I Push!
You Push Back!

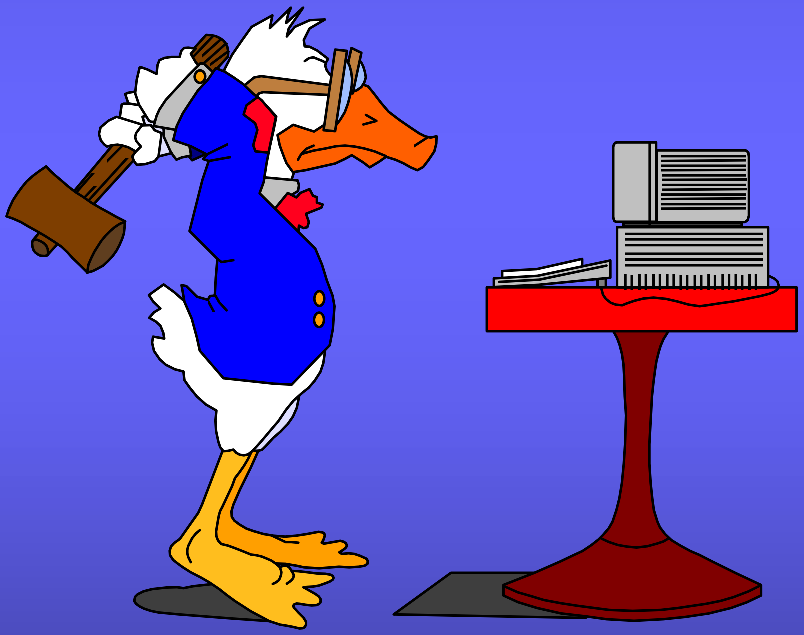
Dvora Geller
New York City Museum School

Ed Gruber
Eastchester High School

Denise McNamara
Health Professions High School

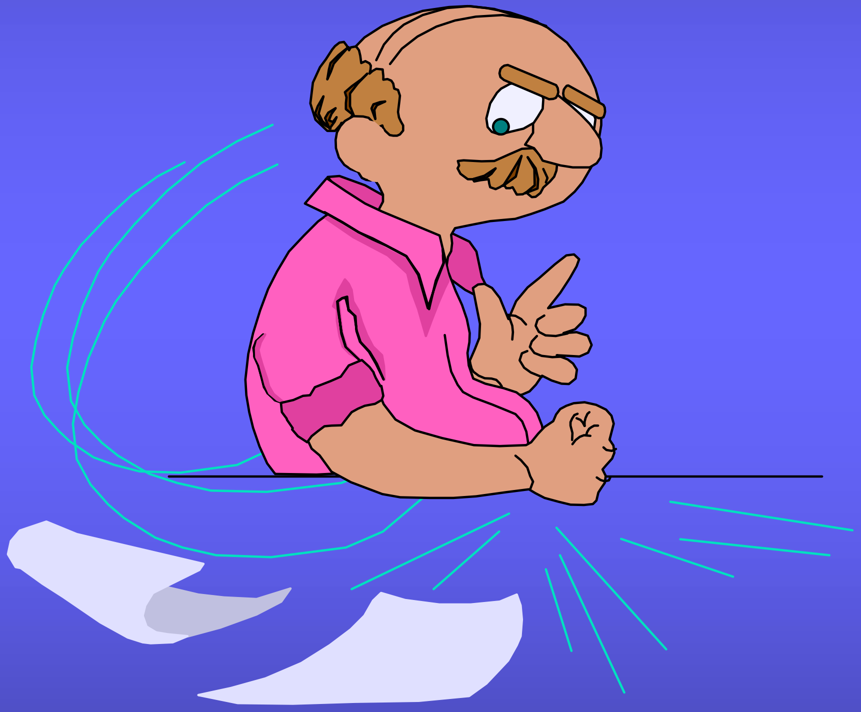
Solve this Question

Which of the objects in this picture is exerting more force, the hammer or the computer being struck by the hammer?



Newton’s Third Law of Motion

Newton’s Third Law states that for every action there is an equal in magnitude and opposite in direction reaction so the computer and the hammer in the previous slide, as well as the table and the arm in the picture to the right, exert equal forces on each other.



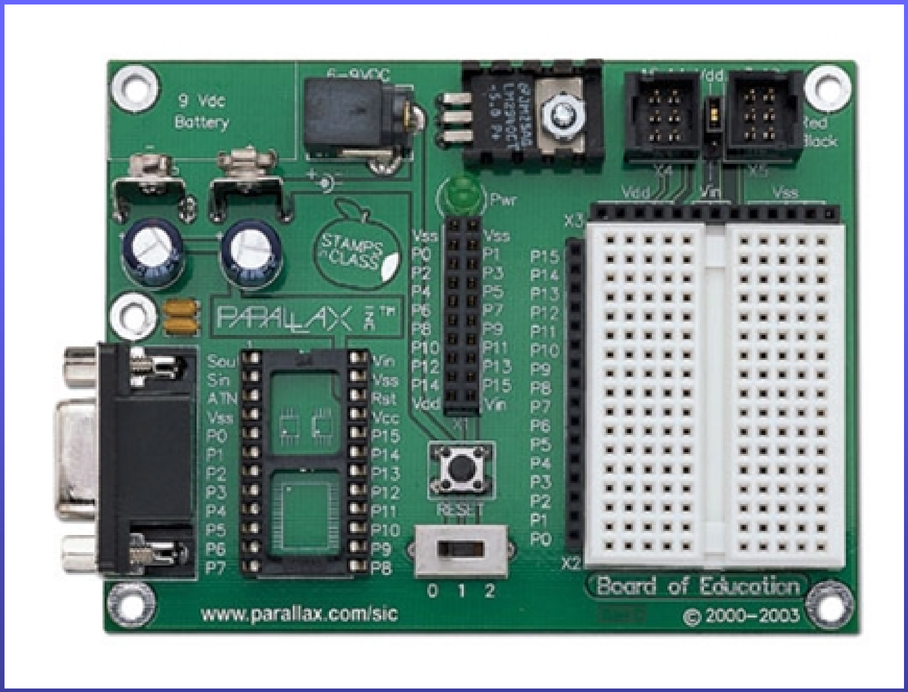
DESIGN OBJECTIVE

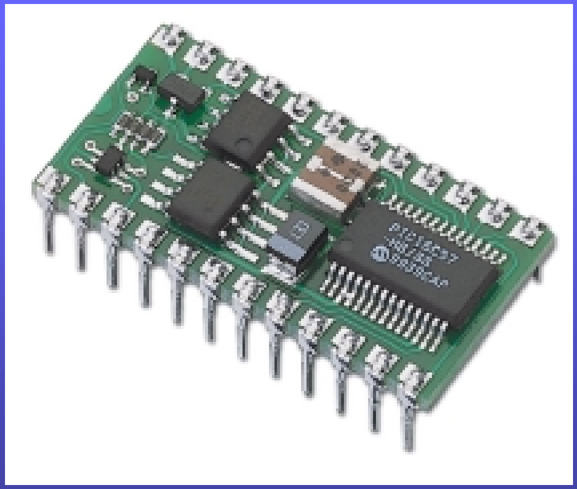
Our objective in creating this project was to prove Newton's Third Law of Motion through practical application. Both of the punch mitts have been wired with FlexiForce® sensors that are calibrated to read the force applied in Newtons. By having the students participate in the trials needed to prove this law, a hands-on experience will reinforce this basic concept.

PROJECT ELEMENTS

Board of Education & Basic Stamp 2

The combination of BOE & BS2 is the microcontroller used for this project.





FlexiForce® Sensors

The FlexiForce® Sensors are thin film single element force sensors that measure the force between two surfaces. The sensor acts as a variable resistor in the electrical circuit and is often used as part of an RCTime circuit.

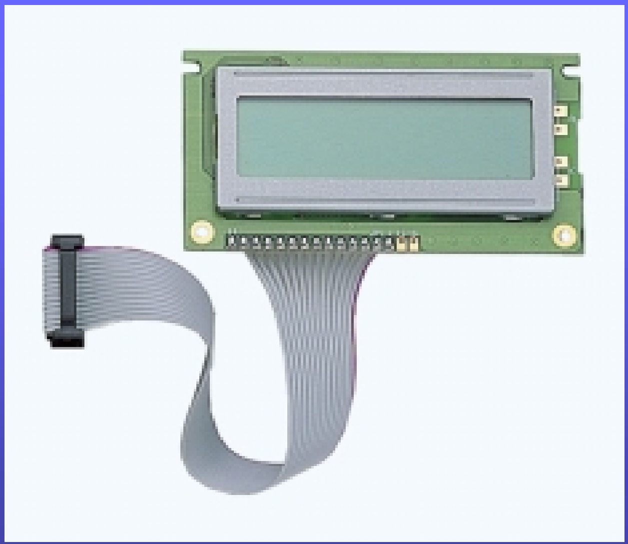
Punch Mitts

EVERLAST High Performance Punch Mitts
embedded with a FlexiForce® Sensor

Liquid Crystal Display

An LCD programmed to display each force in Newtons (N)

Giving a reading after a push has occurred.



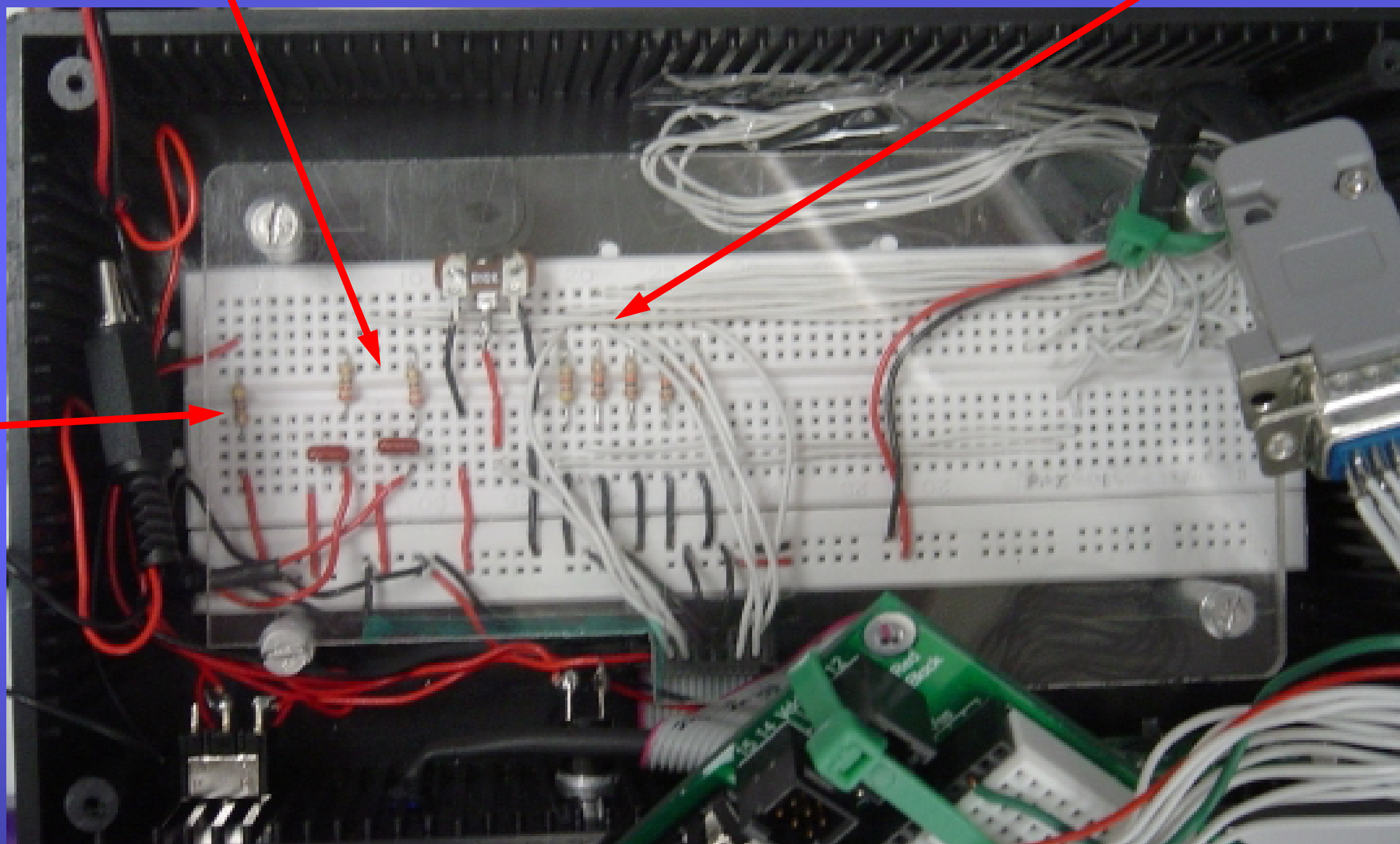
LED, Button and Switch

An LED, Button and Switch to indicate when the power is on, reset the screen for the next trial and to turn the system on/off, respectively.

NOTE: These will only work when the system is powered by the 9V battery lead inside the box.

The Project at Work

The Circuit



Program Logic

- Initialize program & LCD
- Check for use of force sensors
- After readings convert minimum RCTIME value to Newtons
- Output force or error message to LCD
- Restart if error is found

FlexiForce® Sensor Calibration

- Prototype 1 - Sensor inside mitt directly on pad
- Prototype 2 - 1/4”Plexiglas under the sensor nothing on top
- Prototype 3 - 1/4”Plexiglas under the sensor thin Aluminum plate on top
- Prototype 4 - 1/4”Plexiglas under the sensor Copper plate on top
- Prototype 5 - 1/8”Plexiglas under the sensor 1/8” Plexiglas on top

RESULTS

Out of 20 random trials performed by two people, the following was noted about the force readings:

- average difference = 2 N
- 3 readings showed sensors misaligned
- No significant difference as to which sensor read a higher reading

Out of 20 random trials performed by one person applying force with both mitts:

- average difference = 1.5 N
- 1 reading showed sensors misaligned
- larger hands tended to stretch the outer cover of the mitt

CONCLUSIONS

- Differences in force readings between the sensors attributed to:
  - Improper alignment of the sensors
  - Calibration assumed linear over a short range (30-120 N)
  - Unexpected levels of drift and hysteresis

Future Designs

- Future prototypes should address the alignment problem
- Use of a microcontroller that allows for calculations with floating decimals
- Research of custom designed force sensors

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