

# **Engineering Mechanics Studio Classroom**

**Gateway Funded Research  
Summer 1999**

**Investigators:** Professor Perry Grossman  
Professor Vito Guido  
Professor Jackie Li  
Ms. Mary Mahany

# Table of Contents

Executive Summary .....	1
Pedagogy .....	2
Courses .....	2
Teaching Equipment .....	2
Workstations .....	6
Assessment .....	7
Conclusions and Recommendations .....	8
<b>Appendix 1: Courses to Benefit from the Engineering Mechanics Studio Room</b>	
<b>Appendix 2: Tabletop Apparatuses Descriptions</b>	
<b>Appendix 3: Engineering Mechanics Studio Classroom Software</b>	
<b>Appendix 4: Engineering Mechanics Studio Classroom Textbooks and Videos</b>	
<b>Appendix 5: Engineering Mechanics Studio Classroom Floor Plan</b>	

## Executive Summary

In order to further prepare undergraduate engineering students for the complex environments of the job market and graduate programs, The Albert Nerken School of Engineering intends to develop an interactive method of instruction for Engineering Mechanics (ESC100). This project is being conducted in conjunction with a similar undertaking for Fluid Mechanics (ESC140). This new approach to undergraduate education adapts and furthers the "studio" concept of instruction developed at the Rensselaer Polytechnic Institute about five years ago. In this system of learning, student workstations, tabletop experiments, computer software, videotapes and traditional textbooks will all be combined to create a dynamic teaching environment, which integrates the traditional separate activities of instruction: lecture, recitation and laboratory. Students, utilizing the workstation computer to design and analyze, will learn to communicate and function as part of a team. The development of the Studio Classroom for Engineering Mechanics provides with its technology and team based learning an excellent opportunity to introduce undergraduate students to an environment similar to that of today's workplace.

## Pedagogy

From a pedagogical point of view, the purpose of the Engineering Mechanics Studio Classroom is the creation of an environment that models the type of workplace that undergraduate engineering students will encounter in their future endeavors. Like the “interactive classroom” of the Rensselaer Polytechnic Institute, the inclusion of computer technology in the daily instruction of Engineering Mechanics provides students with an atmosphere where computers are necessary to the process of analysis and design. Team projects supported by the workstations allow students to develop the communication, managerial and leadership skills that are necessary to success in the workplace.

## Courses

Due to the fundamental nature of Engineering Mechanics (ESC100), the proposed studio classroom could easily be modified to accommodate more than a dozen additional courses within the engineering curriculum. Civil, mechanical, and electrical engineering students, as well as students enrolled in the Bachelors of Science Program, would all benefit from the studio room facilities of tabletop equipment, videos and textbooks related to statics and dynamics. For a list of the courses that can be integrated into the Engineering Mechanics Studio Classroom, please refer to Appendix 1.

## Teaching Equipment

The purpose of the studio classroom is to transform the traditional divided lecture – laboratory teaching system into an integrated interactive experience. The combination of tabletop experiments and demonstrations, computer software, video tapes and textbooks provide the base for a more efficient course.

At the core of this new teaching style is a series of basic demonstrations and experiments that will be conducted during class time and as homework projects. Four desktop mechanics apparatuses, each portable and easy to maintain, sold by PASCO Scientific, have been chosen for their ability to efficiently demonstrate fundamental topics within Engineering Mechanics.

The Super Pulley Force Table will effectively illustrate the concepts of the addition of vector forces and the resolution of a vector into its components. This device reduces the effect of friction for more accurate results by incorporating ultra-low friction pulleys into the design. The screw-in legs of the table can be snapped underneath the tabletop for easy storage.

The Introductory Mechanics System allows one to efficiently present the concepts of simple machines, vector forces, torque and much more. Several experiments can be performed with this system, including the measurement of forces, the addition of forces, the resolution of forces, the concept of torque, the principle of center of mass, the equilibrium of physical bodies, sliding friction and the principles behind simple machines. The Introductory Mechanics System is stored within a box that is not much larger than a briefcase.

The Introductory Dynamics System, available in both a 1.2-meter and 2.2-meter track, will effectively introduce the concept of linear motion. The system allows students to confirm Newton's Laws, investigate acceleration on an inclined plane, collect data on elastic and inelastic collisions, study the conservation of energy, and more. Both the 1.2-meter and 2.2-meter tracks provide accurate alignment and low friction. The 1.2-meter track is long enough for all standard experiments, including collisions, while the 2.2-meter track is ideal for demonstrations and for experiments that require extended accelerations or more than two carts. Brief descriptions of the more than 20 experiments that can be performed with these devices are included with the system. In addition, full

write-ups with illustrations and blank data-tables are provided for the following experiments: kinematics (average versus instantaneous velocities), coefficient of friction, Newton's Second Law (predicting accelerations), cart calibration (measuring the spring constant), sliding friction and the conservation of energy, conservation of momentum, simple harmonic oscillator, oscillations on an incline, springs in serial and parallel, and acceleration down an incline.

PASCO's Complete Rotational System effectively demonstrates the basic concepts of rotational motion, providing a full range in centripetal forces and rotational dynamics. Using this system, several experiments can be performed including: projectile motion, conservation of angular momentum, and the rotational inertia of a disk and ring.

The bench-scale experiments that have been selected for Engineering Mechanics (ESC100) from PASCO Scientific, when coupled with lectures and homework assignments, will emphasize the basic principles of this course in a clear and concise manner. For a more detailed description of each mechanical device please refer to Appendix 2.

In addition to the bench-scale experiments, software programs will provide additional illustrations of engineering mechanics principles; these programs can be used for homework assignments as well as the efficient depiction of in class example problems. Several different programs and CD-ROM's have been investigated for this purpose; for more information about these programs please see Appendix 3.

MSC Software provides a series of software called MSC.Working Model. This set of software includes Working Model Motion and Working Model 2D. Working Model 2D and Model Motion allow students and professors to visualize scientific concepts taught in the classroom. Both Working Model 2D and Working Model

Motion enable students and professors to design linkages with pin joints, slots, motors, ropes springs, dampers, and gravity, simulate contact, collisions and friction, as well as analyze structures with flexible beams, shear force and bending moment diagrams. With the additional Homework Edition of Working Model 2D, students can build models with bodies and constraints and run simulations from their workstations. Because of the versatility of these programs, the software can be easily integrated into the engineering mechanics course. The software can be used for example problems and demonstrations as well as homework assignments for the students.

Addison-Wesley Interactive provides two programs, Multimedia Engineering Dynamics and Multimedia Engineering Statics. Multimedia Engineering Dynamics (M.E.D.) contains 43 real-world problems that address the major principles covered in an engineering dynamics course. The program uses Apple's QuickTime system as its audio and animations executor. This is unfortunate because the version of QuickTime embedded within the program is outdated and therefore leads to operational difficulties when using this CD-ROM. If this problem can be resolved, M.E.D. would provide a basic tool for professors to illustrate typical example problems that are encountered in the engineering mechanics course. Multimedia Engineering Statics (MES) was also investigated; unfortunately, due to an undetermined incompatibility with the software and the computer operating system, MES was unable be opened and further examined.

In addition to the previously mentioned software programs, the textbook chosen to guide the instruction of Engineering Mechanics (ESC100), *Vector Mechanics for Engineers: Statics and Dynamics* by F. P. Beer and E. R. Johnston Jr., is accompanied by interactive software separated into the two categories of statics and dynamics. Along with this software, the textbook includes homework

problems designed to be solved with a computer. This software will provide both the professor and the student with a more concrete relationship between the textbook and multimedia experience for students.

Traditional teaching tools, such as videos and textbooks, will be coupled with the computer software and tabletop experiments in the studio room method of instruction. A small library of books and videos would enable the studio room to transform from a classroom into a study room when not in use. The list of textbooks and videos intended for use can be found in Appendix 4.

## Workstations

In order to accommodate the interactive type of instruction that is at the core of the Engineering Mechanics Studio Room, the classroom on the second floor of the engineering building (Room 236) must be designed in a manner conducive to multimedia education. In order to accomplish this, workstations have to be arranged in such a manner that students are able to accomplish a variety of activities, including computer based analysis and design, team discussions, team/instructor discussions, as well as participation in "traditional" activities, such as observing the professor addressing the entire class while performing a demonstration from his or her own workstation. Six workstations for the students, each accommodating 4 to 5 students, and one designated for the professor will each maintain a computer, a black laser printer, and a laptop computer. The monitor for each computer will be situated underneath the tabletop of the workstation, ensuring the maximum available work area needed for the performance of demonstrations and experiments. Each workstation will also be fitted with 220 wiring, as well as outlets for compressed air. The studio room will also be equipped with a video projection screen and a white marker board. For a floor plan of this design, please refer to Appendix 5, Figure 1.

## Assessment

Constant project assessment is necessary to evaluate the success of the Engineering Mechanics Studio Classroom once it has been integrated into the curriculum. For this assessment, a committee including a Gateway evaluator should be appointed to carry out the needed investigations. One beneficial method of evaluation that may be utilized depends on an outcomes-based assessment to measure student performance. For example, half of one year's Engineering Mechanics students could be chosen to study ESC100 in the new studio classroom, while the remaining half would receive instruction in the traditional lecture format. Examinations given throughout the semester to both groups would allow the committee to comparatively evaluate the benefits of the interactive learning environment on overall student performance. Additional assessment tools, ensuring constant evaluation and improvement, can be developed and added as the Engineering Mechanics Studio Classroom is instituted.

## Conclusions and Recommendations

The Engineering Mechanics Studio Classroom provides an excellent opportunity to create a new environment for interactive teaching and learning. The Engineering Mechanics Studio Classroom will allow students to further develop the computer, analytical and team-based skills that they already obtain from other courses within the engineering curriculum. To that end, further development of the Engineering Mechanics Studio Room is required. This includes the procurement of videotapes, CD-ROMS, the previously mentioned tabletop experiments, and the equipment needed for each workstation. As another stage of the Engineering Mechanics Studio Classroom development, teaching modules that incorporate the use of videotapes, demonstrations and software programs should be created. These modules should serve as the fundamental basis for an instructor's approach to teaching students in the new studio classroom.

**Appendix 1:**  
**Courses to Benefit from the**  
**Engineering Mechanics Studio Classroom**

<b>ESC 100</b>	-	<b>Engineering Mechanics</b>
<b>ESC 101</b>	-	<b>Solid Mechanics</b>
<b>CE 121</b>	-	<b>Structural Engineering I</b>
<b>CE 122</b>	-	<b>Structural Engineering II</b>
<b>CE 131</b>	-	<b>Soil Mechanics</b>
<b>CE 361</b>	-	<b>Civil Engineering Experimental Projects</b>
<b>CE 369</b>	-	<b>Civil Engineering Project</b>
<b>ME 100</b>	-	<b>Stress and Applied Elasticity</b>
<b>ME 101</b>	-	<b>Mechanical Vibrations</b>
<b>ME 120</b>	-	<b>Design Elements</b>
<b>ME 321</b>	-	<b>Engineering Kinematics</b>
<b>ME 401</b>	-	<b>Advanced Mechanical Vibrations</b>
<b>EID 125</b>	-	<b>Biomechanics</b>
<b>PH 112</b>	-	<b>Mechanics</b>
<b>PH 165</b>	-	<b>Concepts of Physics</b>
<b>PH 291</b>	-	<b>Introductory Physics Laboratory</b>

**Appendix 2:**  
**Engineering Mechanics Tabletop Apparatuses**

# Super Pulley Force Table

ME-9447 \$175

- High Accuracy Every Time
- Easy, Compact Storage
- Inexpensive!

PASCO has redesigned the classic force table using Super Pulleys to obtain more precise results in vector experiments. The new Super Pulley Force Table is easy to use, easy to store, and inexpensive. Students can independently investigate the addition of vector forces and resolve vectors into their components.

## Accurate Results

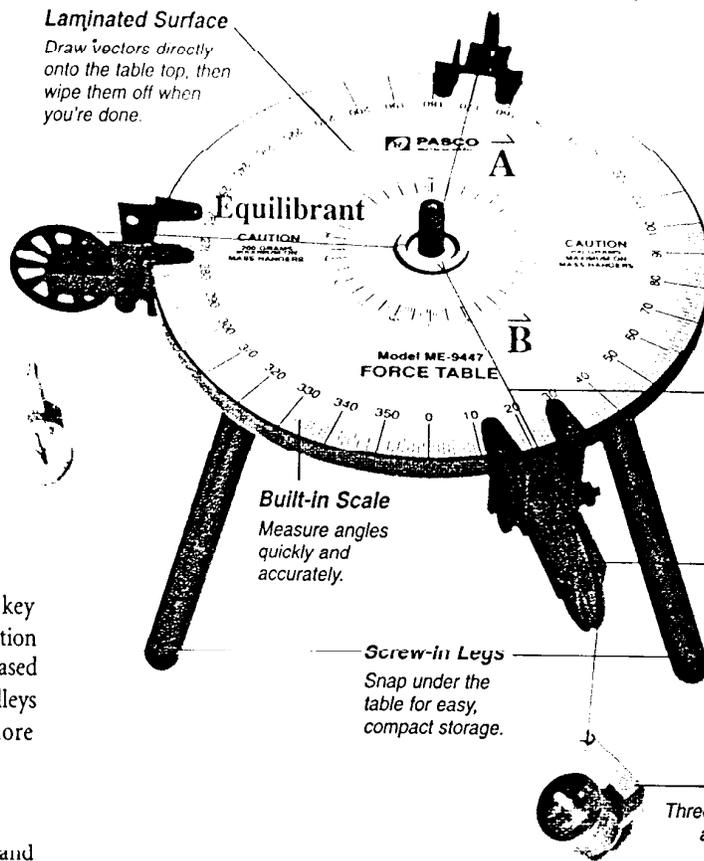
The ultra-low friction pulleys are the key to the Force Table's accurate results. Friction is reduced to a bare minimum for increased sensitivity. The swivel feature of the pulleys can virtually eliminate parallax for more precise angle measurements.

## Inexpensive

You get easier operation, better results, and easier storage— at about a third the cost of a standard, large metal force table.

## Compact, Easy Storage

The screw-in legs snap under the table for easy storage. Fold and stack as shown. When you are ready to use them again, they assemble in seconds!



**Laminated Surface**  
Draw vectors directly onto the table top, then wipe them off when you're done.

Students hang masses to produce force vectors A and B. Then the balancing vector (equilibrant) can be easily and accurately determined on the Force Table.

**String**  
Attach to centering ring (or knot string at center for greater accuracy) and place over pulleys.

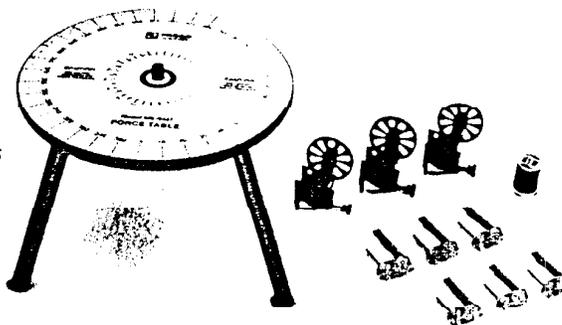
**Low Friction Super Pulley**  
Change a mass by one gram or an angle by one degree—you'll see an immediate change in the equilibrium position.

**Screw-in Legs**  
Snap under the table for easy, compact storage.

**Mass Hangers**  
Three included. (Masses are sold separately.) See Mechanics Supplies Section.

The ME-9447 Super Pulley Force Table includes:

- (1) Write-on/wipe-off table with detachable legs
- (2) Three adjustable Super Pulleys with Clamps
- (3) Six mass hangers (masses purchased separately)
- (4) Plastic centering ring
- (5) Spool of string.

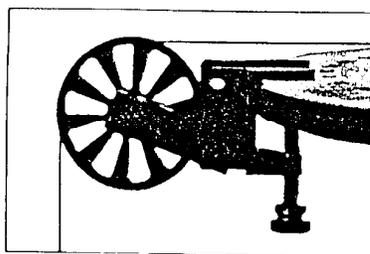


### TO ORDER:

Super Pulley Force Table  
ME-9447 \$175.00

Super Pulley with Clamp  
ME-9448A Pg. 90 \$26.00

Additional Equipment Needed:  
Mass and Hanger set ME-9348 Pg. 92 \$54.00



The PASCO Super Pulley fits tables up to 2 cm thick.

## Already have a force table or an inclined plane?

You can significantly improve your experiments by reducing friction and eliminating parallax. Just replace your old pulleys with our inexpensive Super Pulleys with Clamp. The ME-9448A with its built-in clamp fits tables from 0.8 to 2.0 cm (5/16 to 13/16 in) thick.

# Introductory Mechanics System

ME-9299 \$610

- Complete— Everything You Need for 15 Experiments
- Comprehensive— From Vector Addition to Simple Machines
- Easy Setup— Magnetic Mounting

A complete lab system for demonstrating the basic concepts of simple machines, vector forces, torques, and more.

**Durable, Low-friction Pulleys**  
Will withstand years of classroom use.

**A Degree Scale**  
(In this experiment) gives the angle of the vector force required to balance two others.

**Formulas and Variables**

Can be written on the experiment board with a dry-erase marker, then wiped clean.

Porcelain-Coated Steel

**Three Accurate Scales**

Including the sensitive spring balance shown here— are provided for measuring forces, angles, and loads.

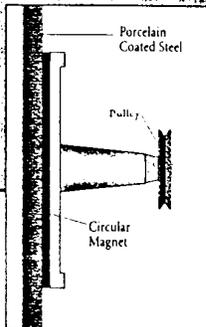
**Magnetic Mountings**

Allow precise repositioning for constructing accurate vector angles.

**All the Accessories You Will Ever Need**  
Including thread, mass hangers, and masses.

**Circular Magnets**

Experimental devices are secured to the board by magnets that will not slide around but are easily repositioned.



**Designed for Students...**

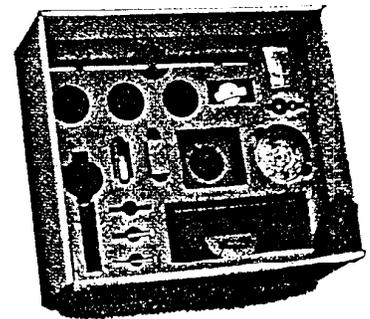
First-time physics students have enough on their minds without unnecessary frustration in the lab. So this system is designed to eliminate many of the problems that are common in statics experiments.

**Unique features include:**

- **Magnetic Mounting**— For quick setup.
- **Special Mass Hangers**— Just wrap a few turns of thread around the mass hangers. They'll stay put. (No need to cut the thread to length or tie it to the hanger.)
- **Drop-proof Masses**— The masses slide over posts. They can't fall off.
- **Accurate, Built-in Scales**— For example, a built-in plumb bob and degree scale indicate the angle of inclination of the inclined plane.

**...and Designed for Teachers**

The same features that make this an ideal system for students make it convenient for the instructor. You'll spend less time helping students use the equipment, and more time helping them understand the physics. For small classes it's an excellent demonstration system. You can write on the experiment board with a dry-erase marker. The storage box keeps everything, including the board, in its place.



**Convenient Storage Box**

In a box that is not much bigger than a briefcase, foam cutouts keep each piece of equipment in its place - including the demonstration board. The 15-experiment manual is not shown.



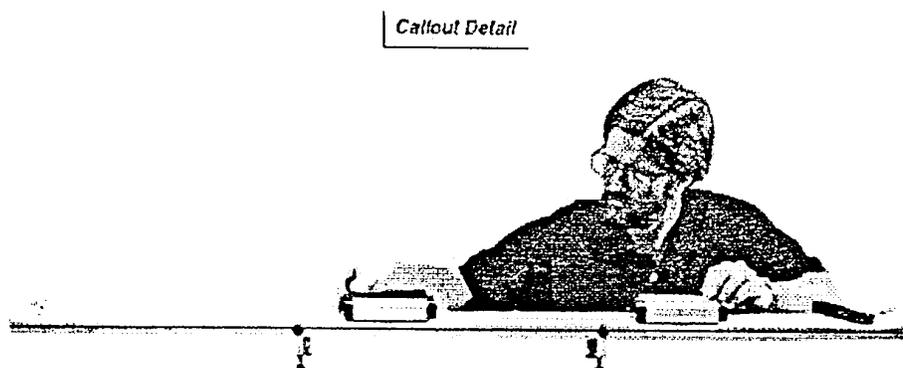
# Introductory Dynamics System (1.2 m)

ME-9429A

Catalog Page: 52

| Product Description | Experiments | What's Included |

- Simple, Accurate, Affordable
- Complete Linear Dynamics Lab
- Wide Range of Accessories



ME-9429A Introductory Dynamics System (1.2 m)

## INTRODUCTION

PASCO's rugged and versatile Introductory Dynamics System (IDS) includes everything you will need to introduce linear motion. Your students will confirm Newton's Laws, investigate acceleration on an inclined plane, collect data on elastic and inelastic collisions, study conservation of energy, and much more.

## FEATURES

- **1.2 m Track**-- Provides accurate alignment and low friction. The 1.2 m track is long enough for all standard experiments, including collisions, yet it fits easily on a standard lab table.

See Related products below for details on the ME-9452 Introductory Dynamics System with a 2.2 meter track.

- **Accurate Alignment--** Precision wheel slots keep the carts accurately aligned and the built-in leveling screws ensure a level surface on any lab table.
- **Tilts to Any Angle--** The track mounts to a standard 12.5 mm (1/2 in.) lab rod (not included) and tilts easily for inclined plane experiments.
- **Easy Measurement--** A measuring tape calibrated in millimeters is permanently mounted on the track.
- **Durable--** The track is a tough aluminum extrusion.
- **Better than an Air Track**

The Dynamics Systems provide such low friction that many teachers prefer them to air tracks. Here's why:

- A little friction can be good-- Air tracks must be extremely straight and level. But PASCO's Dynamics System provides good results on a reasonably level surface. Setups are quicker and a cart stays put until you apply a force.

- o A quieter lab-- No air blower.
- o More varied experiments-- You can work with steeper inclines, a greater range of masses, curved surfaces, etc.
- o Much less expensive-- Buy a complete PASCO Dynamics System at less than a third of the cost of an air track and air supply.

## RELATED PRODUCTS

[IDS\\_Systems](#)

[PASCO\\_Carts](#)

[Dynamics\\_Cart\\_Accessories](#)

---

To contact PASCO,  
send e-mail:  
[sales@pasco.com](mailto:sales@pasco.com)

If you experience problems  
please contact us:  
[webteam@pasco.com](mailto:webteam@pasco.com)



© Copyright 1996  
PASCO scientific  
All rights reserved

# Introductory Dynamics System (1.2 m)

ME-9429A

---

| Product Description | Experiments | What's Included |

## SAMPLE EXPERIMENTS AND RESULTS

**With Teacher's Guide and Sample Data.**

**Brief descriptions of 21 experiments are provided. Full write-ups with illustrations and blank data tables are provided for the following 15 experiments.**

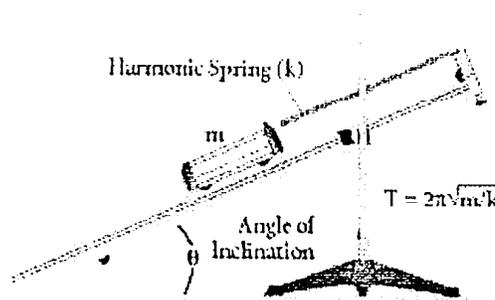
**Note: Experiments 1-6 are also included with a PASCO Dynamics Cart (ME-9430 or ME-9454) if purchased separately.**

1. Kinematics (Average vs. Instantaneous Velocities).
2. Coefficient of Friction.
3. Newton's Second Law (Predicting Accelerations).
4. Cart Calibration (Measuring the Spring Constant).
5. Rackets, Bats and "Sweet Spots."
6. Sliding Friction and Conservation of Energy.
7. Conservation of Momentum in Explosions.
8. Conservation of Momentum in Collisions.
9. Simple Harmonic Oscillator.
10. Oscillations on an Incline.
11. Springs in Serial and Parallel.
12. Newton's Second Law.
13. Newton's Second Law II.
14. Acceleration Down an Incline.
15. Conservation of Energy.



**Experiment 7: Conservation of Momentum in Explosions**

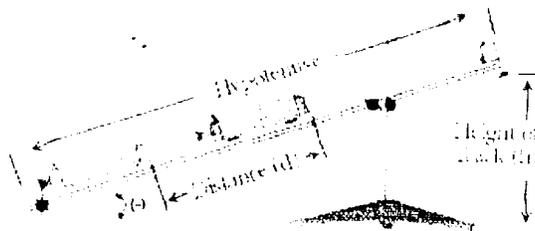
In an explosion, with no external forces,  $m_1v_1 = m_2v_2$ , where  $v_1$  and  $v_2$  are the respective velocities of the carts. This means that the ratio of the velocities is inversely proportional to the ratio of the masses. Arrange the carts so that after the explosion each cart hits the end of the track at the same time. With the times the same, the ratio of the distances is inversely proportional to the ratio of the masses. Check the distances to verify the theory.



**Experiment 10: Oscillations on an Incline**

Measure the period of oscillation ( $T$ ) of the dynamics cart on the harmonic spring. Then measure the mass of the cart ( $m$ ) and calculate the spring constant of the spring ( $k$ ). Finally, calculate the theoretical period of oscillation and compare to the actual period.

Spring PE =  $\frac{1}{2}kx^2$   
 Gravitational PE =  $mgh$   
 Kinetic Energy =  $\frac{1}{2}mv^2$ , Gravitational PE =  $mgh \sin(\theta)$   
 Spring PE =  $\frac{1}{2}kx^2 \sin^2(\theta)$



### Experiment 15: Conservation of Energy

Measure the spring constant of the plunger spring ( $k$ ) by compressing it a distance ( $x$ ). Then measure the mass of the cart ( $m$ ) and the angle of inclination of the track ( $\theta$ ). Use conservation of energy to predict the distance the cart will travel up the track after the plunger is triggered.

To contact PASCO,  
 send e-mail:  
[sales@pasco.com](mailto:sales@pasco.com)

If you experience problems  
 please contact us:  
[webteam@pasco.com](mailto:webteam@pasco.com)



© Copyright 1996  
 PASCO scientific  
 All rights reserved

# Introductory Dynamics System (1.2 m)

ME-9429A

| [Product Description](#) | [Experiments](#) | [What's Included](#) |

## PASCO Dynamics Track

A 1.2 or 2.2 meter track provides an excellent platform for students to experiment with mechanics concepts. With precision wheel slots built-in, your carts will roll straight no matter what type of experiment you try.

### End Stops

Provide both magnets for low-loss elastic collisions or Velcro® tabs for inelastic collisions.

### T-slots

Allow easy attachment of end stops, leveling feet, photogate mounts and other accessories. T-slots span the entire length of the track on both sides.

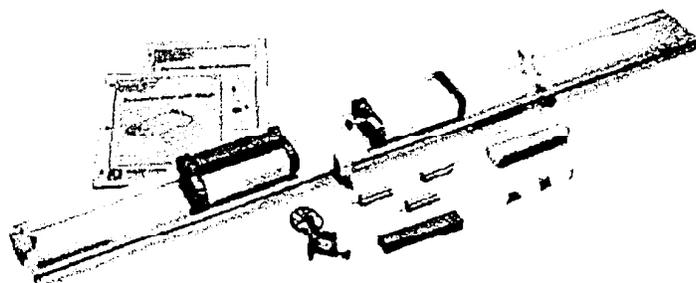
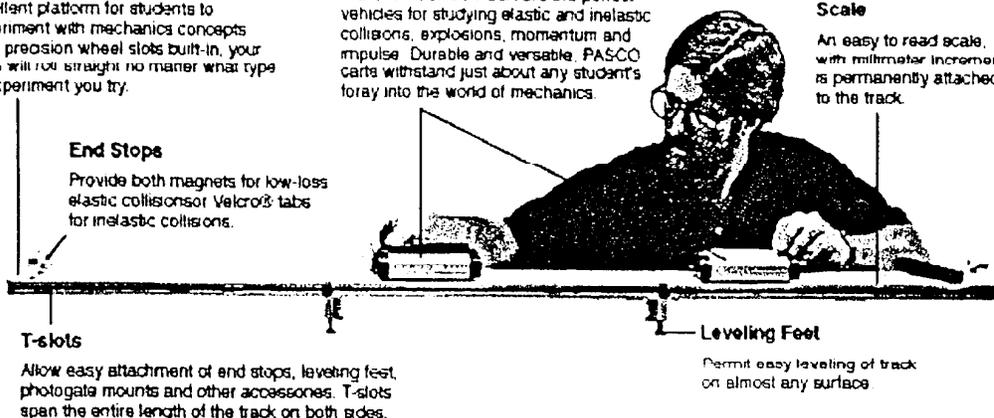
## PASCO Carts— The Key to a Complete Dynamics System

The ME-9430 Plunger Cart and the ME-9454 Collision Cart are the perfect vehicles for studying elastic and inelastic collisions, explosions, momentum and impulse. Durable and versatile, PASCO carts withstand just about any student's foray into the world of mechanics.

## Callout Detail

### Scale

An easy to read scale, with millimeter increments, is permanently attached to the track.



The ME-9429A Introductory Dynamics System (1.2 m) includes:

1. ME-9430 Plunger Cart
2. ME-9454 Collision Car
3. 1.2 meter Track
4. Fixed End Stop and Leveling Screw
5. Adjustable End Stop (with magnets and Velcro pads)
6. Super Pulley with Clamp
7. 2 Neodymium Magnets (for Plunger Cart)
8. 3 Harmonic Springs
9. Friction Block (with 2 different surfaces)
10. Rod Clamp (for tilting the track)
11. 2 Experiment Manuals

- 12. Two 500 gram Masses
- 13. ME-9495 Angle Indicator

---

To contact PASCO,  
send e-mail:  
[salcs@pasco.com](mailto:salcs@pasco.com)

If you experience problems  
please contact us:  
[webteam@pasco.com](mailto:webteam@pasco.com)



© Copyright 1996  
*PASCO scientific*  
*All rights reserved*

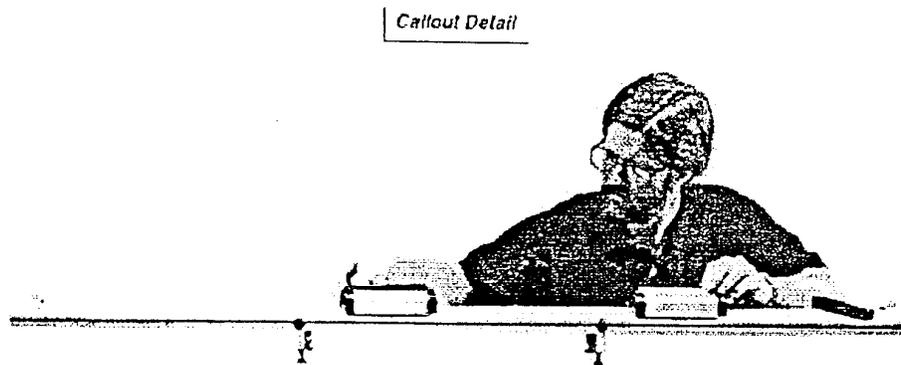
# Introductory Dynamics System (2.2 m)

ME-9452

Catalog Page: 52

| Product Description | Experiments | What's Included |

- Simple, Accurate, Affordable
- Complete Linear Dynamics Lab
- Wide Range of Accessories



ME-9452 Introductory Dynamics System (2.2 m)

## INTRODUCTION

PASCO's rugged and versatile Introductory Dynamics System (IDS) includes everything you will need to introduce linear motion. Your students will confirm Newton's Laws, investigate acceleration on an inclined plane, collect data on elastic and inelastic collisions, study conservation of energy, and much more.

## FEATURES

- **2.2 m Track**-- Provides accurate alignment and low friction. The 2.2 m length is ideal for demonstrations and for experiments requiring extended accelerations of more than two carts.

See Related products below for details on the ME-9429A Introductory Dynamics System with a 1.2 meter track.

- **Accurate Alignment--** Precision wheel slots keep the carts accurately aligned and the built-in leveling screws ensure a level surface on any lab table.
- **Tilts to Any Angle--** The track mounts to a standard 12.5 mm (1/2 in.) lab rod (not included) and tilts easily for inclined plane experiments.
- **Easy Measurement--** A measuring tape calibrated in millimeters is permanently mounted on the track.
- **Durable--** The track is a tough aluminum extrusion.
- **Better than an Air Track**

The Dynamics Systems provide such low friction that many teachers prefer them to air tracks. Here's why:

- A little friction can be good-- Air tracks must be extremely straight and level. But PASCO's Dynamics System provides good results on a reasonably level surface. Setups are quicker and a cart stays put until you apply a force.
- A quieter lab-- No

- air blower.
- o More varied experiments-- You can work with steeper inclines, a greater range of masses, curved surfaces, etc.
- o Much less expensive-- Buy a complete PASCO Dynamics System at less than a third of the cost of an air track and air supply.

## RELATED PRODUCTS

[IDS\\_Systems](#)

[PASCO\\_Carts](#)

[Dynamics\\_Cart\\_Accessories](#)

---

To contact PASCO,  
send e-mail:  
[sales@pasco.com](mailto:sales@pasco.com)

If you experience problems  
please contact us:  
[webteam@pasco.com](mailto:webteam@pasco.com)



© Copyright 1996  
PASCO scientific  
All rights reserved

# Introductory Dynamics System (2.2 m)

ME-9452

| Product Description | Experiments | What's Included |

## PASCO Dynamics Track

A 1.0 or 2.2 meter track provides an excellent platform for students to experiment with mechanics concepts. With precision wheel slots built in, your carts will roll straight no matter what type of experiment you try.

### End Stops

Provide both magnets for low-loss elastic collisions or Velcro tabs for inelastic collisions.

### T-slots

Allow easy attachment of end stops, leveling feet, photogate mounts and other accessories. T-slots span the entire length of the track on both sides.

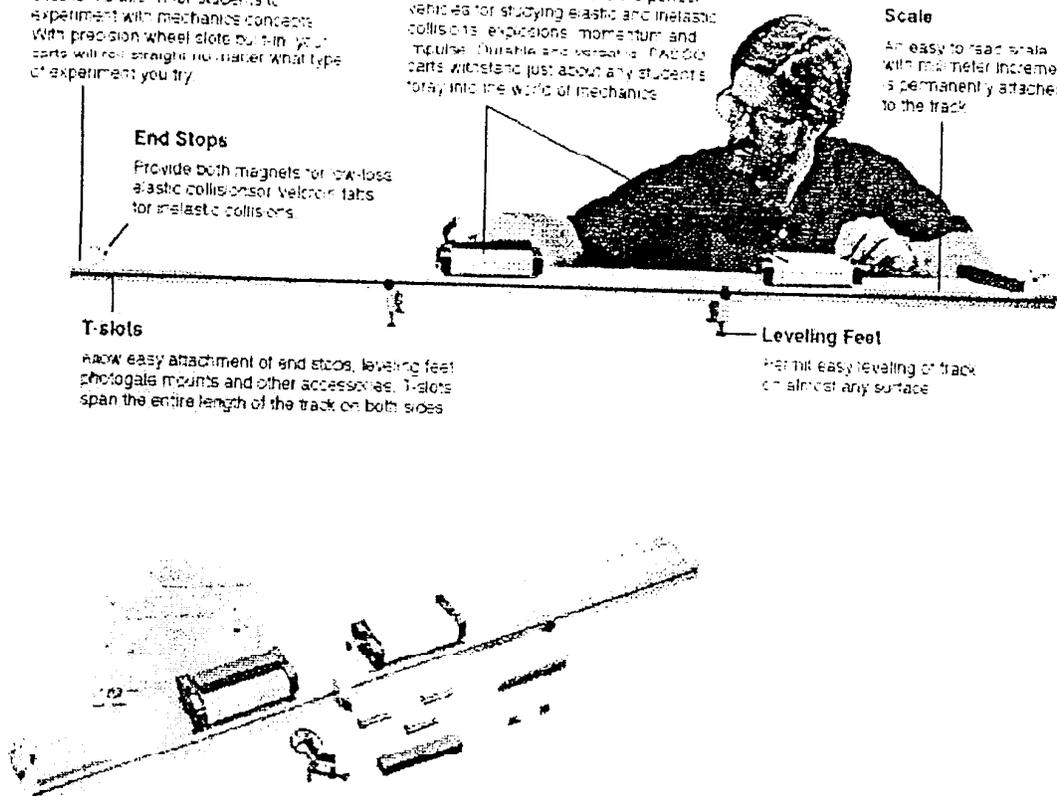
## PASCO Carts— The Key to a Complete Dynamics System

The ME-9430 Plunger Cart and the ME-9454 Collision Cart are the perfect vehicles for studying elastic and inelastic collisions, explosions, momentum, and impulse. Durable and versatile, PASCO carts withstand just about any student's foray into the world of mechanics.

### Callout Detail

#### Scale

An easy-to-read scale with millimeter increments is permanently attached to the track.



## The ME-9452 Introductory Dynamics System (2.2 m) includes:

1. ME-9430 Plunger Cart
2. ME-9454 Collision Cart
3. 2.2 meter Track
4. 2 Adjustable End Stops (with magnets and Velcro pads)
5. Super Pulley with Clamp
6. 2 Neodymium Magnets (for Plunger Cart)
7. 3 Harmonic Springs
8. Friction Block (with 2 different surfaces)
9. Rod Clamp (for tilting the track)
10. 2 Experiment Manuals
11. 2 Adjustable Feet

- 12. Two 500 gram Masses
- 13. ME-9495 Angle Indicator

---

To contact PASCO,  
send e-mail:  
[sales@pasco.com](mailto:sales@pasco.com)

If you experience problems  
please contact us:  
[webteam@pasco.com](mailto:webteam@pasco.com)



© Copyright 1996  
PASCO scientific  
All rights reserved

# Complete Rotational System

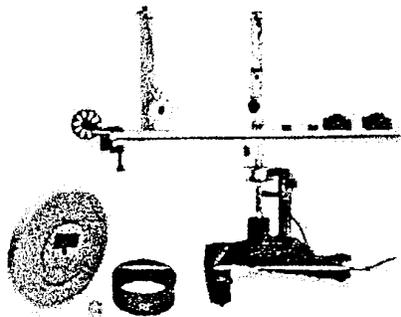
**ME-8950**

Catalog Page: 78

---

| [Product Description](#) | [What's Included](#) |

- **Most Versatile System Available**
- **Stable Base**
- **Low Friction Bearings**



ME-8950 Complete Rotational System

## INTRODUCTION

The system's easy setup, simple measurements, wide variety of experiments, and increased accuracy help students understand both the basic and more subtle concepts of rotational motion.

PASCO's Complete Rotational System provides a full range of experiments in centripetal force and rotational dynamics.

## RELATED PRODUCTS

[ME-8964 Faraday's Law Accessory](#)

## NOTES

The Complete Rotational System components may be bought separately.

---

To contact PASCO,  
send e-mail:  
[sales@pasco.com](mailto:sales@pasco.com)

If you experience problems  
please contact us:  
[webteam@pasco.com](mailto:webteam@pasco.com)

 Made with  
Mac OS  
© Copyright 1996  
PASCO scientific  
All rights reserved

**Appendix 3:**  
**Engineering Mechanics Studio Classroom Software**

# MSC.Working Model

Working Model® Motion

Working Model FEA

Working Model 2D



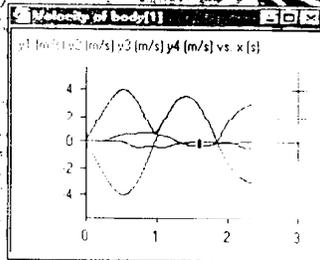
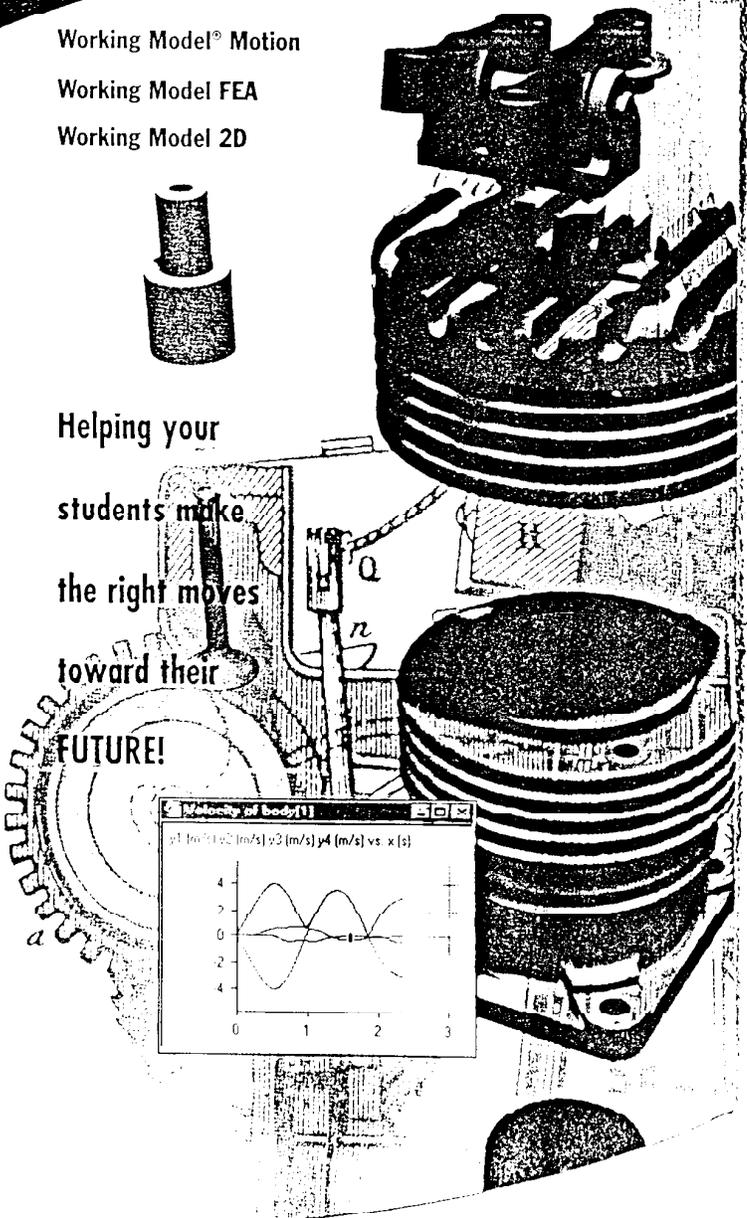
Helping your

students make

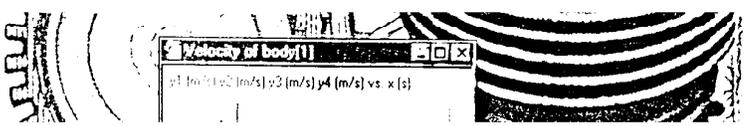
the right moves

toward their

**FUTURE!**



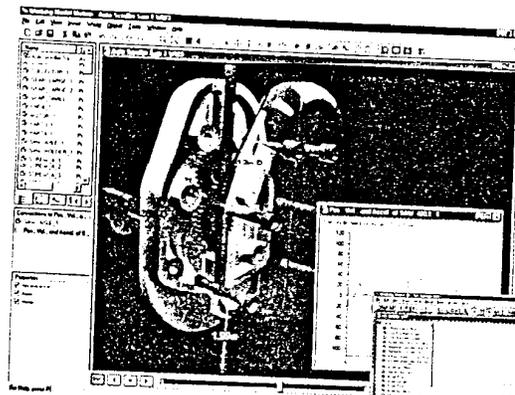
MSC SOFTWARE



# Working Model Motion

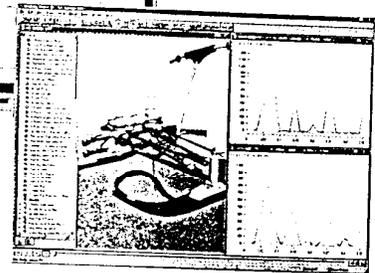
(formerly Working Model 3D)

*The educational standard for design analysis and multimedia presentation.*



*Annotation such as notes and dimensions facilitate design collaboration between work between student and instructor.*

With a rich set of native drawing tools, the ability to import a wide variety of CAD formats and advanced rendering technology, students, educators and professionals can rapidly build models to simulate the physical world. Working Model Motion is particularly well suited for advanced students who design, test, refine and verify mechanical and biomechanical assemblies. Photorealistic rendering, texture mapping, annotation and dimensioning capabilities, allow educators to produce media-quality demonstrations for conferences and the classroom. With an embedded object browser and intuitively simple user interface, impressive simulations are possible within minutes of installation.



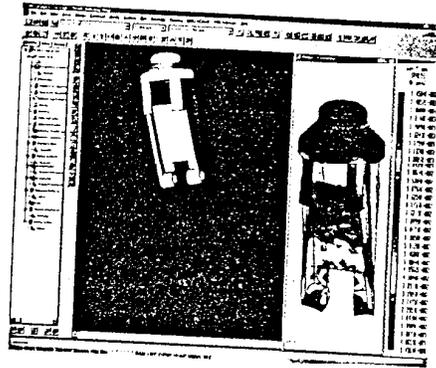
- Design mechanisms with pin joints, slots, motors, ropes, springs, dampers and gravity
- Simulate contact, collisions and friction
- Import geometry from leading computer aided design (CAD) packages
- Keyframe animation for bodies, cameras and lights
- Map assembly mates
- Input values from equations, sliders and tables
- View output as numbers, graphs or vectors in English or metric units



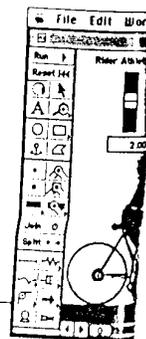
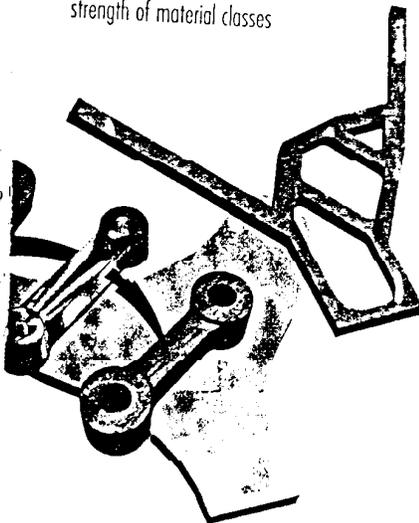
# Working Model FEA

*A new educational tool for structural, thermal analysis and design*

With the ability to measure stress, strain, heat transfer, buckling and vibration, analysts can answer the question "will it break?" The easy-to-use Working Model FEA interface enables students, educators and professionals to rapidly build complex models and test, refine and verify mechanical or biomechanical assemblies. Working Model FEA is particularly well suited for the advanced design student and for classroom demonstrations of sophisticated structural phenomenon in strength of material classes



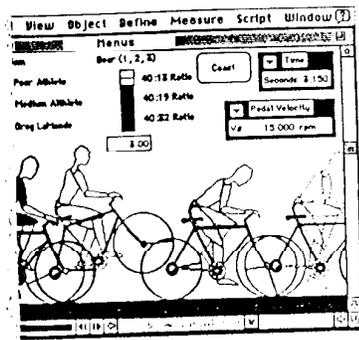
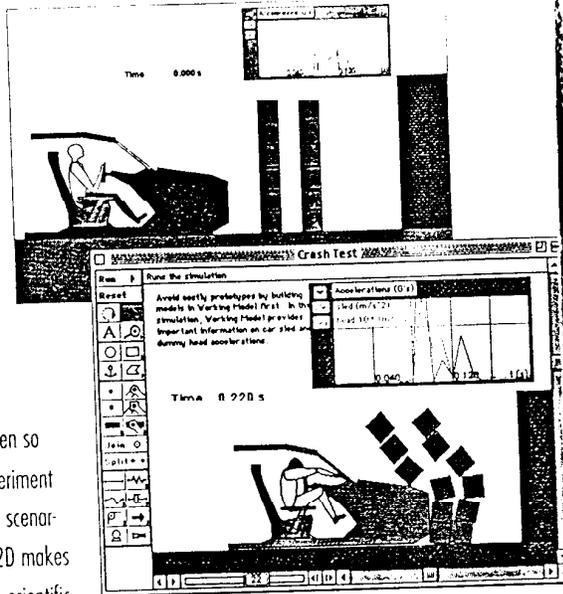
- Built on MSC.Nastran technology
- Structural analysis: stress, deflection, buckling and vibration analysis
- Steady-state heat transfer with conduction and convection
- Single-window integration with Mechanical Desktop, Solid Edge and SolidWorks
- Associative links with CAD geometry for loads, restraints and meshes
- Standard Windows interface
- View output as numbers, graphs and contour plots



# Working Model 2D

The standard for statics, dynamics, vibrations and controls simulation

A diverse set of drawing and mathematical tools enable students, educators and engineers to rapidly build complex models simulating the physical world. Never before has it been so easy to set up an experiment and explore "what if" scenarios. Working Model 2D makes it possible to visualize scientific concepts taught in the classroom making course material more relevant and enjoyable. Further enhancing the interactive student-teacher experience, Working Model 2D provides tools to design, test, refine, and verify mechanical, biomechanical and structural assemblies.



- Design linkages with pin joints, slots, motors, ropes, springs, dampers and gravity
- Simulate contact, collisions and friction
- Analyze structures with flexible beams, shear force and bending moment diagrams
- Input 2D CAD drawings in DXF format
- Input values from equations, sliders and DDE links to Matlab and Excel
- View output as numbers, graphs or vectors in English or metric units
- Create visually appealing presentations with bitmap attachment

## Easy Curriculum Integration

### Homework Edition

Empower your students to use Working Model 2D for out-of-the-classroom assignments, internet projects and take-home examinations. The Homework Edition software has all the power and ease-of-use teachers depend on in the classroom. With the Homework Edition, students can build models with bodies and constraints, meters and input controls; run simulations, print and save on their home computers.

Available to current customers with at least a 10-user license of Working Model 2D, Homework Edition is sold in increments of fifteen CD-ROMs, additional manuals not included. Contact MSC Working Knowledge sales for more information.

### Textbook Partners

Working Model 2D simulations allow students to comprehend physical concepts with virtual experiments that can be reiterated

with various parameters. In addition, a number of textbook publishers offer prepackaged simulations to elaborate exercises. These packages include a Working Model 2D player to run the simulations provided and change their parameters, but not customize or create models. Packages only available from the textbook publishers.

### Curriculum Support Products:

- Complement textbook chapters
- Offer texts, workbooks and exercises for easy lesson planning and grading
- Enable students to quickly explore textbooks examples

### Use with your textbook to:

- Interest and motivate your students
- Clarify abstract topics
- Encourage can-do attitudes
- Provide excellent in-class demos
- Reduce lesson preparation time

PUBLISHER	TITLE	AUTHOR
McGraw Hill, Inc.	Design of Machinery	Robert L. Norton
	Vector Mechanics for Engineers	Ferdinand P. Beer &
	Statics and Dynamics	Russell Johnston, Jr.
Prentice Hall	Engineering Mechanics	Anthony Bedford &
	Statics and Dynamics	Wallace L. Fowler
	Engineering Mechanics	R.C. Hibbeler
	Statics and Dynamics	

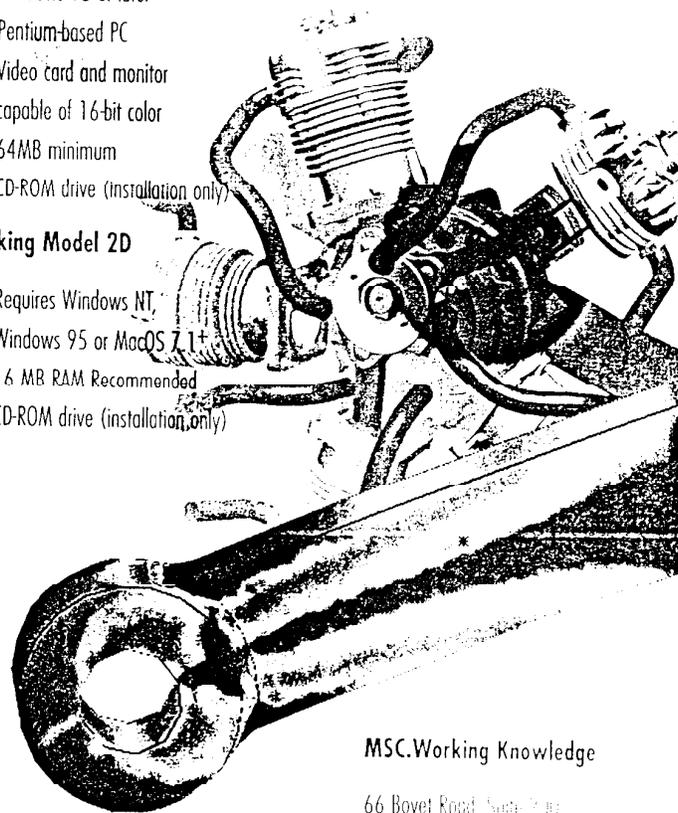
## SYSTEM REQUIREMENTS

### Working Model Motion & Working Model FEA

- Windows NT 4.0,  
Windows 95 or later
- Pentium-based PC
- Video card and monitor  
capable of 16-bit color
- 64MB minimum
- CD-ROM drive (installation only)

### Working Model 2D

- Requires Windows NT,  
Windows 95 or MacOS 7.1+
- 16 MB RAM Recommended
- CD-ROM drive (installation only)



### MSC Working Knowledge

66 Bovel Road, Suite 200

San Mateo, CA 94402

800.746.8800 • 650.574.1777

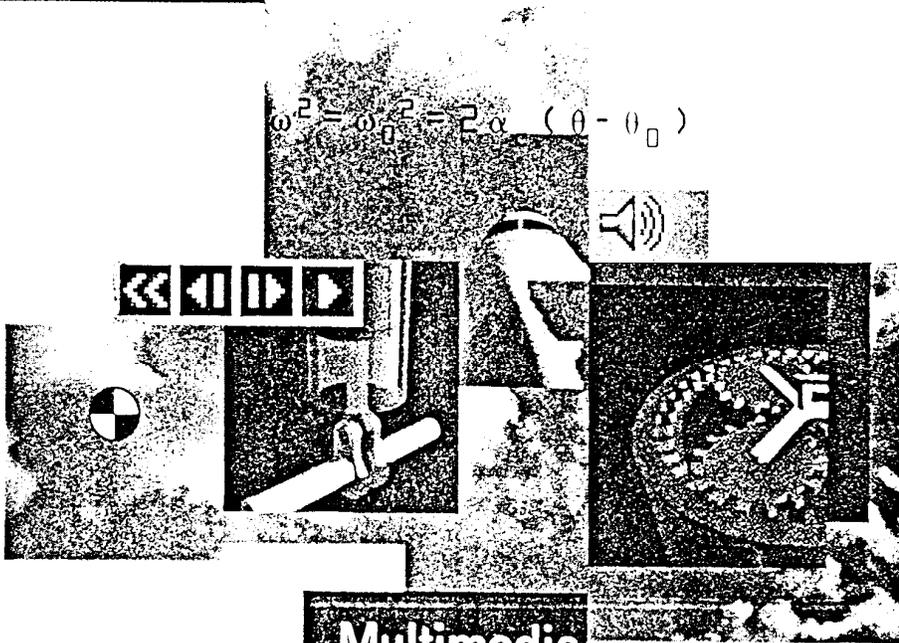
650.574.1777

win info@workingknowledge.com

[www.workingmodel.com](http://www.workingmodel.com)

Addison-Wesley Interactive

**CD-ROM**  
Hybrid for  
Windows and  
Macintosh



**Multimedia**

# Engineering Dynamics

Kurt Gramoll and Rob Abbanat

## **Multimedia Engineering Dynamics**

Multimedia Engineering Dynamics (M.E.D.) contains 43 creative, real-world problems that explore all of the major concepts covered in a typical engineering dynamics course.

M.E.D. is designed as a new component to a course in engineering dynamics, and can complement a textbook, lab activity, and/or lecture. M.E.D. can be used with any textbook and fits a variety of teaching approaches and learning styles.

M.E.D.'s unique multimedia format provides a robust learning environment that helps users visualize concepts like work and energy or kinematics of rigid bodies in a way not possible using traditional methods or other forms of technology. Also, users can actively explore their assumptions about how to solve problems and build confidence in their problem-solving ability.

### **Integrating M.E.D. Into Your Study Or Teaching Program:**

M.E.D. can be used for self-study, lecture demonstration, lab activities, tutorial help or assignments.

If you are using M.E.D. on your own for self-study, be sure to check out the appendixes for important reference information, the "Book" feature for mapping M.E.D. to your particular textbook, and the "Theory" and "Solution" sections of M.E.D., which can really reinforce the steps and logic necessary for approaching various dynamics problems and help you develop intuition for solving them. A key feature of M.E.D. is the inclusion of robust simulations that allow the user to manipulate the physical situations described in the problems and see what is really happening.

If you are an instructor who is interested in using M.E.D., you should also check out the "Book" feature for mapping M.E.D. to the textbook you have adopted. This will help you integrate M.E.D. into your syllabus. You may want to require that students purchase personal copies of M.E.D., and/or stock your lab with copies of M.E.D. for self-study, tutorial sessions or assignments. You can also use M.E.D.'s animations and simulations in lecture demonstrations to help convey important concepts. Instructors are encouraged to participate in an on-line discussion group for M.E.D. users via our web site:

<http://www.awi.aw.com/new/med/usergroup/usergroup.html>

You can also contact us via email: [awi-info@aw.com](mailto:awi-info@aw.com).

M.E.D. combines the benefits of engineering theory, explanations, descriptive animations and tutorial material *with* powerful interactive simulations that illustrate the engineering concepts being taught.

### **M.E.D. Authors and Developers:**

Dr. Kurt Gramoll is a Professor of Aerospace Engineering at Georgia Institute of Technology. For a number of years, he has been involved with multimedia development and research on the use of multimedia products in education.

Rob Abbanat is an engineer, and president of Engineered Multimedia, a multimedia development company in Atlanta, Georgia, specializing in scientific and technical multimedia products for higher education. Engineered Multimedia was responsible for developing M.E.D.

### **AWI Partners:**

Knowledge Revolution is a software-development company in San Mateo, California, specializing in the development of software tools that model complex mechanical and physical systems. They produce and distribute two powerful, widely-used products: *Working Model* and *Interactive Physics*.

Working Model is a powerful modeling tool that can be used to create models of mechanical systems. Working Model was used to create most of M.E.D.'s interactive simulations and a special Working Model "player", included on this CD-ROM, is used to run these simulations.

### **For Additional Information:**

- You can contact AWI on e-mail ([awi-info@aw.com](mailto:awi-info@aw.com)). Use email to request specific information, to ask questions about M.E.D., to seek technical help using M.E.D., or to report a problem.
- If you have access to the world-wide web, you may find our web pages interesting and informative. This is a good place to find out what other multimedia offerings are available from Addison-Wesley Interactive. We are developing products in engineering, mathematics, physics, and astronomy. You will find guided tours to these products from time to time. You will also find web-pages that list technical information, helpful hints, and a place for requesting technical assistance or reporting a problem. Come spend some time with us and find out what we are up to: <http://www.aw.com/awi.html>.

## ***The M.E.D. CD-ROM***

M.F.D. comes equipped with all of the software that you will need to run it on your computer. M.E.D. will run on both Windows and Macintosh computers. Check the section on system requirements, listed below, to make sure that the computer you plan to use meets these requirements. In general, most recent multimedia computers will be able to run M.E.D..

### **The Contents of the M.E.D. CD-ROM:**

43 engineering dynamics activities with over 370 screens of information containing over 340 audio files, over 260 movies and animation files, and 38 simulations.

Runtime executable programs for the Macintosh and Windows platforms.

Working Model player from Knowledge Revolution. This version of Working Model allows you to work with the simulations included in M.E.D. This version of Working Model also allows you to open any simulation that has been created in Working Model, and allows you to create your own simulations (see the section on Working Model at the end of this booklet).

Apple's QuickTime system. This is used for M.E.D.'s audio and animations. A Windows version and a Macintosh version of the QuickTime player are on the CD-ROM. See the load instructions and refer to the README file for instructions on using this material.

## ***System Requirements for M.E.D.***

The minimum recommended computer configurations for Windows and Macintosh computers are listed below. As with most software, if your computer system is more powerful than these minimum requirements, you will enjoy better response time, faster transitions, smoother audio and movie playback, and faster running simulations. If your computer system has only the minimum requirements, the performance of this product will be good, as it was engineered to run on computers of this configuration. If your computer does not have the minimum

**Appendix 4:**  
**Engineering Mechanics Studio Classroom**  
**Textbooks and Videos**

Textbook:

*Vector Mechanics for Engineers: Statics and Dynamic*, F. P. Beer and E. R. Johnston Jr., McGraw-Hill, Sixth Edition, 1997.

Reference Textbooks:

1. *Engineering Mechanics: Statics and Dynamics*, Pytel and Kiusalaas, Brooks/Cole, Second Edition, 1999.
2. *Engineering Mechanics: Statics and Dynamics*, W. P. Riley and L. D. Sturges, Wiley, 1993.
3. *Engineering Mechanics: Statics and Dynamics*, J. L. Meriam and L. G. Kraige, Wiley, Third Edition, 1992.
4. *Engineering Mechanics: Statics and Dynamics*, B. I. Sandor, Prentice-Hall, Second Edition, 1987.
5. *Engineering Mechanics: Statics and Dynamics*, D. J. McGill and W. W. King, PWS-Kent, Second Edition, 1989.

Videos:

*Engineering Mechanical Concepts*, Multimedia Engineering

Figure 1

# Engineering Mechanics Studio Classroom

