

Laboratory 1 : Synch and Delay

To: R&D Team
From: James W. Bales
Date: 8 September 2005
Re: Synch and Delay
IM1-JWB

This R&D lab pioneered the *synch and delay* method of analyzing high-speed phenomena (you have all seen the milkdrop photo that the old-timers studied for our food-products division). Our production division pointed out about a dozen different places in the plant where this analysis technique may be of use.

It appears that a difficult part of synch and delay is triggering the strobe. I've seen references to optical triggers (sometimes called "beam-break" or "reflective" triggers), switch closure (or "contact") triggers, and audio triggers. I've also read reports that claim that it is important that the event be reproducible, but they did not quantify what they meant by this term.

I'd like your team to investigate the three different kinds of triggers, and report to me your findings. In particular:

1. Describe in detail the procedure used for each trigger.
2. State the reproducibility you found for each triggering method.
3. Present a series of photographs illustrating the process by which a balloon pops.
4. For each trigger method, describe an application where it might be the best choice.

Assignment

Take photos of a balloon as it is popping. Use these three triggering methods for your photos:

- Optical beam-break
- Sound
- Switch closure

Take five photos for each trigger method using a fixed time delay – one that gives an aesthetically pleasing result! Use the five exposures to bracket by half-stops to \pm one f/stop above and below the aperture predicted by the BCPS equation.

Demonstrate that you can map out the entire process from initial contact of the pin onto the rubber to the point where the balloon is essentially gone. I would expect that at least 3 to 5 different time delays are required. For each delay, bracket your exposures full stops, not half stops.

Your lab team should bring a print that one of you made to our regular meeting at 12:05 on Sept. 21 (Teams 1-3) or Sept. 23 (Teams 4-6).

Write up your results in a memo (a separate memo from each member of the team). Your memo should meet the four requirements listed above.

Pre-Laboratory Assignment

Complete the three questions at the end of this section before the first lab session. Your answers should be written into your notebook and ready to be handed in to the lab instructor.

Assume you have a strobe with a BCPS of 100, and that at a distance of one foot from the strobe, the hotspot is one foot in diameter. Your 35-mm camera (negative size is 36 mm by 24 mm) has a 50 mm lens and ASA 400 film. Your subject is a 12-inch-diameter balloon, and you want its image to almost fill the negative. What do you select for:

1. *The camera-to-subject distance*
2. *The strobe-to-subject distance*
3. *The aperture?*

Objectives

1. To determine the relative strengths and weaknesses of three methods for triggering strobes: optical beam-break, audio, and switch contact.
2. To map out the process by which a balloon pops

Deliverables

The deliverable for this effort is a report that will

1. Provide the background that the reader needs to understand
 - a. What is meant by "synch and delay"
 - b. How the three triggering methods work
2. A detailed procedure (with set up diagrams and/or photos and a list of equipment used) that would allow a reasonably skilled researcher to re-create your experiments
3. Characteristic images of a balloon popping.
 - a. For each of the three trigger methods, five images will be included, all taken with the same delay setting, intended to show the reproducibility (or lack thereof) for that process. The images will have different exposures, as different aperture settings will be used.
 - b. A sequence of three to five images of the process of a balloon popping, taken with different delays, but using the same triggering method.
4. A discussion of the relative merits of the three methods, with examples where each might be the best choice.
5. Recommendations as to when to choose one method over the other, and of ways to improve the results of the experiment if it were done again

Process

Take a series of pictures of balloons as the pop using all three triggering methods describe above. To test the reproducibility of the images, for each trigger take five images at the same delay setting. Use these images to bracket the aperture about that predicted by the BCPS equation. Then, pick one triggering method and take a sequence of images with different delays (three to five images should suffice) mapping out the process of the balloon popping. Take complete lab notes, and use those notes and the images above in preparing the report.

Partial Procedure

Setup for optical beam break triggering

Set up the Woods Electronics Shutter Beam as an optical beam break. Align the beam and use the system to trigger a flash from the Strobolume. Change the settings so the unit works as an audio trigger and use it to flash the strobe. Demonstrate that you can vary the delay between the trigger and the flash using the delay knob on the Strobolume.

Setup to measure delay

Connect the oscilloscope to the shutter-beam to capture when the trigger occurs. Connect the vacuum photocell to the oscilloscope, and use it to capture when the Strobolume flashes. Demonstrate that you can measure the delay with the oscilloscope.

Setup the apparatus and the scene

Set up the apparatus for popping balloons. Consider the background behind the balloon and the angle of illumination relative to both the point where the balloon will be punctured and the direction from which the camera is viewing the subject.

Take images with beam-break trigger

Using the beam-break trigger, take 5 images of balloons popping with the same delay setting, but 5 different aperture settings, bracketing by half-stops to \pm one f/stop above and below the aperture predicted by the BCPS equation

Take images with audio trigger

Repeat step 5 using the audio trigger to trigger the strobe.

Take images with audio trigger

Repeat step 5 using a switch closure to trigger the strobe. (You can connect your switch directly to the Strobolume, removing the Wood's Electronics unit from the circuit.)

Map out the process of a balloon popping

Select one triggering method and map out the process by which the balloon pops. Since you don't know *a priori* the right delay, try this approach:

- a) Start with the delay you used before and double it.
- b) If the balloon is gone, split the difference between the original delay and the most recent delay (e.g., started with $500\ \mu\text{s}$, but at $1\ \text{ms}$, the balloon is gone so drop back to $750\ \mu\text{s}$).
- c) If the balloon is still popping, then double the time step (e.g., started with $500\ \mu\text{s}$, but at $1\ \text{ms}$, the balloon is still popping so go to $2.0\ \text{ms}$).
- d) Repeat b) or c) until you have a sequence of images of the event.

Don't forget to bracket your shots - you need not take 5 shots per delay, 3 shots per delay will suffice (bracket up and down by one full f-stop).

Document your work

Document your work carefully, include a table of photos taken, measurements of all distances for your set-up diagrams. We recommend that you take photos of the set-up for your report - use the FM-10 to take those images, log them in your notebook, and make the prints as you would any other images for your lab work.