



The GEARS-IDS™ 2005 Educator's Work Shop

More Engaging – More Engineering - More Educationaland lot's more Fun!

GEARS Educational Systems produce engineering education workshops throughout the United States. This coming summer we are pleased to offer 2 workshops in historic Plymouth, Massachusetts; Just 45 miles South of Boston, and 12 miles from the Cape Cod Canal!

The 4 day workshop July 11 - 14



These are hands on science and engineering workshops in which participating teachers use GEARS-IDS™ products to create exciting and engaging math, science and engineering programs for use in their particular classroom setting.

This document describes the educational objectives and topics covered in the GEARS-IDS™ 4 day workshop and includes a detailed schedule of the daily activities and topics covered in this workshop.

The Gow School Work Shop South Wales New York

Because the Plymouth workshop is centrally located between Boston and Cape Cod, participating teachers may elect to bring their families. For this reason we offer the following informational resources to help you better plan your time in Eastern Massachusetts.

Explore the links below for information on how you and your family can enjoy your time in Plymouth, Boston and Cape Cod Massachusetts:

[Information about what to see and do in Plymouth, Massachusetts](#)

[Information about what to see and do on Cape Cod](#)

[Information about what to see and do in Boston, Massachusetts](#)

[And remember the Red sox will be hosting the Yankees for a 4 day series at Fenway Park on July 14th through the 17th!](#)

For additional information including registration, workshop fees or travel and lodging, please call Mark Newby at the GEARS Educational Systems office in Norwell Massachusetts, 781 878 1512.

The GEARS-IDS™ Educators Work Shop Goals

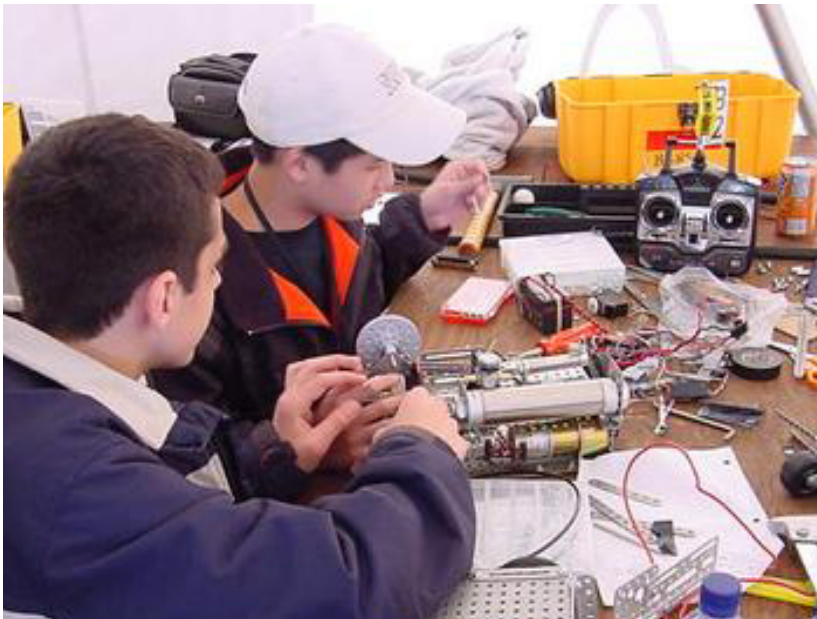
- **Create Engineering Challenges** and build radio controlled mechanisms and machines to meet the challenge using GEARS-IDS pneumatic, electronic, and mechanical components
- **Demonstrate** an exciting program of engaging activities by which students develop technical literacy and skills through team work, problem solving critical thinking, troubleshooting, communicating effectively, and managing projects.
- **Explain** how GEARS-IDS based activities support educational standards and objectives in Mathematics, Science and Technology.
- **Present** educational tools, resources and programs that allow students to demonstrate what they know and are able to do through participation in engineering based activities.
- **Give** participating instructors an educational resource that can be used as a stand alone program or as a math, science or engineering unit of study.



Dunwoody Institute Minneapolis Minnesota

Passion Enhances Learning

GEARS-IDS based programs and activities provide teachers and students with both the competitive excitement of sports and the academic empowerment and satisfaction that comes from knowing how to use science and mathematic skills to solve technical challenges.



Learn How Your Students Can:

- Work in teams to successfully design and building competitive mechanisms.
- Use accepted engineering methods and practices to invent solutions to technical problems.
- Use computer tools to organize, analyze and manage information.
- Visualize solutions using mathematical models and sophisticated graphic design tools.
- Learn and apply physical science concepts to predict the performance of their designs.
- Identify and use engineering components correctly and safely.

The GEARS-IDS Educators Work Shop 2005 Topics

College and high school teachers use the GEARS-IDS educational products to teach a wide variety of engineering skills and knowledge. The following lists offer examples of educational topics that can or will be covered in the GEARS-IDS Teacher Work Shop.

Academic Skills and Knowledge

- Creative Technical Writing/Presentation
- Organizational skills
- Electronic fundamentals
- Kinematics
- Units and measurement
- Work, power and energy
- Robot control
- Making and using spreadsheets
- Forces and motion
- The Process of engineering and design
- Engineering drawing
- 3D solid modeling
- Computer animation
- Algebraic Manipulations
- Geometry Basics
- Data Analysis
- Fluid Power/Pneumatics
- Simple Machines
- Basic Electronics



Career Skills and Knowledge (SCANS)

- Creative Thinking
- Exercise Leadership
- Integrity / Honesty
- Work with Diversity
- Self-management
- Identify Resources
- Procure Resources
- Allocates Resources
- Negotiate
- Apply Technology to a Task
- Research and Test
- Contribute to a Team
- Self-management
- Decision Making
- Interpret Information
- Maintain Technology
- Teach Others
- Accept Responsibility
- Serve Clients/Peers
- Monitor and Correct Performance

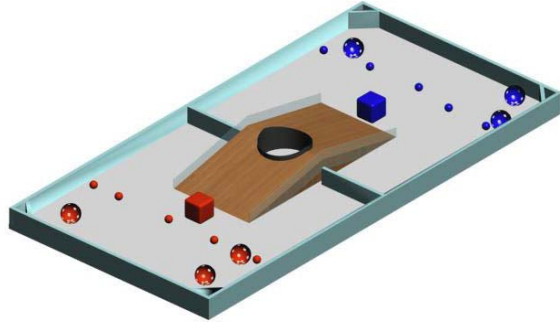
The GEARS-IDS Engineering Education Program of Activities

GEARS-IDS™ educators work shop participants will be given the instruction and resources necessary to offer these activities in their classrooms.

Engineering and Design

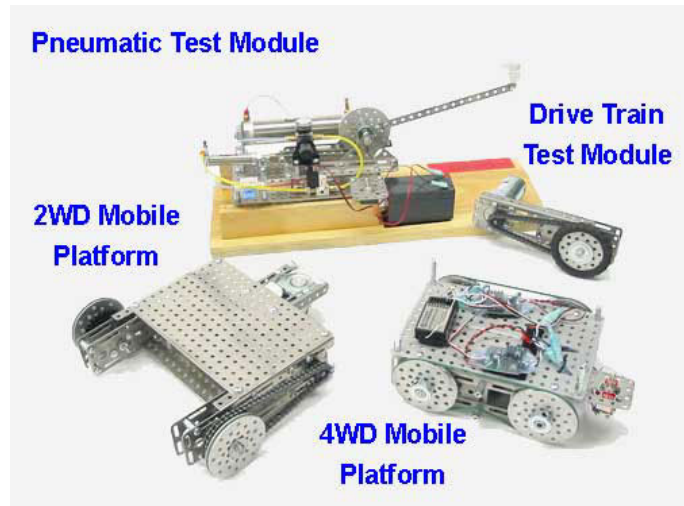
The application of the scientific method to the creative process.

- Participants use accepted design methods to “Brainstorm” designs for a mobile robot game and /or a robot to play a pre existing game.
- The **Five Budgets** design concept is explained and used to drive the design process.
- Competition rules and regulations are established.
- Game Playing Strategies are discussed
- The integration of components and subassemblies is explained.
- Visualization tools and techniques are demonstrated and used.
- Participants analyze and experiment with ideas, components, materials and processes.
- Various design methodologies are introduced.
- Sources of additional design information will be identified.



Scheduling and Organization

- Develop time lines, benchmarks and milestones.
- Milestones: Completion of the three major subassemblies; Mobile Platform, Active System, Control System
- Organize/inventory/maintain materials and supplies
- Use spread sheets to manage material costs and weights.
- Competition logistics will be discussed and responsibilities for designing and building the game field and equipment will be assigned.



Research

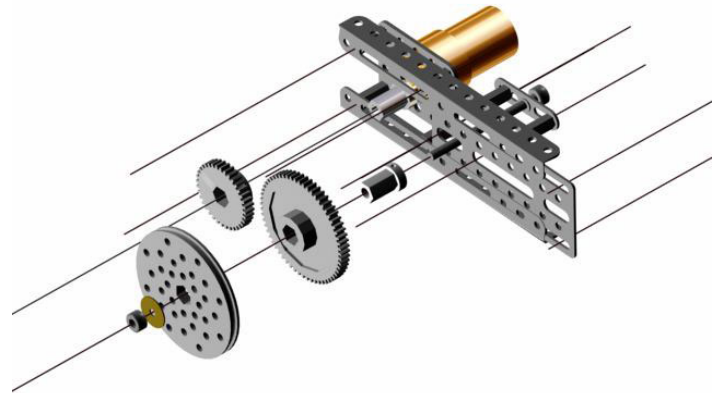
- Learn to identify and describe the operation and use of the GEARS-IDS™ engineering components.
- Determine the performance limits of the GEARS-IDS™ components such as motors, batteries and pneumatic actuators by building, testing and analyzing modules.
- Identify and use online [conversion calculators](#) to solve problems with “Mixed” Imperial, SI and Metric units.

Engineering Design and Communication

- Engineering drawing
- 3D parametric design
- Virtual prototyping
- Graphic analysis and spread sheets
- Techniques for classroom assessment and maintaining a journal will be discussed.

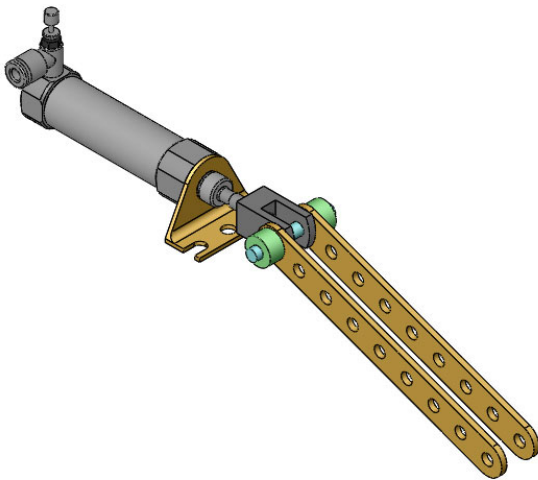
Motors and Magnetism

- DC motor theory of operation
- Torque
- Current, voltage and resistance
- DC motor analysis



Fluid Power and Pneumatics

- Force and pressure
- Boyles law
- Volume of gasses
- Analyzing mechanical systems
- Surface area and volume



Mechanics

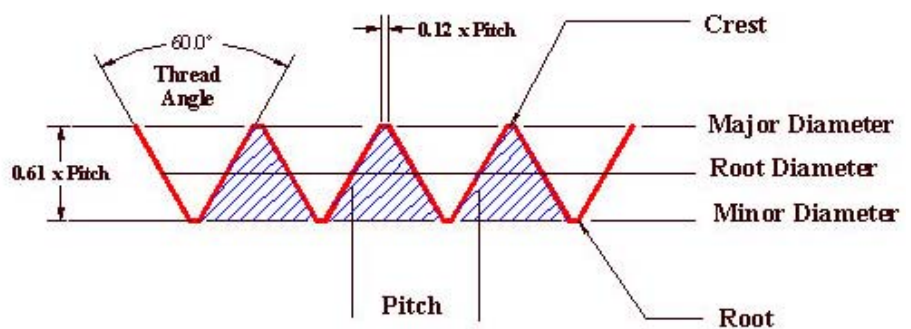
- Levers and linkages
- Material properties: Hardness, strength and elasticity
- Gearing and mechanical advantage
- Threaded fasteners
- Bearings
- Chain, gear and pulley drive systems

Electronic Control

- Basic Circuits
- PWM DC motor control
- Battery basics; Amp/hours, voltage and battery capacity
- Wire ampacities and wiring techniques.
- Using a Multimeter

Safety

- Establishing a safe culture.
- Battery safety
- Pneumatic safety
- Control safety
- Tool safety
- Fabrication safety



Thread Terminology

Unified National Screw Thread
UNC Inch Sizes

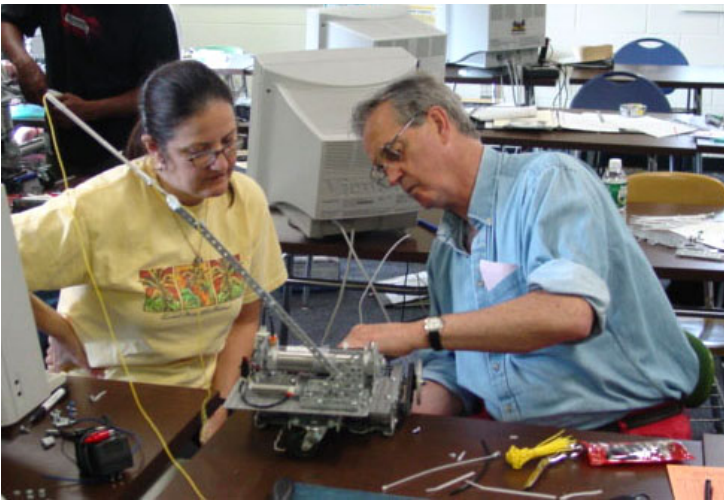
Related Math

- Measurement
- Algebra
- Geometry
- Trigonometry
- Spreadsheets

Acceleration Equation

An object's **Acceleration** is a function of the **Change in Velocity** (Δv) divided by the **corresponding change in time** (Δt)

$$\text{Acceleration} = \frac{\Delta v}{\Delta t} = \frac{(v_2 - v_1)}{(t_2 - t_1)}$$



Physical Science

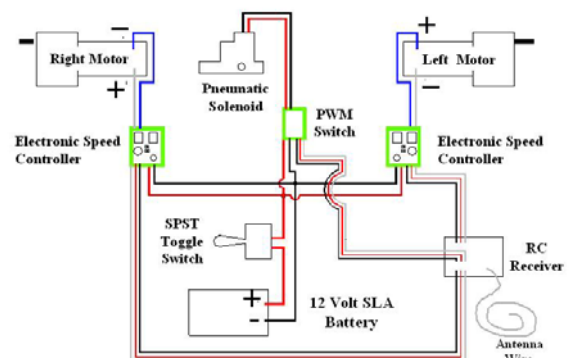
- Friction
- Mass and Motion
- Distance and Velocity
- Acceleration
- Energy, Work and Power
- Electricity
- Boyles Law
- Levers and simple machines
- Force and torque
- Matter and materials



Computer Science Applications

- Micro-controller applications
- Sensors
- Semi autonomous and autonomous operation

GEARS-IDS RC Control System Schematic



The GEARS-IDS Educators Work Shop

Daily Activities Schedule

Day 1

The Process of Design

1. Personal Introductions
2. Introductory Slide Show About the GEARS Program
3. Engineering is a team sport (Educational Strategies for having 2 – 10 students on a team)
4. The difference between components and modules.
5. The 5 Engineering Budgets: Money, Weight, Power, Time, Knowledge
6. The Process of Design The importance of examining and knowing your “Stuff”(Reviewing the GEARS-IDS catalog)
 - a. Developing Ideas Through Experience and Prototyping (Building Modules)
 - b. Virtual Prototyping (Sketching and solid models)
 - c. Hands on CADD Demonstration (Using the Software)
7. Introduction to the GEARS-IDS Kit and components. (Review the documentation)
8. Know the limitations. Rules and Regulations (Review the documentation and develop strategies)
9. Game playing strategies. Strategies determine what components and modules are to be used and how they will be used. This in turn defines what you need to know.
10. Designing or understanding the engineering game is a precursor to designing a machine to play the game. (Game Examples)
11. The Game Described (Teachers participate in making up the rules)
12. Demonstrate a game playing Robot.
13. Developing Ideas, Sketching and modeling (Present Game Ideas and “sell” or communicate them to the group. Remember to identify and use only available resources!)
14. Reaching Consensus on Ideas. (accept and/or develop a game)

Motors and Drive Trains

15. Analyzing and assessing motor torque and performance.
 - a. Electric motor theory and magnetism
 - b. Define torque...give examples.
 - c. Analyze a motor using GEARS Motor Test Stand, photo tach and scale.
 - d. Review GEARS-IDS™ Dynamometer Project.
16. Drive trains and gear ratios (Belts, pulleys, gears and chains) Refer to the GEARS drive train torque and speed spread sheet)
17. Weight distribution, stability and traction. Do some simple pulling tests with a model robot..introduce coefficient of friction. Where do you put the weight?
18. Designing and building a mobile chassis. (Using the GEARS-IDS™ Documentation build a drive system)
19. Speed vs force; Power is the limiting factor. (Batteries and Motors)

Day 2

Understanding the Battery

20. Analyzing and assessing battery capacity and performance. (One Light Bulb test using the GEARs Battery) 20 Hr. Ratings.
 - a. Use motor design information to approximate robot run time based on measured battery capacity.

Force, Pressure and Pneumatics

21. Introduce the 5 pneumatic components. Make and test a working system. Use GEARs-IDS project documentation.
22. Pneumatic forces, pressures and capacities of the GEARs-IDS™ system
23. Introduce the SMC CBL Module.

Levers, Linkages and Mechanical Systems

24. Levers and linkages. (Model and predict the performance of a pneumatic powered lever system.)
25. Build a Pneumatic Catapult. (Use GEARs Documentation)
26. Tracking Weights and Costs (GEARs-IDS™ documentation and spread sheet)

Day 3

Controlling the Machine

27. Control basics
 - a. Radio control essentials
 - b. Speed controllers
 - c. Valve controllers
28. Ampacities and Wiring Techniques
 - a. Wiring is the primary source of failure

Integrating the Components and Modules

29. Electro Mechanical Integration
 - a. Build and test a complete machine
30. Testing and modifying (Optimizing speed and traction)
31. Integrate the components and modules (Finish the day with a working machine)

Day 4

Game Day

32. Adjustments and revisions
33. The importance of practice time (We won't have any in this 4 day workshop)
34. Play the game
35. Disassemble and organize the equipment

The Wrap

36. Questions and debriefing