Veloc-
imeter



Modell-
ing the
System



Free
Vibration



Forced
Vibration



Model
Param-
eters



Vibra-
tional
Param-
eters



Stress
Strain
Relation-
ship

Sub-section
Page



Lab
Room



Back



Previous

Exit



Map



Index



Quick Look

Print



Search



Help

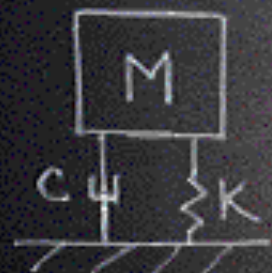


Options



About ...

Lab Room



$$M\ddot{y} + c\dot{y} + Ky = F(t)$$

Theory



Apparatus

Assignment



Lab
Room

Move the mouse over the picture
to select a topic area.

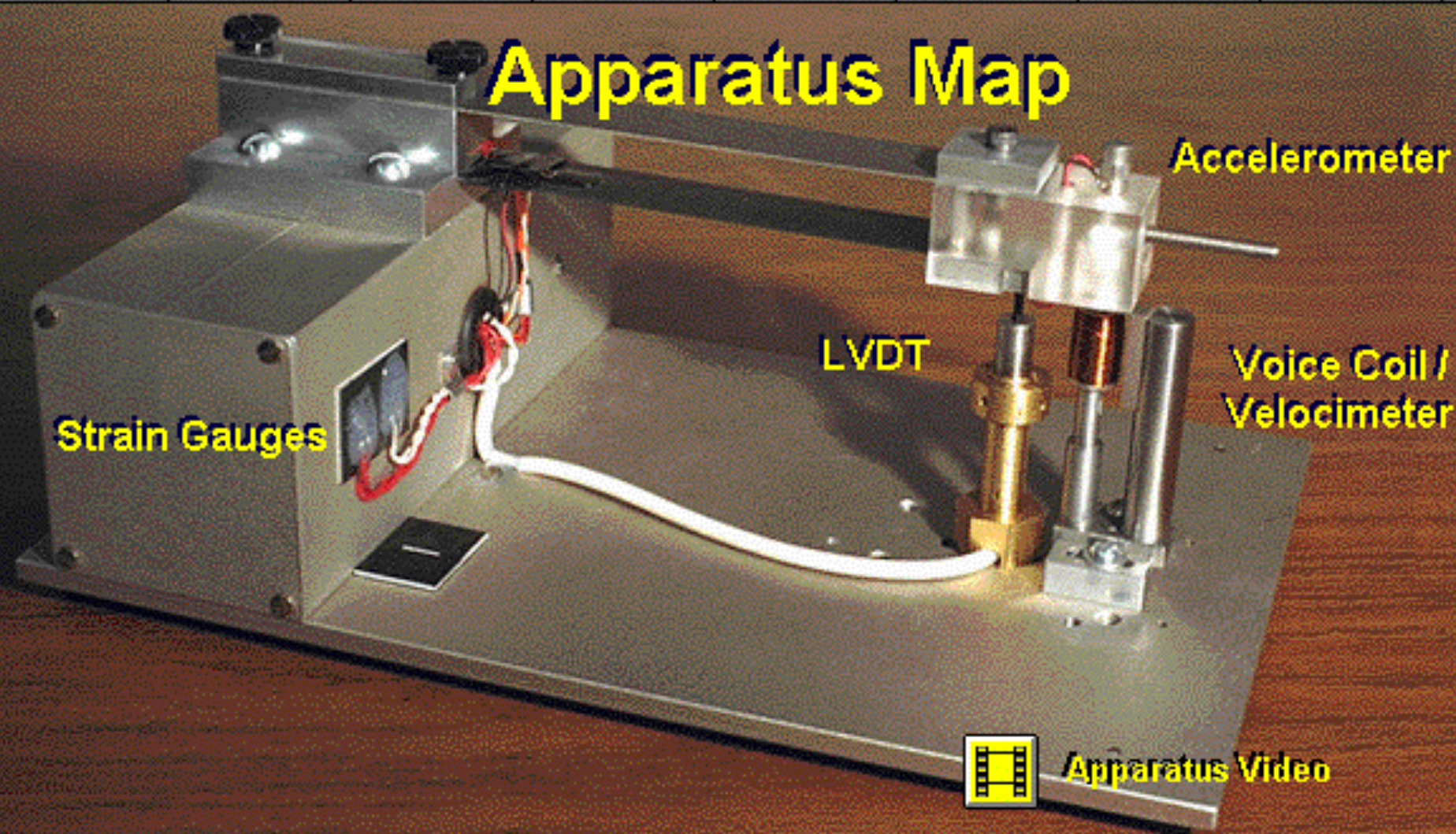


Selected Area



Back

Apparatus Map



Lab
Room

Move the mouse over the picture
to select a topic area.



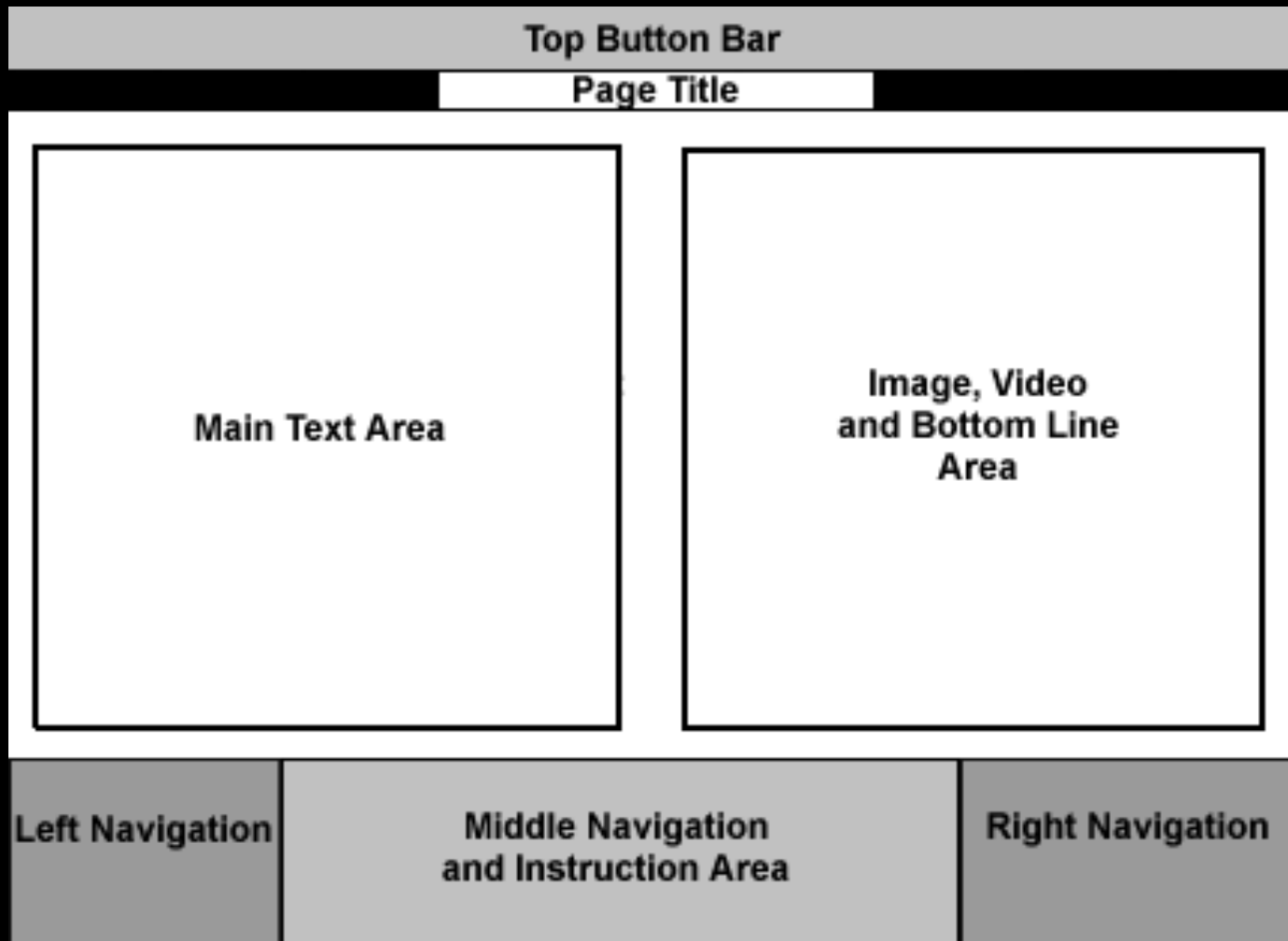
Selected Area



Back



Next



Content

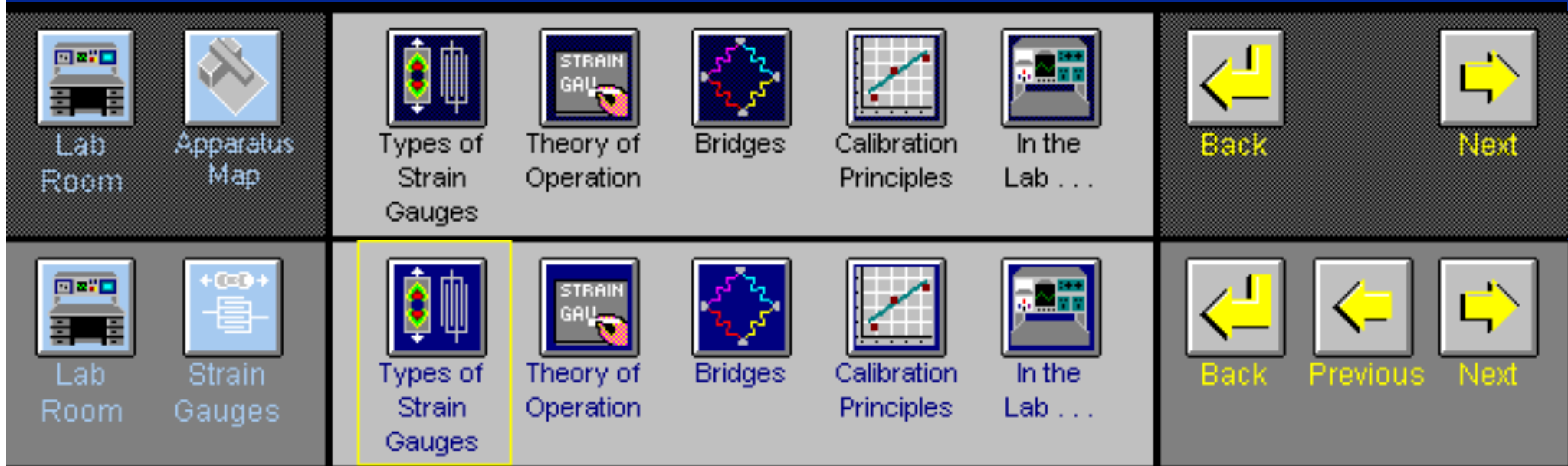
- **Breadth: Basic Information Describing the Apparatus**
 - Theory and Apparatus sections
 - Main Text
 - Bottom Line
- **Depth: Additional Material Including Derivations and Models**
 - *It can be shown that . . .* windows
 - MathCad documents

Navigation

- *Lab Room and Maps*
- **Bottom Navigation**
- *Index Page*
- *Map Page*
- **Search**
- **Hotwords**

Bottom Navigation

- Three Separate Areas
- Right Navigation
- Left Navigation
- Middle Navigation



Index

Welcome

Lab Room

Index

Mathcad Documents

Map

Quick Look

Assignment

Assignment

Apparatus Map

Apparatus Map

Apparatus Video

Strain Gauges

Types of Strain Gauges

Theory of Operation

Bridges

Single Active Arm Bridge

Double Active Arm Bridge

Apparatus Map

Calibration Principles

Strain Gauges In the Lab

Strain Gauge Set-Up Video

Strain Gauge Calib. Video

LVDT

Theory of Operation

Theory of Operation, cont.

LVDT Animation

LVDT Non-linearity Effects

Carrier Demodulator

LVDTs In the Lab

LVDT Set-Up Video

LVDT Calibration Video

Accelerometer

Types of Accelerometers

Theory of Operation

Frequency Response

Amplitude Response

Calibration Principles

Accelerometers In the Lab

Apparatus Map

Accelerometer Set-Up Video

Accel. Calibration Video

Voice Coil/Velocimeter

Voice Coil Theory of Oper.

Veloc. Theory of Oper.

Veloc. Calib. Principles

Coil/Veloc. in the Lab

Coil/Veloc. Set-Up Video

Veloc. Calibration Video

Theory Map

Theory Map

Modelling the System

Governing Equation

Free Vibration

Free Vib Eqn Solution

Forced Vibration

Forced Vib Eqn Solution

Theory Map

Magnitude Ratio

Phase Shift

Model Parameters

Effective End Mass, M_{eff}

Spring Constant, k

Vibrational Parameters

Free Vib. Sys. Parameters

Ringing Frequency

Time Constant

Nat. Freq. and Damp. Ratio

Forced Vib. Sys. Param.

Amplitude Response

LSQVIB

Stress/Strain Relationship

Strain and Displacement

About this Book

How to use the Index Page

Where you CAN visit

Where you ALREADY visited

Where you JUST visited



Lab
Room



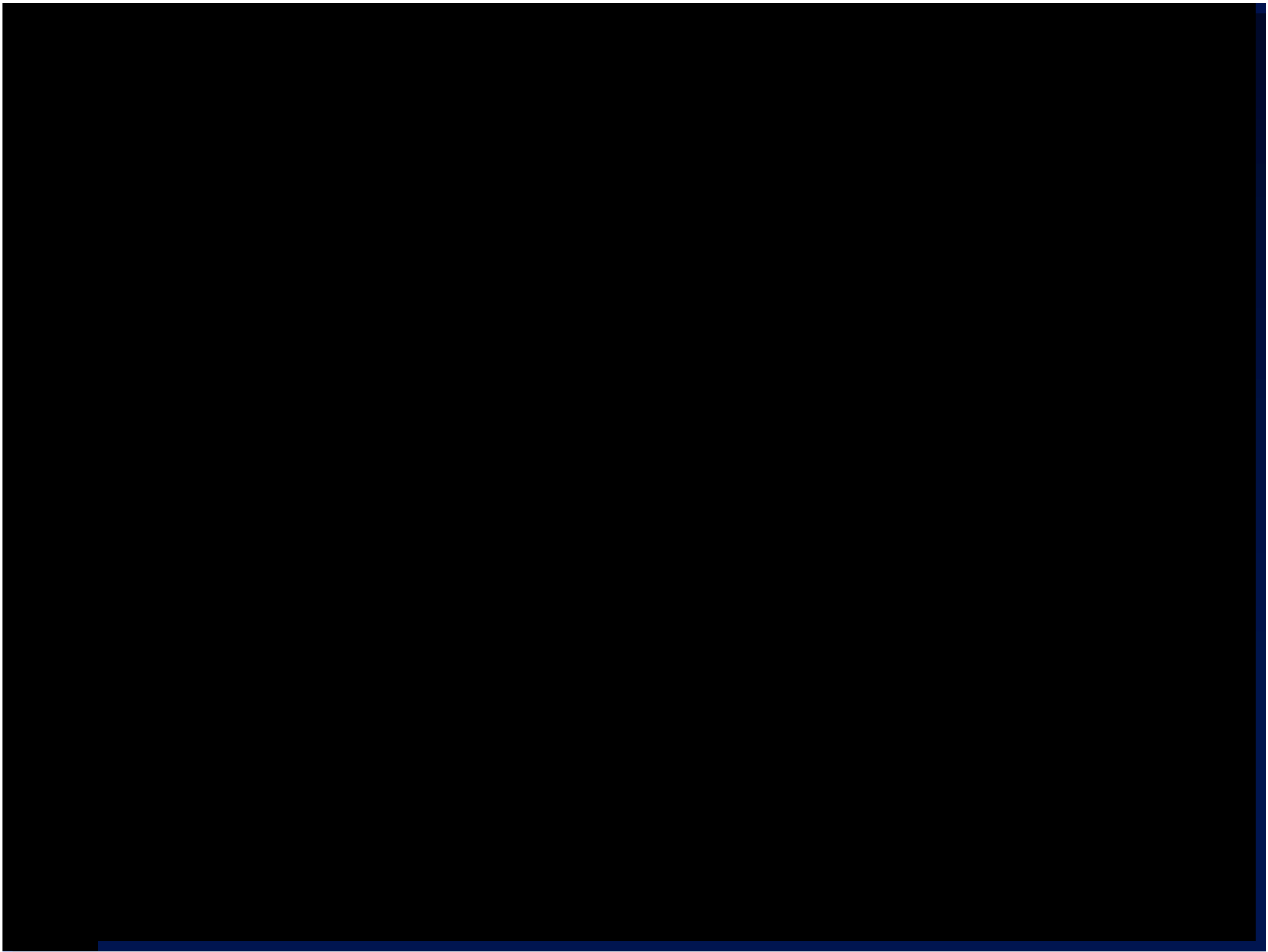
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Quick Look

- **Task-oriented**
- **Different Structure and Navigation**
- **Designed to be Used by Someone Already Familiar with the Material**



Data Collection

- **Surveys**
 - Content accessibility
 - Navigation
 - Depth of material
 - Motivation (Spring 1995 only)
- **Usage Logs / Navigation Audit Trail**
 - Pages
 - Navigation methods
 - Duration

Overall Usage

	<u>Fall 1994</u>	<u>Spring 1995</u>
Total Users	81	39
Total Use Duration	277 hrs	59 hrs
Average Use per Access	41 min	43 min
Total Average Use per Person	132 min	91 min
Average Number of Accesses per Person	3.22	2.10

Usage

	<u>Fall 1994</u>	<u>Spring 1995</u>
Duration Using <i>Theory Map</i>	49%	25%
Duration Using <i>Apparatus Map</i>	28%	58%
Overall Effectiveness	3.66	3.69
Contribution to Understanding the Lab	3.69	3.15
Contribution to Understanding Homework	3.89	3.15

Usage (cont.)

- **Low Response to Questions Pertaining to Depth of Material About Homework Questions**
 - Material was present
 - Survey showed students could find information
 - Students want explicit presentation
- **Students More Interested in Practical Tips**
- **Negligible Usage of *Quick Look***
- **Mixed Usage of MathCad Documents**
 - Fall 1994 used it 23% of the time because their homework required its usage
 - Spring 1995 negligible usage
- ***Quick Look* Low Usage**

Usage (cont.)

- **Mixed Results in Preferred Navigation**
 - Fall 1994 preferred the *Index Page* (63%)
 - Spring 1995 split over Linear Navigation (33%) and Map/Section buttons (38%)
- **Most Actual Navigation Still Linear**
 - Measured by audit trails
- **Surprising Use of Middle Navigation**

Suggested Improvements

- **Add an “Experiment Planning” Section**
- **Add “Reflective Quizzes”**
- **Improve Presentation of the ‘Big Picture’**
- **Add a How to Use the Courseware Section**
 - **Tips**
 - **Informative video/audio**
- **Improve Animation and Simulation**
 - **Add Working Model interactive simulations**

Summary

- **Developed a Centralized Source of Information**
- **Presented Material at a Greater Depth than Traditionally Available**
- **Presented Visualizations of Apparatus Use and Laboratory Procedures**
- **Allowed Students to Explore Information at Multiple Levels**
- **Provided Multiple Navigation Schemes**
- **Computer-based, Enhanced Laboratory Manual**



Vibrating Beam Experiment Instructional Courseware

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