An Inexpensive Lab Timer that Enhances Student Learning

R. Carey Woodward, Jr.
University of Wisconsin—Fond du Lac

Motivation

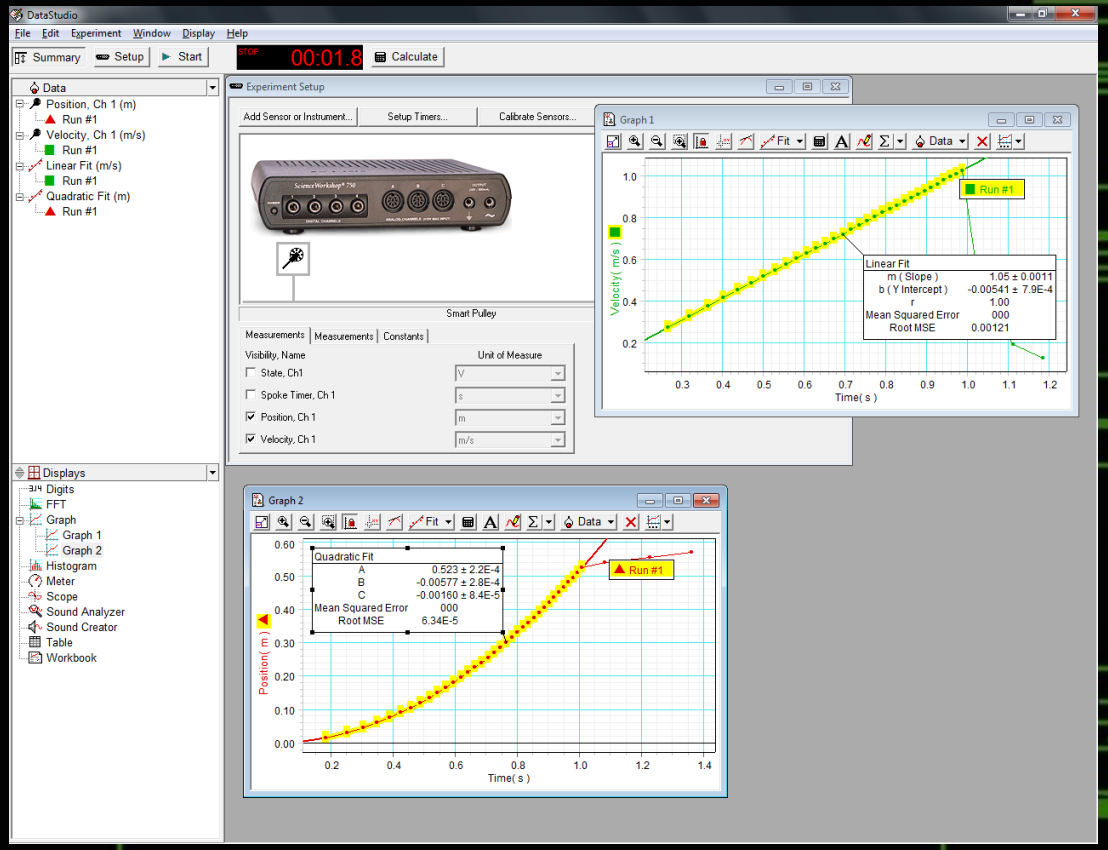
Question during Atwood lab: What is actually being measured? Some answers:

- Position?
- Velocity?
- Acceleration?
- Force?
- Energy?

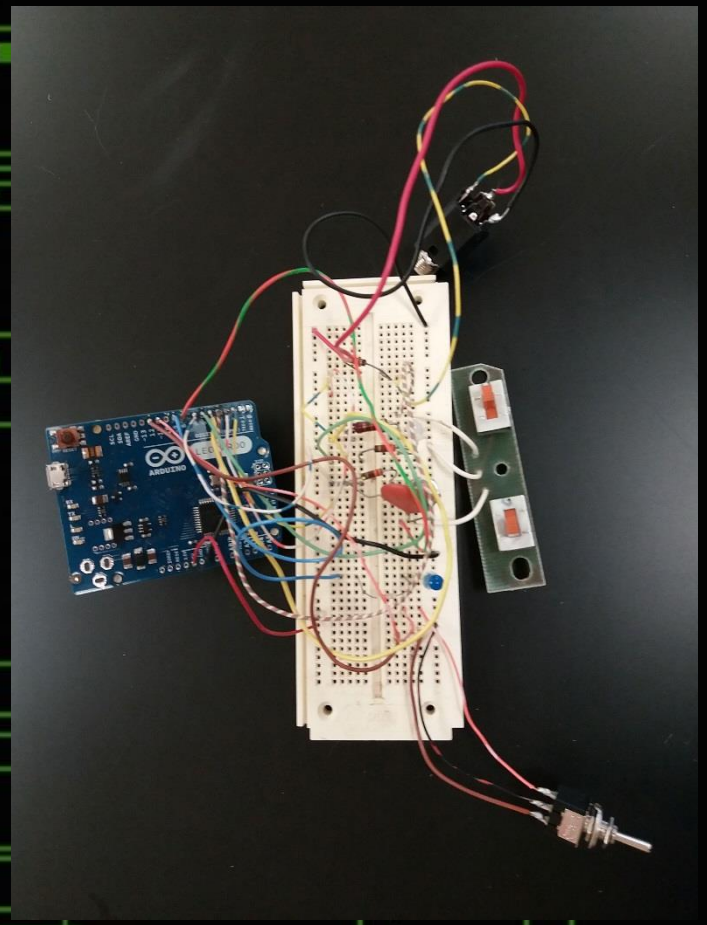
Look at the apparatus! Can only measure (and time) blocking and unblocking of beam.

A possible culprit

- The “easy to use” interface and software automatically computes position and velocity
- Even the pulley diameter and spoke number are built in



A possible solution:
An interface that only reports times



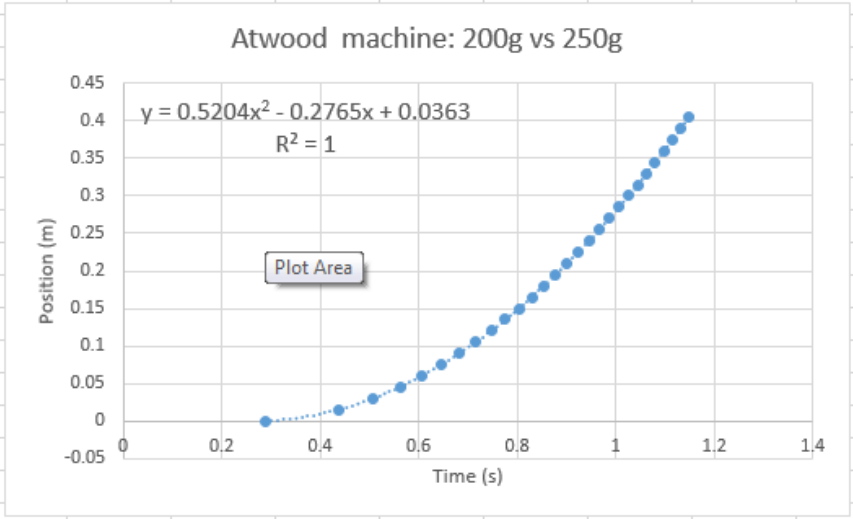
- Built around the Arduino Leonardo or Micro board with a few (?) support components
- Accepts Pasco and compatible digital sensors
- Looks like a USB keyboard to the computer
  → can use with Excel, Notepad, whatever

The interface reports "just the facts":

	A	B	C	D
1	Time (s)	Port	Transition	
2	0.28902	Jack 1	Rising	
3	0.438024	Jack 1	Rising	
4	0.50774	Jack 1	Rising	
5	0.561712	Jack 1	Rising	
6	0.607048	Jack 1	Rising	
7	0.64692	Jack 1	Rising	
8	0.68284	Jack 1	Rising	
9	0.715968	Jack 1	Rising	
10	0.74684	Jack 1	Rising	
11	0.775824	Jack 1	Rising	
12	0.803336	Jack 1	Rising	
13	0.8295	Jack 1	Rising	
14	0.854552	Jack 1	Rising	
15	0.878544	Jack 1	Rising	
16	0.90168	Jack 1	Rising	
17	0.924004	Jack 1	Rising	
18	0.945532	Jack 1	Rising	
19	0.966324	Jack 1	Rising	
20	0.986468	Jack 1	Rising	
21	1.006112	Jack 1	Rising	
22	1.025324	Jack 1	Rising	
23	1.044056	Jack 1	Rising	
24	1.062404	Jack 1	Rising	
25	1.080368	Jack 1	Rising	
26	1.097928	Jack 1	Rising	
27	1.115076	Jack 1	Rising	
28	1.132044	Jack 1	Rising	
29	1.1491	Jack 1	Rising	

It is up to the student (and instructor) to figure out how to determine acceleration, *etc.*

	A	B	C	D
1	Time (s)	Port	Transition	Position (m)
2	0.28902	Jack 1	Rising	0
3	0.438024	Jack 1	Rising	0.015
4	0.50774	Jack 1	Rising	0.03
5	0.561712	Jack 1	Rising	0.045
6	0.607048	Jack 1	Rising	0.06
7	0.64692	Jack 1	Rising	0.075
8	0.68284	Jack 1	Rising	0.09
9	0.715968	Jack 1	Rising	0.105
10	0.74684	Jack 1	Rising	0.12
11	0.775824	Jack 1	Rising	0.135
12	0.803336	Jack 1	Rising	0.15
13	0.8295	Jack 1	Rising	0.165
14	0.854552	Jack 1	Rising	0.18
15	0.878544	Jack 1	Rising	0.195
16	0.90168	Jack 1	Rising	0.21
17	0.924004	Jack 1	Rising	0.225
18	0.945532	Jack 1	Rising	0.24
19	0.966324	Jack 1	Rising	0.255
20	0.986468	Jack 1	Rising	0.27
21	1.006112	Jack 1	Rising	0.285
22	1.025324	Jack 1	Rising	0.3
23	1.044056	Jack 1	Rising	0.315
24	1.062404	Jack 1	Rising	0.33
25	1.080368	Jack 1	Rising	0.345
26	1.097928	Jack 1	Rising	0.36
27	1.115076	Jack 1	Rising	0.375
28	1.132044	Jack 1	Rising	0.39
29	1.1491	Jack 1	Rising	0.405



a = 2*0.5204 = 1.0408 m/s²

Other advantages

- Cheaper (if you don’t count your own labor): $50 *vs*. $600
- Easier and faster setup
- More precise timing: <10 µs *vs.* 100 µs
- Use your favorite analysis software
  - Something specific to the lab?
  - Something students will use in “real life”?

- Construction details at http://tinyurl.com/LabSplits

- Questions?