Video-Based Motion Analysis for Classroom & Homework

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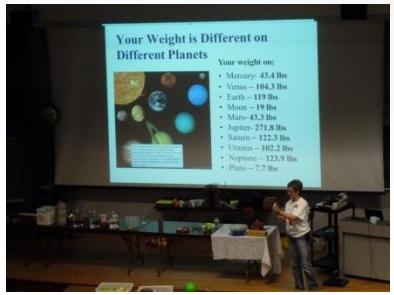
Catalyst 2011, October 21-22, 2011
British Columbia Science Teachers' Association





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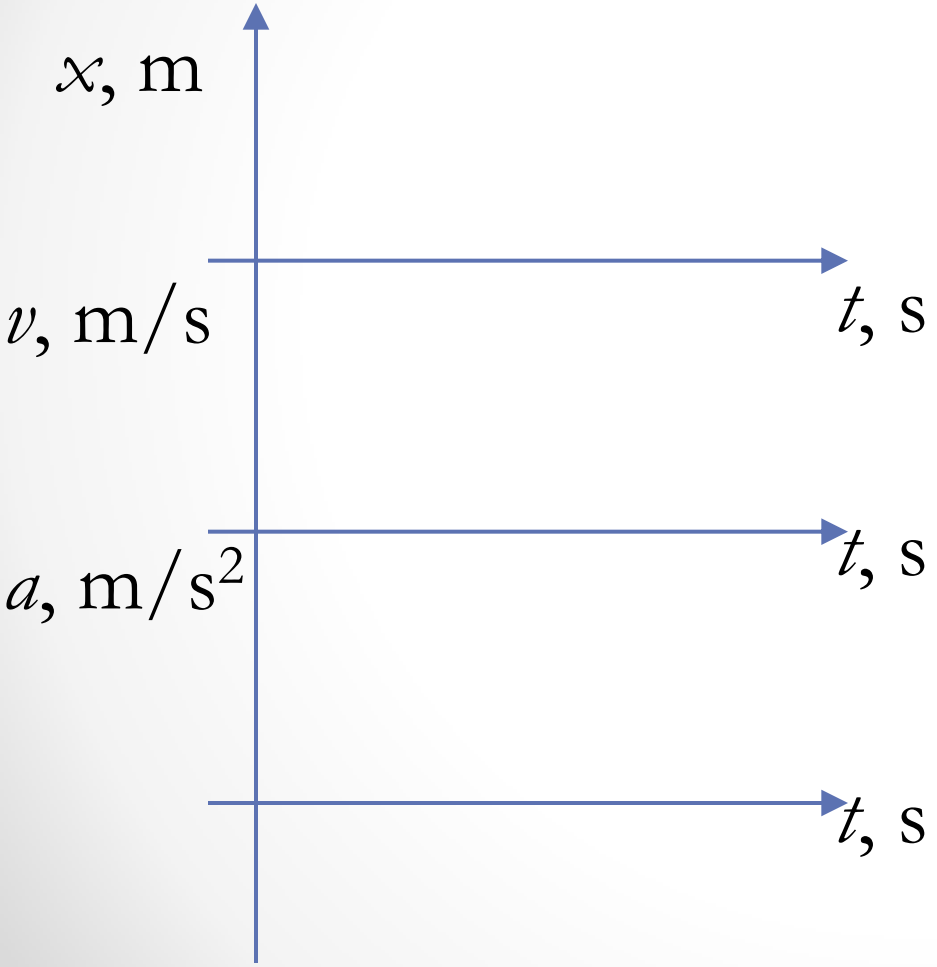
UBC 2011 Faculty of Education Math & Science Fair

- Saturday, November 5
- UBC Scarfe Building
- A fun science and math day for children and their parents
- Hands-on Science activities presented by UBC science and math educators and prospective teachers
- http://blogs.ubc.ca/mmilner/math-science-fair-2011/
- **FREE but RSVP is required**

Let Us Warm Up…

Consider a hot air balloon travelling upwards at a constant speed of *4 m/s*. A passenger drops a small sandbag over the side of the balloon. Produce the ***y(t)***, ***v(t)*** & ***a(t)*** stacked graphs for the sandbag after it has been released. Assume the positive *y* axis is directed upward and *y=0* at the ground.

Stacked Graphs:



How do you think high school physics students solve this problem? Where do they encounter difficulties? What are the causes of these difficulties?

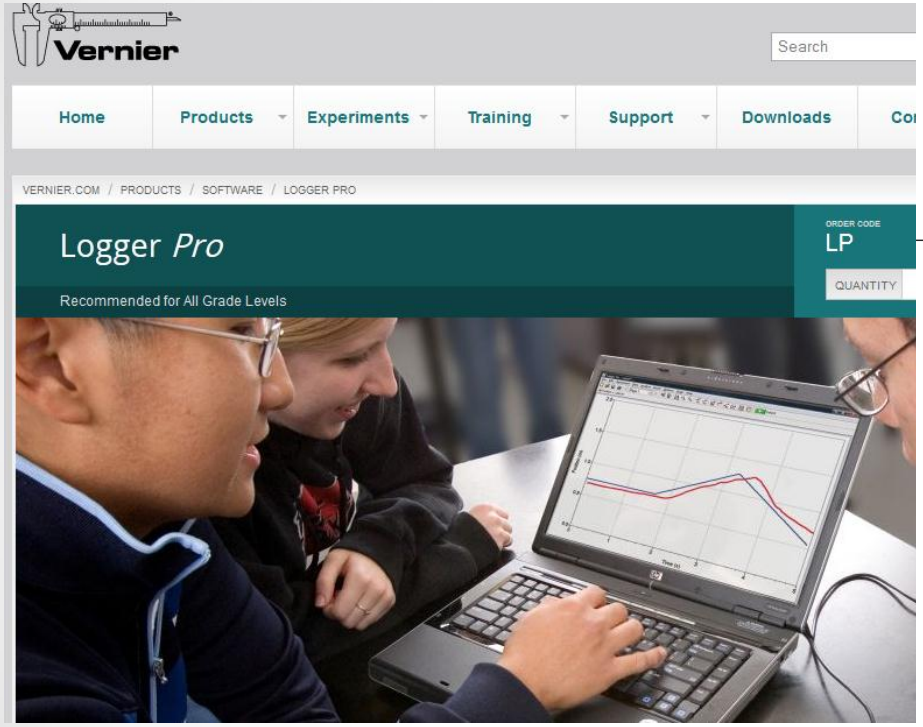
What is Video-Based Motion Analysis?

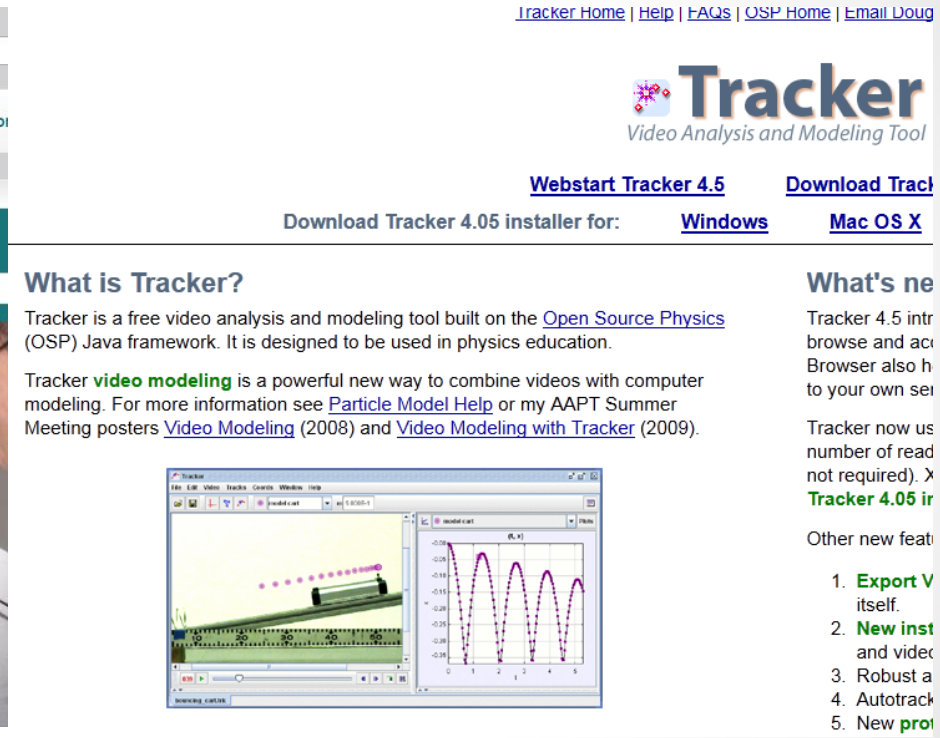
- Video Analysis (VA) allows to extract physical data from digitally recorded images
- Originally used for kinematics
- Any phenomenon where visible changes in the setup or in the device reading takes place can be studied using VA

Video Analysis

- **Recording:** Experiments or real-life events (i.e. roller-coaster rides, car races, falling objects) are video recorded, and uploaded on a computer.
- **Analysis:** Software (Logger *Pro*, Tracker, etc.) is used for motion analysis:
  - Time & position data are obtained from each frame
  - Then the data are analyzed using the software

Video Analysis Software





Vernier Logger Pro: www.vernier.com

Tracker – video analysis tool http://www.cabrillo.edu/~dbrown/tracker/

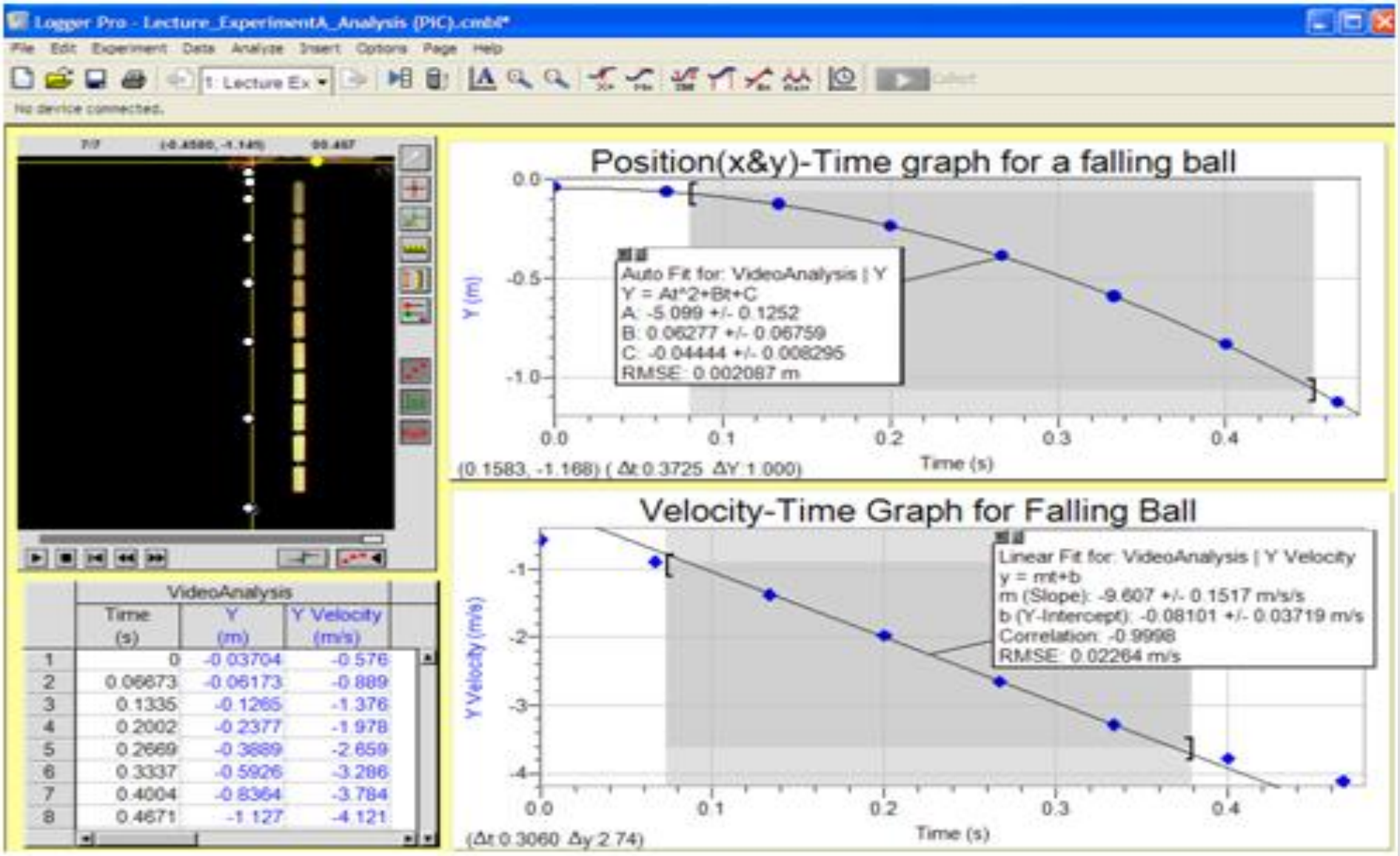
Equipment

- A **camcorder** or a webcam connected directly to the computer (to capture real-time event)
- Most modern digital cameras (including cell phone) allow recording of short video clips for later analysis

Advantages of Using VA

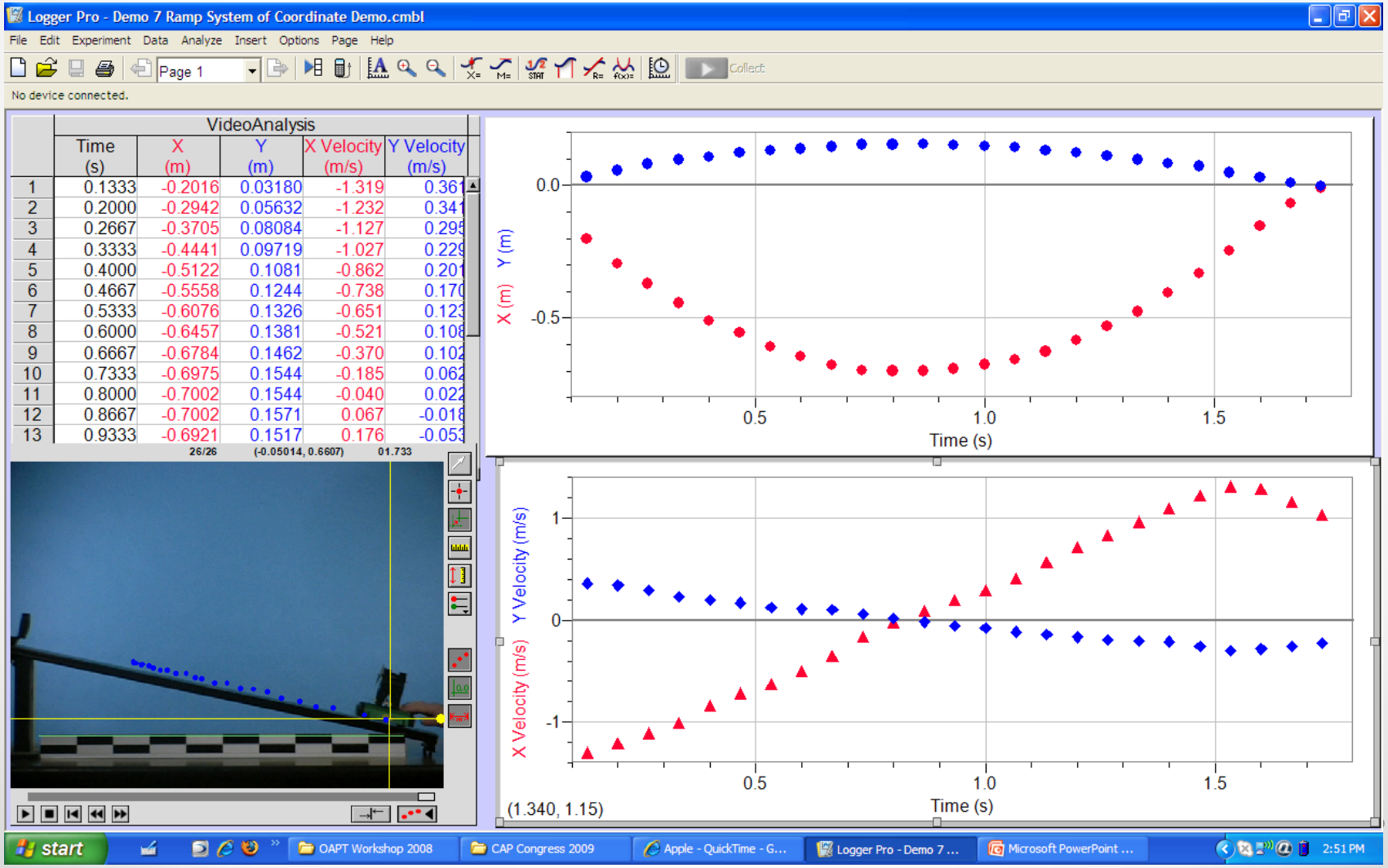
- Easy to learn: for both students and teachers
- Cost-effective alternative to live experiments
- Excellent for fast motion that is too fast for a naked eye
- Excellent to analyze events occurring outside of the classroom
- Has enormous potential to engage students
- Data for modeling that comes from real experiments (see Tracker resources)

Example 1: Free Fall

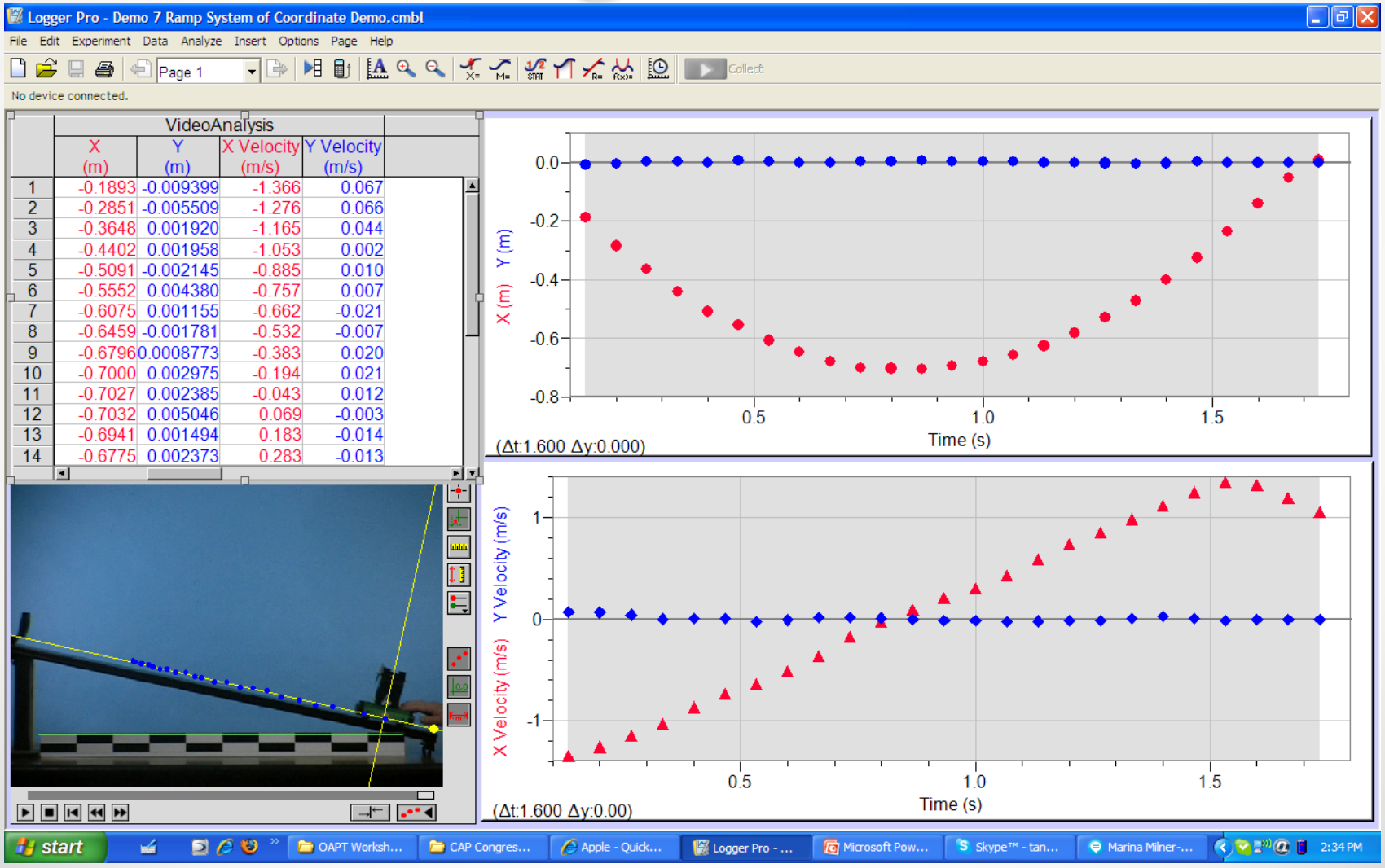


	VideoAnalysis		
	Time (s)	Y (m)	Y Velocity (m/s)
1	0	-0.03704	-0.576
2	0.06673	-0.06173	-0.889
3	0.1335	-0.1265	-1.376
4	0.2002	-0.2377	-1.978
5	0.2669	-0.3889	-2.659
6	0.3337	-0.5926	-3.286
7	0.4004	-0.8364	-3.784
8	0.4671	-1.127	-4.121

Example 2: Ramp (x - horizontal)



Example 3: Ramp (x - along the incline)



Example 4: A Curved-Track Demo

Question: Two metal balls are released from the top point simultaneously. Which one will finish first?

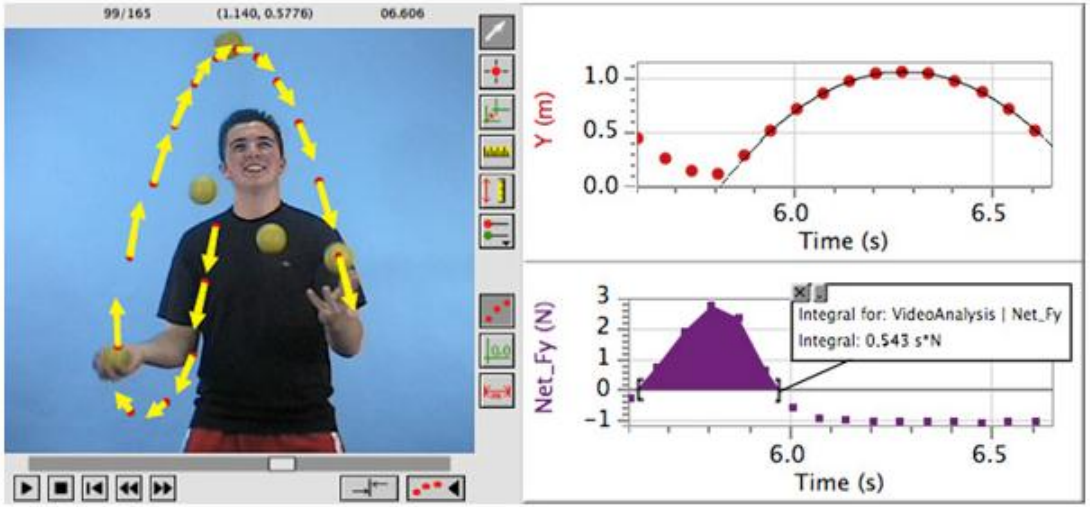
Example 5: Unsolicited Videos from Students

FREE Physics Movie Collection for Physics Teaching

LivePhoto Physics Project

LivePhoto Physics

Mechanics Videos | Other Videos | FAQ and Info | Workshops | LivePhot



Short videos, often just 20 to 30 frames in length, can be extremely useful in teaching physics and other sciences. Not still photographs, but too short to be considered movies, these "live photos" are designed for analysis in a computer. Positions of objects in the video frame can be measured by pointing a mouse and clicking. The data can be graphed, analyzed in spreadsheets, compared to theoretical models, and even used to display vectors or points superimposed on the original video.

LivePhoto Project Example

LivePhoto Physics

Mechanics Videos Other Videos

Loop Track

These clips show a steel ball rolling down a soft plastic track and into a vertical loop. The

To download a movie, right-click on the link and choose

Ball on Loop Track #1

Ball on Loop Track #2

Ball on Loop Track #3

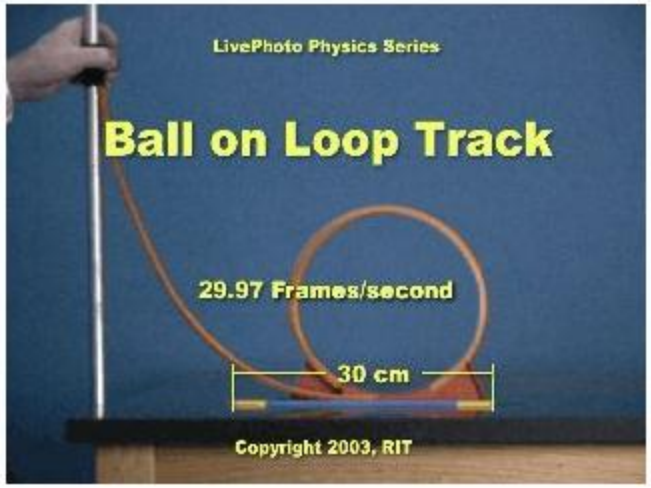
Ball on Loop Track #4

Ball on Loop Track #5

Ball on Loop Track #6

http://livephoto.rit.edu/LPVideos/loop/

Excellent movies to use for Video Analysis in your physics class



Special Thanks!

- Prof. Tetyana Antimirova, Ryerson University, Toronto Canada
- American Association of Physics Teachers' Colleagues who introduced me to Logger *Pro* and its amazing possibilities
- Vernier Technology – for excellent workshops and support
- Bob Teese, David Sokoloff, Ron Thornton, Maxine Willis and Priscilla Laws, for Video Analysis workshops
- BCAPT colleagues for their expertise and encouragement.

Resources:

- Vernier-Technology. (2011). Logger *Pro* (Version 3.8). Portland, Oregon: Vernier Technology.
- Brown, D. (2011, August 2011). Tracker: Open Source Physics Java Video Analysis. http://www.cabrillo.edu/~dbrown/tracker/
- Teese, R. (2009, March 2009). LivePhoto Physics Project http://livephoto.rit.edu/. http://livephoto.rit.edu/wiki/
- Cooney, P. J. (2009). Making Movies for Video-Based Motion Analysis. Retrieved March 25, 2009, from http://muweb.millersville.edu/~pjcooney/making-movies/