Single Pass Printing for Labelling & Packaging
- A Software & Electronics Perspective

Presented by
Debbie Thorp, Business Development Director
Global Inkjet Systems Ltd

AWA Labelling & Packaging Print Seminar
8-9 November 2011
Agenda

- **Single pass systems**
  - Labelling, packaging
  - Product decoration
    - The move to no labels
- **Stitching & colour registration**
- **Data processing**
- **Production issues & challenges**
  - Zero gap & overlap printing
  - Pause, rewind, resume
- **Curved surface printing**
  - Direct product printing – no label
Single Pass Evolution – Labelling & Packaging

Long established single pass systems

DRUPA 2000: Dotrix Dot Factory
High res/greyscale
2 heads wide

DRUPA 2004: Inca FastJet
demo
52cm wide 200x300dpi
1.6m/sec

Inca FastJet
104 cm wide

DRUPA 2008/ IPEX 2010/ Label Expo 2011

IIJ
Up to 35 cm wide

PPSI - DICE
Up to 56cm wide

Agfa Dotrix
63cm wide

Nilpeter Caslon
310-420mm wide
greyscale

Domino N600

CSAT

Jetrion 4900

Linoprint

Global Inkjet Systems © 2006/11
Single Pass Evolution – Industrial Manufacturing

**Ceramic Tiles**
- Kerajet K700/720
- 1m - 1.26m wide

**Textiles**
- MS Italy La Rio
- Up to 75m min
- 1.6m wide

**Industrial Product Decoration**
- Ceramic Tiles
- Laminates
- Textiles
- Food

**Ferro Kerajet**
- 35cm wide
- 180dpi

**SMT Digital**
- 2000

**ITW TransTech InDecs**
- 2008

**Global Inkjet Systems © 2006/11**

2000

2008

2010/2011
Single Pass Evolution – Number of Printheads

<table>
<thead>
<tr>
<th>Product</th>
<th>Printhead Type</th>
<th># Printheads</th>
<th>Colours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nilpeter: Caslon</td>
<td>Xaar 1001</td>
<td>Up to 24</td>
<td>CMYK</td>
</tr>
<tr>
<td>Agfa: Dotrix Modular</td>
<td>TTEC</td>
<td>Up to 72</td>
<td>CMYK + OV</td>
</tr>
<tr>
<td>Cretaprint: Cretaprinter</td>
<td>Xaar 1001</td>
<td>Up to 96</td>
<td>Up to 8</td>
</tr>
<tr>
<td>MS Italy: La Rio</td>
<td>Kyocera KJ4</td>
<td>Up to 120</td>
<td>Up to 8</td>
</tr>
</tbody>
</table>

> 1m wide systems
> 100 heads
Scanning vs. Single Pass

• **Scanning**
  – Safe and reliable
  – Errors recoverable
  – Lower productivity

• **Single pass**
  – No room for error
  – Defects highly visible
    • Missing nozzles
    • Jet straightness
    • Consistent jet velocity
  – High productivity
  – Reliability critical

Source: Industrial inkjet
Printhead Stitching

• Why is a good stitch important?
  – The human eye is very good at spotting discontinuities especially in areas of flat colour

• What needs to be controlled?
  – **Printhead alignment**: typically positioned to within <20% of the diameter of a drop
  – **Printhead calibration**: printheads ideally need to be tuned for jet straightness and drop size conformity
  – **Ink substrate interaction**: Ink moves over time creating visible artefacts – ink migration control

• Stitched printheads do not all jet in the same place at the same time

• Some will be printing *wet on dry* while others will print *wet on / near wet*
Stitching Strategies

• **Digital stitching strategies**
  – Can massively improve output quality
  – Different applications benefit from different strategies

• **50% stitch**
  – Printing with alternating lines from each printhead in the region of overlap. Simple to implement

• **1-D density**
  – Density gradient blend from 1 printhead into the next in the cross print direction
  – Good where media can stretch. Better than 50% stitch

• **2-D density**
  – Same as 1-D but with dithering in the print direction
  – Better than 1-D but requires excellent media control to avoid white gaps

• **Moving stitch**
  – Typically a sinusoidal or saw tooth stitch that disrupts the visible stitch line
  – Can be improved by using different frequencies for each ink
Stitching Examples

“Flat” or “No” Stitch across flat colour

‘Moving Stitch’ across flat colour

Higher Density Bands

• **Software solutions**
  – GIS tools give customers the power to develop their own stitching strategies
  – Choice all depends on the application and substrate
Poor Colour Registration Image Effects

- Images are less clear
- Text less readable
- Fine detail is lost
- Colours are not accurate
  - Gamut reduced
- Some images look worse than others
- Mono text & graphics tend to look ok
Causes of Poor Colour Registration

• Mechanically misaligned printhead/s

• Time of flight variation
  – Printhead waveform settings
  – Height off the substrate

• Encoder noise/jitter

• Substrate/web errors
  – Web weave
  – Web stretch and compression

• Media wetting/drying
Improving Colour Registration

- Mechanical/software alignment for misaligned printheads
- Printhead calibration
- Head height
- Mechanical alignment
- Dryer
- Noise filtering & quadrature
- Input management
- Encoder jitter
- Web stretch & compression
- Mechanical substrate control & multiple encoders
- Substrate dependent
- System configuration – corona etc
Critical Datapath Challenges of Single Pass Systems

• Number of printheads
  – Greyscale printheads

• N-colours
  – 8+ colours

• Pre-coat & varnish

• Print speed
  – >1m/sec

• Variable data usage
  – Partially variable
  – Every image different
    • Natural material simulation

• Wide widths
  – >1m becoming well established

• Increasing demands on print data
Increasing Demands on Print Data

• **Application Drivers / Quality Improvements**
  
  – **Monochrome vs. Colour**: Process colour requires at least 4 times the amount of data of monochrome
  
  – **Resolution and Greyscale**: Increasing resolution and moving to greyscale all require more data per square mm
  
  – **Static vs. Variable Data**
    
    – **Static**: All print data can be downloaded to print electronics before printing
    
    – **Partially Variable**: Similar to static data but a small section is downloaded on each print
    
    – **Fully Variable**: New print data needs to be downloaded every time at the speed it is consumed by the printheads
# Variable Data Applications

<table>
<thead>
<tr>
<th>Application Example</th>
<th>Requirements</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking</td>
<td><strong>Data Path</strong> Partially variable</td>
<td><img src="image1" alt="Tracking Example" /></td>
</tr>
<tr>
<td></td>
<td><strong>RIP</strong> Real-time</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Text/Barcode</strong> Fully variable</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Images</strong> Pre-cached</td>
<td></td>
</tr>
<tr>
<td>Late Stage Product Customisation</td>
<td><strong>Data Path</strong> Partially variable</td>
<td><img src="image2" alt="Late Stage Example" /></td>
</tr>
<tr>
<td></td>
<td><strong>RIP</strong> Offline</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Text/Barcode</strong> Static/fully variable</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Images</strong> Pre-cached/fully variable</td>
<td></td>
</tr>
<tr>
<td>Number Plate Printing</td>
<td><strong>Data Path</strong> Fully variable</td>
<td><img src="image3" alt="Number Plate Example" /></td>
</tr>
<tr>
<td></td>
<td><strong>RIP</strong> Real-time</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Text/Barcode</strong> Fully variable</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Images</strong> Pre-cached</td>
<td></td>
</tr>
<tr>
<td>ID Card/Passport Printing</td>
<td><strong>Data Path</strong> Fully variable</td>
<td><img src="image4" alt="ID Card/Passport Example" /></td>
</tr>
<tr>
<td></td>
<td><strong>RIP</strong> Real-time</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Text/Barcode</strong> Fully variable</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Images</strong> Fully variable</td>
<td></td>
</tr>
<tr>
<td>Natural Material Printing</td>
<td><strong>Data Path</strong> Fully variable</td>
<td><img src="image5" alt="Natural Material Example" /></td>
</tr>
<tr>
<td></td>
<td><strong>RIP</strong> Offline</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Text/Barcode</strong> N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Images</strong> Pre-cached</td>
<td></td>
</tr>
</tbody>
</table>
Industrial Inkjet Printhead Data Rates

- Printhead data rates have increased over 100 times over the last 15 years
- Colour/Resolution/Speed/Variable Data/ # of Heads

### Data Rate Per Head (Mb/s)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyocera KJ4B</td>
<td>128</td>
<td>128</td>
<td>500</td>
<td>256</td>
<td>1001</td>
<td>512</td>
<td>1024</td>
<td>512</td>
<td>256</td>
<td>2656</td>
<td>2656</td>
<td>2656</td>
<td>2656</td>
</tr>
<tr>
<td>Kyocera KJ4A</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dimatix Sapp/10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dimatix Polaris/35</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Konica 1024 L</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Konica 512 S</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Xaar 1001</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Xaar 500/40</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dimatix SL-128</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Xaar 128/80</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Printhead Specifications

- **Nozzles**: 128, 128, 500, 256, 1001, 512, 1024, 512, 256, 2656, 2656, 2656
- **Grey Levels (non-zero)**: 1, 1, 1, 1, 7, 3, 1, 1, 1, 3, 4, 4
- **Bits per nozzle**: 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 3, 2
- **Sub-drop Freq (kHz)**: 5, 30, 8, 20, 50, 20, 7.6, 30, 50, 20, 30
- **Native Resolution (dpi)**: 185, 50, 180, 100, 360, 360, 360, 200, 100, 600, 600
- **Head Height (mm)**: 17.4, 64.5, 70.4, 64.8, 70.5, 36.1, 72.2, 64.8, 64.8, 108.2, 108.2
- **Date Rate Per Nozzle (kb/s)**: 5, 30, 8.2, 20, 29.3, 13.3, 7.6, 20.4, 16.96, 63.8, 63.8
- **Data Rate Per Head (Mb/s)**: 0.6, 3.8, 4.1, 5.1, 29.3, 6.8, 7.8, 10.4, 4.3, 169.4, 169.4
Challenges for RIP and Workflow Manufacturers

Graphics Designers ➔ Jobs ➔ Partially Variable Print Engine ➔ Partially Variable Output

Single pass inkjet press

Fully variable print applications require vast amounts of data and artwork

Graphics Designers ➔ Jobs ➔ Fully Variable Print Engine ➔ Fully Variable Output

Single pass inkjet press
Large Single Pass System
Single PC Architecture Example

Single PC Solution
- Limited Processing Speed
- Limited Memory Bandwidth
- Limited Peripheral I/O
- Slow Start Up
- Limited Variable Capability
Large Single Pass System
Multiple PC Architecture Example

Full Variable Data Capability

RIP Server
User Interface Control

TCP / IP (Network)

PC running GIS master controller software

Slave 1
Slave 2
Slave 3

PCs running GIS software

Additional Print Controllers

Open inkJet Systems © 2006/11
Zero Gap & Overlap Printing

• Ideally suited for combining inkjet with traditional printing

• Traditional printing techniques can have zero gap between plates
  – Adding inkjet requires a hardware Print/Go with zero gap or close to zero gap

• Overlap printing solves this issue allowing:-
  – Small inter-label gaps; zero gaps; and even negative inter-label gaps or ‘overlap’
Zero Gap & Overlap Printing
• Problems unconnected with the printing station may require the line to be stopped; backed up; and then restarted
• If a production line is stopped, a short distance of additional travel is beneficial to cure the ink
• Print, Pause, Rewind, Resume allows production lines to be stopped, reversed and the print resumed precisely from the point it was stopped
Curved Surface Printing

- **Direct product printing**
  - More flexible than label printing
  - Cuts out at least one step in the production process
  - No need to manage label stock
  - Less waste

- **Some of the key issues include:**
  - Throw distance
  - Jet straightness
  - Drop density
Curved Surface Printing

Resolution changes when printing onto curved surfaces
Printing Without Correction

- Nozzle misalignment
- Changes in dot gain
- Time of flight differences
- Increasing Density
Printing with Partial Correction

- No density correction
- No screener correction

Incorrect density

Screener artefacts
Printing with Correction

- Correct nozzle alignment
- Density correction
- No dot gain issues
- No screening artefacts

Image distortion can also be managed in original artwork
GIS Curved Surface Map Generator

![GIS Utility - Curved Surface Map Generator](image_url)

- **Shape Preview**
- **Shape Type**
  - **Shampoo**
    - **Property** | **Value**
      - **Long Edge** | 86.362500
      - **Short Edge** | 53.090000
      - **Outer Curve** | 14.769000
      - **Inner Curve** | 8.180000
    - **Printhead**
      - **Invert Nozzle X** | False
      - **Invert Nozzle Y** | False
    - **Export**
      - **Export Folder** | C:\Program Files\Global ...
      - **Filename** | 
      - **Number of Inks** | 4

- **Status**
  - Ink 2 of 4
  - Running correction map...
  - Calculating correction for section 2 of 8

![Generate Correction Map](image_url)
Summary

• **Inkjet technology acceptability**
  – Printhead reliability
  – System reliability
    • System electronics architecture
    • Software capabilities
    • Datapath capacity

• **New application developments driven largely by:**
  – Advanced product handling/system design
  – Sophisticated software features
Contacts

**Nick Geddes**, Managing Director
nick.geddes@globalinkjetsystems.com

**Jim Brotton**, Director
jim.brotton@globalinkjetsystems.com

**Debbie Thorp**, Business Development Director
debbie.thorp@globalinkjetsystems.com

**Global Inkjet Systems Limited**
St. John’s Innovation Centre
Cowley Road
Cambridge CB4 0WS

Tel: +44 (0)1223 421 522
Web: [www.globalinkjetsystems.com](http://www.globalinkjetsystems.com)