MACHINE VISION IS INDUSTRY 4.0 READY

John Jackson | April, 2018

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AGENDA

- **Basics of Industry 4.0 and Machine Vision**
- **What does Machine Vision Do?**
- **Why is machine vision used?**
- **Industry 4.0 models**
- **Cognex-specific technology**

- **Q&A**

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WHAT IS THE 4TH REVOLUTION?

1ST REVOLUTION
Water/Steam
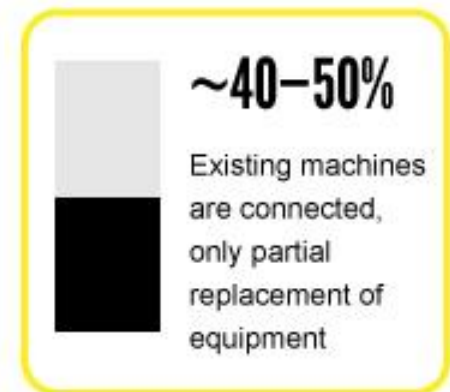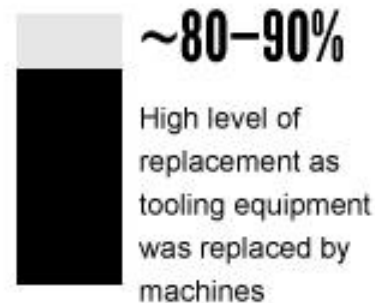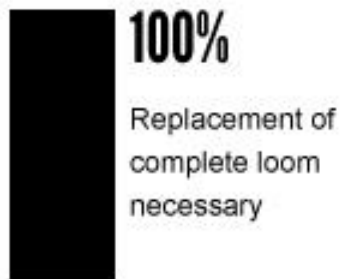
2ND REVOLUTION
Electricity

3RD REVOLUTION
Automation

4TH REVOLUTION
Cyberphysical systems

REPLACEMENT OF EQUIPMENT
Percent of installed base

100%
Replacement of complete loom necessary

~10–20%
Little replacement, as tooling equipment could be kept, only conveyor belt needed

~80–90%
High level of replacement as tooling equipment was replaced by machines

~40–50%
Existing machines are connected, only partial replacement of equipment

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DEFINITION

A Cyber-Physical System (CPS) is defined as a system that links the digital (cyber) and physical world

Machine Vision is an example of this…..

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WHAT IS MACHINE VISION?

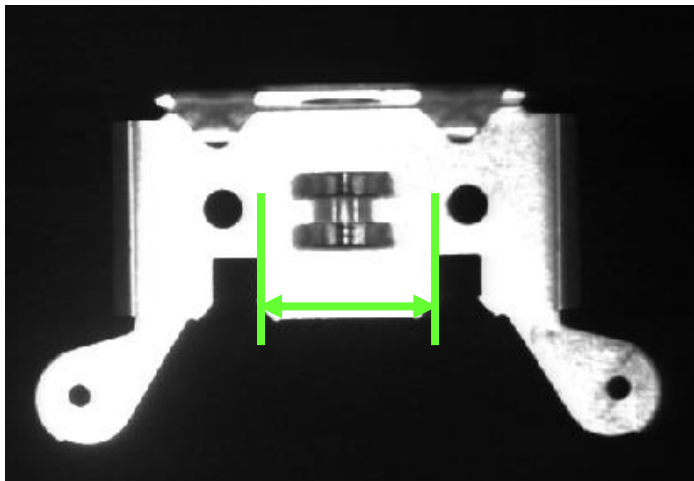**The camera lens and sensor capture images…**

Cognex advanced vision tools

interpret what's being seen

SIMPLE EXAMPLES

Machine vision systems:

1. Analyze images

2. Makes decisions and returns results about each image

The center tab on this bracket is 37.255 mm wide

Good Oil Filter: All holes are open
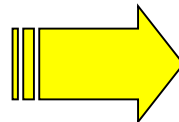
Bad Oil Filter:

Some holes are blocked

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IMAGE ANALYSIS

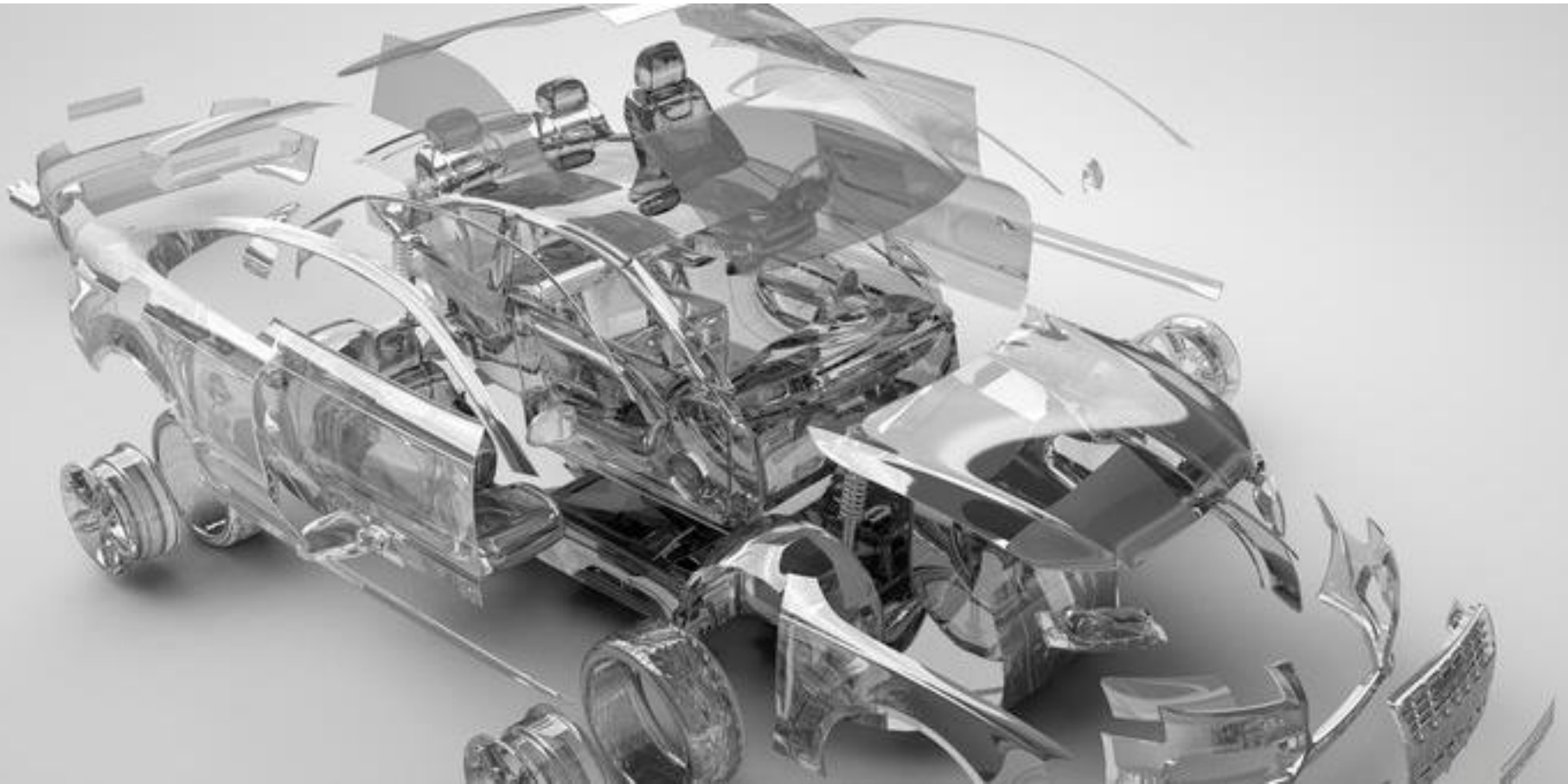The primary purpose of machine vision is *image analysis*

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WHAT DOES MACHINE VISION DO?

GUIDE   INSPECT   GAUGE   IDENTIFY

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CYBORGS CLASS OF 2018
VISION USED FOR GUIDANCE

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GUIDANCE

Determines part position (x, y, and angle)

Automates handling of parts for machines:

- Alignment & Placement
  - 2D & 3D Picking
  - Eliminates need for fixturing & improves robot flexibility

Vision tool alignment, fixturing

- Locate at least one feature on a part for the purpose of calculating the (x, y) position and rotation of the part to position other vision tools precisely

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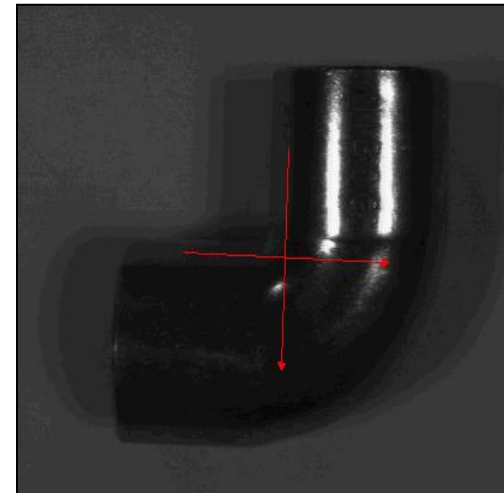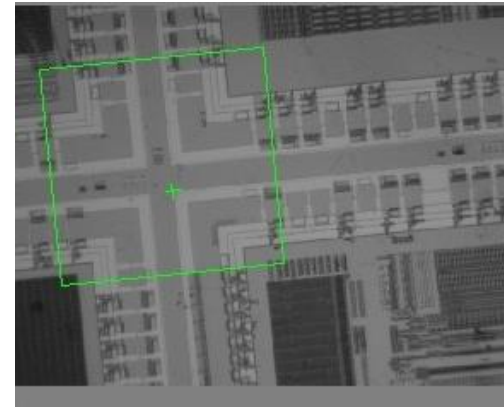
GEOMETRIC PATTERN MATCHING

Trained Image

Confusing Background

Out of focus

Rotation and Scale Changes

Occlusions

Uneven Lighting

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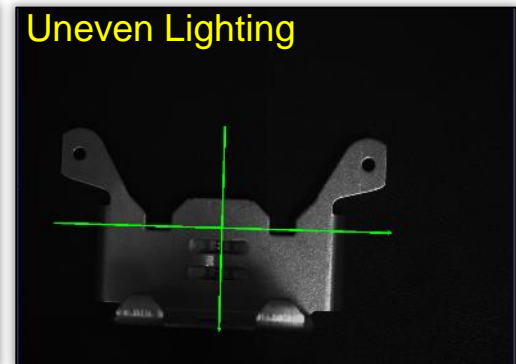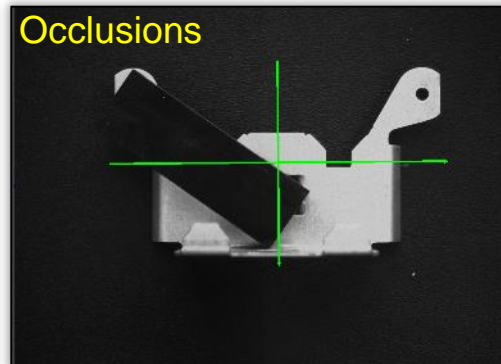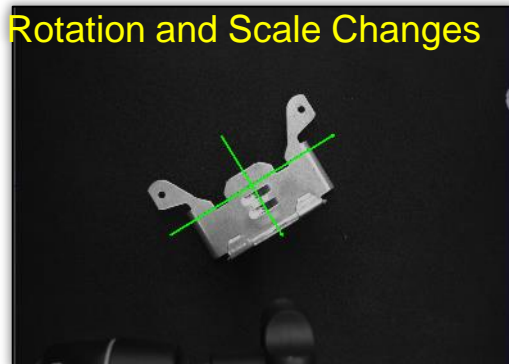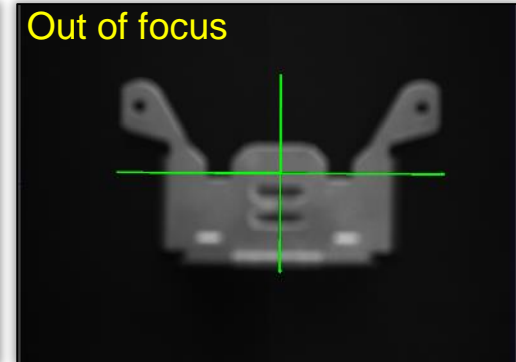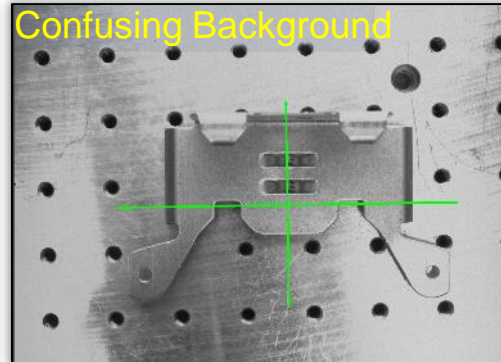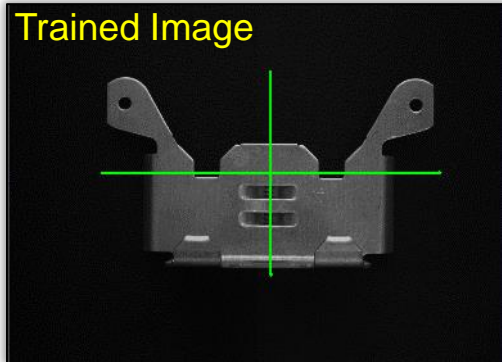
INSPECTION

Correct location

- Orientation
- Skew

Quality

- Defect Detection
- Surface Inspection
- Contaminants

Completeness

- Fill Level
- Feature Presence
- Counting
- Assembly Verification

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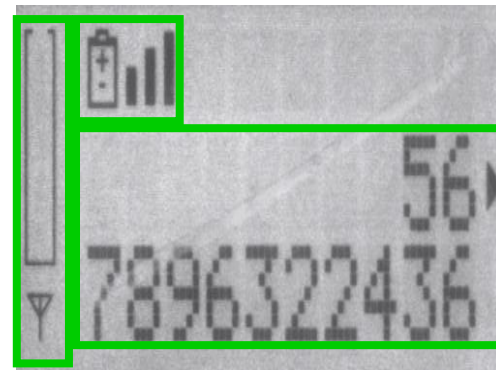
GAUGING

Precise dimensioning

- Automated metrology and data recording

Ensures tolerances

- Diameters

- Gaps

- Bushings

- Threads, etc.

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IDENTIFICATION

Read Codes

- Printed 1-D Barcodes & 2-D Matrix

- Direct Part Mark

Read Characters

- OCR / OCV

Recognize Objects

- Based on color, shape, or size

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WHY IS MACHINE VISION USED?

- Automate manufacturing processes

- Improve product quality

- Protect brand image

- Reduce operational costs

- Overcome inefficient manual inspection processes

- Increase manufacturing throughput

- Reduce material waste

- Minimize the risk of recalls

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CRITICAL FOR ACHIEVING STRATEGIC GOALS

- High speed production lines
- Clean room environments
- Hazardous environments
- Microscopic inspection
- Closed-loop process control
- Robot guidance
- Precise non-contact measurement

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BENEFITS OF MACHINE VISION

Manufacturing Goal	Machine Vision Applications
Improved product quality	Inspection, measurement, gauging, and assembly verification
Increased productivity	Repetitive tasks done manually are automated with machine vision
Production flexibility and less machine downtime	Automatic product changeovers
Increased manufacturing throughput	High-speed inspection keeps up with the fastest production lines
Reduce manufacturing waste	Detecting defects earlier in the process prevents adding value to defective products

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INDUSTRY 4.0 MODELS / FRAMEWORKS

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INDUSTRY 4.0 / IIoT ECOSYSTEM

Business Intelligence & Governance

Advanced Analytics & Smart Data

Customers

Suppliers

Security, Big Data & Cloud Computing

Product Design & Production Optimization Strategy

Yield

Power Use

Predicative Alerts

Real-Time Device Data Acquisition

Simulate & Validate Product Changes

Reduce Raw Materials & Energy

Adapt to Market

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WHAT HAPPENS WHEN 50B MACHINES ARE CONNECTED?

INDUSTRIAL INTERNET

Real-time Network Planning

Shipment Visibility

Packaging Optimization

Intelligent Devices

Connected Machines

Smart Grid

Factory Optimization

Logistics Optimization

Connected Retail Establishment

Connected Distribution Center

Connected Power

Connected Factory

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IT – OT CONVERGENCE

ERP
MES
Logistics
CRM
….

Business Systems

IT

Transactional
Secure
Private

Secure Common Network

Operations

OT

Real Time
Safe
Resilient

Machines
Controllers
Sensors

Vision

…

PURDUE CIM REFERENCE MODEL

L4 — **Business Logistics**
Plant Production Scheduling, Shipping, Receiving, Inventory, etc.

ANSI/ISA-95

L3 — **Manufacturing Operations Management**
Dispatching, Detailed Production Management, Scheduling, Production Tracking

L2

L1

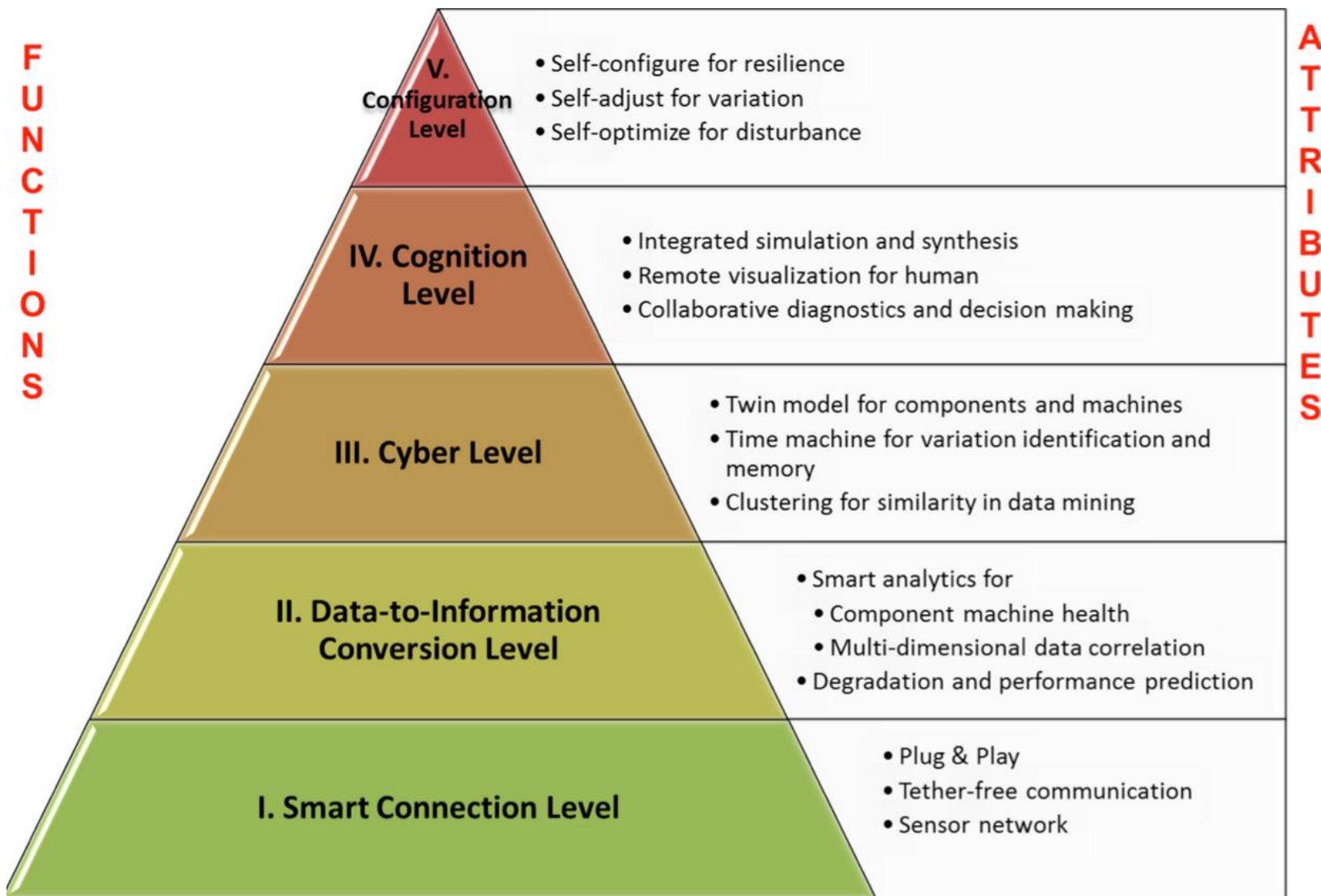**Batch Production Control**

Continuous Production Control

Discrete Production Control

L0 — **Actual Production Process**

5C ARCHITECTURE FOR DESIGNING CYBER-PHYSICAL SYSTEMS IN MANUFACTURING

FUNCTIONS

ATTRIBUTES

V. Configuration Level
- Self-configure for resilience
- Self-adjust for variation
- Self-optimize for disturbance

IV. Cognition Level
- Integrated simulation and synthesis
- Remote visualization for human
- Collaborative diagnostics and decision making

III. Cyber Level
- Twin model for components and machines
- Time machine for variation identification and memory
- Clustering for similarity in data mining

II. Data-to-Information Conversion Level
- Smart analytics for
  - Component machine health
  - Multi-dimensional data correlation
- Degradation and performance prediction

I. Smart Connection Level
- Plug & Play
- Tether-free communication
- Sensor network

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MULTIPLE FRAMEWORKS

Industry 4.0 Standard

OPC-UA Protocol (Unified Architecture)

Industrial Internet Architecture

Data Distribution Services & HTTP

Common Industrial Protocol (CIP)

EtherNet/IP Framework

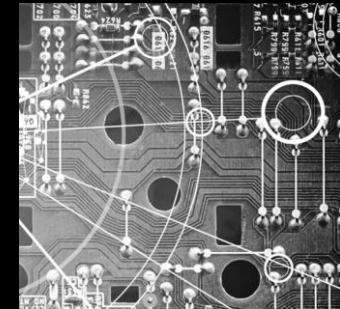**Lightweight Publish/Subscribe Messaging Transport**

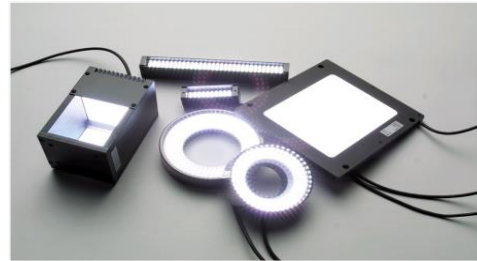**Limit Bandwidth Applications**
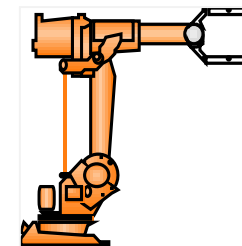
COMMON GOALS

Security

Data Integrity

Interoperability

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COGNEX TECHNOLOGY EXAMPLES

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KEY PARTS OF A VISION SYSTEM

Light Source

Communication

I/O Comm.

Lens	Camera	Vision Software
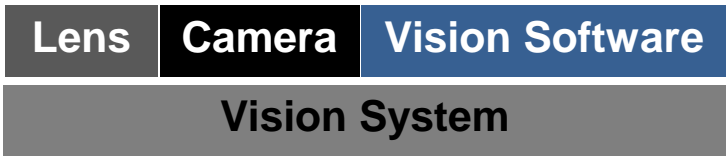
Vision System

Inputs/Outputs: switches, PLCs, robots, lights

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IN-SIGHT 7000 SERIES

Powerful vision system with unprecedented modularity and integration

Onboard SD card for additional data storage

Suite of enhanced vision tools including PatMax RedLine®, SurfaceFX™ and OCRMax®

Wrap-around LED indicator light for visual pass/fail inspection results

Flexible Image Technology™ optimizes image formation and reduces reliance on external lighting

IP67-rated housing

Field-changeable C-mount, S-mount and autofocus lenses for best image resolution based on working distance

Step-by-step setup with EasyBuilder®

PICK AND PLACE EXAMPLE

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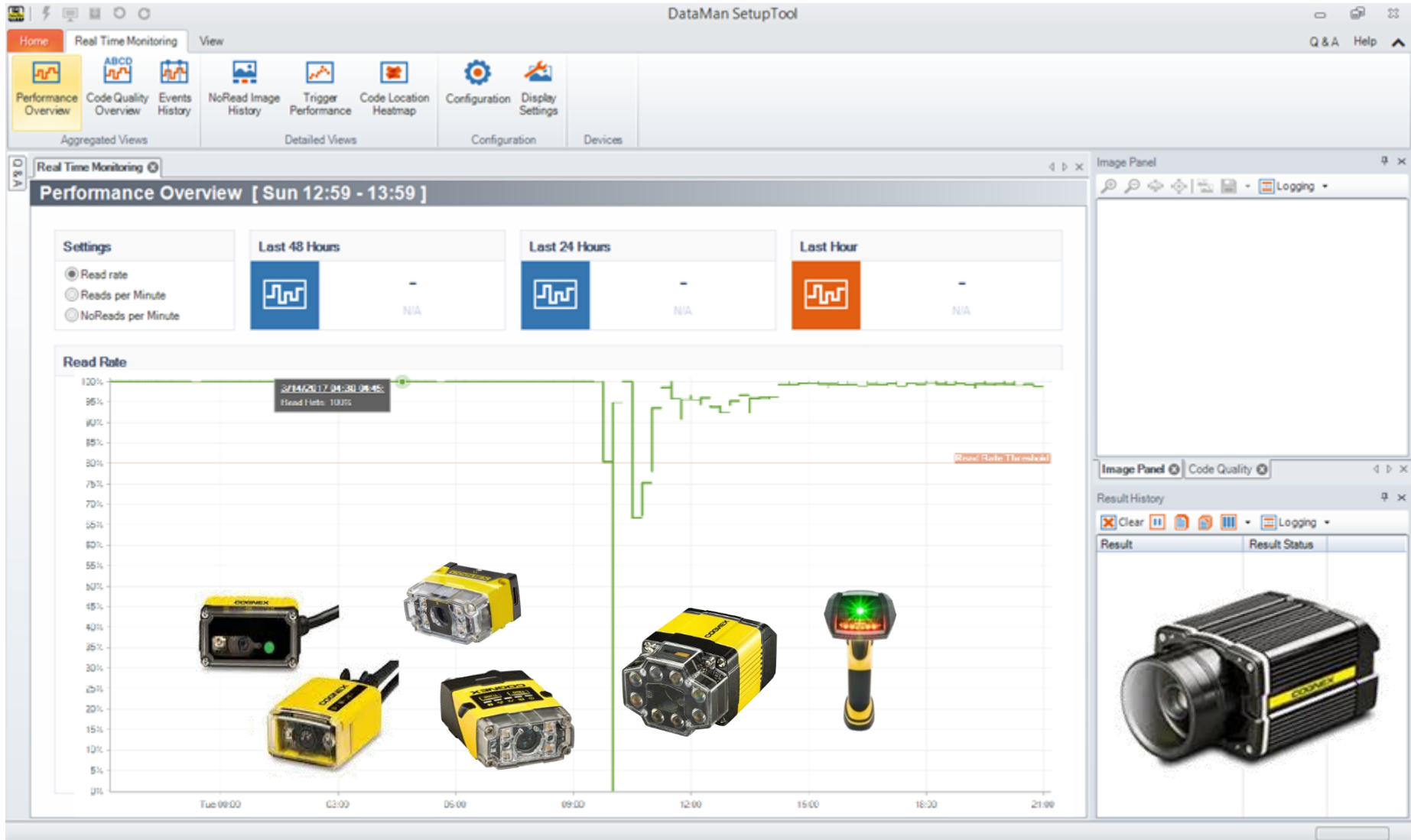**COGNEX**
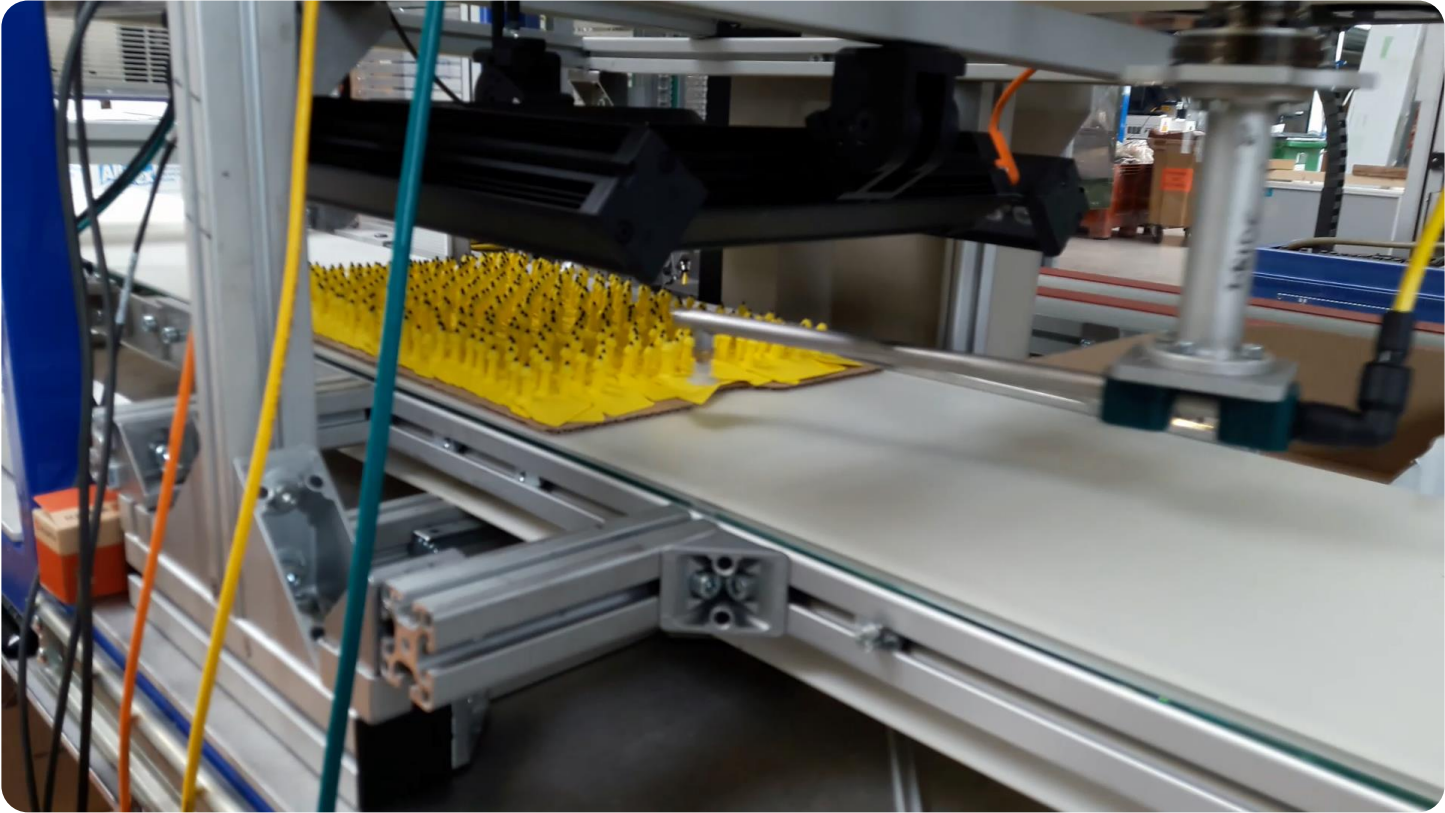
IN-SIGHT SMART CAMERA APPLICATION

- **Application:**
  - Pick & place cattle ID tags

- **In-Sight solution:**
  - IS8402, with SurfaceFX and PatMax RedLine

- **Success factors:**
  - SurfaceFX with external light for large FOV
  - PatMax Redline speed
  - Ease-of-use

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IN-SIGHT VC200 HTML5 HMI

Local HMI via HDMI display and USB mouse/keyboard

Remote HMI via web browser

Or Ethernet

remote computer

Tablet

Mobile Phone

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COGNEX EXPLORER RTM

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NO READ IMAGE HISTORY

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SUMMARY

- I4.0 Is defined as Cyber Physical system of which machine vision can be an important element.

- Gauging, Inspection, Guidance, and Identification are the key applications

- Key components are the lens, camera, lighting, vision software and communications

- Make products better, faster, and less expensively

- Don't go it alone…get help from experts!

- Cognex and Routeco can help..

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THANK YOU!

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SUMMARY

- **Industry 4.0 and IIoT**
  - **Common goals**
  - **Different technologies**

- **Information Technology and Operational Technology**
  - **Converge for a secure common network**
  - **More peer-to-peer communications**

- **Essential Tools**
  - **Machine vision systems**
  - **Vision based bar code readers**

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TODAY vs. TOMORROW

Security

- Local (if any) credentials

- Active Directory Server
- Group Policies

Data Integrity

- Device specific methods
- Asset management software

- Integrated audit trails
- Integrated historians

Interoperability

- Vendor-specific protocols
- Multiple gateways

- Common protocols
- Edge gateways

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