Ensuring Readable Codes with Machine Vision Verification

Live Q&A following the presentation.

Presented by:

Nico Hooiveld

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Microscan Product Manager, Machine Vision

Product Manager for Microscan’s complete machine vision line, Nico has over 20 years of experience in the auto ID and machine vision industry supporting technical applications and influencing solutions from smart cameras to software to lighting.

To ask a question during the following presentation, please use the Questions window in the GoToWebinar interface. Questions will be queued and answered after the presentation.
Ensuring Readable Codes with Machine Vision Verification

- The Problem with Unreadable Codes
- Why Good Codes Go Bad
- The Solution: Machine Vision Barcode Verification
- What is Verification
- Different Levels of Verification: Verification vs. Validation
- Examples
- Solution Requirements
- Verification with AutoVISION™
The Problem with Unreadable Codes...
Process Downtime

- Relabeling
- Re-scanning
- Manual Data Entry
Loss of Product Traceability

- Internal Track & Trace
- Supply Chain Visibility
Rejected Shipments

- Customer Fines
- Costly Returns
## Supplier Disqualification

- **Required compliance with standards**
- **Negative perception of quality practices**

### Approved Vendor List

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Contact</th>
<th>Overview</th>
<th>Compliance with ISO 15415</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC Company</td>
<td>1-757-899-3992 <a href="mailto:abc@abcco.com">abc@abcco.com</a></td>
<td>ABC Provides top-notch components for you</td>
<td>✓</td>
</tr>
<tr>
<td>Business Two</td>
<td>1-223-425-3344 <a href="mailto:info@abcco.com">info@abcco.com</a></td>
<td>Provides great products</td>
<td>✓</td>
</tr>
<tr>
<td>Manufacturing Co.</td>
<td>1-244-9002-2998 <a href="mailto:info@mfgco.com">info@mfgco.com</a></td>
<td>Manufacturer of high quality products</td>
<td>✓</td>
</tr>
<tr>
<td>Vandelay Industries</td>
<td>1-568-425-3344 <a href="mailto:art@vandelay.com">art@vandelay.com</a></td>
<td>Latex and related products</td>
<td>✓</td>
</tr>
<tr>
<td>XYZ Manufacturing</td>
<td>1-223-425-3344 <a href="mailto:xyz@abcco.com">xyz@abcco.com</a></td>
<td>Widgets for manufacturing</td>
<td>✓</td>
</tr>
</tbody>
</table>
Why Do Good Codes Go Bad?
Why Do Good Codes Go Bad?

- Every Marking System Degrades Over Time
- Barcodes NEVER Get Better After Leaving the Marking System
- Human Error Can Result in Product Mix-Ups
The Solution:
Machine Vision Verification
Verification ensures that EVERY product ships with a good quality barcode.
What Is Machine Vision Verification?

- Verification is measuring the quality of a barcode to a published standard
  - ISO 15415/AIM DPM : 2D symbols
  - ISO 15416 : 1D symbols
- Verification results are expressed in grades
  - 4 / A = perfect  - 0 / F = very poor
- Machine vision verification is camera-based
  - Images are captured for processing by machine vision software
Reading vs. Verification

- Reading tells you only that the code can be read right now by your reader. It may still be unreadable by your customer’s reader.

- Verification tells you not only that you can read a mark, but also how close you are to the edge of readability or if you are heading that way. It ensures that any suitable reader can read.
Find out if the marking system is creating poorer marks before you have a problem

Without verification, thousands of “bad” parts escape into the process

With verification, we prevent bad barcodes from ever being made
2 Levels of Quality Grading

- **Process Control/ Validation**: validate the quality of the applied mark to internal quality standards

- **Conformance Verification**: verify that the applied mark meets ISO or AIM standards
Printed Symbols and DPM

- Printed High Contrast Symbols
  - High contrast
  - Some form of printing
  - Substrate is controlled

- Direct Part Marks (DPM)
  - Lower contrast
  - Mark is typically applied by some form of controlled violence
    - Dot peen
    - Laser deposition or ablation
    - Chemical etching
  - Substrate is “as you find it”

ISO 15415 - Printed High Contrast 2D symbols
ISO 15416 - Printed High Contrast 1D symbols
AIM DPM - Direct Part Marks
## AutoVISION Verification

### 2D Verification Evaluation Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Example</th>
<th>ISO 15415</th>
<th>AIM DPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial Non-Uniformity</td>
<td>Amount of deviation along a symbol's major axes</td>
<td><img src="image1.png" alt="Axial Non-Uniformity Example" /></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Symbol Contrast</td>
<td>Difference in reflectance between light and dark symbol elements</td>
<td><img src="image2.png" alt="Symbol Contrast Example" /></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Cell Contrast</td>
<td>Difference in grayscale value between light and dark symbol elements</td>
<td><img src="image3.png" alt="Cell Contrast Example" /></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Modulation</td>
<td>Deviation in grayscale values of symbol elements</td>
<td><img src="image4.png" alt="Modulation Example" /></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Cell Modulation</td>
<td>Deviation in grayscale values of symbol elements</td>
<td><img src="image5.png" alt="Cell Modulation Example" /></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Decodability</td>
<td>Legibility per a reference decode algorithm</td>
<td><img src="image6.png" alt="Decodability Example" /></td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
## 2D Verification Evaluation Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Example</th>
<th>ISO 15415</th>
<th>AIM DPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Pattern Damage</td>
<td>Damage to the quiet zone, finder pattern, or clock pattern</td>
<td><img src="image1.png" alt="Damage Example" /></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Grid Non-Uniformity</td>
<td>Amount of deviation of grid intersection</td>
<td><img src="image2.png" alt="Non-Uniformity Example" /></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Minimum Reflectance</td>
<td>Minimum reflectance of light elements</td>
<td><img src="image3.png" alt="Reflectance Example" /></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Reflectance Margin</td>
<td>Degree to which each module is correctly distinguishable compared to the global threshold</td>
<td><img src="image4.png" alt="Reflectance Margin Example" /></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Unused Error Correction</td>
<td>Remaining error correction available</td>
<td><img src="image5.png" alt="Unused Error Example" /></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
## AutoVISION Verification

### 1D Verification Evaluation Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Example</th>
<th>ISO 15416</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decodability</td>
<td>Legibility per a reference decode algorithm</td>
<td><img src="barcode1.png" alt="Example" /></td>
<td>✔️</td>
</tr>
<tr>
<td>Defects</td>
<td>Voids in bars or spots in spaces</td>
<td><img src="barcode2.png" alt="Example" /></td>
<td>✔️</td>
</tr>
<tr>
<td>Edge Determination</td>
<td>Detection of all bars and spaces using a global threshold</td>
<td><img src="barcode3.png" alt="Example" /></td>
<td>✔️</td>
</tr>
<tr>
<td>Minimum Edge Contrast</td>
<td>Minimum reflectance difference for any bar/space combination</td>
<td><img src="barcode4.png" alt="Example" /></td>
<td>✔️</td>
</tr>
<tr>
<td>Minimum Reflectance</td>
<td>Reflectance of the darkest bar vs the lightest space</td>
<td><img src="barcode5.png" alt="Example" /></td>
<td>✔️</td>
</tr>
</tbody>
</table>
AutoVISION Verification

1D Verification Evaluation Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Example</th>
<th>ISO 15416</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulation</td>
<td>Relation between wide and narrow symbol elements</td>
<td><img src="image" alt="Modulation Example" /></td>
<td>✓</td>
</tr>
<tr>
<td>Symbol Contrast</td>
<td>Difference in reflectance between the darkest bar and the lightest space</td>
<td><img src="image" alt="Symbol Contrast Example" /></td>
<td>✓</td>
</tr>
<tr>
<td>Quiet Zone</td>
<td>Size of the quiet zone</td>
<td><img src="image" alt="Quiet Zone Example" /></td>
<td>✓</td>
</tr>
</tbody>
</table>

- ISO 15416 samples the symbol at 10 locations across the height
Direct Print on Cardboard Cartons

- Direct printing is economical
- Symbol quality varies greatly
- Large retailers fine vendors for no reads

**Solution:** Monitoring and control of 1D direct marks on cartons. Verify to ISO 15416.
Laser Marked PCBs

- Marked in process
- Low contrast marks
- Marks are essential for traceability
- No reads slow throughput
- Unreadable codes may cause expensive parts to be scrapped

**Solution**: Custom Validation Solution for Inline Process Control.
Printed Labels on Pharmaceuticals

- 1D and 2D Verification
- High Mark Contrast
- Substrate is Controlled
- Stringent Traceability Requirements

**Solution:** 1D and 2D Verification to ISO 15415 and 15416 Standards.
Solution Requirements
Software

- Robust software with standards-based verification using parameters specific to ISO or AIM barcode quality standards.
Camera

- Smart Cameras with integrated lighting for process control/validation applications.

- Barcodes that must comply with published quality standards require a verification system with superior optics (i.e., C-mount lens)
Lighting

- True verification requires a compliant light
- ISO 15415 specifies:
  - 4 sided light at 45 degree angle (45)
  - 4 sided lights at 30 degree angle (30)
  - A 90 degree light (90)
- AIM DPM additionally specifies:
  - 1 and 2 sided lights
  - Dome light
- ISO 15416 does not specify lighting
Verification with AutoVISION™

SIMPLE JUST GOT SMARTER
Why Use AutoVISION for Verification?

- AutoVISION is targeted at **inline** symbol verification
- Verify or validate the symbol immediately after printing
- Deviate from the standards if process or circumstances require
- Provide results that correlate directly with ISO and AIM standards
- Verify per the standards with the proper setup
AutoVISION Verification

Supported Verification Options

<table>
<thead>
<tr>
<th>Verification Standard</th>
<th>Vision MINI or Vision HAWK Internal Illumination</th>
<th>Vision MINI Standard + Compliant Light</th>
<th>Vision HAWK C-Mount + Compliant Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 15415</td>
<td>Not recommended</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>ISO 15416</td>
<td>Not recommended</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>AIM DPM</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>ISO 15416, compensated</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Two levels of quality grading:

√ - Process Control/Validation: validate the quality of the applied mark to internal quality standards

√ - Conformance Verification: verify that the applied mark meets ISO or AIM standards

Conformance verification is possible with an ISO or AIM DPM compliant setup and strictly controlled ambient light and operating distance.
AutoVISION Verification

Recommended Platforms

- Three convenient smart light configurations available today:
  - Red DOAL ®
  - Pharmalite
  - Red HI-BRITE 300 Wide

  - Allowed per ISO 15415 and AIM DPM
  - Close to ISO and AIM low angle light
  - Verification of large 1D codes

Vision HAWK C-Mount Smart Camera
NERLITE® Smart Series DOAL® with Vision MINI smart camera
NERLITE® Smart Series HI-BRITE 300
NERLITE® Smart Series Pharmalite
AutoVISION Verification

System Calibration

- Calibration required for measuring reflectance (contrast) and dimensions
- AutoVISION can validate symbols without calibration
- A single calibration card is used for all three standards
- Values on the card are to be copied into the calibration setup screen

**CALIBRATION CARD**

**Dimensions and Reflectance**

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>NOMINAL</th>
<th>ACTUAL (MEASURED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflectance (Min.)</td>
<td>4%</td>
<td>62%</td>
</tr>
<tr>
<td>Reflectance (Max.)</td>
<td>82%</td>
<td></td>
</tr>
<tr>
<td>Symbol 1 Width (X)</td>
<td>0.240 IN.</td>
<td></td>
</tr>
<tr>
<td>Symbol 2 Width (X)</td>
<td>0.480 IN.</td>
<td></td>
</tr>
</tbody>
</table>

Standards: AIM DPM, ISO/IEC 15415, ISO/IEC 15416
Wavelength: 840nm

Calibration is only valid when serial number and measured values are included.

SERIAL NUMBER: __________ MICROSCAN P/N: 10-000522-01
AutoVISION Verification

Custom Verification

- Pass/fair/fail levels can individually be set at the parameter level
- Validation can be tailored to process requirements
- Custom verification does NOT meet standards requirements when parameters are disabled
AutoVISION Verification

ISO 15416 Signal Compensation

- True 1D verification needs an even illumination across the entire symbol
- Use of built-in lens and light will cause verification to fail due to uneven illumination
- Signal compensation option normalizes the signal before verification
- Compliant illumination is needed for true verification!
AutoVISION Verification

2D Verification to ISO 15415
AutoVISION Verification

1D verification to ISO 15416
Conclusion

- Unreadable Codes Are Bad For Business!
- Barcode Verification Ensures that EVERY Product Ships with a Readable Code
- AutoVISION™ Enables Simple Verification and Validation of 1D and 2D Codes
Thank You

- If you have questions regarding this presentation or topic, please send an e-mail to info@microscan.com.

- For further information about barcode, machine vision or lighting products, visit our website at www.microscan.com.