

# Industrial Inkjet for Coating Automotive Surfaces

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## Agenda



- Brief introduction to GIS
- Industrial inkjet in production environments
- Capabilities and advantages of using inkjet technology
- Overcoming challenges
- Coating (and decorating) complex curved surfaces



#### www.globalinkjetsystems.com © Global Inkjet Systems Ltd

# **Global Inkjet Systems**



- 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 Machine Control Atlas<sup>®</sup> Server Print Controllers Datapath & Drive Electronics Ink Delivery Systems Controlled Temperature, Pressure and Flow

- For those new to inkjet, GIS provides consultancy, project management & introductions to a network of specialist inkjet integrators and potential project partners to bring projects to life – and completion
- We work with our customers in partnership



#### 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 in Production



#### Not this ....



# Inkjet in Production – Big Presses











# Industrial Inkjet



- Industrial decoration
  - Ceramic tiles decoration & glazes



# Industrial Inkjet



- Industrial decoration
  - Ceramic tiles
  - Textiles



# Industrial Inkjet



- Industrial decoration
  - Ceramic tiles
  - Textiles
  - Wood/MDF etc
    - Texturing







Image Source: Hymmen, Cefla, Kuei

## Inkjet Technology

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## • Industrial piezo inkjet printheads

- Dominant technology: Drop on demand
- Drop sizes: 2 200 picoLitres
- Firing rates: 10 220kHz
- Highly integrated: 100s 1000s of nozzles per head
- Printheads and variants for many applications



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Drop on demand drops generated only when required

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# Inkjet Strengths



- Non contact
- Additive process
- Subtractive process
- Broad fluid capability (subject to viscosity)
  - UV curable inks, resists & adhesives
  - Conductive fluids
  - Jettable polymers & dielectrics
  - Jettable active & passive electronics
  - Acid resist
- Precise drop formation
  - Small drops for small features
  - Large drops for coatings/area fill

- Precise drop location
- Conserves expensive materials
- Reduces cost
- High drop production rate capability
- Long printhead life
  - Heavy duty cycle capability
- Proven reliability in production environments
- Inkjet as a partial or complete solution
- Integrated into standalone & hybrid manufacturing systems
- Highly integrated, modular technology

# Inkjet – Direct to Shape (DTS)



- 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











# 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 even when some processes are inefficient and wasteful of materials
- Inkjet moving from partial to full coverage printing of any object







Photo credit: © Upper Austrian Research, Hartwig Zörgl

Images from YouTube, Airbus & Ritzi (Heidelberg)

## 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 & Automotive – So Far





## Inkjet for Automotive Surfaces



Features	Benefits
Precise drop formation and placement Digital control	High transfer efficiency Fluid cost savings
Drop on demand technology Digital control	No overspray Precision coatings Environmental management cost savings
Digital control	Graphics/coating without physical masking Short run customisation Labour cost savings
Highly integrated, modular, scalable technology	Fluid changes by switching print module Support wider range of colours for decorative applications

# **Inkjet Challenges**



- We also have some challenges
  - Jettability
    - Viscosity limitations
  - Throw Distances
    - Jetting distance
  - Complex Curved Surfaces
    - Print paths
  - Navigation & Motion control
    - Combining inkjet and robotic systems

## Inkjet Challenges – Throw Distances



- Inkjet typically designed to throw ink drops a distance of 1 2mm to the surface
  - Produces sharp, detailed graphics and text down to 2pt @ 1200dpi
  - Also 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





# **Inkjet Challenges - Jettability**



- 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
  - Automotive paints viscosity challenging for most piezo inkjet printheads
  - Automotive hardcoats some can be as low as 10cps





Image Source: Momentive SilFORT Hardcoats

Image Source: ImageXpert



## **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

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# **Shape Variation Compensation**

### Measure the target shape accurately

- Mechanical profile gauges
  - Adequate, but rather slow
  - Contact with target shape may be a problem
- Laser triangulation sensors
  - Resolutions down to ~1  $\mu$ m, sample rates 1-100kHz
  - Non-contact
- Apply measurements as corrections to the mesh model
  - For per unit variations this can be done as a late stage correction
  - Output adjusted swathe data





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## 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

## Sphere Printer – Apply the Workflow













#### Result: a printed polypropylene spheroid

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



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# Coating onto Wing Mirror





Generic 3<sup>rd</sup> party after-market component, sourced from retail supplier



Corner - radius of curvature < 1mm



Valley – 26mm deep



## **Virtual Printing**







#### Modelling in ABB RobotStudio



## **Coating onto Wing Mirror**







## Summary - Implications & Opportunities

- Opportunities in automotive applications
  - Coatings
  - Decorative graphics in development
- Advances in printhead technologies, software and fluids continues
  - Ink jettable fluids key to unlocking more applications
- Inkjet no longer constrained to flat surfaces
- Great potential for further usage



Image source: GIS







## Contacts



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