Machine *Vision* Dos *and* Don'ts

Small tips on how to avoid big headaches.

For some people, learning how to ride a bike or swim comes naturally. For others, it's one of the hardest things they ever do. Implementing machine vision technology can often be a similarly easy or difficult scenario.

This vision system uses LED lighting to inspect felt-tip pens. ***Photo courtesy Cognex Corp.***

Despite numerous advances, vision systems remain somewhat intimidating. However, thanks to new software and improved components, the black art of imaging and image processing is better understood these days.

More manufacturers are becoming comfortable with machine vision, thanks to lower costs, simpler designs, increased flexibility, higher reliability, more powerful algorithms and increased processing speed. End users are also benefiting from increased functionality and new capabilities, such as higher resolutions, greater field of view and better color imaging. In addition, there is less proprietary hardware and software available today. That gives end users more freedom to mix-and-match components, and become less dependent on a single vendor.

Those positive factors are expected to help the machine vision market grow 10 percent annually over the next four years. However, because of time constraints and cost concerns, end users often repeat the same mistakes. Many of those problems can be avoided if engineers simply do their homework and follow some of the tricks of the trade suggested by various vision experts.

Identify Basic Requirements

Too often, end users simply fail to identify the basic requirements of their machine vision application. "We frequently see situations in which the user sets out to accomplish one thing and ends up attempting to solve a set of issues well beyond the original scope of the task," says Dan Holste, director of vision products at Banner Engineering Corp. (Plymouth, MN). "Hence, the equipment may or may not be able to offer an adequate solution."

Many manufacturers have unrealistic expectations for machine vision systems. "Often, this disparity is a result of the unwillingness of the user to accept realistic constraints, the equipment involved, promises made by salespeople, or the conditions in which the image analysis occurs," explains Holste.

Some end users fail to realize the multidiscipline nature of machine vision.

■ **Austin Weber**
Senior Editor

Optics, lighting, mechanical engineering, image processing, electronics and software are the main ingredients.

"You need to search for, find and follow the right balance during implementation," says Endre Toth, director of business development at Vision Components (Hudson, NH). "Find the bottle neck and solve it. If you happen to have a mechanical mounting problem, do not try to solve it with lighting or by setting software parameters. Often, people try to modify [something] or just solve a problem with the discipline they are more comfortable with."

Before specifying a component, such as a sensor, it's a good idea to define the entire scope of the application to ensure that the vision system has enough performance headroom in terms of speed, accuracy and acquisition requirements.

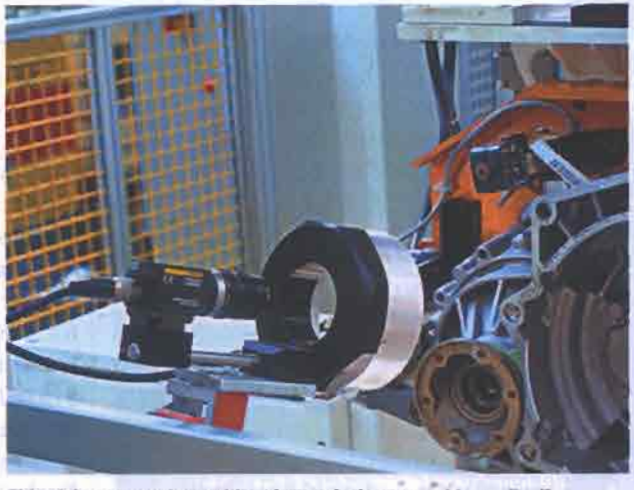
"As users become familiar with the power of machine vision, they tend to want to accomplish as many vision tasks as possible," notes Gilbert Chiang, an application engineer at Cognex Corp. (Natick, MA). "[You should] consider any future requirements for increased throughput, ability to accommodate new product or changes to the existing product."

According to Holste, failing to understand optical and vision basics can also lead to problems. "[Often, we see people who have] not taken time to learn a set of basic principles and processes, such as the importance of contrast within the image or the basics of lighting and lens selection," he points out. Holste says it's important to take time to read up on the basics.

One of the biggest problems facing manufacturing engineers when implementing machine visions systems is trying to find the right system components to create a customized solution given the myriad products available in the marketplace. "Engineers are challenged to select the correct lens, lighting, camera and software with general specification information," says Gregory Hollows, vision integration partner coordinator at Edmund Optics (Barrington, NJ). "However, a more detailed analysis of each component is actually required to attain a machine vision solution. Putting all of the pieces together is a complicated puzzle that can be largely dependent on the integration environment, such as a factory floor."

"Understanding your application requirements in detail [will make the process of selecting various] technologies and components easier," adds Himanshu Shah, a senior analyst at ARC Advisory Group Inc. (Dedham, MA). "More options are confusing when users do not understand basic technology.

"The fast-changing nature [of machine technology] will always place doubts in users' minds about whether or not the right technology is being used for their applications," says Shah. "Users must understand the basics of the technology to convey their requirements [to integrators and vendors], to minimize risk and to achieve the highest benefits from the latest technologies."



This vision sensor is used in a transmission assembly application.
Photo courtesy Omron Electronics LLC

Machine vision systems often fail if applications are not well specified in the early phases of a project. "Before starting a project, make sure that all the parameters are well understood," suggests Peter Galea,

boxes. *Illustration courtesy ATS Automation Tooling Systems*

group leader of the vision systems group at ATS Automation Tooling Systems (Cambridge, ON). "Part changes, part presentation, realistic tolerances, cycle times and other environmental concerns must be known before a vision system can be specified."

Engineers should always ask themselves a simple question: Why do we need a vision system? "If you don't know the answer, then you are not done with your homework yet," warns Vision Components' Toth. "There is a good chance that there are other solutions that you have to evaluate and compare before proceeding."

Understand Lighting

Because lighting and optics make up more then 70 percent of the typical vision application, this is the area where most mistakes are made. According to Ben Dawson, director of strategic development at IPD (Billerica, MA), lighting can make or break an application.

"Lighting always is a stumbling block," warns Dawson. "No one has figured out a good way to package it in a box so that someone can use it immediately. Lighting requires a certain amount of experimentation."

"Don't underestimate the importance of lighting to creating observable contrast and forming a good image," adds Cognex's Chiang. "When considering lighting, consider not only lighting type, but also lighting color. Ensure that lighting coincides with the depth of field and field of view."

Lighting and component mounting is critical. "Often, inexperienced vision users will underestimate the importance of stable lighting and camera mounting," says Joshua Jelonek, machine vision application engineer at Keyence Corp. of America (Woodcliff Lake, NJ). "The repeatability of the inspection is directly related to the repeatability of the image captured by the camera. Ensuring that the camera is rigidly mounted and that the application lighting does not fluctuate are critical to maintaining high image repeatability."

According to Jelonek, incorrect lighting and mounting are usually the result of inexperience. "Someone may evaluate the cost of the typical machine vision illumination device and think 'I can get a bulb over at the hardware store for $15,'" he points out. "Unfortunately, the time spent trying to stabilize the $15 bulb outweighs the cost of the original machine vision light."

Sometimes, Jelonek says brackets for the lights and camera are made without taking machine vibration or opera-

tor interaction into account. Adhesive can help hold cameras and lights in place, reducing the effects of heavy machine vibration.

"Make sure that the lighting solution provided for the application has been proven," warns Jelonek. "Also, be sure to design camera and lighting fixtures so that they're not considered an obstacle by operators and maintenance personnel."

"Frequently, end users do not understand the importance of lighting," adds Ilias Levis, product manager for visual imaging products at Sony Electronics Inc. (Park Ridge, NJ). "On many occasions, lighting works fine on the test bench, but fails when transferred to the factory floor."

Manufacturing engineers should also consider the pros and cons of LED lighting. According to Joe Rogers, vice president of marketing at PPT Vision Inc. (Eden Prairie, MN), LED is an excellent technology with no real downside. "The advantage is long life, high brightness, and consistent illumination across the object," he points out.

LED lighting is popular for monochrome vision applications. It is great for strobing and for highlighting features of a given wavelength. However, white LEDs are not consistent across the visible spectrum, so they are often not recommended for all applications.

The advantages are extremely long lifetime and consistent illumination over the life of the light. Other types of illumination tend to degrade gradually over time. But, the output of an LED is much more constant over its life. In addition, LEDs generate less heat than other light sources, and can be easily arranged to provide customized lighting configurations.

However, cost is a disadvantage, because they are generally more costly than other types of illumination. Though LEDs are getting brighter, they can still fall short in applications that require high-power illumination.

Keith Russell, director of marketing at Redlake MASD Inc. (San Diego), says LED lighting provides the ability to specify wavelengths that help bring out detail. "They allow for accurate control over pulse duration, run cool,

last a long time, are able to provide natural-looking light and may be arranged in a variety of system configurations," he explains. "Disadvantages of LED lighting include its price, directional characteristics and tendency to fade over time."

Test and Verify Parts

In many assembly applications, the ability to find multiple parts—or parts that vary in shape, size and texture due to the materials they are constructed of—requires a vision tool that can find and identify their presence and location. It's always important to understand what features distinguish a good part from a bad part.

"The more precise the specifications, the easier it is to solve an application," says Cognex's Chiang. "Most importantly, [you should] obtain and test marginal product in order to minimize false accepts and rejects."

Often, not all the different parts are tested. "Usually, after the first part has been 'tested' and the vision system installed to accommodate the first tested samples, the requirements of the part change, changing the nature of application," notes Robert Lee, strategic marketing manager at Omron Electronics LLC (Schaumburg, IL). "Most engineers will not adjust the requirement of the vision system to the new part, and thus, [it may not be] correctly 'trained' to the new part.

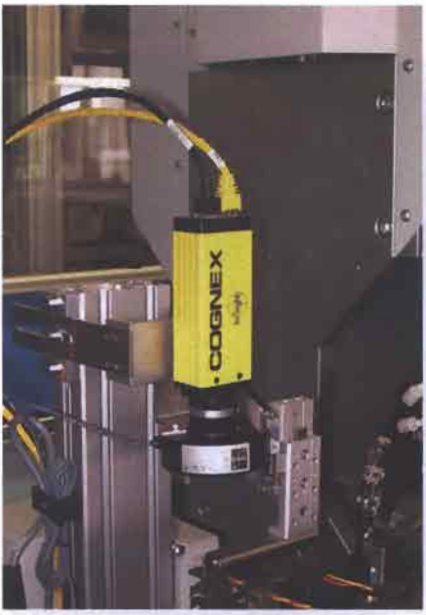
"This is most prevalent with the lighting settings," adds Lee. "Even when the part has been bench tested to particular lighting conditions, when the part changes, it may also need new lighting requirements to illuminate the part correctly for the vision system. In addition, in most cases that we have seen, parts are usually bench tested, and the vision system chosen. This is a static proof. In most cases, it does not reflect or simulate a dynamic proof—or the product actually in motion."

According to Lee, most end users don't have the range of lighting or lensing needed to simulate production requirements. He suggests tapping into a vendor's vision lab, which is often well stocked with a variety of equipment to provide the optimal solution.

Address Cost Concerns

In today's cost-conscious economy, end users are forced to look at the bottom line. But, choosing a machine vision system solely on price can be a big mistake.

"The golden rule of 'you get what you pay for' most certainly applies," warns Keyence's Jelonek. "What is sometimes not taken into account is the cost to implement and maintain the system. A particular vision system may cost $1,000 to $2,000 less than another, but if the less expensive system is difficult to learn and troubleshoot, the project's return on



Defective auto parts are marked by a jet of ink at this inspection station, preventing them from being used on the assembly line.
Photo courtesy Cognex Corp.

investment could be significantly reduced by the subsequent long periods of downtime on the production line."

"Don't base the buying decision on price alone without considering all of the potential add-on items required," adds Cognex's Chiang. "Spending more initially on a vision system with more powerful software can save money by reducing the need for more costly lighting, optics or part fixtures."

While the least expensive solution can sometimes work quite well, making a decision on price alone does not guarantee the repeatability and reliability that an application may require. "When everything looks the same on paper except the cost, it is very easy to purchase a system that will not perform adequately for your requirements," concludes Edmund Optics' Hollows. "Without proven performance on the specific application under real world conditions, cost should not be the only factor considered." **A**