selecting and driving inkjet print heads

presented by Clive Ayling, Meteor Inkjet Ltd
selecting and driving inkjet print heads
Inkjet Technologies

Main Ink Jet Technologies Classes

- Continuous
  - Piezoelectric Excitation
  - Thermal Excitation
  - Binary Deflection
  - Multiple Deflection
  - Hertz Method
- Drop-on Demand
  - Piezoelectric
    - Shear Mode
    - Bend Mode
    - Push Mode
  - Nozzle Excitation
  - Squeeze Mode
  - Thermal
    - Double Heater
    - Suspended Heater
    - Moveable Member

Focus on Commercial Printheads
inkjet print head types

FUJIFILM  Dimatix  EPSON

KYOCERA  TRIDENT

INDUSTRIAL INKJET  RICOH

imagine. change.

Electrode (positive)
Electrode (negative)
Cavity

Displacement of 100 nm
Apply voltage

shared wall – “ABC” mode
MultiDrop – Grey Scale Technology

- MultiDrop binary
- GreyScale
Nozzle Plate Technology

- Nozzle Plate Materials
  - Nickel
  - Stainless Steel
  - Polyimide
  - Silicon

- Nozzle Holes
  - Etching
  - Laser Drilling
  - Punching
  - Electroform
  - MEMs

- Nozzle Plate Coatings
  - Wetting – no coating
  - Non-Wetting Coating
Continuous Circulation

Key benefits:
- Improves initial priming
- Enables fast jet recovery
- Prevents settling of heavily pigmented inks
- Improves open time of fast drying inks
- Uniform Temperature Control
# Printhead Specifications

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<th>Performance</th>
<th>Electrical / Power</th>
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<td>Drive Voltage</td>
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<td>Drop Sizes</td>
<td>Power</td>
</tr>
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<td>Drop Velocity</td>
<td>Data Interface</td>
</tr>
<tr>
<td>Number of Nozzles</td>
<td>Number of Drops / Gray Scale</td>
<td></td>
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<td>Nozzle Plate Surface</td>
<td>Crosstalk</td>
<td></td>
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<tr>
<td>Rows of Nozzles</td>
<td>Jet Straightness</td>
<td></td>
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<tr>
<td>Temperature</td>
<td>Drop Frequency</td>
<td></td>
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<tr>
<td>Ink Viscosity</td>
<td>Head Life</td>
<td></td>
</tr>
<tr>
<td>Ink Surface Tension</td>
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<td></td>
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<tr>
<td>Printhead Materials</td>
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</table>
Drop Size(s)

Native Drop Size
Larger Drops Created by multi-drop
Variation +/-10% @ 1-s
(1-sigma = 68%)
Comparison: Ink Lay-Down at similar line speeds

<table>
<thead>
<tr>
<th></th>
<th>Dimatix SG1024M</th>
<th>Dimatix SG1024L*</th>
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<tbody>
<tr>
<td><strong>Ceramic Ink</strong></td>
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<tr>
<td>Large Drop (ng)</td>
<td>91</td>
<td>182</td>
</tr>
<tr>
<td>Max Freq (kHz) – Grayscale Mode</td>
<td>13.8</td>
<td>10</td>
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<tr>
<td>Native Resolution (dpi)</td>
<td>400</td>
<td>400</td>
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<tr>
<td>Process Resolution (dpi)</td>
<td>840</td>
<td>840</td>
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<tr>
<td>g/m2</td>
<td>44</td>
<td>68</td>
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<tr>
<td>Ng-KHz</td>
<td>1256</td>
<td>1820</td>
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<tr>
<td>Line Speed (m/min)</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

* Product spec subject to change
Deviation Angle – Jet Straightness

Specified in mRad
±5 milli-radians
1-sigma = 68%
Larger gap = higher placement variation
Selection process

1. Media type
2. Ink type
3. Chemical compatibility
4. Print Quality / Resolution
5. Cost
6. Performance / Number of nozzles per colour
7. Physical Layout / Carriage
8. Greyscale / Binary mode selection
9. Time to market opportunity
10. Technology Partners

Flowchart:
- Media type → Ink type → Chemical compatibility → Print Quality / Resolution → Cost
- Performance / Number of nozzles per colour → Physical Layout / Carriage → Greyscale / Binary mode selection
- Technology Partners → Time to market opportunity
media and ink come first:

- Ink must work in the printhead and meet the end use characteristics
- Considerations
  - substrate topology
  - surface energy
  - surface treatments
  - time-to-cure
  - time-to-dry
  - food grade
  - color brightness
suppliers who support customers to develop their own waveforms

- Dimatix
- HP
- Konica Minolta
- Lexmark
- Ricoh
- Seiko
- Toshiba TEC
- Trident
- Xaar 1201
- Xerox

suppliers who support customers only by supplying a waveform file

- Kyocera
- Toshiba TEC
- Xaar
Meteor DropTuner
reliability

- start-up
  - how quickly do you get 100% of nozzles working? (minutes, purges, mL, etc)

- sustainability
  - how long before you lose a nozzle? (minutes printing, minutes resting)
  - how long before you need a re-start? (minutes printing, minutes resting)

- reliability
  - how long before you have a non-recoverable nozzle? (weeks)
  - how repairable is a non-recoverable nozzle?
  - what warranty will you have?
Selection process

- Media type
- Ink type
- Chemical compatibility
- Print Quality / Resolution
- Cost
- Performance / Number of nozzles per color
- Physical Layout / Carriage
- Greyscale / Binary mode selection
- Time to market opportunity
- Technology Partners
- Technology Partners
## Drop Size

### Target Color Saturation

<table>
<thead>
<tr>
<th>Ink Coverage</th>
<th>0.0050</th>
<th>0.0075</th>
<th>0.0100</th>
<th>0.0125</th>
<th>0.0150</th>
<th>0.0175</th>
<th>0.0200</th>
<th>ml/sqm</th>
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<tbody>
<tr>
<td>dpi</td>
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<td>360</td>
<td>24</td>
<td>36</td>
<td>48</td>
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<td>540</td>
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<td>6</td>
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<td>4</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>11 pl</td>
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<td>1260</td>
<td>2</td>
<td>3</td>
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<td>5</td>
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<td>7</td>
<td>8 pl</td>
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<td>1440</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6 pl</td>
<td></td>
</tr>
</tbody>
</table>

Where does saturation occur? 60%. 80%. 120%
size of print head

**large head size**
- fewer heads to mount
- fewer heads to align
- fewer drive electronic components
- fewer cables
- fewer ink tubes
- lower cost/nozzle [?]

**small head size**
- less expense for lab system
- less expense to replace one head after a blocked nozzle
- less expense to carry stock
credibility of partners

- partners

  - is past performance an indicator of future performance or just unfair anecdote?
  - conflict of interest (direct and inter-customer)
  - service and support
driving the print head

**Electronics**

- PC runs the Software and outputs via
  - USB or Ethernet
  - PCIe to fibre or firewire
- Print Controller synchronises to the Encoder Signal and performs real-time image adjustments in responses to sensors
- Head Driver provides power supplies and/or waveforms to the head
- Head Cable

**Software**

- Image composition
- PDF input via RIP
- Colour management
- Screening
- Swath generation
- Stitch masking
- Control of electronics and motors
- Feedback and compensation to all the features above
- User Interface
Meteor the supplier of driver electronics for all head types

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This presentation is given with thanks to co-author Mike Raymond and the holders of copywrite images

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