

# Slowing things down with **high-speed** cameras

It can be tough to see what's going wrong with an assembly line throwing 500 perfectly good products on the floor every minute or on pieces of equipment carrying out 250 assembly processes a minute, half of them defective. But slow down the line and equipment to a virtual crawl and the fatal flaw becomes obvious. And one way to effectively slow things down is to film the action at full speed and play it back at a slower speed. This usually means buying a camera capable of acquiring hundreds of images per second.

Here's some advice on buying the right camera from three experts in the field, Bob Sharp of **Southern Visions**

**Systems**, Grant Reig of **Olympus NDT**, and Rick Robinson of **Ametek**.

## The basics

There are lots of high-speed cameras on the market and they vary in complexity and cost. Which one's right for the job depends on several factors. They include:

- ▶ Frame rate (fps) or speed, which should be high enough to slow action so that it can be analyzed and eliminate blurring.
- ▶ Resolution should be high enough to see details in the images.



High-speed photography can freeze time, letting engineers see what is going on when a golf club hits a golf ball, a cartridge ejects from a pistol, or a knife slices through an orange. These images were taken with cameras from Southern Vision Systems or Vision Research, an Ametek Co.



#### WHAT'S THIS?

When you see a code like this, take a photo of it with your smart phone (iPhone 3G-S gives best results) and, using software from [www.neoreader.com](http://www.neoreader.com), you will be connected to relevant content on [machedesign.com](http://machedesign.com)

Got problems? A 500 frames-per-second video could help troubleshoot seemingly impenetrable design issues.

- ▶ Light sensitivity should be high enough to minimize the need for supplemental lighting. (ISO-12232 is the ISO spec for measuring digital-camera light sensitivity.)
  - ▶ Flexibility that lets operators switch to appropriate lenses.
  - ▶ Degree of portability, usually a combination of size, weight, and power source
- Three of these factors — speed, resolution, and light sensitivity — are interrelated, says Robinson. “And it is hard to develop a camera with a high degree of all three. For example, as resolution rises, pixel size drops (for a given lens). And with smaller pixels, the area available to acquire light or light sensitivity goes down. But with more resolution, there are more pixels to manage and speed therefore goes down.”
- So users should think about how they intend to use the camera before going shopping for one.

Authored by:

#### Stephen J. Mraz

Senior Editor  
[stephen.mraz@penton.com](mailto:stephen.mraz@penton.com)

#### Resources:

**Olympus NDT,**  
[www.olympus-ims.com](http://www.olympus-ims.com)

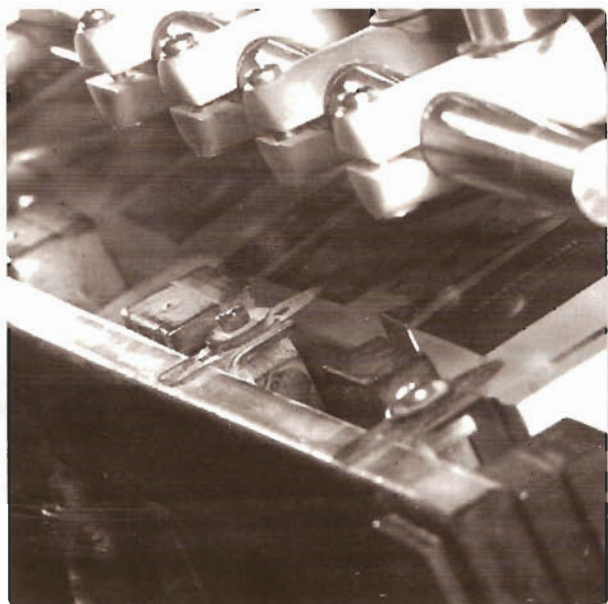
**Southern Vision Systems Inc.,**  
[www.southernvisionsystems.com](http://www.southernvisionsystems.com)

Watch several high-speed images from this company at <http://tiny.cc/6MTao>

The Gallery at this site leads to a list of high-speed videos

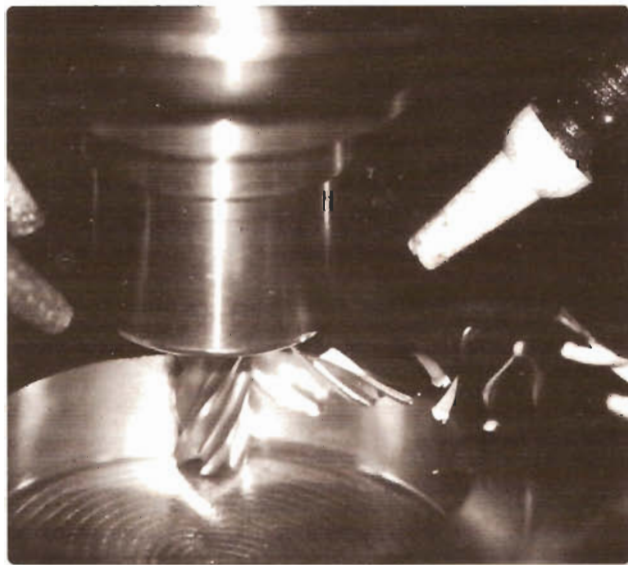
**Vision Research,**  
[www.visionresearch.com](http://www.visionresearch.com)

See dozens off high-speed videos from Vision Research at <http://tiny.cc/xFyua>



**This image from a Vision Research video camera shows the pickups that move up to 10,000 sheets/hr in an offset printer. The video, shot at 1,000 fps with 900- $\mu$ sec exposures and 8-bit image pixel depth, helped uncover the cause of paper jams.**

**This still shot, a 50- $\mu$ sec exposure taken with an Vision Research video camera running at 4,000 fps with an 8-bit image pixel depth, shows an end mill running in 1018 steel at 9,600 rpm and moving at over 200 ipm. Such videos are used to detect flaws in controlled-chip-size milling and to verify performance of the cutting tools, tool holder, and other hardware.**



Relatively low-end cameras, those with frame rates of 1,000 fps or less, should cost about \$15,000," says Reig. "But specialized data collection to go with the video or software to process and extract data from the video will add costs."

Robinson pegs the cost of a low-end camera a bit lower at \$10,000, while Sharp points to his company's Stream-View LR camera which comes in at around \$6,000. But all agree that costs go up from there depending on resolution, speed, and data storage you want.

### Standards and training

When it comes to video standards, Robinson suggests

## Common camera mistakes

**Avoid the blur:** Bob Sharp points out that troubleshooting with high-speed cameras relies on clearly seeing details in each frame, which means no motion blur. Blur stems from shutter speeds too slow to freeze all motion. "Even at 500 fps and using the default shutter speed of  $1/500$ th of a second won't guarantee a sharp image. We recommend shutter speeds of  $1/2,000$ th of a second or faster for crisp, sharp images," he says.

But be careful what you wish for. If you film at 500 fps and need to examine 5 sec of video, you must step frame-by-frame through 2,500 images. Set the resolution too high and you will have too many images to really study.

Robinson concurs, pointing out that unnecessarily high frame rates lead to larger files, too much data, and an extra load on computer memory and file transfers.

**Get the light right:** Poorly exposed images represent a waste of time and money, says Robinson. Instead, chose a camera with enough light sensitivity or go the extra step and add lighting, which goes along with the next tip.

**Pay attention to the little things:** Don't underestimate the seemingly small details such as lighting and lens selection. "If you take care of the details, you can take great shots with a low-end camera. If you don't, you can end up taking poor shots with a high-end camera," says Reig.

the camera should at least output NTSC/PAL. For higher-resolution cameras, however, he says to look for HD-SDI outputs.

Southern Vision cameras all use Gigabit Ethernet for connecting the camera to a host PC. "This allows for cable runs of up to 300 ft and supports continuously streamed video at 250 fps with  $640 \times 480$  resolution," says Sharp. "For higher framer rates, the camera needs internal memory and then Ethernet is used to download memory to the PC for storage."

It also helps if the person who will be using the camera has a background in photography or lighting, says Reig. "And if the camera is relatively low-end with frame rates



**The camera catches the cause of failure in a high-speed stamping press producing motor laminations: A lamination leaving the press collides with a lamination that failed to fall flat over the stacking guide.**

of 1,000 fps or lower, the operators should need only a few hours of training

### **Advice and tips**

**Keep it simple.** “Don’t buy more complexity than you need,” says Sharp. “You want a camera that is so easy to set up that high-speed video for troubleshooting becomes a ‘first’ rather than a ‘last’ resort. I’ve visited many companies that own high-speed cameras but they admit the cameras are rarely used because they are just too complicated and time consuming to use day-to-day.”

**Know what you want to accomplish.** Knowing how you plan to use the camera will let sales people help you

find the right cameras without going over budget, according to Reig. “A camera capable of capturing 1,000,000 fps is nice to have but is not often needed for high-speed video.”

**Get for the biggest bang for the buck.** “Get the most performance and flexibility while staying within your budget, because once you have the camera, you will find dozens of additional uses for it,” advises Robinson.

**Look for versatile triggering options.** This tip from Robinson is especially true for fast cameras, where starting to film 5 sec early can lead to 50,000 unneeded images to wade through. “For example, our faster cameras can be triggered to start filming when the camera detects a deviation from previously static imagery.” **MD**