

# **BUYING A VISION SYSTEM**

## **10 Questions You Must Ask**

10Q Guide

**COGNEX**

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### INTRODUCTION

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With so many vision systems available today, it can be a daunting task trying to figure out which one is right for your particular application. Simply finding a system that can perform the necessary vision tasks is not enough; there are several other factors that need to be considered to ensure a successful deployment.

These include:

- Variations in lighting conditions
- Networking and communications capabilities
- Accessories and product support options
- Ongoing post-deployment support

Whether you are new to machine vision or an experienced user, this guide will help you through the vision system selection process, providing answers to ten critical questions and valuable tips for evaluating specific product features.

1. Does the vision system make it easy to set up applications, create custom operator interfaces and administer vision system networks?
2. What is the importance of part location tools, and how can I assess their performance?
3. Does the vision system have a complete set of image pre-processing tools?
4. What should I look for in character reading and verification capabilities?
5. How can I determine the repeatability of a vision system's gauging tools?
6. How do I evaluate industrial code reading tools and what are some specific features to look for?
7. What networking and communications features should I look for?
8. What should I know about vision system accessories?
9. Does the vision system vendor offer a wide range of hardware options? Are they rugged enough for my environment?
10. Does the vision system supplier provide the support and learning services I need?

As the world leader in machine vision, Cognex® Corporation is here to help make all of your vision projects successful. For additional information about selecting vision systems, please contact Cognex at (877) 264-6391 or visit [www.cognex.com](http://www.cognex.com).

## 1. Does the vision system make it easy to set up applications, create custom operator interfaces and administer vision system networks?

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Setting up a vision application should not require you to be a machine vision expert. Does the setup interface walk you through all of the steps of a vision application, including setting up the acquisition settings, finding and inspecting the part and communicating the results to other devices on the factory floor? Does it require programming knowledge, or is it a configurable system? Does the setup software make it simple to calibrate the system to work in real world units instead of pixels? As you add tools to the application, does it show you a quick view of which tools are passing and failing to help you understand how well

the application is set up? Does it allow you to build a complete operator interface to allow changing tolerances or to support line changeovers?

### VISION TIP

Make sure the operator interface you create can perform the following tasks:

- Display images with graphics to allow for immediate analysis of failed parts,
- Enable operators to easily turn the inspection on and off and modify tolerances, and
- Display pass/fail results statistics to quickly spot shifts in trends.

## 2. What is the importance of part location tools, and how can I assess their performance?

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Part location software tools find the part within the camera's field of view. This is typically the first step in any vision application, from the simplest robot pick-and-place operation to the most complex assembly verification task. It's also the most critical step, because it often determines whether an application succeeds or fails, since you can't inspect, measure or identify the part if you can't find it

While it sounds simple enough, locating parts in an actual production environment can be extremely challenging. Vision systems are trained to recognize parts based on a pattern, but even the most tightly controlled manufacturing processes allow some variability in the way a part appears to the vision system. Therefore, the vision system's part location tools must be intelligent enough to quickly, and accurately compare trained patterns to the actual objects moving down a production line, and tolerate variations in part appearance. It's important for pattern matching tools to be able to tolerate large variations in contrast and ignore lighting changes, while being reliable enough to always find the right part.

## VISION TIP

How can you tell if a vision system's part location tools will be able to accurately and reliably find parts under the range of conditions in your factory? Following is a list of ten of the most problematic conditions vision systems face, potential causes for those problems, and quick tests you can use to evaluate a vision system's ability to locate your parts under each condition.

CONDITION	POTENTIAL CAUSES	THE VISION TEST
ROTATION	<ul style="list-style-type: none"> <li>▪ No part fixturing</li> <li>▪ Loose part fixturing</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rotate the part from 0 to 360 degrees</li> </ul>
BLUR	<ul style="list-style-type: none"> <li>▪ Part is in motion</li> <li>▪ Nearby motors and other production equipment causing vibration</li> <li>▪ Camera lens is out of focus</li> <li>▪ Distance between camera and part varies slightly</li> </ul>	<ul style="list-style-type: none"> <li>▪ Slightly shake the part around under the camera</li> <li>▪ Defocus the camera lens</li> <li>▪ Move the camera nearer to and farther from the part</li> </ul>
SCALE CHANGES	<ul style="list-style-type: none"> <li>▪ Distance between camera and part varies slightly</li> </ul>	<ul style="list-style-type: none"> <li>▪ Move the camera nearer to and farther from the part</li> </ul>
POOR CONTRAST	<ul style="list-style-type: none"> <li>▪ Part blends into background</li> <li>▪ Part has poorly defined edges</li> </ul>	<ul style="list-style-type: none"> <li>▪ Present part against a background of a similar color</li> </ul>
UNEVEN LIGHTING	<ul style="list-style-type: none"> <li>▪ Ambient light changes over time, e.g. external sunlight</li> <li>▪ Robot arm or other equipment creates shadows</li> <li>▪ Surface reflectivity varies from one part to the next</li> </ul>	<ul style="list-style-type: none"> <li>▪ Change room lighting between bright and dim, and open and close lens aperture</li> <li>▪ Use your hand or other object to create a shadow over the part</li> <li>▪ Shine bright light across the part surface</li> </ul>
OVERLAPPING PARTS	<ul style="list-style-type: none"> <li>▪ Multiple, unfixtured parts moving down the line</li> </ul>	<ul style="list-style-type: none"> <li>▪ Overlap a portion of the part with another object</li> </ul>
PROCESS VARIATIONS	<ul style="list-style-type: none"> <li>▪ Inconsistencies in the manufacturing process</li> </ul>	<ul style="list-style-type: none"> <li>▪ Present multiple parts that vary in appearance from process effects</li> </ul>

### 3. Does the vision system have a complete set of image pre-processing tools?

Image pre-processing tools alter the raw image to emphasize desired features while minimizing undesirable features. This prepares the image for optimal performance by more powerful vision tools and can significantly improve the accuracy and robustness of the overall system. Pre-processing tools can:

- Increase the contrast between the part and its background,
- Mask insignificant and potentially confusing image features,
- Eliminate "hot spots" reflecting off the part surface, and
- Smooth rough surface textures.

Make sure that a complete set of image pre-processing tools is included with the vision system you choose.

## 4. What should I look for in character reading and verification capabilities?

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Whether you're reading stamped alphanumeric codes on automotive parts or verifying date and lot code information on medicine bottles or packages, there are several capabilities to look for when evaluating character reading and verification tools, including:

- **Statistical font training**—This capability builds a font by learning models of characters that appear in a series of images. The images should include multiple instances of each character, and span the full range of quality likely to occur in production. The resulting font will be highly tolerant of normal variations in print quality, whether due to poor contrast, variable locations, degradations, or variations in stroke widths. Unless you know in advance that every code will be marked with the same quality seen in the reference images used to learn the character models, statistical font training can be crucial to the success of your reading or verification application.
- **Image pre-processing tools**—These tools optimize a trained model by sharpening the edge contrast of characters and filtering out extraneous background in the image. Optimized models maximize the reliability and repeatability of the vision system. See Question 3 for more information about image pre-processing.
- **Instant image recall**—This capability enables line operators and technicians to quickly and easily view failed images on a display. Whether the failure is caused by a camera jarred out of position or a missing or damaged label, it is important to know immediately why the failure occurred so corrective action may be taken.

### VISION TIP

In a packaging plant, package and container materials, labeling equipment, printing methods, and ambient lighting conditions can vary considerably over time.

As you evaluate a vision system, be sure to test the system on a large sample of good, marginal, and poor quality labels to see how the system performs under variable real-world conditions.

And because character positions can shift from label to label, it's also a good idea to enlarge the region of interest around the character string.

This will help you determine how reliably the vision system's reading and verification tools operate within a larger search region.

## 5. How can I determine the repeatability of a vision system's gauging tools?

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If your application involves critical dimensional measurements, the vision system's gauging tools must be accurate and perform with a very high degree of repeatability.

The vision system should have a full suite of gauging tools which will allow you to choose the right one to fit the requirements of your measurement application without having to write custom scripts or functions.

For high accuracy measurements, the vision system should be able to correct the lens distortion that can affect measurements, especially in the outer areas of the image.

### VISION TIP

Gauging repeatability can be tested by presenting a part to the vision system and having it perform the same measurement 25 times or more without changing part position, lighting, or any other variables. Record and analyze the measurements, making sure that any variance is well within the measurement tolerance for your application.

## 6. How do I evaluate industrial code reading tools and what are some specific features to look for?

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Industrial environments demand a vision system that can read 2D Data Matrix codes that are degraded, poorly marked, or vary in position from part to part. The vision system should perform well regardless of the part material (such as metal, glass, ceramic, and plastic) and the type of part marking method employed (such as dot peen, etching, hot stamping, and inkjet).

Beyond these criteria, there are several specific code reading features worth inquiring about:

- **Code quality verification**—Look for products that can verify code quality to established standards. This can provide valuable information about how well the marking process is working.
- **Reading speed**—Depending on your production line speed and throughput requirements, you may need a very high-speed reader. The fastest vision systems available today can read more than 7200 codes per minute.

## VISION TIP

To evaluate industrial code reading tools, start by measuring the vision system's reading speed. To do this, present a well-marked code to the vision system and have it read the code hundreds of times under pristine conditions to determine the number of reads per minute. Make sure the read rate under these optimized conditions is 100%, or you may face problems later when conditions might be less than ideal. For example, at a production line speed of 2000 parts per hour, a read rate of 99.7% would fail to read the ID codes on 48 parts in just one eight-hour shift!

After establishing the system's reading speed, you should run a more challenging read rate test to determine the impact of factors such as line vibration, variable lighting conditions, and extremely high line speeds on the vision system's reading performance in your application. To do this, present a large sample of codes of good, bad, and marginal quality to the vision system. At the same time, simulate vibration and motion blur by shaking the part and sliding it back and forth beneath the camera as it acquires an image. This test will provide a good initial assessment of how well the vision system's read rate will hold up under real-world production conditions.

## 7. What networking and communications features should I look for?

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Networking is essential to many vision applications as a means to share data, support decision-making, and enable highly-efficient integrated processes. For example, networking enables vision systems to transmit pass/fail results to PCs for analysis, or communicate directly with PLCs, robots, and other factory automation devices in an integrated process control system.

If you need to link your vision systems to PCs at the enterprise level, choose a system that supports the complete set of standard networking protocols:

- **TCP/IP client/server** enables vision systems to easily share results data with other vision systems and control devices over Ethernet without any code development.
- **SMTP** (Simple Mail Transfer Protocol) enables you to immediately receive an e-mail on your PC or cell phone when a problem occurs on the production line.
- **FTP** (File Transfer Protocol) allows inspection images to be stored on the network for later analysis.
- **Telnet** is an Internet standard protocol that enables remote login and connection from host devices.
- **DHCP** (Dynamic Host Configuration Protocol) allows a vision system to automatically receive its network IP address from a server, enabling true plug-and-play performance.
- **DNS** (Domain Name Service) allows you to assign each vision system a meaningful name, such as "Bottling Line System 1", instead of having to use a numeric IP address.

To integrate a vision system with the PLCs, robots and other automation devices in your plant, the system you choose must also support the following:

- Industrial Ethernet protocols such as **EtherNet/IP**, **PROFINET**, **MC Protocol** and **Modbus TCP**. These enable vision systems to be linked to the most popular PLCs and other devices over a single Ethernet cable, eliminating the need for complex wiring schemes and costly network gateways.
- Fieldbus networks, including **CC-Link**, **DeviceNet**, and **PROFIBUS**. A protocol gateway accessory is usually needed to add a vision system to a Fieldbus network.
- **RS-232** and **RS-485** serial protocols, needed to communicate with most robot controllers.

Finally, as more and more vision systems are used throughout the manufacturing process, the need for a centralized way of managing them becomes increasingly important. Make sure the vision system you choose comes with software that allows you to easily control and monitor the operation of all your vision systems remotely over the network from any location—on or off the plant floor.

## **8. What should I know about vision system accessories?**

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Too often, so much attention is given to evaluating the vision system that accessory products are almost an afterthought. But the choice of accessories can go a long way towards ensuring trouble-free system integration and, in the case of lighting, can even make or break the application.

For quick and painless integration of your vision system, it makes sense to buy from a vendor that offers a complete family of compatible accessories. This gives you the assurance of knowing that each and every accessory has been tested and confirmed to be compatible with the vision system. More importantly, during the application evaluation process, the salesperson should be able to help specify the best lighting and optics solution to give the best chance for a successful vision application.

Accessories to look for include:

- **Lights**—No two production areas have the same ambient light conditions, and parts can exhibit a wide range of surface characteristics. Nearly every machine vision solution requires a unique lighting approach to meet its objectives and optimize performance. Your vision system vendor should offer a variety of lighting options, including: ring lights, which provide soft, even illumination from all directions; back lights, which create maximum contrast between a part and its background; and dark field lights, which provide low-angle illumination for imaging of part surface irregularities.

- **Communications modules**—Make sure your vendor offers communications peripherals such as I/O modules and network gateway modules that support easy, quick connectivity between the vision system and PLCs, robots, and other factory automation devices and networks. Industrial connectors?
- **Operator interface panels**—A networked operator interface panel allows easy, plug-and-go set-up and deployment, plus ongoing monitoring and control of vision systems without a PC. When selecting an operator interface panel, look for one with an intuitive, touch-screen interface and support for multiple camera views. It should also be tough enough to stand up to the manufacturing environment, with an anti-glare impact shielded LCD display and NEMA-rated mounting bezel that provides a dust- and liquid-tight seal when mounted in a panel or enclosure.

## **9. Does the vision system vendor offer a wide range of hardware options? Are they rugged enough for my environment?**

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Your chosen supplier should be able to offer you a variety of choices of systems base on performance, resolution and durability. Machine vision is not a “one-size-fits-all” purchase. Your application may require a line scan camera as opposed to an area scan system or even a color system. You may need more resolution in order to meet your tighter tolerances or need a system that can withstand wash down. Your supplier should be able to provide options that will meet your needs of inspection and also for your physical environment.

Additional questions include: Do you have room to install a vision system on your line? If space is a constraint, there should be options in terms of actual system size as well as acquisition options. For example: If the viewable product space is limited, a line scan camera maybe an option to consider. Unlike area scan cameras that need to see the entire part to take a full snapshot of it, a line scan camera needs to see only a sliver of the product to build the entire image into memory. Think of this comparison as a photo copier (area scan), vs. a desktop scanner (line scan). Or if the space to install the vision system is limited, a smaller package would take up less room and require less mounting space.

Once you have the physical size constraints taken care of, it is now a question of what resolution is necessary for your specific application. Resolution of a vision system is the size of the imager used and is given in pixels. Typically, the more pixels you have, the more data you capture per feature. The more data per feature, the more accurate and repeatable measurements you will have. To get an idea of resolution, ask yourself, what field of view do I really need? Do I need to capture the width of the assembly line, or a portion of a larger part, or the entire part itself? What do I need to see in the image in order to inspect this part? The target resolution is determined from these answers. For example: Your inspection is to count the number of parts on a tray. If your field of view is the width of your assembly line, for example, 12 inches, and your vision system has a

resolution of 640 x 480, then you would have 640 pixels to equal 12 inches. This equates to 53 pixels per inch (or each pixel represents 0.018 inches). If you are counting the number of parts in each tray, this resolution may be sufficient. However, if you are measuring the width of each individual part and need a tolerance of +/- 0.001 inches. Then more pixels will provide you with more data per feature to achieve the accuracy of the tolerance.

Sometimes, the features you are inspecting do not have enough contrast in a monochrome vision system, even with specific lights and filtering. A color system maybe able to bring out the subtle differences in features and colors that you need in order to complete your inspection.

Some vision systems are assembled into rugged, IP and NEMA-rated metal cases to withstand dust and moisture without requiring a separate enclosure accessory. However, if the environment in your plant is especially harsh or requires frequent wash down of equipment, ask your prospective supplier if they offer external enclosures pre-qualified for use with the system.

## **10. Does the vision system supplier provide the support and learning services I need?**

Even the highest performance vision system is only as good as the suppliers who stand behind it. Whether you buy your vision system from a distributor, a systems integrator, or direct from the manufacturer, it's important to know in advance the full range of support services available to you. Be sure that the vision supplier you choose understands your unique support requirements and provides you with all of the resources you will need during every phase of the project, from application development and systems integration, to deployment and beyond.

Important questions to consider include:

1. Can the vision supplier provide a dedicated machine vision specialist to assist you with the initial application evaluation? It's important to work with experienced sales and applications engineers to make sure that the application can be done, and at the right price/performance.
2. Does the vision system manufacturer have a global network for post-sales support? This is especially important if the system is commissioned in one location and shipped to another.
3. Does the vision system manufacturer offer a wide range of cost effective training and support options, including online self-help and training courses, worldwide phone support, and personalized training services?
4. If you are buying from a distributor or systems integrator, are they authorized partners of the vision system manufacturer?

5. Does the vision system manufacturer have a history of successful installations and the financial stability to support your needs over the long term?
6. Does the vision supplier offer more sophisticated systems and tools if your application requires it, or if your needs change?

## Final Thoughts

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The best suppliers don't merely try to sell you a *product*—they take the time to carefully understand and evaluate all of your requirements before proposing a *solution*.

This is exactly the approach that Cognex and its global network of distributors and system integrator partners take. We're here not just to answer all of the *10 Questions You Must Ask*, but any other questions you may have. Working closely with you, we'll match you to the right solution for your application, whether it's a full vision system, affordable smart sensors, or customized PC solutions.

### About Cognex® Corporation

Cognex Corporation designs, develops, manufactures, and markets machine vision sensors and systems, or devices that can "see." Cognex vision sensors are used in factories around the world to automate the manufacture of a wide range of items and to assure their quality. Cognex is the world's leader in the machine vision industry, having shipped more than 500,000 machine vision systems, representing over \$2.5 billion in cumulative revenue, since the company's founding in 1981. In addition to its corporate headquarters in Natick, Massachusetts, Cognex also has regional offices and distributors located throughout North America, Japan, Europe, Asia, and Latin America. Visit Cognex on-line at <http://www.cognex.com>.

# COGNEX

Companies around the world rely on Cognex vision to optimize quality and drive down costs.

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