GIS GLOBAL INKJET SYSTEMS

# Design and Operation of Inkjet Ink Delivery Systems

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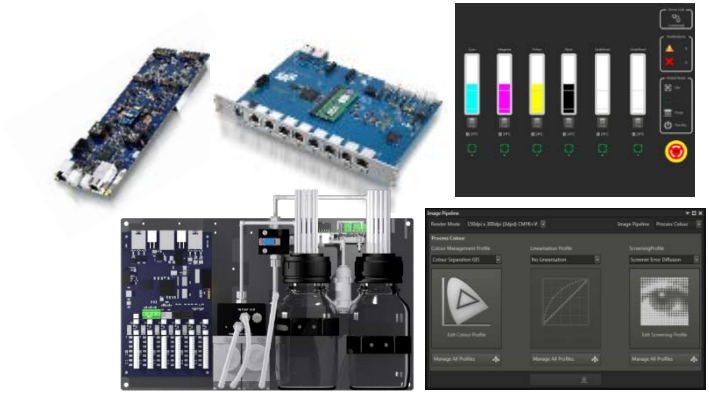
# GIS – Global Inkjet Systems

- **Founded November 2006**
  - Privately owned
- **Leading provider of technology solutions for industrial inkjet systems**
- **HQ in Cambridge, UK**
- **Technical support in UK, China and Japan**
- **>60 employees**
- **Over 150 customers**



- **Drive electronics for wide range of inkjet printheads**
- **RIP software**
- **Application software**
- **Customisable user interfaces**
- **Ink delivery system components**

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# Agenda

- **Main functions and basic requirements of ink delivery systems (IDS)**
- **Flow modes and printhead types**
- **Design options & challenges**
  - Heating
  - Degassing
  - Customizing print bars
- **Typical IDS issues**
  - Diagnosing common issues
  - Troubleshooting and solutions

Image source: GIS

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# Main Functions of Ink System

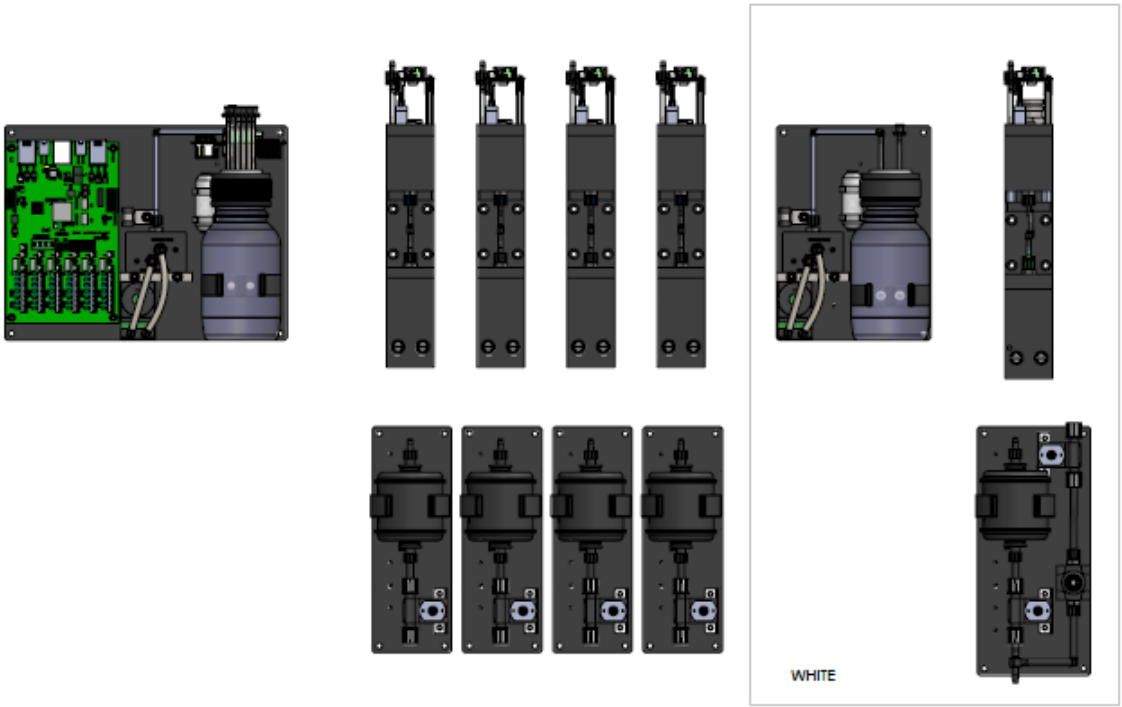
- **Meniscus pressure**
  - Ink pressure inside the printhead
    - Meniscus is formed by a slight negative pressure at the nozzle
- **Air pressure control**
  - Negative air pressures to maintain meniscus pressure of each printhead
  - At different flow rates
  - Scanning XY systems – withstand the acceleration/deceleration of printhead carriage
- **Ink pumping**
  - Control for pumping of ink from bulk ink tank
- **Purging**
  - Positive pressure to the ink in the printhead
    - Low pressure and high pressure purge (required by some printheads)

# Basic Requirements

- **Filtration**
  - Minimise chance of particles clogging the nozzles
- **Flow modes**
  - Support for recirculation or no recirculation
- **Degas**
  - Stop air bubbles reaching the printhead/nozzles
  - Avoid air pockets in ink system
- **Heat the ink**
  - For correct operating temperature (printhead dependent)

# Basic Requirements

- **Shared or individual pressure**

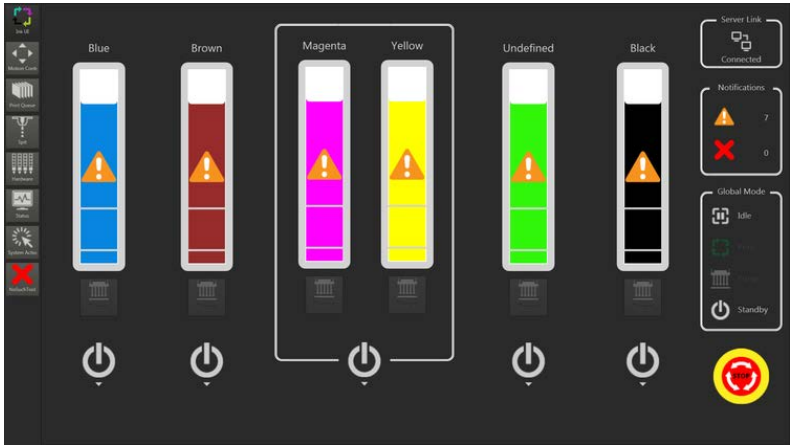


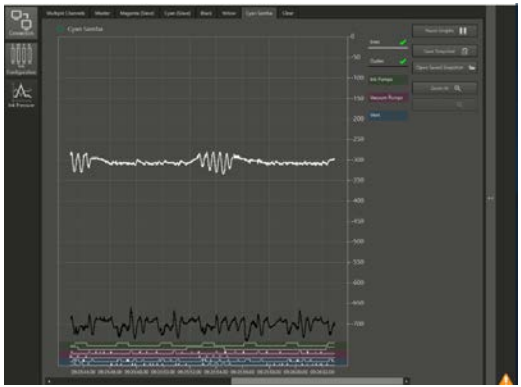

Example shows shared pressure CMYK and individual pressure White

Image source: GIS

# Basic Requirements

- **System monitoring**
  - User friendly GUI
  - Graphing tools – pressure, pump & solenoid activity etc.



**Ultimate aim: Reliable system for production environments!**

Image source: GIS

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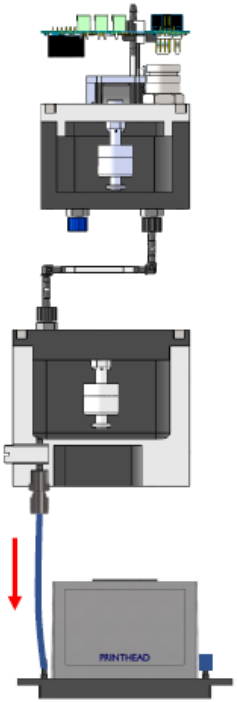
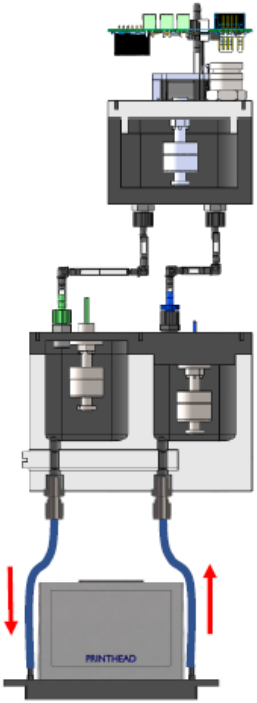
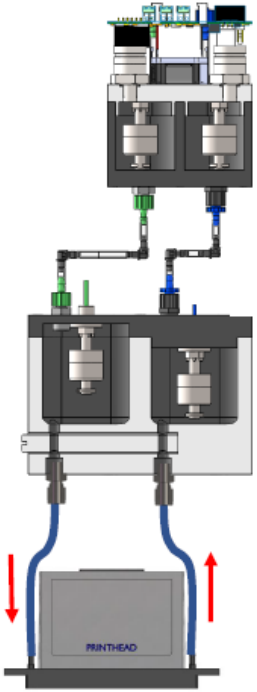
# Flow Modes




No Flow




Low Flow




Controlled Flow

Image source: GIS

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# No Flow/End Shooter

- **Basic characteristics**
  - Air pressure range typically 250-500mm between header tank and nozzle plate
  - In this example, negative pressure P (-350mm) applied to balance the positive head of fluid (300mm) and provide a negative meniscus pressure of -50mm at the nozzle plate

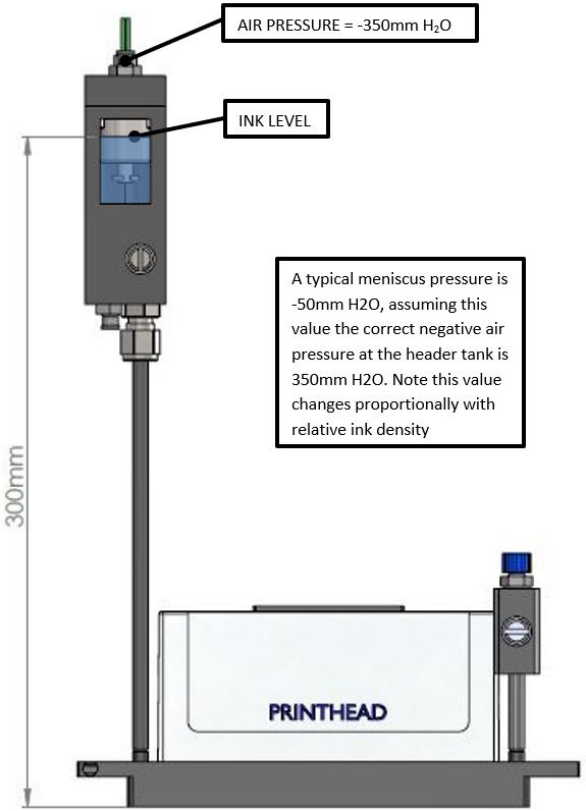


Image source: GIS

# Low Flow/End Shooter

- **Basic characteristics**
  - Height difference between the header tanks
  - Same negative air pressure applied to both tanks
  - System constantly tries to level and creates low flow through the printhead

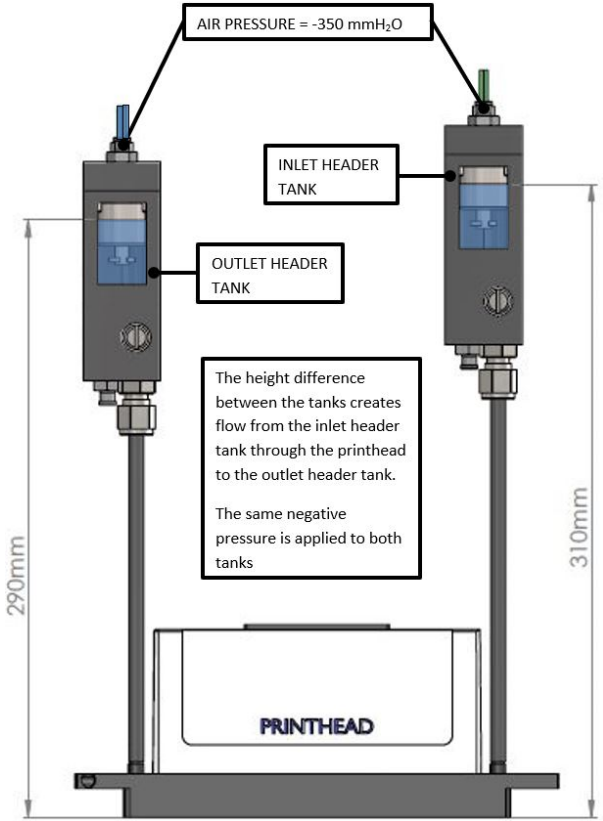


Image source: GIS

# Controlled/Adjustable Flow

- **Basic characteristics**
  - Two pressure values assigned
  - Printhead manufacturers tend to specify the pressure difference
  - Differential air pressure creates flow through the printhead
  - Air Pressure[1] and Air Pressure[2] are both adjustable to vary/control the flow rate

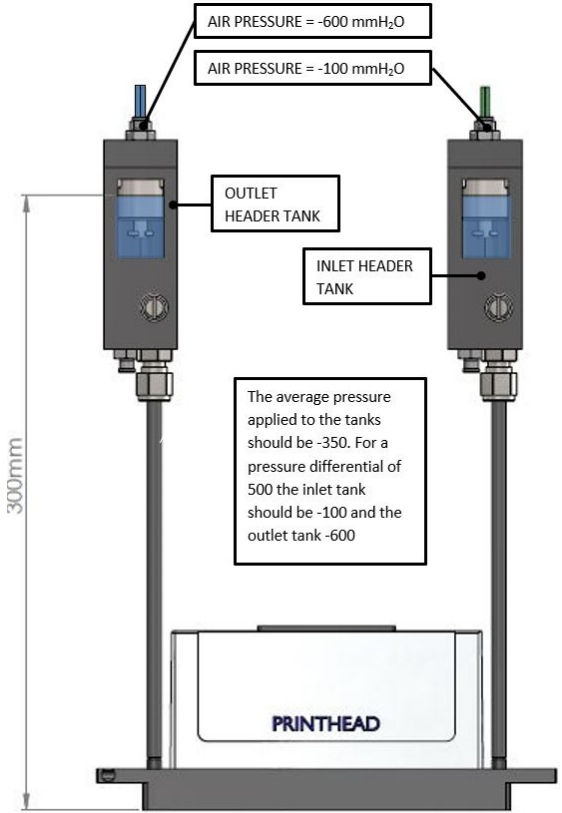


Image source: GIS

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# Printheads & Flow Modes

| Example Printheads | No Flow | Low Flow | Controlled Flow |
|---|---|---|---|
| Fujifilm Samba G3L/G5L | ✗ | ✗ | ✓ |
| Fujifilm Starfire SG1024 | ✗ | ✗ | ✓ |
| Fujifilm Sapphire 256 | ✓ | (✓) | ✗ |
| Konica Minolta 1024i | ✓ | (✓) | ✗ |
| Kyocera KJ4B-QA/YH | ✓ | (✓) | ✗ |
| Kyocera KJ4A-TA/AA/RH | ✓ | (✓) | ✗ |
| Ricoh MH5441 | ✓ | (✓) | (✓) |
| TTEC CF1/CF3 | ✗ | ✗ | ✓ |
| Xaar 1003 | ✗ | ✗ | ✓ |
| Xaar 5601 | ✗ | ✗ | ✓ |

**Key**

✓ Required

(✓) Optional

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# Ink Requirements

| Ink Type | Typical Ink System Requirements |
|---|---|
| **UV Cure** | • Requires heating (most printheads have heaters and/or use heated mounts)<br>• Degassing can be advantageous - best for high frequency/large number of heads. Must be used with care - can make ink over-sensitive to curing |
| **Aqueous** | • (Requires) degassing |
| **Oil based** | • None special |
| **Solvent** | • May require materials compatibility testing |
| **White/ Ceramic** | • Require special pumps due to abrasive ink pigment and particle settling |
| **Fluid Deposition/ Functional Fluid/ Ink Development** | • Requires materials compatibility testing<br>• Typically requires small volumes due to high value of fluid– may affect header tank design/size |

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# Heating

- **Ink performance varies with temperature**
  - Higher temperature
    - Reduces viscosity
    - Increases evaporation
- **Inks have a recommended operating temperature window (consult you ink supplier)**
- **Temperature most critical at the printhead/jetting**

| Mode of Heat | Comment | Pros | Cons |
|---|---|---|---|
| **In-line Heaters** | • Only work with recirculating systems | • Provide fast and controllable ink heating | • Cost |
| **Heated Header Tanks** | • Typically used in no flow or low flow systems | • Lower cost than in-line heaters | • Only suitable for low density printing<br>• Temperature control less accurate |
| **Heated Head Plates** | • Can be used with all flow modes | • Provides uniform thermal environment<br>• Reduces workload on printhead/ink system heating improving thermal control | • Thermal expansion<br>• Adds cost |

# Degassing

- **(Required) for aqueous inks**
  - Sometimes not used on small systems to save cost
- **Recommended for some UV inks**
  - Typically on large, high print frequency systems
- **Contactor must be right size for flow rate and compatible with ink**
- **Vacuum must be applied**
  - High vacuum for aqueous ink
  - Lower vacuum for UV ink
    - Risk stripping all oxygen out of the ink and cause curing

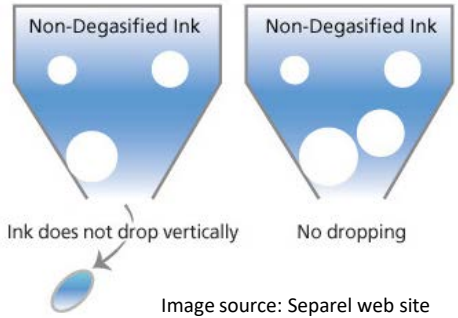



Image source: Separel web site

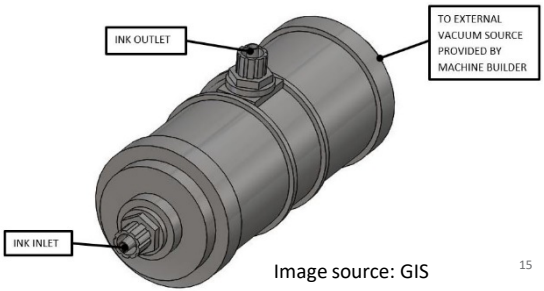
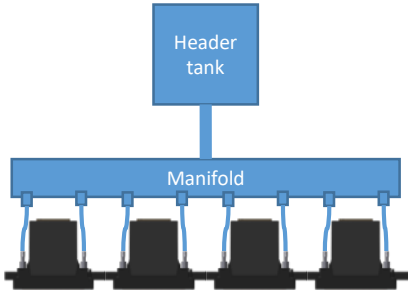
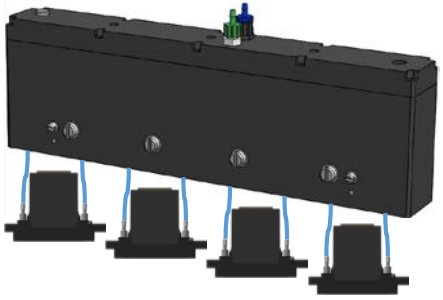



Image source: GIS

# Larger Print Bars – Tank Options




- **Manifold system**
  - Popular design
  - Cost efficient to implement
  - Can be prone to air traps
    - Trapped air can sit at top of manifold
  - Can be difficult to fill
  - Extendable



- **Custom header tanks**
  - Header tank acts as manifold
  - Valve for each printhead
  - Equal flow resistance
  - Extendable

Image source: GIS

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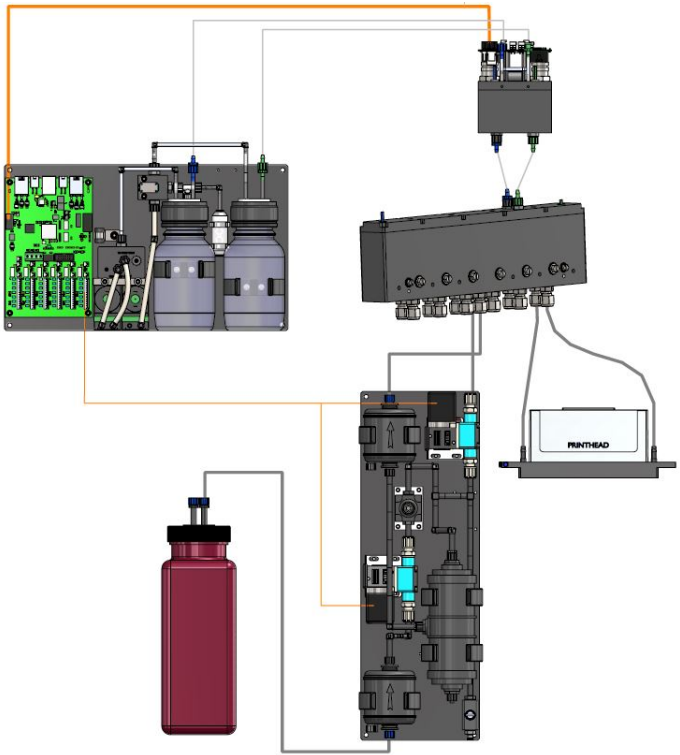
# Typical IDS Issues

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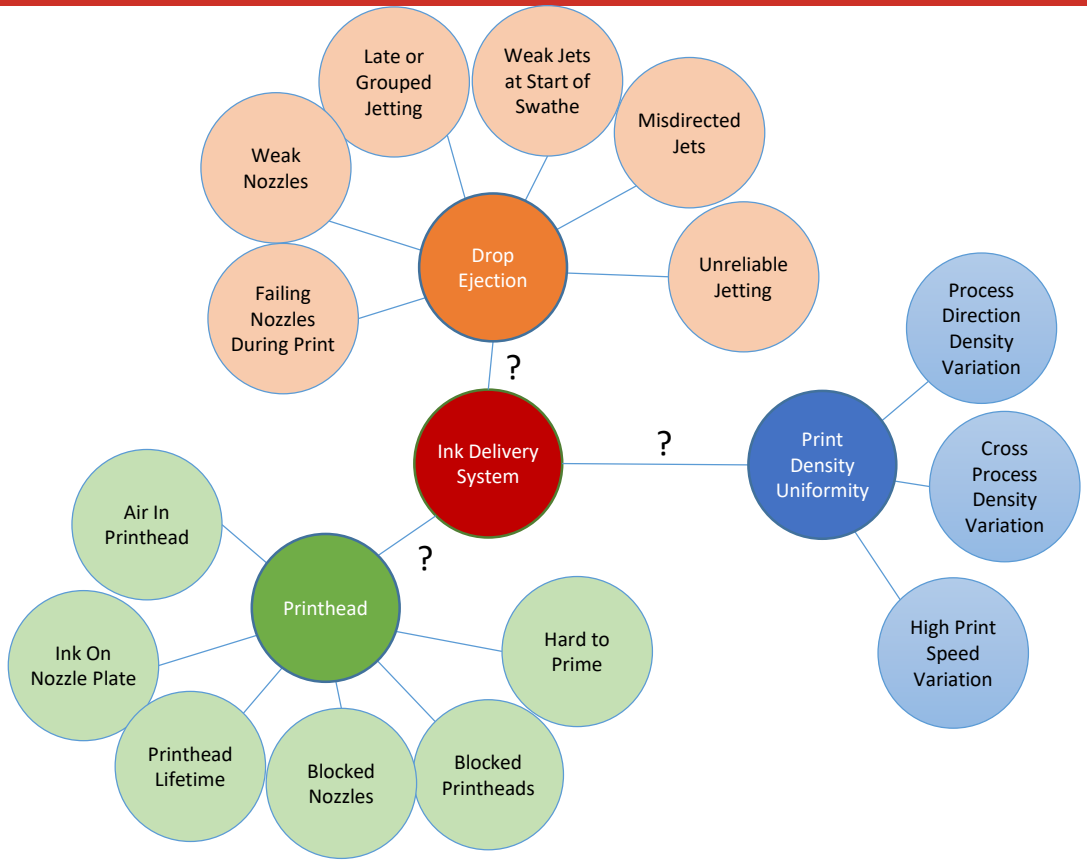
# Common Issues Attributed to IDS



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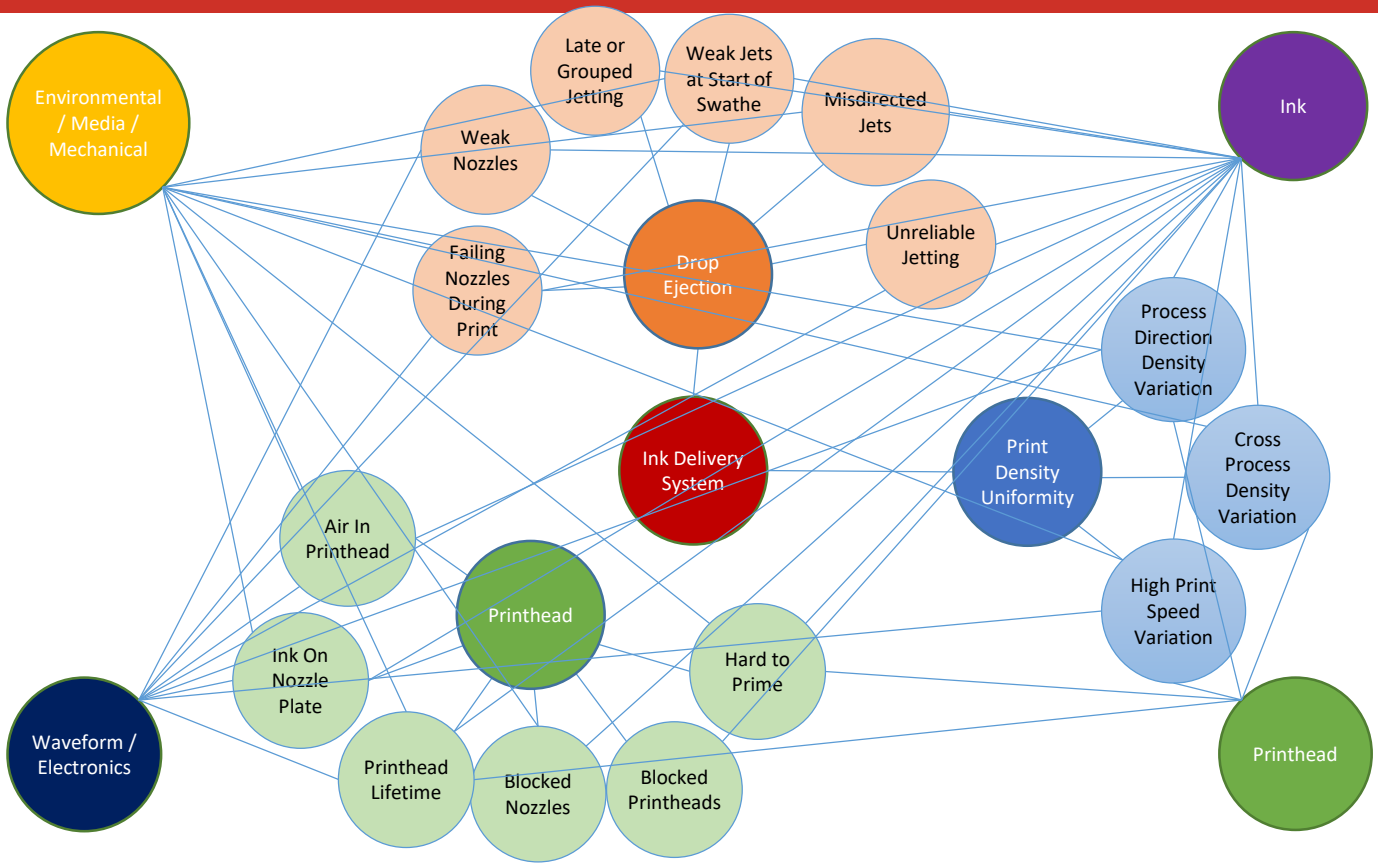
# Common Issues with Alternative Causes



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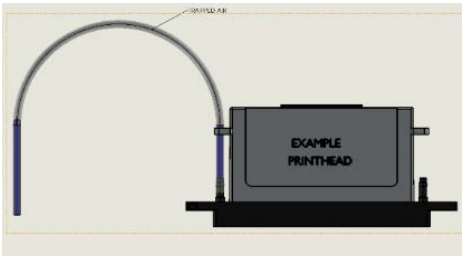
# Trapped Air

- **Symptoms**
  - Difficult morning start up
  - Ink dripping from nozzle plate, even when pressure set correctly
  - Intermittent printing
    - Heads may print well for short time until air moves into the head
    - Heads may print well for low density images but fail quickly for high density images




- **Solutions**
  - Ink degassing
  - Avoid tubing with uphill path or loops
  - Correct tube size (not too small or too large) – restricted flow can lead to air being sucked into the nozzle as the head fails to pull ink through the system
  - Avoid restrictions in valves & fittings

# Materials Compatibility

- **Symptoms**
  - Blocked nozzles
  - Ink starvation
  - Swelling of tubes
  - Failure of the system
- **Solutions**
  - Can be difficult to fault find
  - Can cause expensive problems
  - Choose components and do sufficient materials compatibility testing
    - Material can leech into the ink
    - Use e.g. FEP or PTFE

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# Poor Pressure Control

- **Symptoms**
  - Ink dripping at the head or air sucking into the head
  - Variations in optical density in the image – volume of ink in each drop is affected
- **Causes**
  - Vacuum pump on continuously  creates loss of pressure
  - Dirt in vacuum pump diaphragm
  - Vacuum setting incorrect
  - Pulses from pump
- **Solutions**
  - Control of vacuum pressures +/- fluctuations
  - Smooth flow control – not pulsing
  - Maintain adequate flow of ink – don't run out

Image source: GIS

# Sedimentation

- **Symptoms**
  - Heads clog
  - Parts of the ink system clog – filters etc.
  - Reduced flow to heads
- **Causes**
  - Heavily pigmented inks (pigment agglomeration)
  - Unstable/poor dispersion
- **Solutions**
  - Recirculating flow mode
  - Adjustable flow rate useful
  - Avoid pigment collection points
  - Use special pumps – resistant to abrasion which can wear internal components
  - Agitation of ink – in bulk tank

Image sources: Porvair & Pall filters

# General System Unreliability

- **Causes**
  - Unsuitable components e.g. ink pump type
  - Poor quality components
  - Poor control logic/software
- **Solutions**
  - Appropriate components e.g. ink pump type
  - Good quality components
  - Tried and tested components
  - Implement industry standard control techniques/software

Image source: GIS

# Summary

- **Insure against future problems by careful design and planning**
  - Materials compatibility, correct components, follow ink and printhead manufacturer guidelines etc.
- **Over-specify on prototype**
  - Simplify and cut cost when proven
- **Low flow use with end shooter printheads is growing**
  - No flow for CMYK
  - Low flow for W
- **Recirculating/controlled flow printheads increasing**
  - More demanding for IDS design and implementation

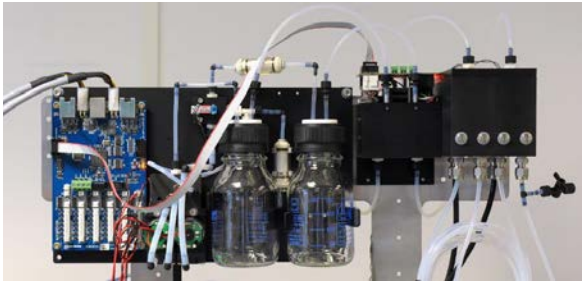

Image source: GIS

# Contacts

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