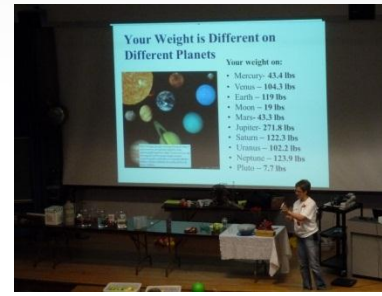


# Video-Based Motion Analysis for Classroom & Homework

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The University of British Columbia  
Vancouver, Canada*



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



Teaching for the future

# BC ASSOCIATION OF PHYSICS TEACHERS



American Association of **Physics Teachers**  
Enhancing the understanding and appreciation of physics through teaching

BC APT

Teaching for the future



American Association of **Physics Teachers**  
Enhancing the understanding and appreciation of physics through teaching

A screenshot of the BCAPT website homepage. The header includes the UBC logo, the tagline 'a place of mind', 'FACULTY OF EDUCATION', and 'BC ASSOCIATION OF PHYSICS TEACHERS'. A navigation bar contains links: BCAPT HOME, EVENTS/PRO-D, JOIN BCAPT &amp; AAPT!, AAPT, SPOTLIGHT, PHYSICS TEACHING RESOURCES, PHYSICS IN CANADA, and PHYSICS JOKES. The main content area features a large banner for 'AAPT2012' with the subtitle 'The Wave Nature of Light &amp; Matter'. Below the banner is a section titled 'AAPT Winter Meeting in Ontario, California!' with a 'Read More' button. To the right is a sidebar with a list of links under a minus sign icon: BCAPT Home, BCAPT Newsletters, About BCAPT, BCAPT Prizes and Awards, BCAPT Past Events, BCAPT Finances, BCAPT History, BCAPT Executive 2011-2012, BCAPT Reports to AAPT, Contact BCAPT, Financial Statements, Join BCAPT &amp; AAPT!, Events/Pro-D, AAPT, Spotlight, Physics Teaching Resources, and Physics Jokes. A small '1 / 10' indicator is visible between the banner and the sidebar.

[www.bcapt.ca](http://www.bcapt.ca)

# UBC 2011 Faculty of Education Math & Science Fair

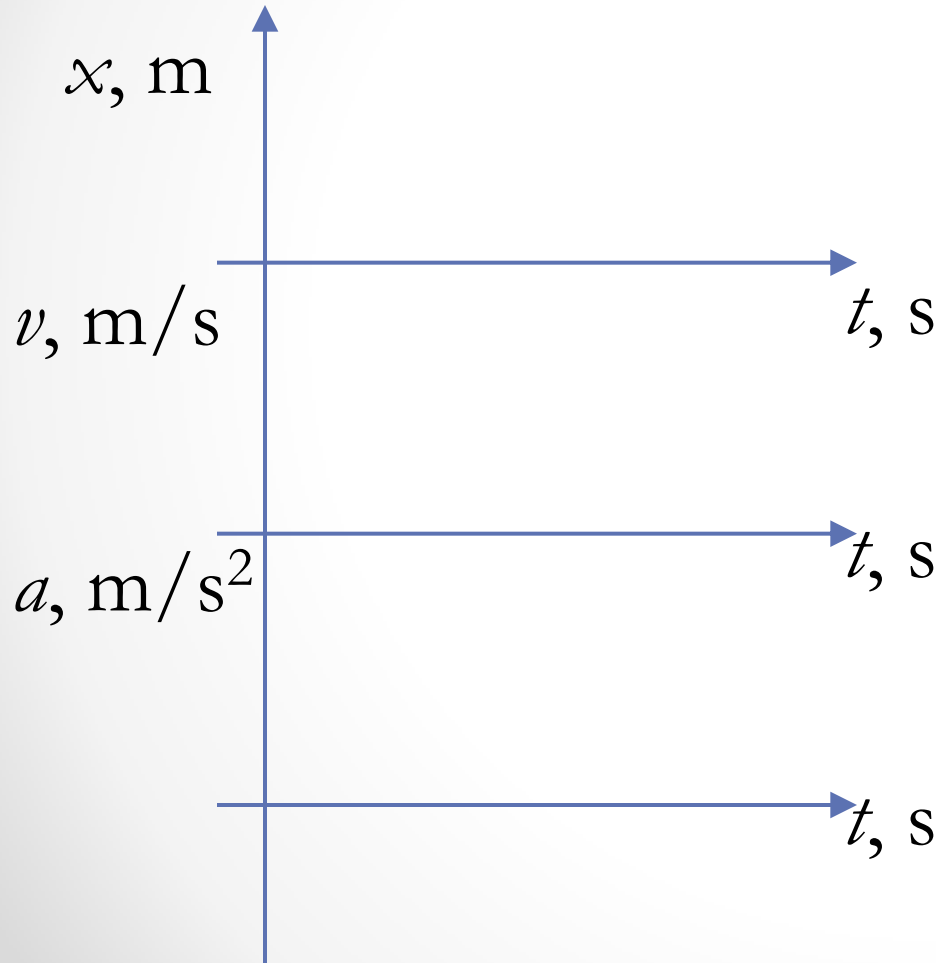
- Saturday, November 5
- UBC Scarfe Building
- A fun science and math day for children and their parents
- Hands-on Science activities presented by UBC science and math educators and prospective teachers
- <http://blogs.ubc.ca/mmilner/math-science-fair-2011/>
- **FREE but RSVP is required**

# Let Us Warm Up...

Consider a hot air balloon travelling upwards at a constant speed of  $4 \text{ m/s}$ . A passenger drops a small sandbag over the side of the balloon. Produce the  $\mathbf{y(t)}$ ,  $\mathbf{v(t)}$  &  $\mathbf{a(t)}$  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?

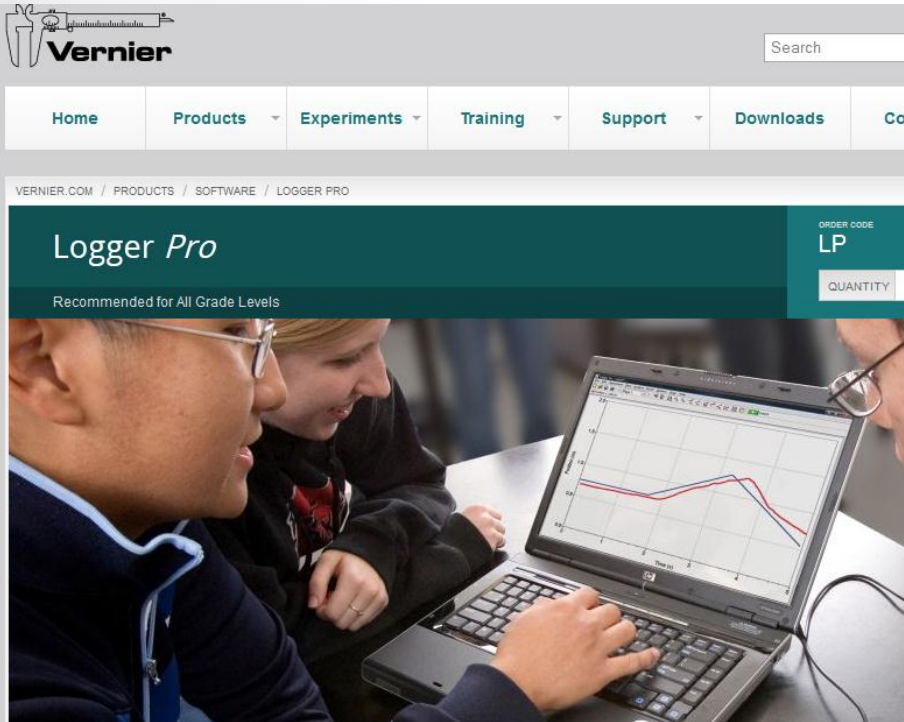
- Video Analysis (VA) allows to extract physical data from digitally recorded images
- Originally used for kinematics
- Any phenomenon where visible changes in the setup or in the device reading takes place can be studied using VA

# 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

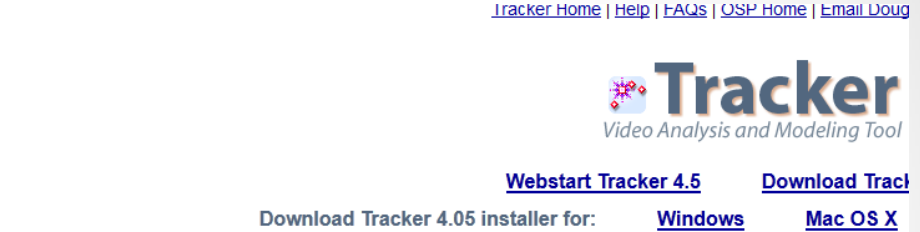


# Video Analysis Software



The image shows the Vernier Logger Pro software interface. At the top, there is a search bar and navigation links: Home, Products, Experiments, Training, Support, Downloads, and Contact. Below this, a breadcrumb trail reads: VERNIER.COM / PRODUCTS / SOFTWARE / LOGGER PRO. The main heading is "Logger Pro" with the subtext "Recommended for All Grade Levels". To the right, there is a section for "ORDER CODE LP" and a "QUANTITY" input field. The background of the interface features a photograph of two students, a boy and a girl, looking at a laptop screen. The laptop screen displays a graph with two data series, one in red and one in blue, plotted against time.

Vernier Logger Pro:  
[www.vernier.com](http://www.vernier.com)

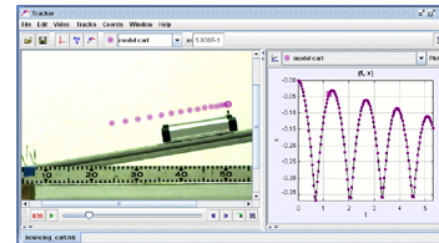


The image shows the Tracker software interface. At the top, there are links: Tracker Home, Help, FAQs, OSP Home, and Email Doug. The main heading is "Tracker" with the subtext "Video Analysis and Modeling Tool". Below this, there are links for "Webstart Tracker 4.5" and "Download Tracker 4.05". A section titled "Download Tracker 4.05 installer for:" has two options: "Windows" and "Mac OS X".

## What is Tracker?

Tracker is a free video analysis and modeling tool built on the [Open Source Physics](#) (OSP) Java framework. It is designed to be used in physics education.

Tracker **video modeling** is a powerful new way to combine videos with computer modeling. For more information see [Particle Model Help](#) or my AAPT Summer Meeting posters [Video Modeling](#) (2008) and [Video Modeling with Tracker](#) (2009).



## What's new

Tracker 4.5 introduces a new browser and a new browser also has a new feature to your own server.

Tracker now uses a new number of read (not required). X  
**Tracker 4.05 introduces**

Other new features

1. **Export V** itself.
2. **New inst** and video
3. Robust a
4. Autotrack
5. New **pro**

Tracker – video analysis tool

<http://www.cabrillo.edu/~dbrown/tracker/>

# Equipment

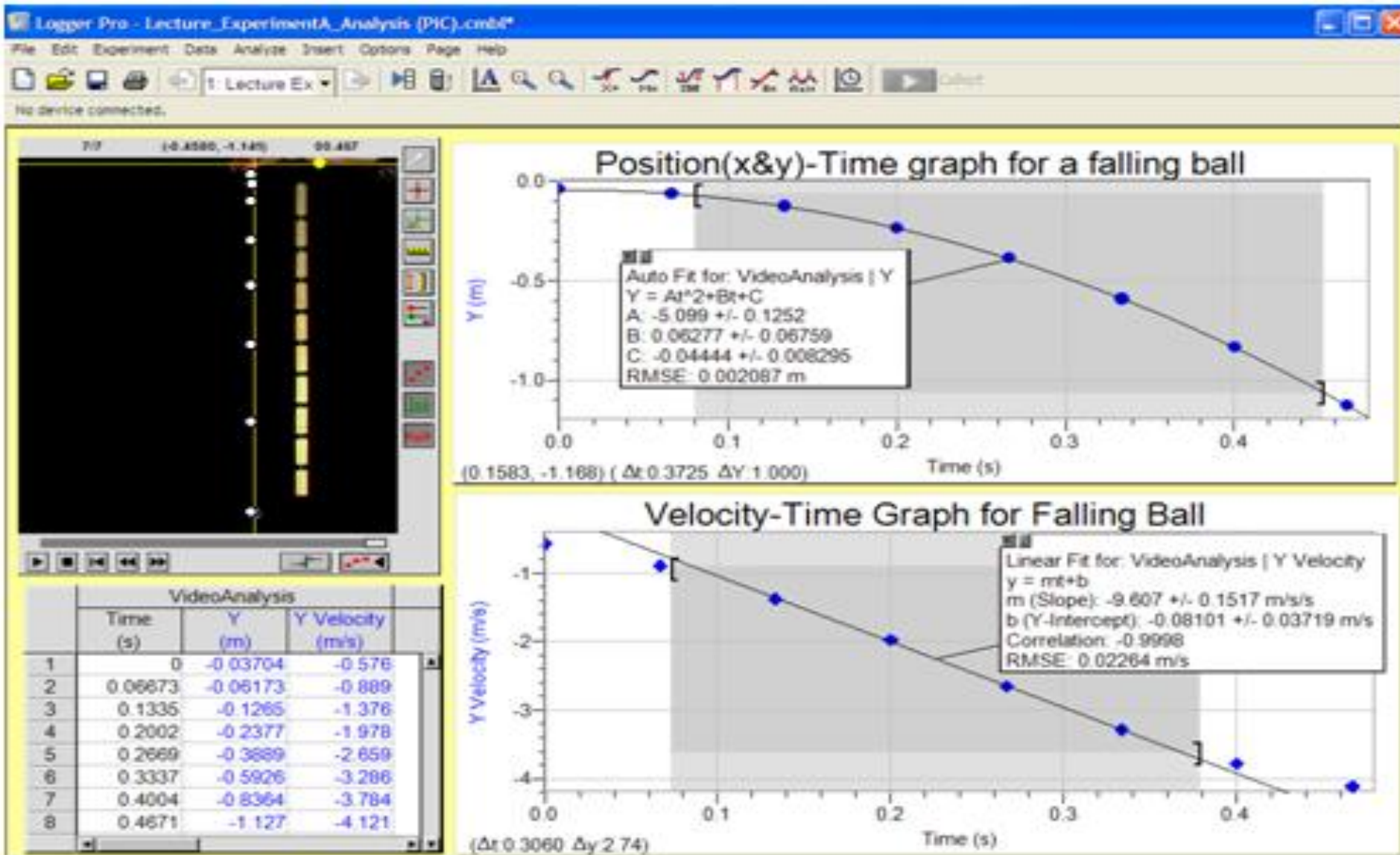
- A **camcorder** or a webcam connected directly to the computer (to capture real-time event)
- Most modern digital cameras (including cell phone) allow recording of short video clips for later analysis



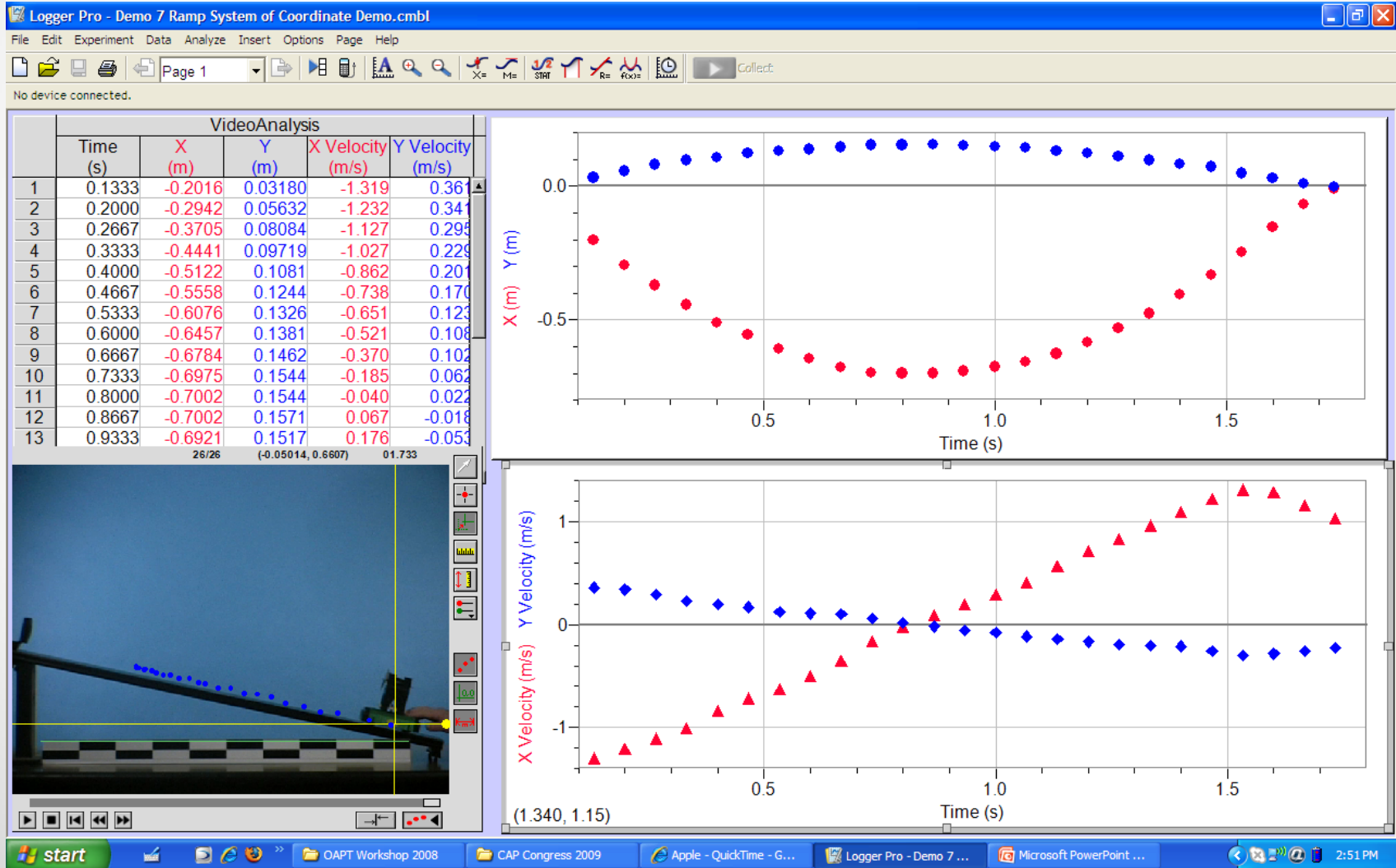
# Advantages of Using VA

- 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

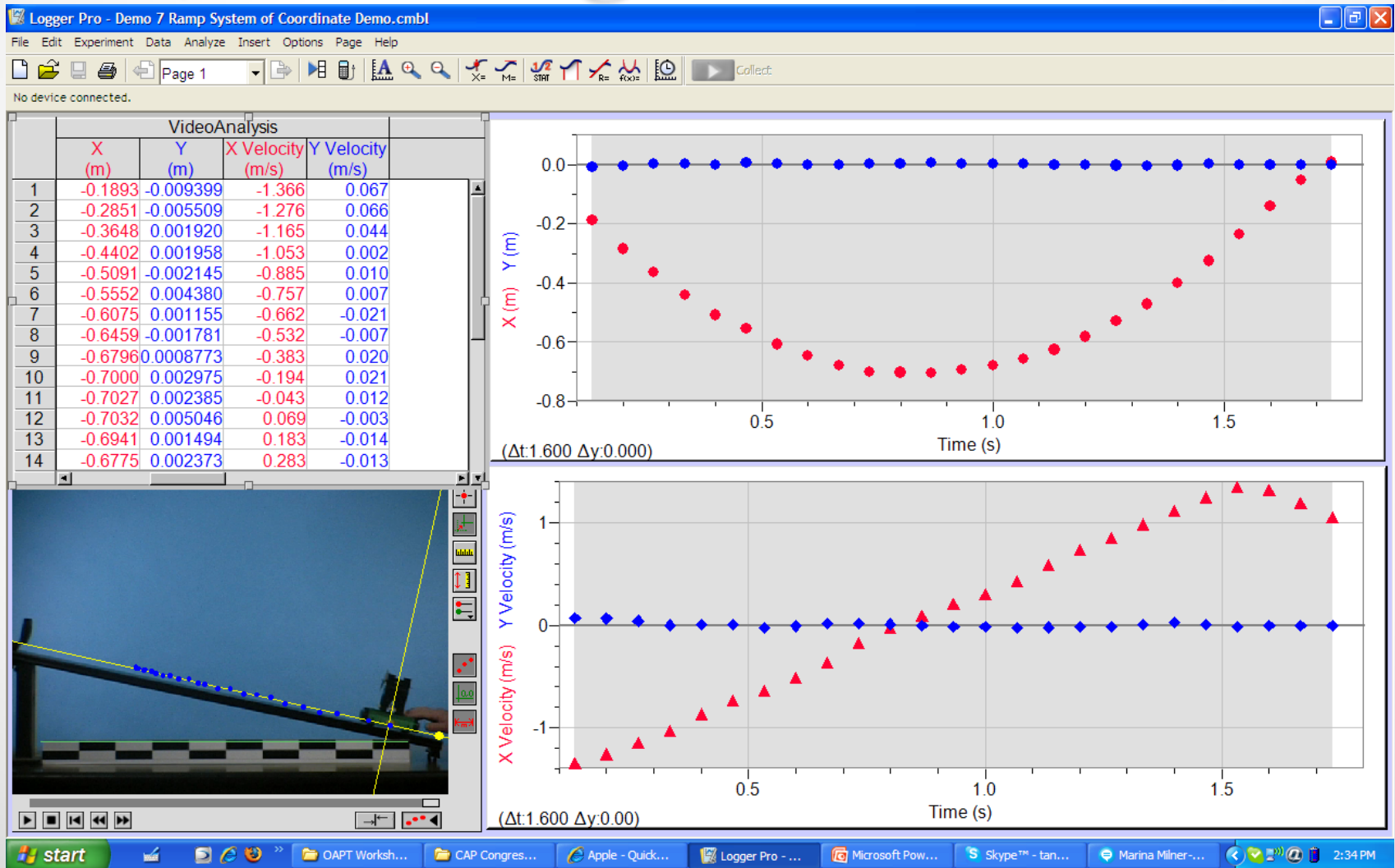


# Example 2: Ramp ( $x$ - horizontal)





# 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*

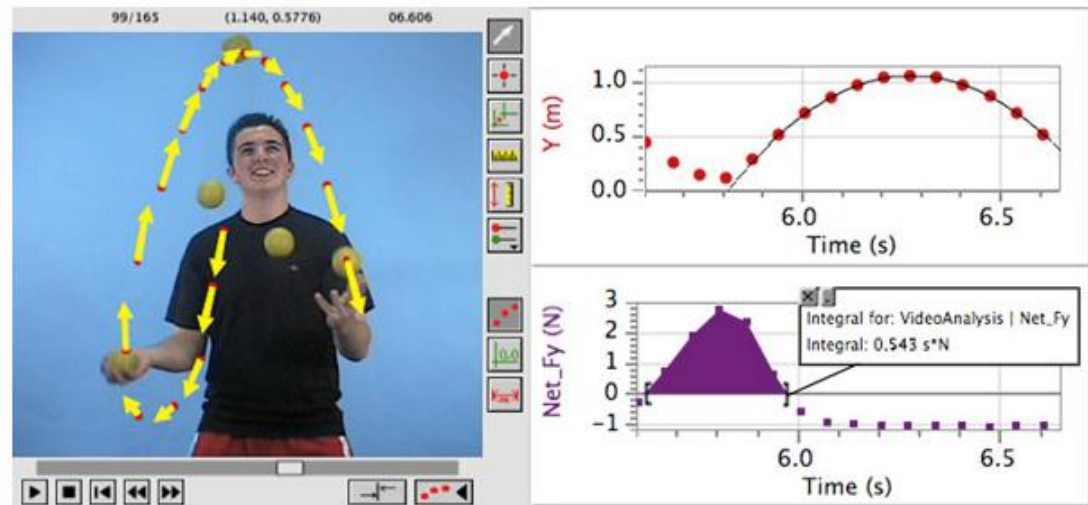
Mechanics Videos

Other Videos

FAQ and Info

Workshops

LivePhoto



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](#)

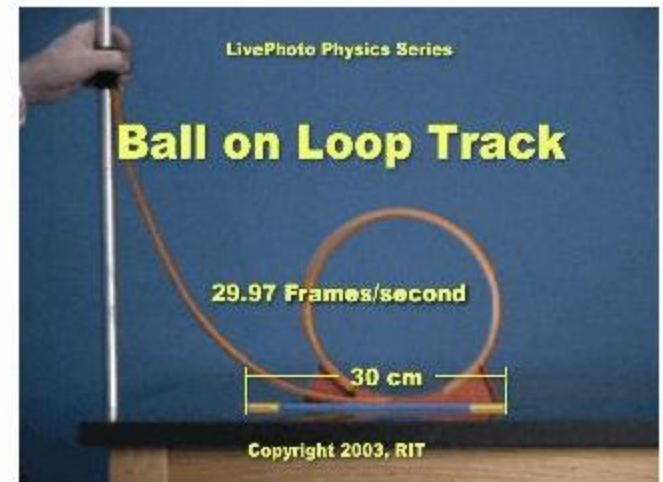
[Ball on Loop Track #4](#)

[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/>