GIS GLOBAL INKJET SYSTEMS

Achieving Uniform Coatings and Flat Solid Colours on Conventional Substrates and Complex Objects

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INPRINT MUNICH

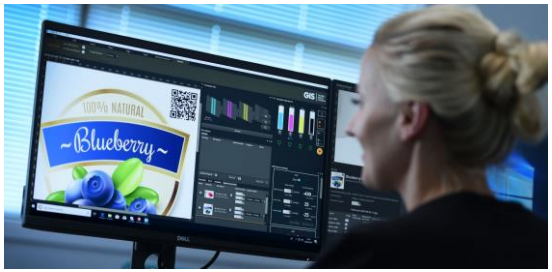
GIS – Company Overview

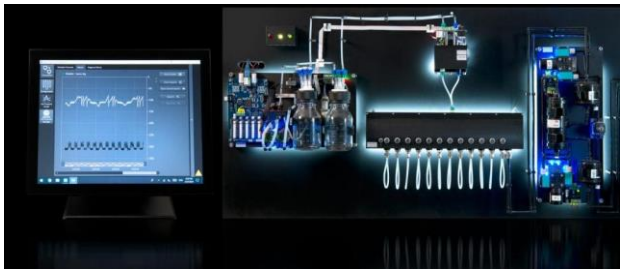
- Leading provider of technology solutions to industrial inkjet systems builders
- Supported printhead manufacturers
  - **Fujifilm Dimatix, Konica Minolta, Kyocera, Ricoh, Toshiba Tec, Xaar**
- Founded November 2006
  - **Privately owned**
- Based in Cambridge, UK
  - **Technical support in UK, China and Japan**
- Employees 70+
- Patent protected technology
- Supplier & partner to over **130** customers worldwide

The GIS EcoSystem

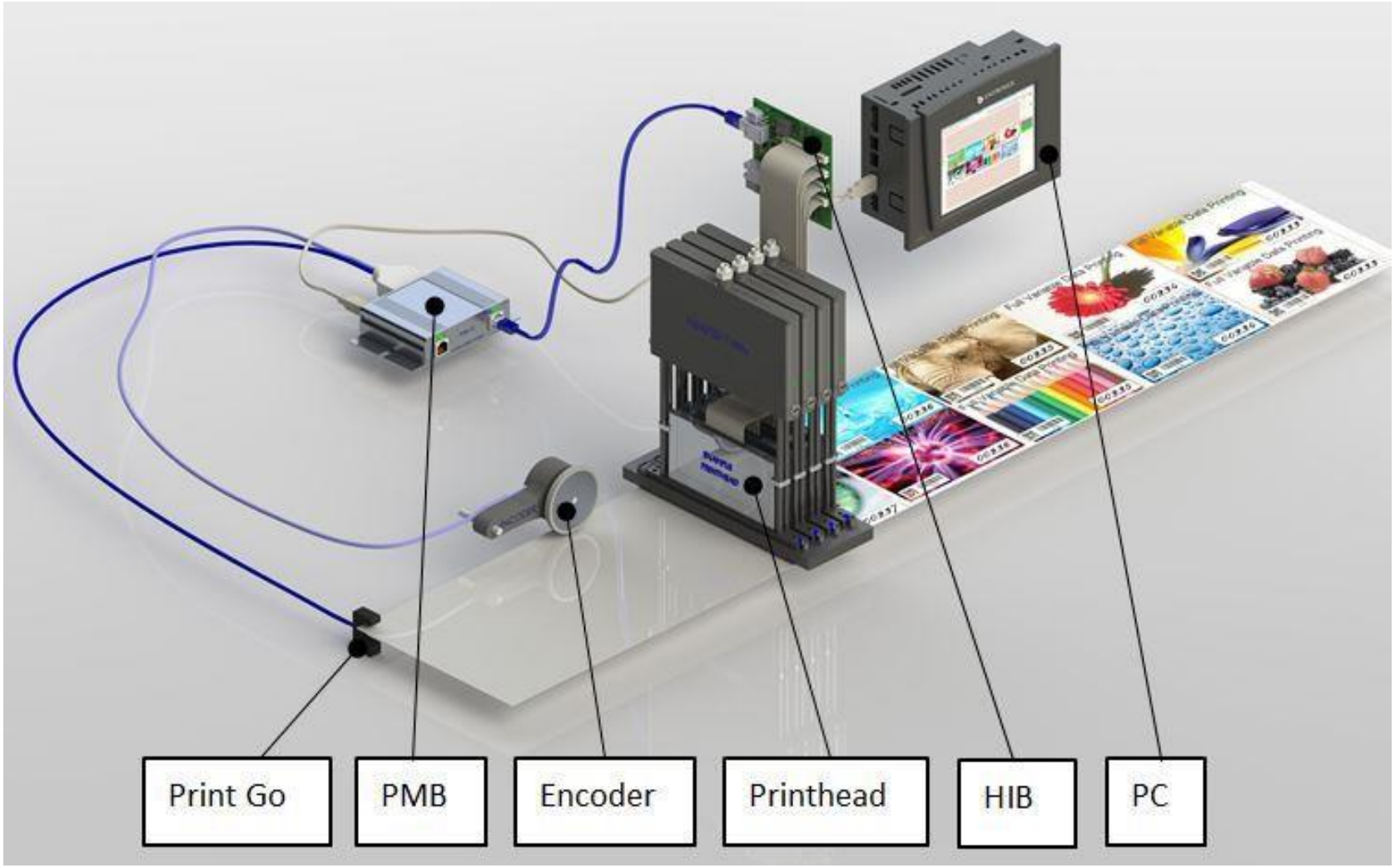
GIS GLOBAL INKJET SYSTEMS

Complete image management from pixel to drop





How Hard Can It Be?



Nothing is perfect and digital printing is no exception

However software can compensate for machine imperfections

PRINT QUALITY ISSUES

What are the real world issues experienced in the field

SOFTWARE CORRECTION METHODS

What methods are available to correct these issues

Factors Affecting Print Quality

Printhead Alignment and Stitching

Why is a good stitch important?

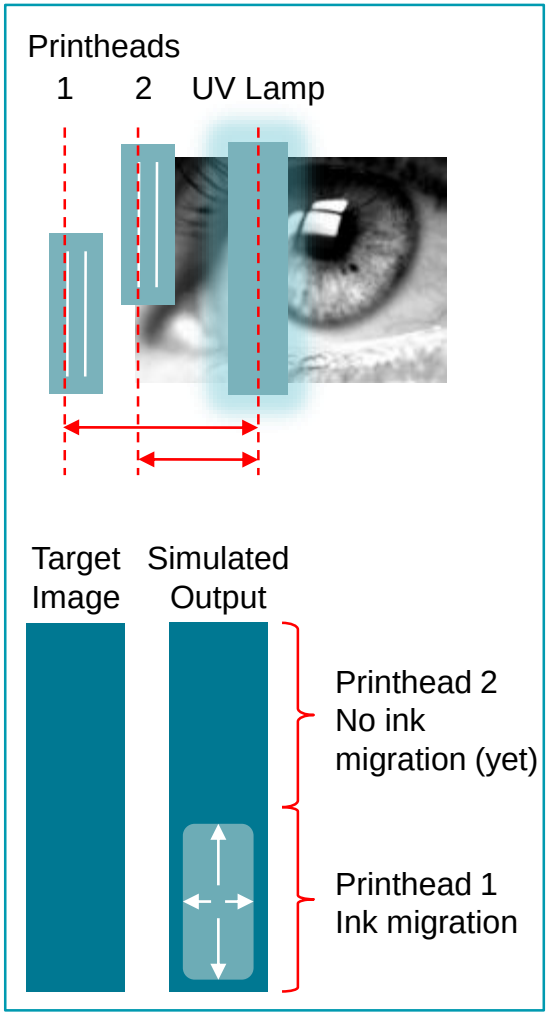
- The human eye is very good at spotting discontinuities especially in areas of flat colour

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

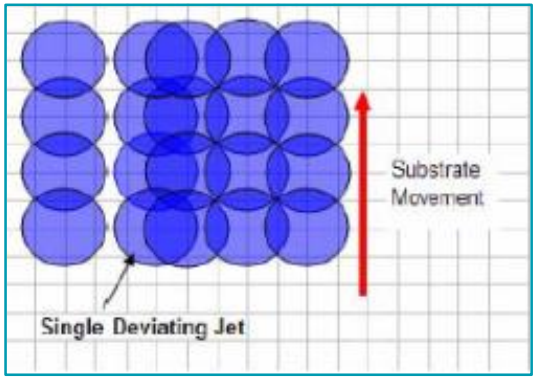
Some will be printing *wet on dry* while others will print *wet on / near wet*



Printhead Stitching

Scanning / Multi-pass (x1, x2, x3, x4, …)

- **Safe and reliable**
- **Errors recoverable**
- **Lower productivity**

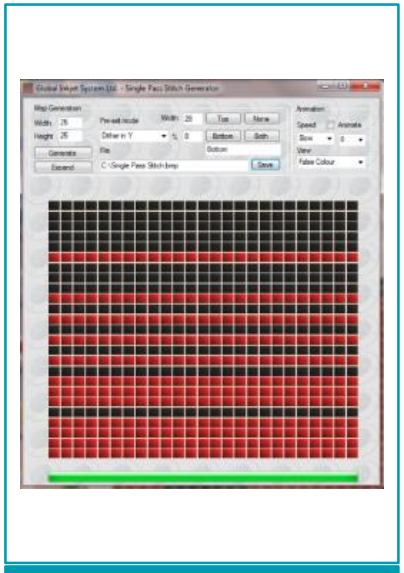


Single pass

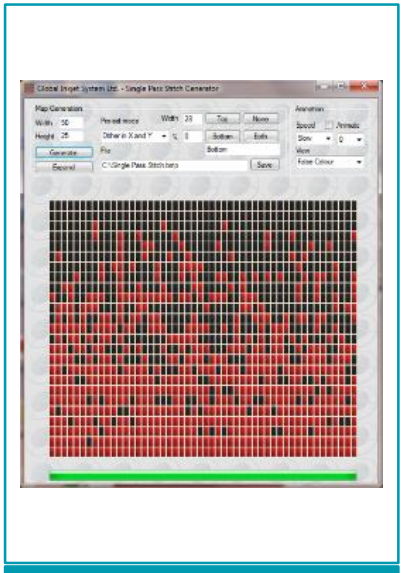
- **No room for error**
- **Defects highly visible**
  - Missing nozzles
  - Jet straightness
  - Consistent jet velocity
- **High productivity**
- **Reliability critical**

Hard Stitching – Binary Printing

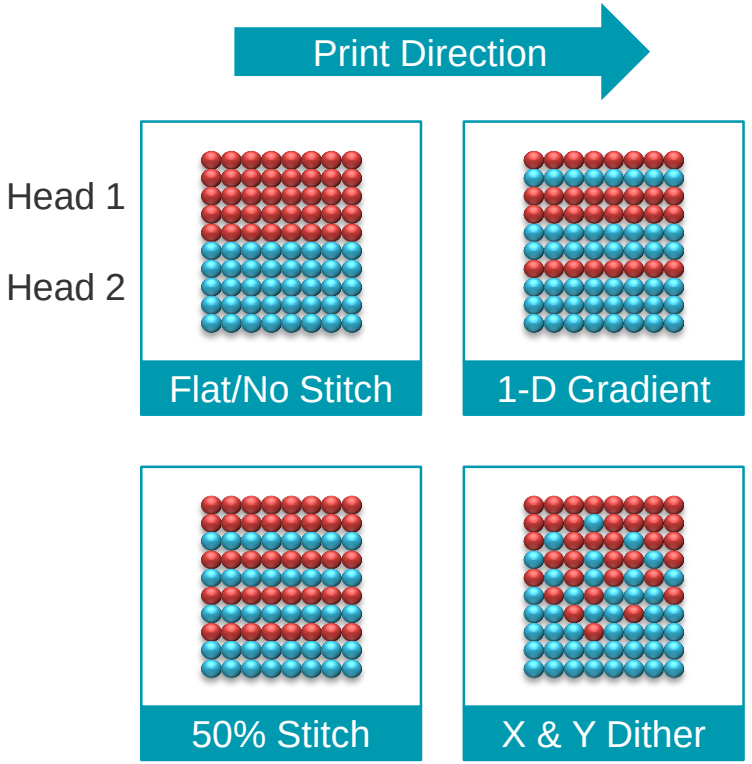
- **Masking (Hard Stitching)**
  - Nozzle on/nozzle off
  - Wide variety of options
- **Stitches can massively improve output quality & different applications benefit from different strategies**



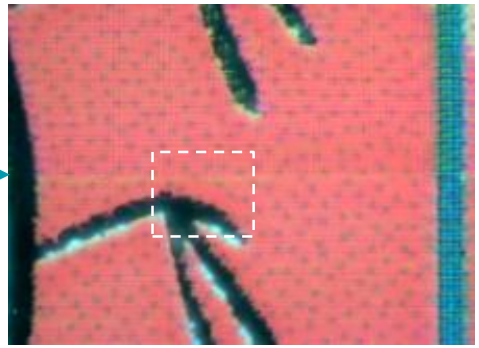
2-D Density

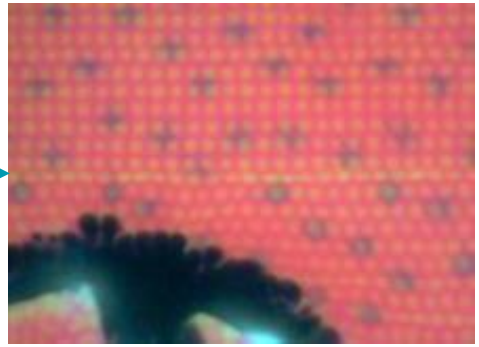


X & Y Dither

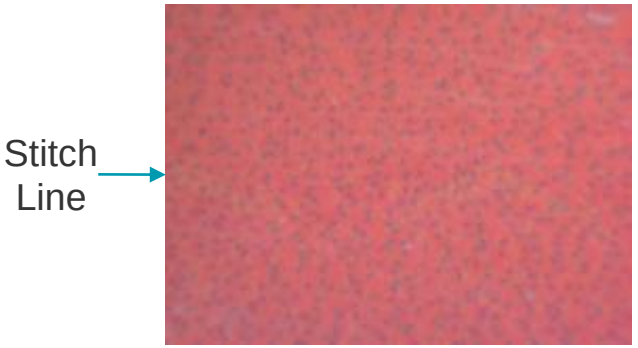


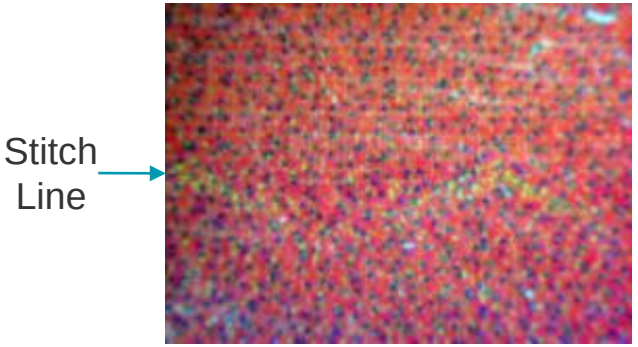
Stitching Examples





“Flat” or “No” Stitch across flat colour





‘Moving Stitch’ across flat colour

Exploring Stitching Strategies

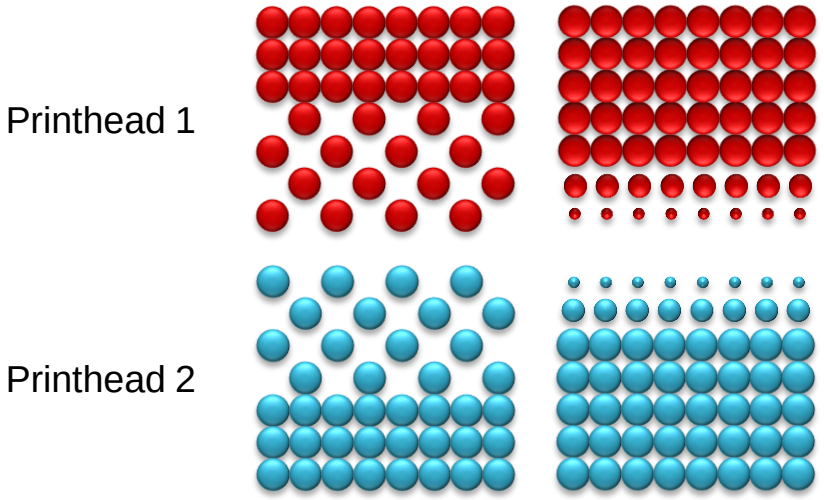
- Multi-pass
- Single-pass
    - substrate

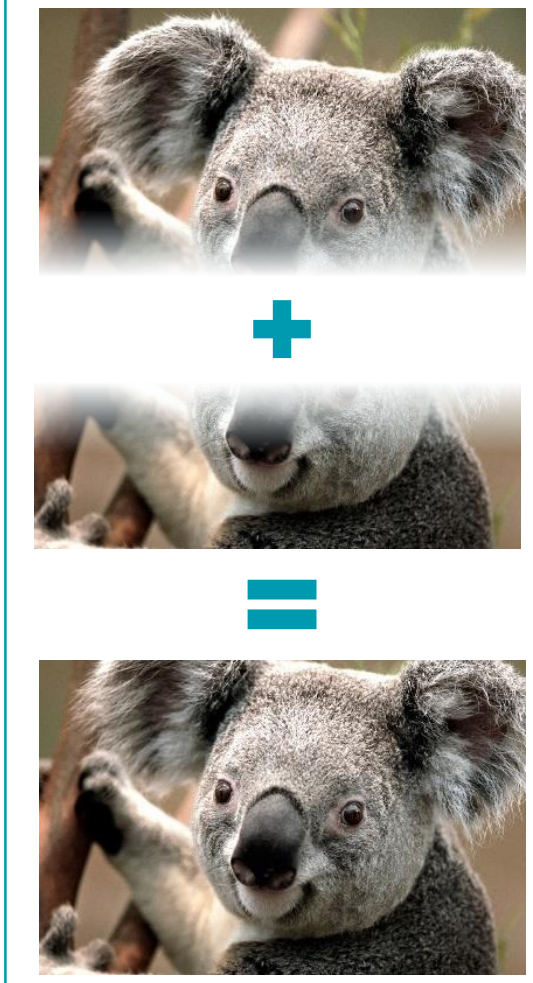
- Printhead-to-printhead non-uniformity
- Colour-to-colour density variation
- Alignment errors (printhead-to-printhead, colour-to-colour)
- Jetting errors (nozzle jet deviation)

Stitching Strategies – Understanding Errors

Soft Stitching – Grey Scale Stitching

- **Greyscale stitching makes full use of the greyscale capabilities of the head**
  - Slowly reduces the density of the image printed by one printhead while increasing the density printed by the next printhead
- **Only adds value over masking in areas where the density of the image is greater than the smallest drop size**





Linear Printhead Density

Inkjet systems need to:

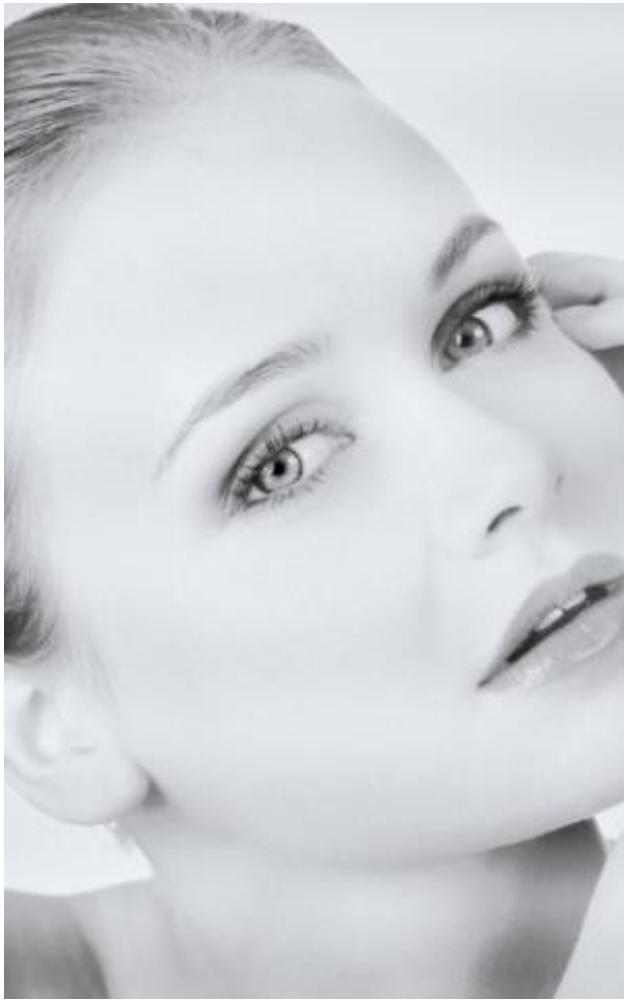
- Stitch printheads without visible joins
- Print large areas of solids/flat colours

Drop volumes not always consistent across printhead

- More apparent the more heads you have in an array
- “Non-linearity” in drop volume
- Even small difference can affect final print – particularly areas of solid colour
- We want uniformity - flat colours

Lots of reasons this can happen:-

- Printhead manufacturing issue - drop ejection may not be consistent
- Temperature variation in ink system - affects ink viscosity
- Piezo activity - heavy use of some sections of printhead creates warm areas
- Electronics - uncalibrated/low quality electronics may affect drop volume



Linear Colour Channel Density

Incorrect colour channel density linearization means the input colour value for a single colour does not match the output colour value comparatively to other colours

Results in non-linear response and incorrect colour

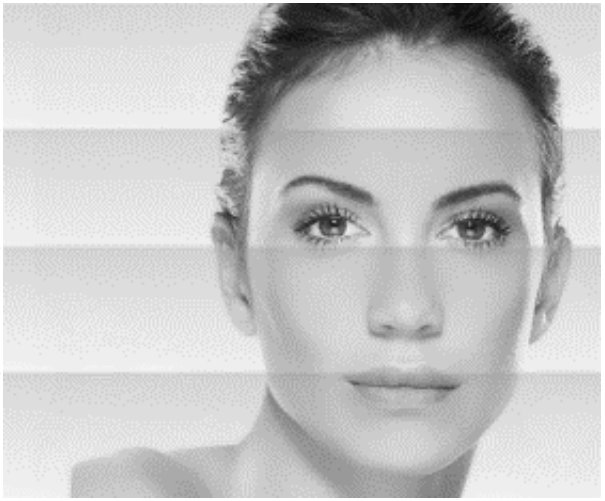
Process black (=C+Y+M+K) shows colour shift

Printhead Linearisation
(via image correction)

Printhead banding →

Printhead banding →

Printhead banding →



Linearized printhead →

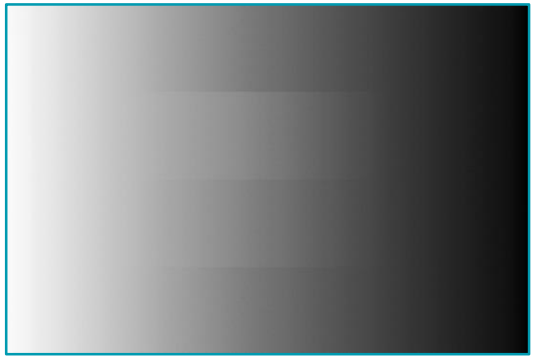
Printhead Linearisation Correction

Electronic/printhead solutions

- Depending on printhead technology
- Trim each nozzle/cluster of nozzles/nozzle bank
- Trimming can introduce drop alignment problems
  - (Tuning for volume will modify velocity)

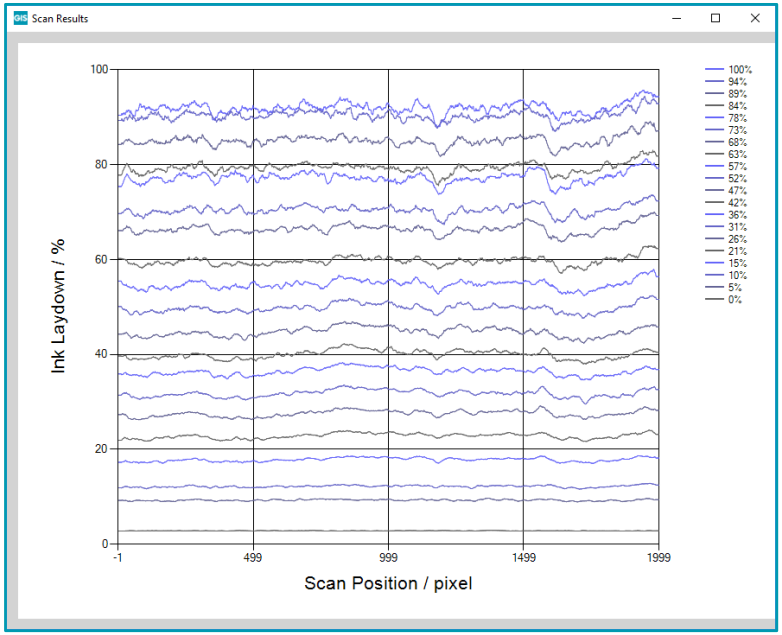
Image correction – offers greatest capability

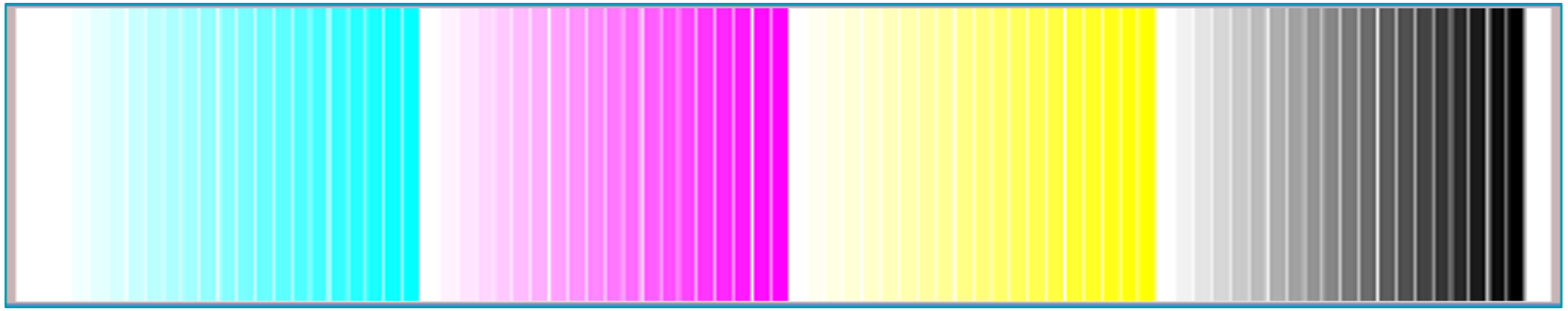
- RIP'ed data (contone or screened) can be manipulated to:
  - Reduce the number of drops in given area, or
  - Reduce the size or value of the greyscale drop in a given area



Printhead Linearisation
(via image correction)

- Aim is to ensure achieve even density across a full printhead array for each grey level
- Achieved by printing grey scale test pattern for each colour channel and measuring the density across the printhead array at a range of grey levels
- Then adjusting the grey level mapping at intervals across the printhead array





Printhead Linearisation
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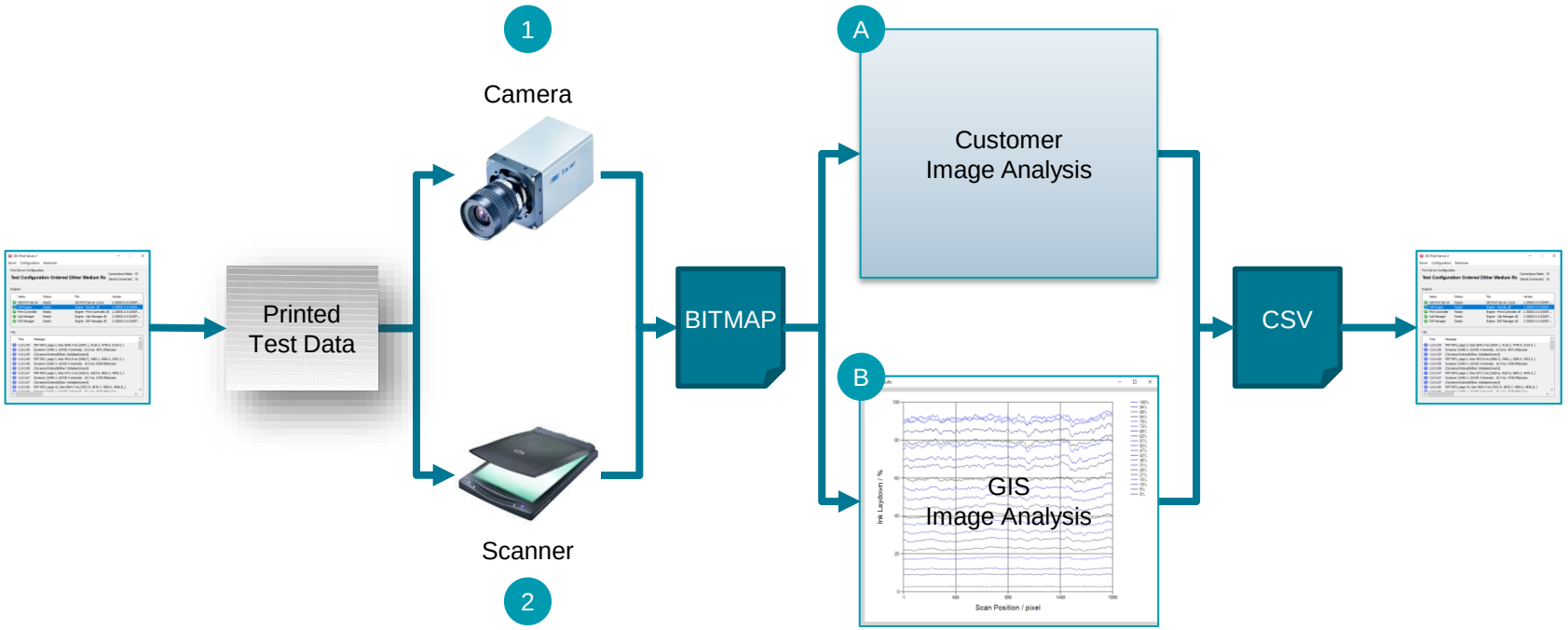


Colour Channel Linearisation

What is it?

- Linearization ensures the printer maps contone values evenly throughout the scale, from 0-100%

Why do it?

- It makes multiple printers behave in a similar predictable way
- It makes colour management easier

Method of control?

- Generate a linearisation test chart
- Print it
- Measure the output data
- Import the measurement data into the RIP to apply

Figure 1: Not linearised

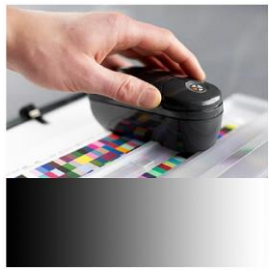


Figure 2: Linearised

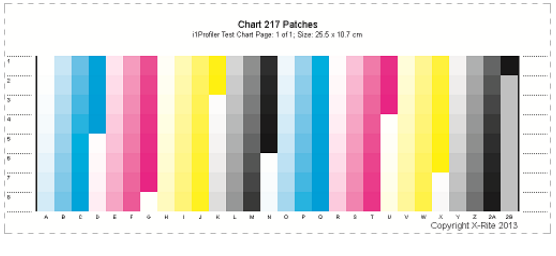
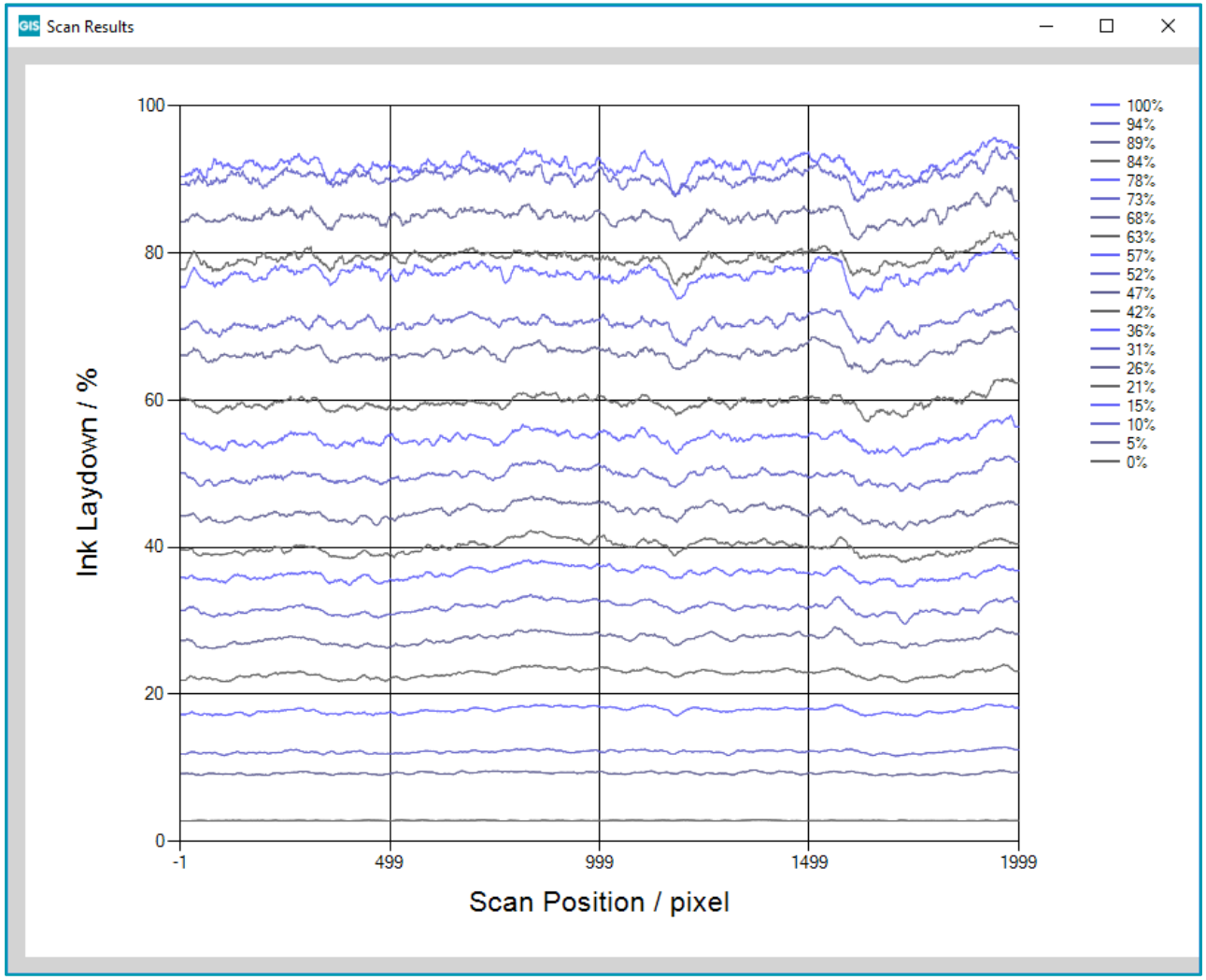
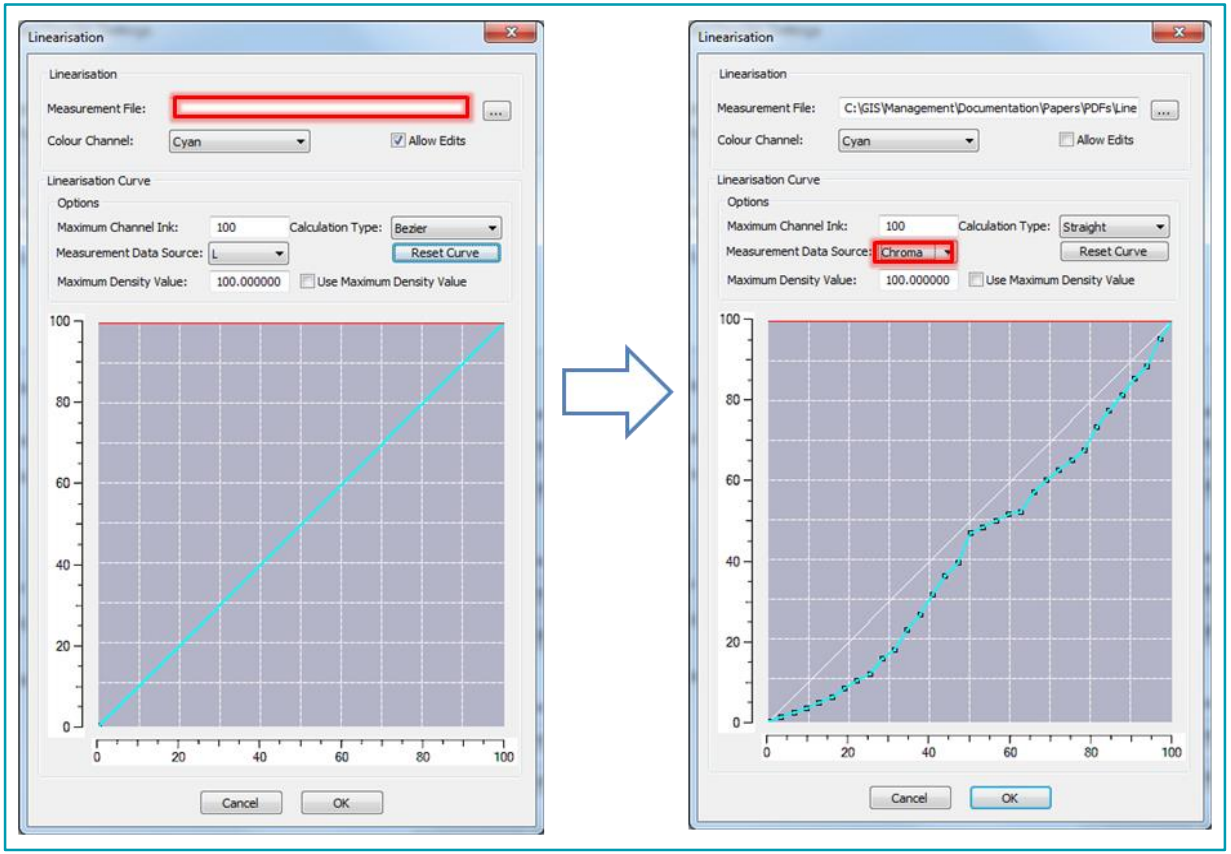


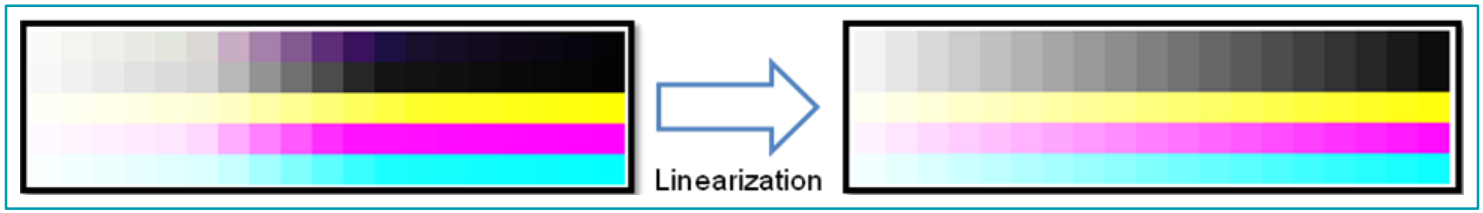
Figure 3: A Linearisation Test Chart

Colour Channel Linearisation



Colour Channel Linearisation





Density & Colour Drift

Jetting performance results in density variation and colour drift due to

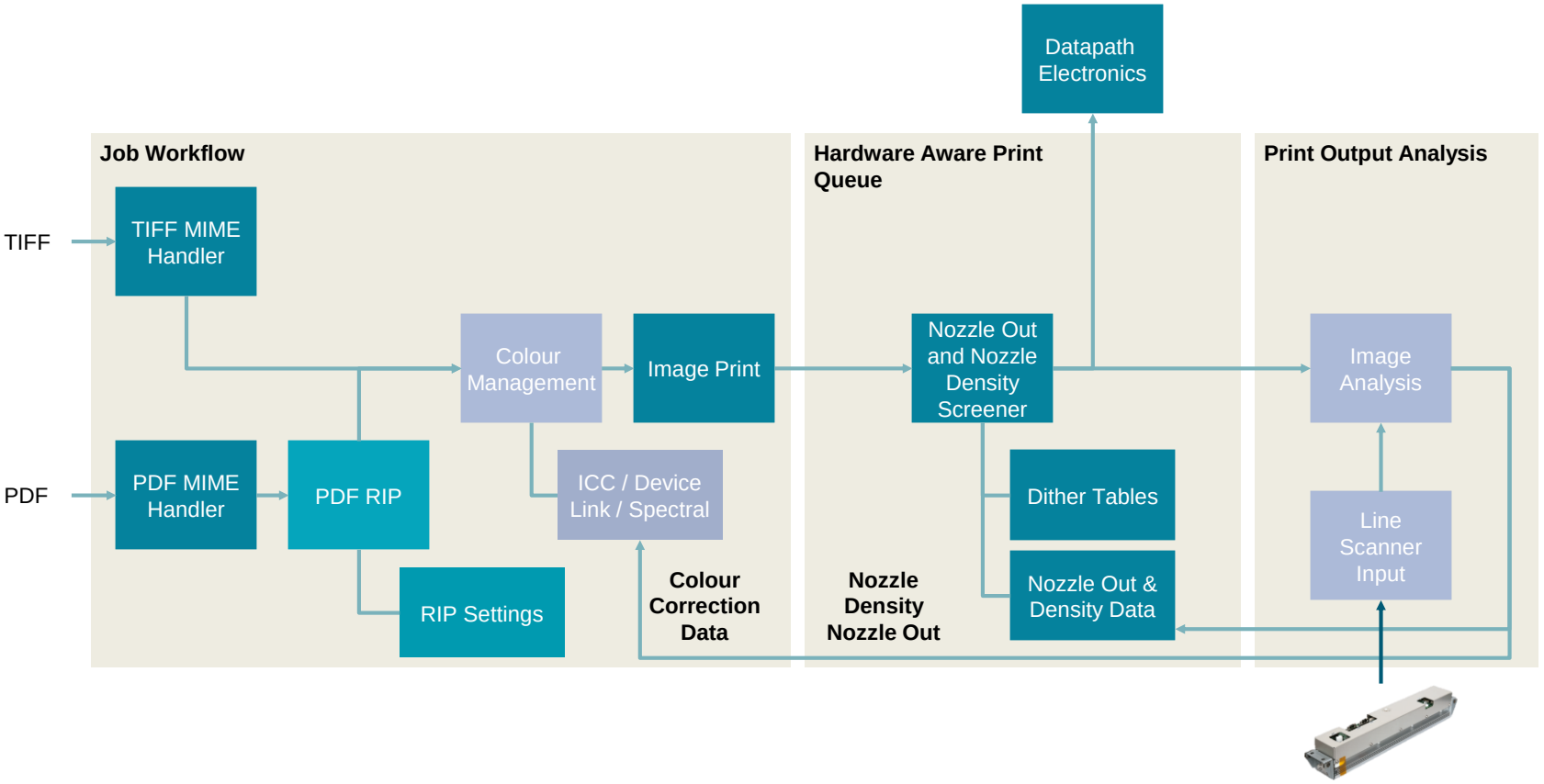
- Temperature changes affecting ink viscosity and jetting characteristics
- Temperature variations across large print arrays
- Printhead temperature affects jetting performance
- Each colour may be affected differently

Strategies

- Pre-job print calibration
  - Test pattern print at beginning of print job or production shift
  - Colour calibration and ICC profile corrections applied
- Real-time image analysis
  - May be sufficient to only measure the density of each colour and correct density of the colour channel
  - May require full colorimetric measurements and ICC profile update

Closed Loop Workflows

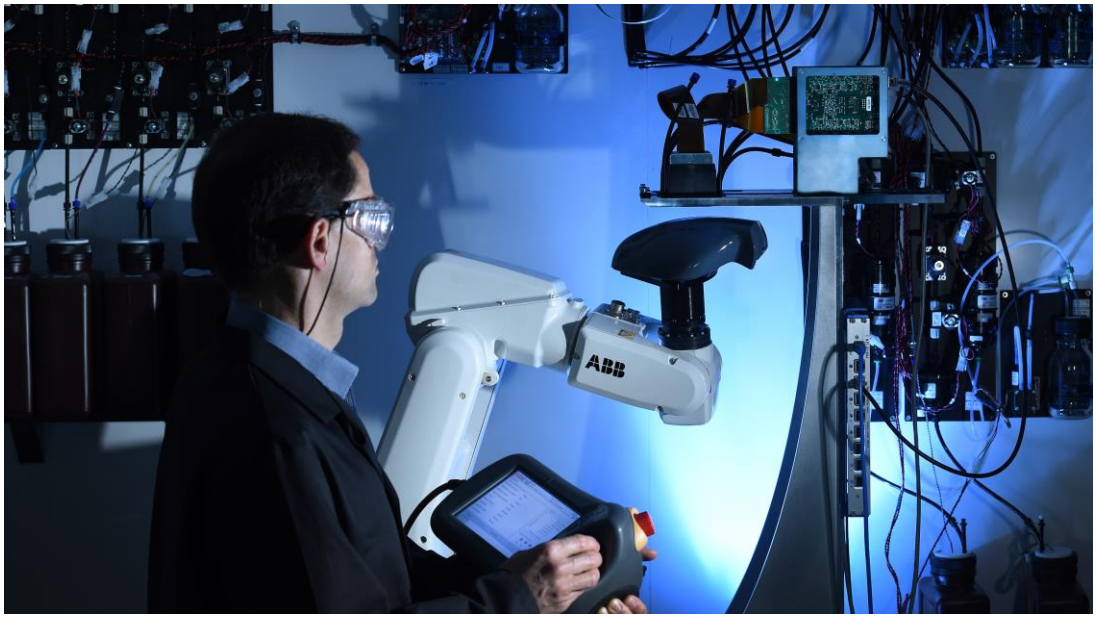
Closed loop nozzle, density and colour correction



Direct-to-Shape

Direct-to-shape requires a combination of complex techniques

- Time of flight compensation
- Resolution correction
- Curved surface screening
- Density and drop size compensation



Tubes, Cones & Tubs

Tubes well established/well understood technology

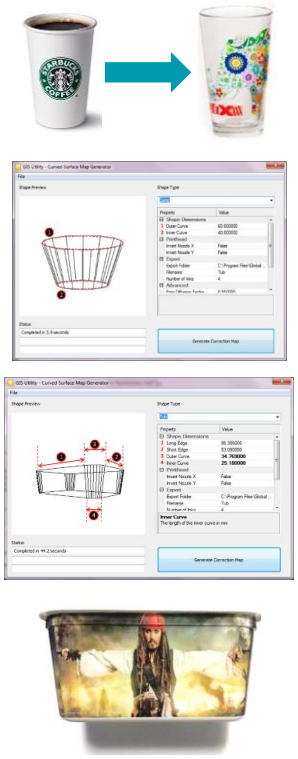
Cones or conical/tapered shapes

Software correction required?

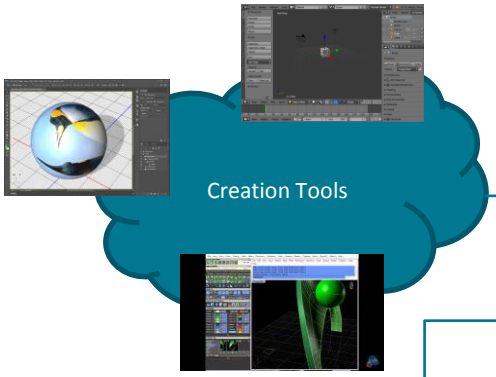
- Typically no, for small area coverage
- Yes, for significant or full wrapping
  - Corrects nozzle alignment
  - Provides density correction
  - Ensures no dot gain issues
  - Ensures no screening artefacts

Tubs

- Requires correction changes during the print
  - Often from pixel to pixel
  - Multi-dimensional nozzle, density and screener correction technology can be adjusted to each surface type and associated application process

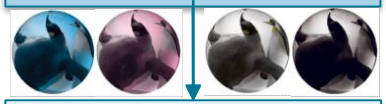


Complex Objects



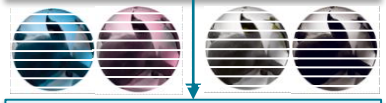
Import
Mesh & Texture

Colour Separation



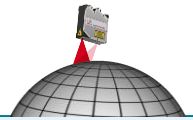
Swathe Decomposition

Unwrap



Swathe
paths

Density Correction
& Screening

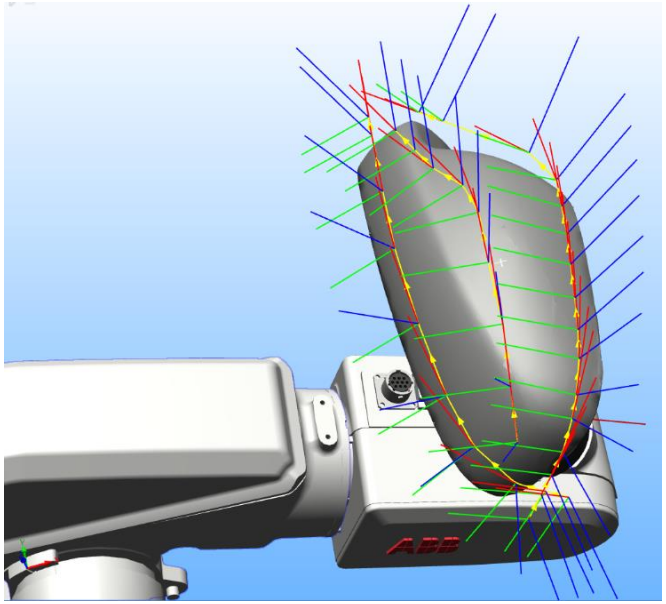


Transport Control

Measure & Correct

Print Control

Full Object Coating – GIS Print Path Designer



Summary

- Huge range of factors affect print quality
- Software compensation can significantly improve image performance for system inaccuracies and errors
- GIS offers complete eco-system
  - Complete image management from pixel to drop
    - Flat surfaces
    - Complex shapes
  - Many more tools than we've been able to cover in this presentation
- Please visit our booth #437 to learn more

GLOBAL INKJET SYSTEMS

THE QUEEN'S AWARDS FOR ENTERPRISE

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