

# Inkjet Decoration & Coating of Consumer Products & Industrial Parts

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### Agenda



- Brief introduction to GIS
- Introduction to Direct to Shape (DTS)
- Decoration on cylinders, cones & tubs
- Functional coatings with inkjet
  - Challenges and solutions
- More complex shapes
  - Some more challenges and solutions

#### Image source: GIS

# Global Inkjet Systems Ltd

- Leading independent developer of inkjet technology
  - Supply inkjet capability to OEM system builders, specialist integrators and end users
  - Support a broad range of inkjet printheads in wide range of applications and industries
- Based in Cambridge, UK
  - 12+ years of growth & technology innovation
  - 70+ employees
  - 130+ customers world-wide
  - Support offices in UK, Japan and China











#### **GIS - Product Groups**





Atlas<sup>®</sup> User Interface **Raster Image Processing** 

Atlas<sup>®</sup> Server

Datapath & **Drive Electronics**  Controlled Temperature, Pressure and Flow

- GIS provides key technology to industrial inkjet systems builders, specialist integrators ۲ and large end users
- From pixels to droplets: we supply technology for the whole data pipeline from image to print



#### Disclaimer

Global Inkjet Systems supplies inkjet technology and components to 130+ original equipment manufacturers world-wide. As a matter of policy, we do not disclose our customer relationships.

Some of the following slides contain images chosen to illustrate the range of inkjet print systems which are available in the market. The presence, or absence, of any manufacturer's products in these images does not in any way imply a commercial relationship between that manufacturer and GIS.

# Inkjet DTS Development Timeline





Image source: Mimaki, InkCups Now, EPS, Krones, Machines Dubuit, Nakan, ITW, Martinenghi, Plastic-Molds, Wifag

# Inkjet – Direct to Shape



- Not everything we want to decorate or coat is flat
- Tubes, cones, tubs now well established technology
  - Many systems low & high production
  - Glass, plastics, aluminium
- Cones & tubs require correction in software









#### Tubes



- Well established/well understood technology
  - Fixed radius of curvature
  - Cylinder unwraps to a rectangle or square
- Flight time differences become more complex as print speed is increased, and/or radius of curvature decreased
  - Printheads with slim format/two rows of nozzles popular
  - Flight time difference can be significant for multi-column print heads





#### Cones



- Cones or cone sections are useful for many applications
  - Unfolds to an arced rectangle / section of a circle
  - Corrections are relatively straightforward, provided heads are narrow and mounted symmetrically – more complex for larger heads
- Challenges
  - Nozzle alignment
  - Density correction
  - Dot gain management
  - Avoid screening artefacts





#### Tubs



- Mixture of cone sections and flat surfaces
- Required corrections change during the print
  - Often from pixel to pixel
- Print system is more complex
  - No longer rotating about a single axis
  - Transport design may require a synthetic encoder



		-	
	Snape Type	Tub	~
	Printhead Type	Gen5-1C	~
	Property	Value	
	Shape Dimension	s	^
<b>1 9 2</b>	<ol> <li>Long Edge</li> </ol>	86.362500	
	2 Short Edge	53.090000	
	3 Outer Curve	14.769000	
	Inner Curve	8.180000	
	Printhead		
	Invert Nozzle X	False	
	Invert Nozzle Y	False	
	Printheads per ink	1	
	Export		
4	Export Folder	C:\ProgramData\Global	
	Filename	Tub	
	Number of Inks	1	
	Split map into printhe	ad False	
Generate Correction Map	Create zero map	True	
	Invert Map Y	False	
15	Advanced		
	Error Diffusion Factor	0.990000	
	Random Noise	0 200000	~

Image source: GIS software, Wifag

### Many DTS Systems Available













Image source: InkCups Now, Engineered Print Solutions, Machines Dubuit , Hinterkopf, Martinenghi

#### Inkjet Challenges – Curved Surfaces



	Flat Surfaces	Curved Surfaces
Density Correction		
Throw Distance & Flight Time		
Nozzle Alignment & Interleaving		
Screening		

#### **More Complex Shapes**



- Many complex shapes have eluded inkjet printing & coating
- Analogue technologies dominate
- Inkjet moving from partial to full coverage printing / coating of any object







Photo credit: © Upper Austrian Research, Hartwig Zörgl

#### Inkjet Challenges – Navigation & Motion Control



	Flat Surfaces	Curved Surfaces
Geometry	2 Dimensions 2 Degrees of Freedom	3 Dimensions 6 Degrees of Freedom
Print Path		
Shape Data		
Motion Control		

# **Inkjet Challenges - Jetability**



- Viscosity
  - Most drop on demand printheads require fluids with viscosities in the range 7-15 centipoise (cps) at jetting temperature
    - Higher viscosity fluids can be heated to reduce viscosity to be jettable
    - Some new printhead developments will enable higher viscosities
  - Opportunities for inkjet to add efficiency and precision drop placement



Image source: JetXpert

Ligament volume measurement

View droplet formation

#### Inkjet Challenges – Throw Distances



- Inkjet printers are typically designed to throw ink drops a distance of 1 2mm to the surface
  - This produces sharp, detailed graphics and text down to 2pt @ 1200dpi
  - And works well even when the head or surface are moving at up to 5m/s relative speed
  - But has created a perception that greater throw distances are a problem
- In fact, nozzle drop velocities are in the range 5-8m/s
  - Medium to large drops will travel over 20mm
  - Placement accuracy does degrade with range, so a trade-off must be found
    - Fine detail can be achieved on near-flat surfaces with shorter throw distances
    - Coating coverage can be achieved even in concavities up to ~25mm depth











- Typical spray path
- Two passes overlap
- Begins & finishes off the part
- Can't be controlled over gaps

#### **Disadvantages of Spray**



10 © Cyan Tec Systems Ltd. 2018

www.cyan-tec.com





- Product surface 575cm<sup>2</sup>
- Spray pattern 2,243cm<sup>2</sup>
- Waste 1,668cm<sup>2</sup>
- Waste 74%

# **Disadvantages of Spray**



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# The Robotic Digital Deposition Process

- Complete piano black facia
- Scratch resistant coating
- Zero overspray
- Virtually zero waste
- >70% material reduction
- >70% VOC emissions reduction



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06/03/2019



#### Complex Shapes - From Concept To Reality

- Starting with a sphere
- Using a robot to position the shape under the printheads
- We built a test print rig



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# Mesh & Texture



#### 3D Mesh







#### • Many tools available for wrapping

- Well established technologies from gaming, augmented reality industries, etc.
- Many different ways to wrap, edit directly on to 3D surfaces
- Result is expressed as a texture map



# **Print Paths**





- Design a print path
  - Taking into account the constraints of the object to be printed, inkjet printhead, capability of the robot

# Positioning Accuracy



Industrial robots have sufficient accuracy for many industrial applications ...



#### ... but printing requirements are tight

- Typical industrial robots can achieve absolute pose accuracy with calibration of 200-500  $\mu m$
- Inkjet printing requirements for graphics are typically 5-10x finer, but not so precise for coating
- Robot repeatability is better than absolute accuracy, so further calibration is possible













#### Result: a printed polypropylene spheroid

- CMYK 1200 dpi
- Latitude swathes
- 300dpi native x 4 interleave



# Software Solutions



- Nothing is perfect and inkjet printing / coating is no exception
- However, software can compensate for many print quality issues
- Intelligent image management
  - Colour correction
  - Printhead stitch correction
  - Nozzle density correction
  - Nozzle out compensation
  - Geometry correction









#### Summary - Implications & Opportunities

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- Inkjet already being used in many decorative and functional coating applications
- Advances in printhead technologies, software and fluids continues
  - Some highly viscous fluids for coatings remain a challenge
  - Ink jettable fluids key to unlocking more applications
- Inkjet no longer constrained to flat surfaces
- Great potential for further usage particularly in industrial products









#### FOR MORE INFORMATION - PLEASE VISIT US ON BOOTH 319

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