

Ink System Design and the Importance of Diagnostics

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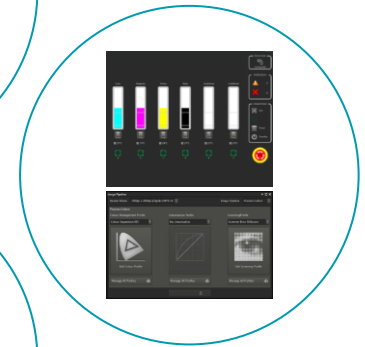
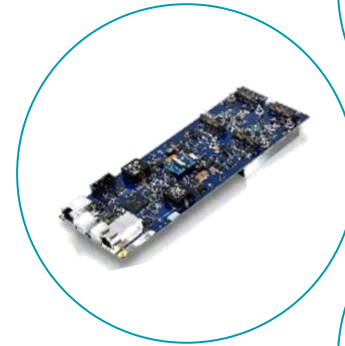
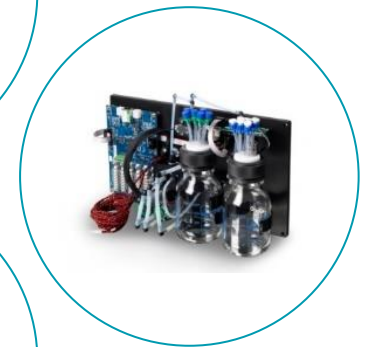
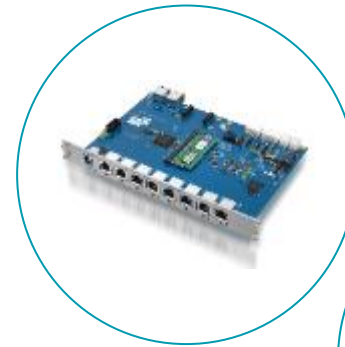
IMI Inkjet Age of Materials Online Conference

19th May 2021



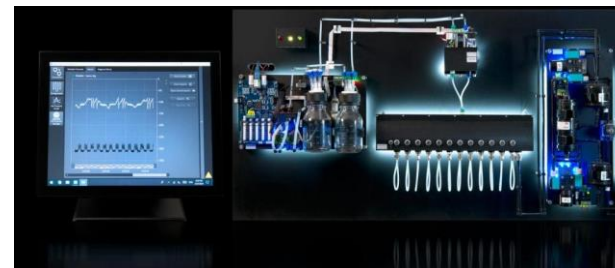
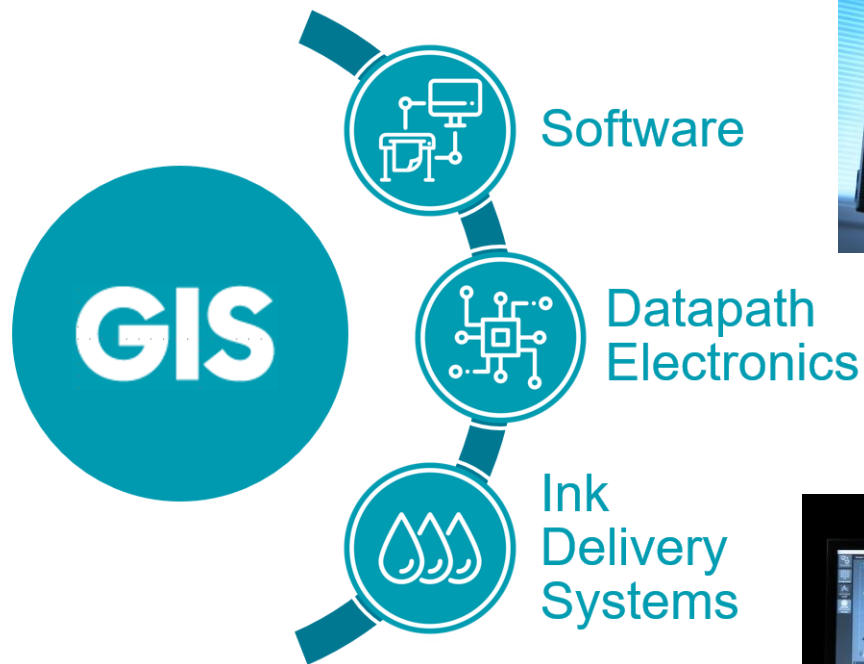
GIS – Company Overview

- Leading provider of technology solutions to industrial inkjet systems builders
- Supported printhead manufacturers
 - Epson, Fujifilm Dimatix, Konica Minolta, Kyocera, Ricoh, SII, Toshiba Tec, Xaar
- Founded November 2006
 - Privately owned
- Based in Cambridge, UK
 - Technical support in UK, China and Japan
- Employees ~65
- Patent protected technology
- Supplier & partner to over 150 customers worldwide



GIS Products

Complete image management from pixel to drop



GIS customers - system builders, OEMs, integrators, large end users and fluid developers worldwide - in many different applications and markets

Agenda

- **Main functions and basic requirements**
- **Design principles**
- **Troubleshooting and diagnostics**

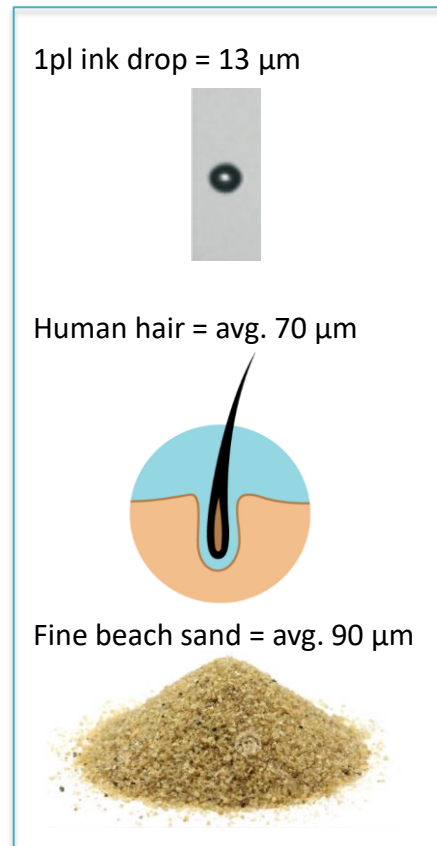


Overview of IDS Control Functions

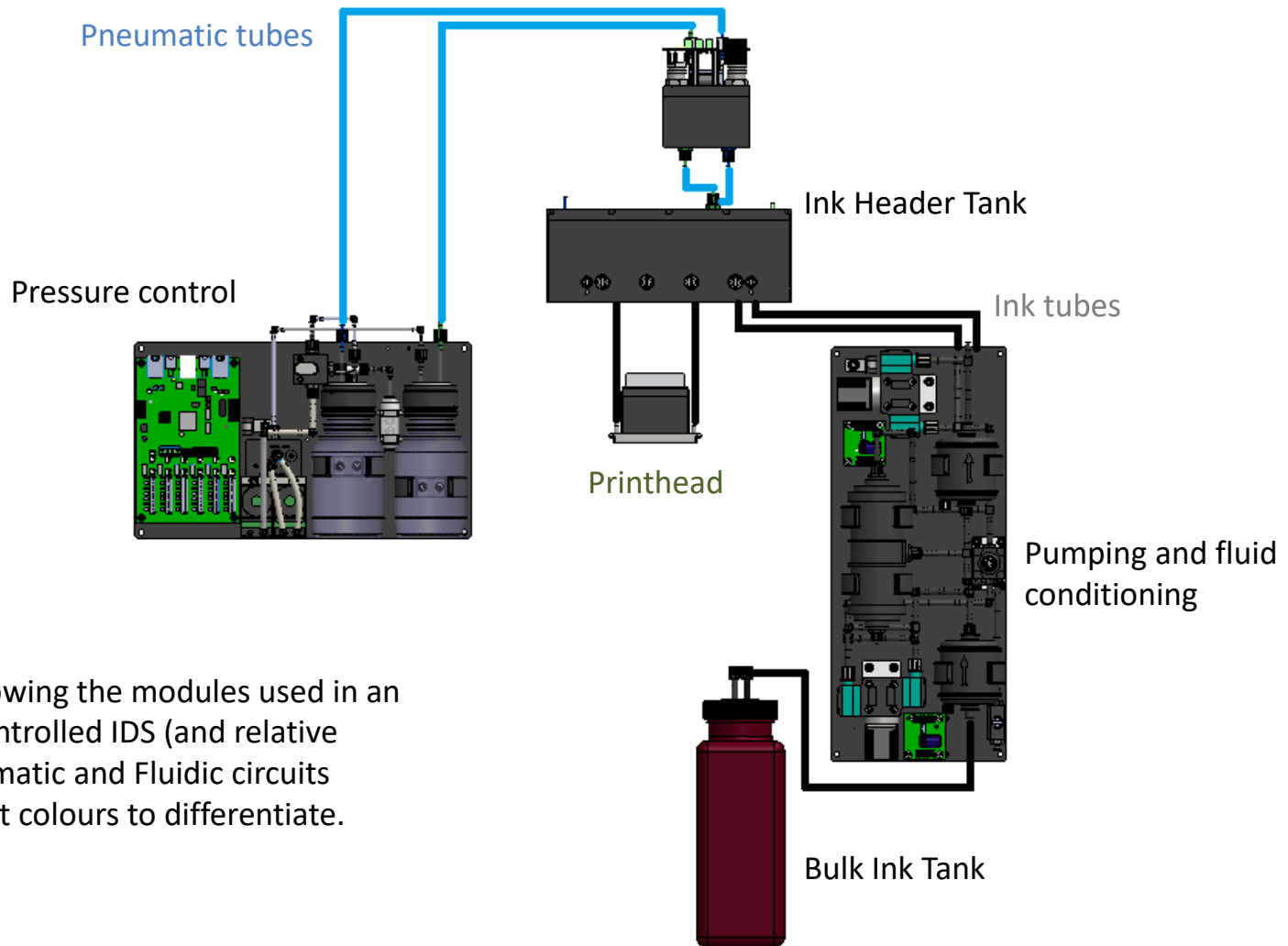
- **Flow modes**
 - Support for high, low or no recirculation rates
- **Pneumatic pressure control**
 - Meniscus pressure control
 - Regulating the pressure at the nozzle plate of the attached printheads during use
 - Pressure differential control
 - Managing the flow rate of the fluid through the attached printheads
 - Rapid pressure adjustments
 - Regulating the applied pressures to compensate for any acceleration/deceleration of a printhead carriage
- **Ink pumping**
 - Control for pumping of ink to and from the Ink tank and printheads
- **Purging**
 - Apply a positive pressure to the ink in the printhead
 - Low pressure and high pressure purge (required by some printheads)

Overview of IDS Operational Functions

- **Fluid Conditioning**
 - **Filtering**
 - Essential
 - **Degassing**
 - Fluid dependent
 - Reduce dissolved gas in the fluid - reliability and performance
 - Absorb any trapped air in the system over time
 - **Heating**
 - Fluid/printhead dependent
 - For correct operating temperature
- **System Configurations**
 - Suitable pressure control for fluid set used by colour
 - Efficient fluid path for thermal or degassing control
 - Selecting components to match scale of system



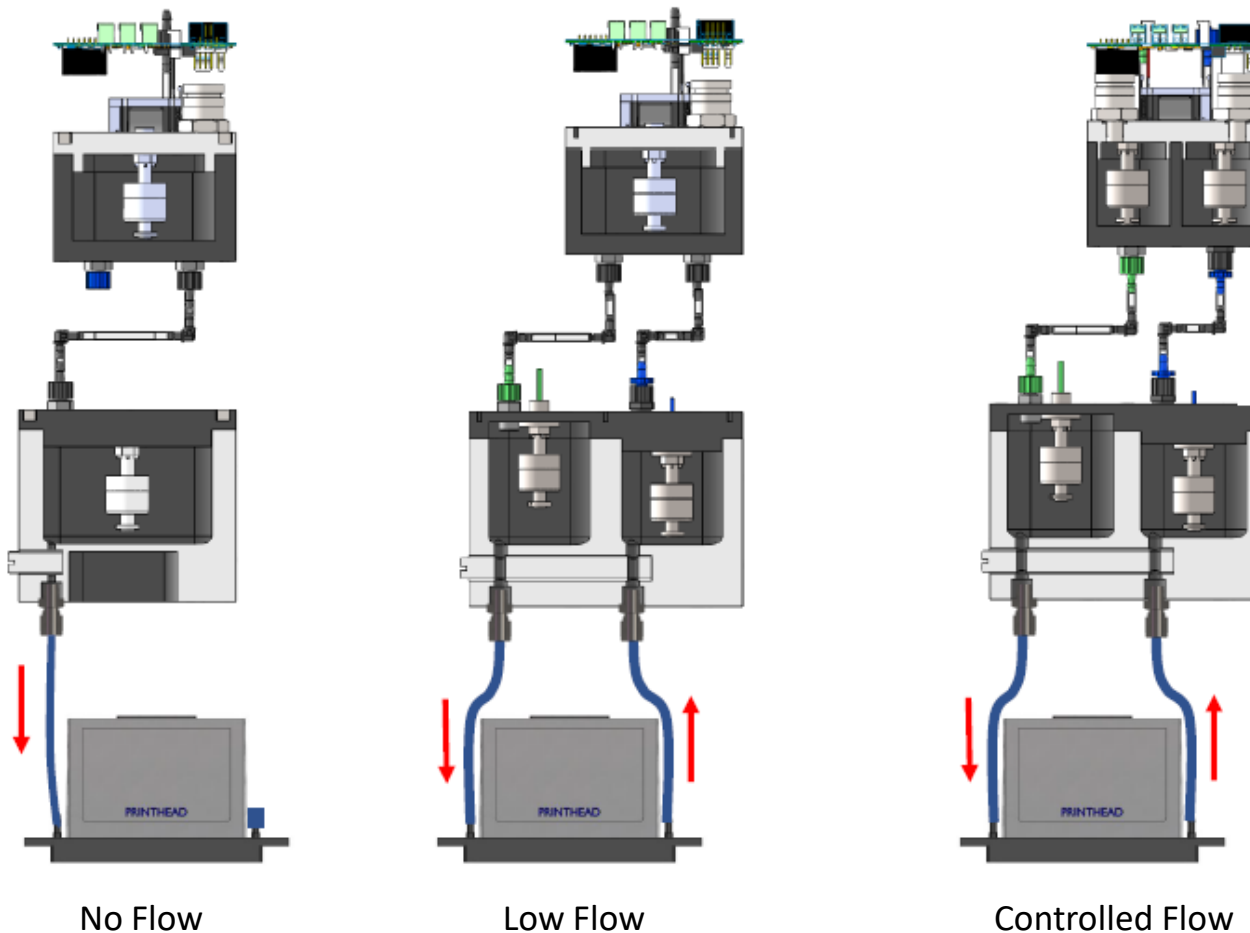
Example Ink System



Simple layout showing the modules used in an pneumatically controlled IDS (and relative positions). Pneumatic and Fluidic circuits shown in different colours to differentiate.

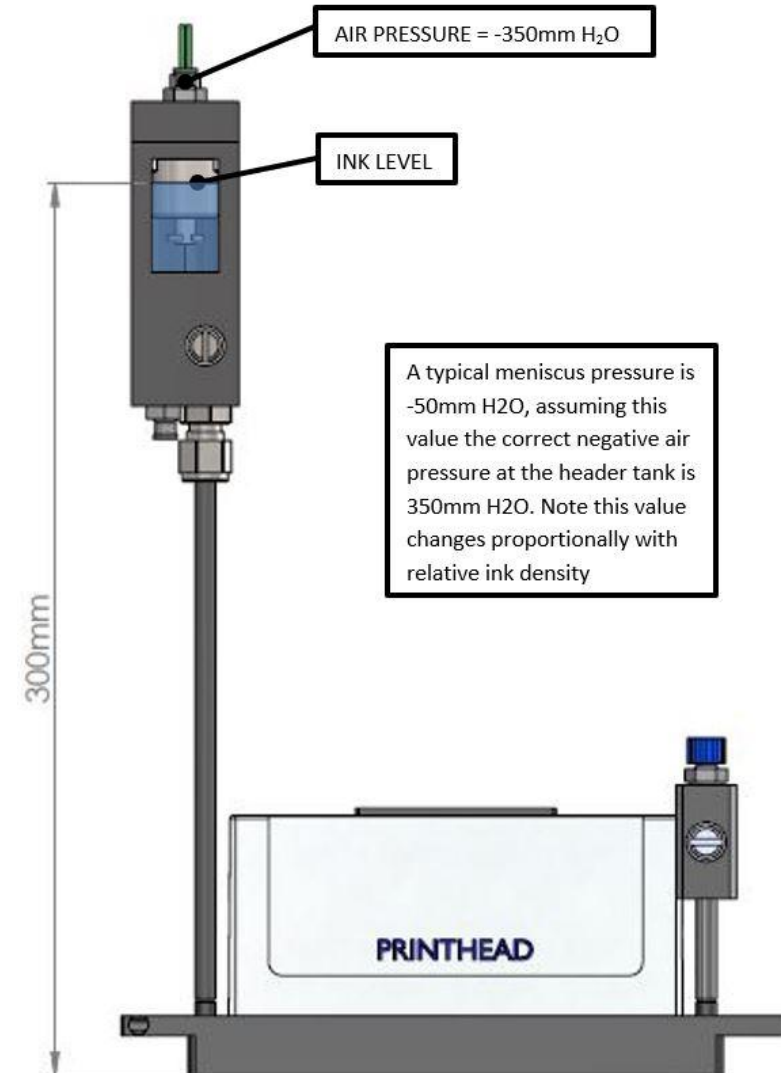
Flow Modes

Experience shows that there is a 'functional' advantage to have flowing ink, but this has to be balanced against cost/footprint of the system – unless specifically required by the printhead



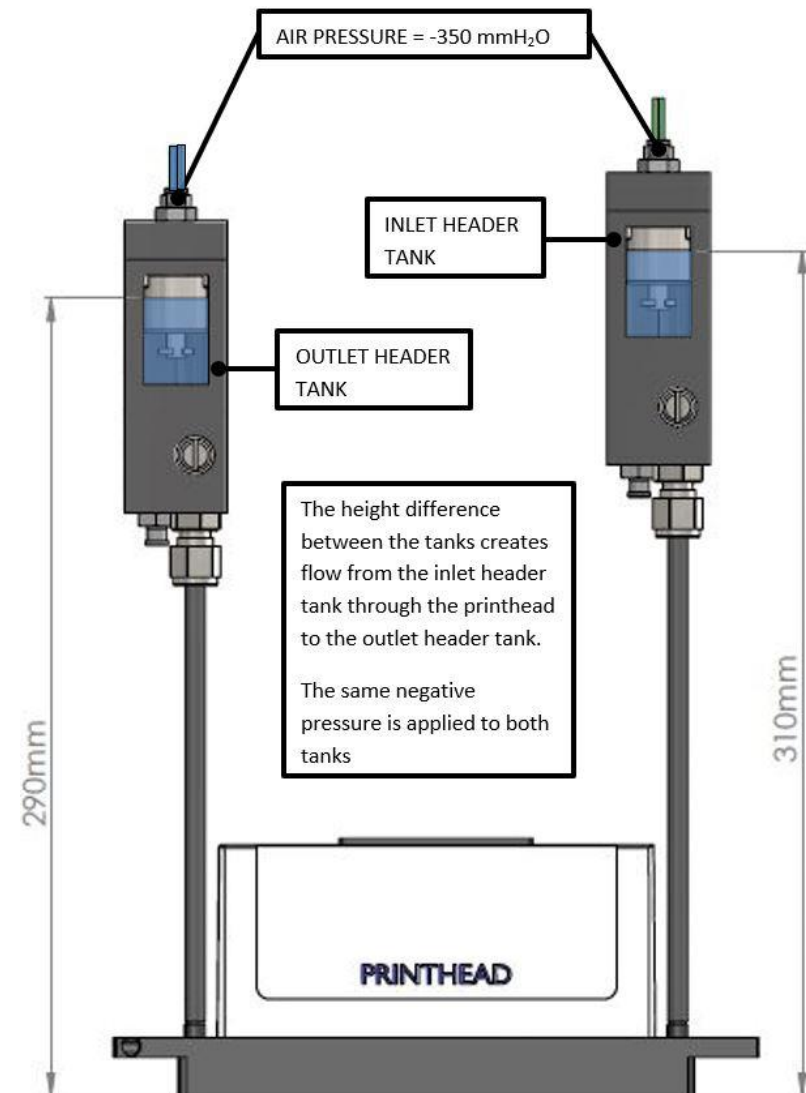
No Flow/End Shooter

- **Basic characteristics**
 - Simplest style of system
 - Lower cost
 - Suitable for printheads which operate in end shooter configurations or low consumption applications, which are less sensitive to fluid temperature supply or dissolved gas
 - Low weight of modules over printhead
 - 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



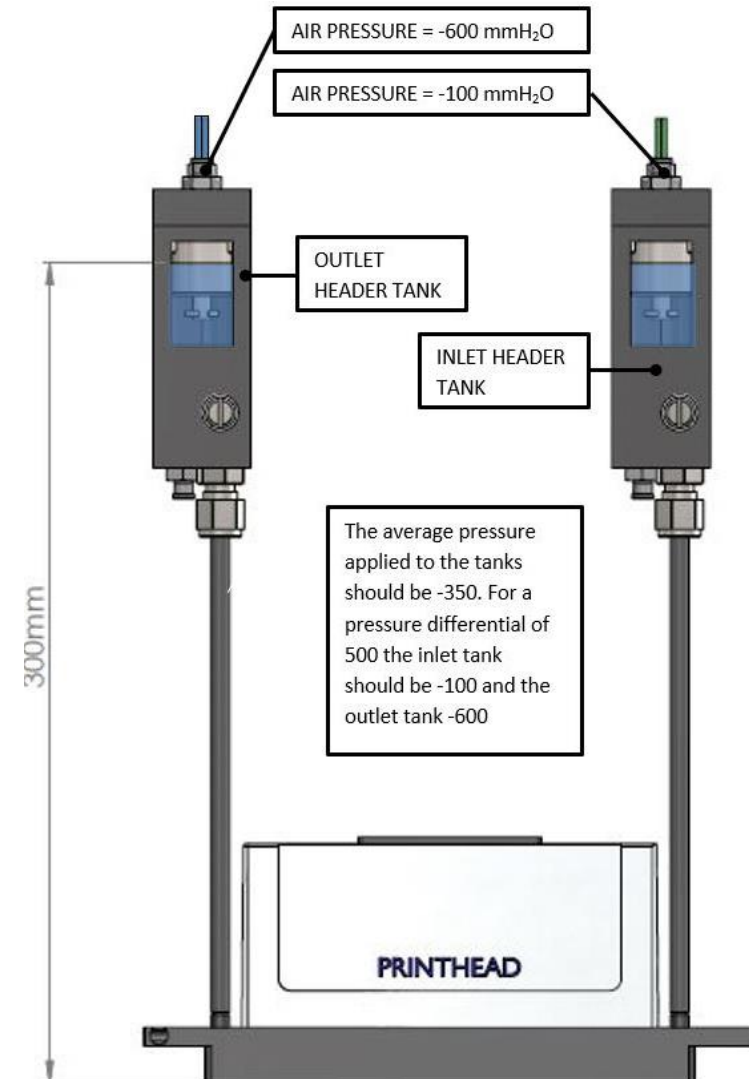
Low Flow/End Shooter

- **Basic characteristics**
 - Difference between the fluid level in the header tanks results in a low flow through the printhead as the levels equalise
 - Supports printheads with an inlet and outlet port
 - Can increase reliability
 - Option to apply degassing
 - Option to heat the header tanks to assist thermal control of printhead if required
 - No flow vs low flow - advantage in operation for a relatively minor cost increase
 - Even if installed as a basic system - would allow for the addition of degassing or tank heating at a later date if required



Controlled/High Flow

- **Basic characteristics**
 - Controls two pressure environments to generate a pressure differential across a printhead
 - Pressure difference can be adjusted to suit the printhead and fluid combination used
 - Allows thermal control of printhead (with in-line heater)
 - Allows effective degassing of printhead (optional)
 - Allows effective priming of printhead
 - Gives increased reliability
 - System operation and fluid condition is more consistent and any environmental effects minimalised



Printheads & Flow Modes - examples

Example Printheads	No Flow	Low Flow	Controlled Flow	High Pressure*
Fujifilm Samba G3L/G5L	x	x	✓	(✓)
Fujifilm Starfire SG600	x	x	✓	(✓)
Konica Minolta 1024i	(✓)	✓	x	x
Kyocera KJ4A/B-AA/QA	(✓)	✓	x	x
Ricoh MH5441	(✓)	(✓)	✓	(✓)
Ricoh MH5421F	x	x	(✓)	✓
TTEC CF1/CF3	x	x	✓	x
Xaar 1003/2002	x	x	(✓)	✓

Key
 ✓ Optimal
 (✓) Optional

*High Pressure: Enables control of greater pressure environments which supports the full operating capacity of the latest printheads and larger systems. Allows the control of high pressure differentials ($\pm 2000\text{mm H}_2\text{O}$) across a printhead.

Heating

- **Ink performance varies with temperature**
 - A higher temperature reduces viscosity of the ink
 - Maintaining an elevated ink temperature can allow thermal regulation even when ambient is varied
- **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	<ul style="list-style-type: none">• Only work with recirculating systems	<ul style="list-style-type: none">• Provide fast and controllable ink heating	<ul style="list-style-type: none">• Adds cost
Heated Header Tanks	<ul style="list-style-type: none">• Typically used in no flow or low flow systems	<ul style="list-style-type: none">• Lower cost than in-line heaters• Usable for Low Flow systems	<ul style="list-style-type: none">• Only suitable for low density printing• Temperature control less accurate
Heated Head Plates	<ul style="list-style-type: none">• Can be used with all flow modes	<ul style="list-style-type: none">• Provides uniform thermal environment• Reduces workload on printhead/ink system heating improving thermal control	<ul style="list-style-type: none">• Thermal expansion• Adds cost• Adds complexity

Degassing

- **Contactors must be right size for flow rate and be compatible with the ink**
- **Vacuum must be applied**
 - High vacuum for aqueous ink
 - Lower vacuum for UV ink
- **Can improve reliability and operating limits for the application**
 - Generally makes the printhead less susceptible to any variations
 - Improves the stability of a fluid's behaviour within the printhead as fire frequency is increased allowing a more productive solution
- **Required for aqueous inks**
 - Sometimes not used on small systems to save cost
- **Recommended for UV inks**
 - Typical on large, high print frequency systems

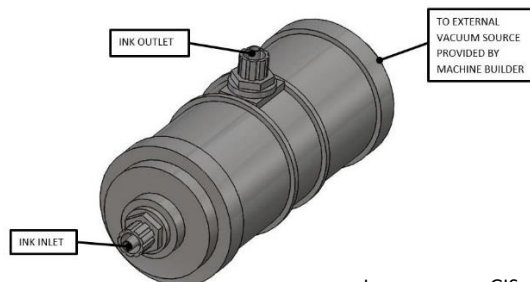


Image source: GIS

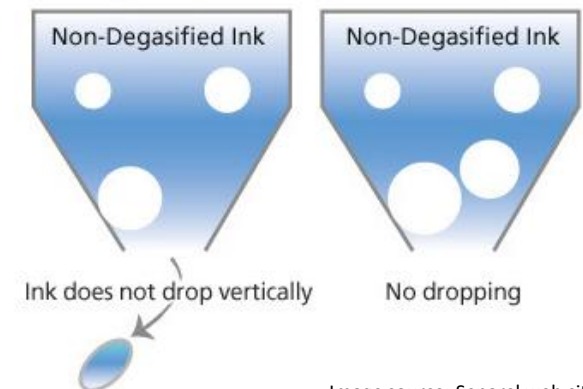
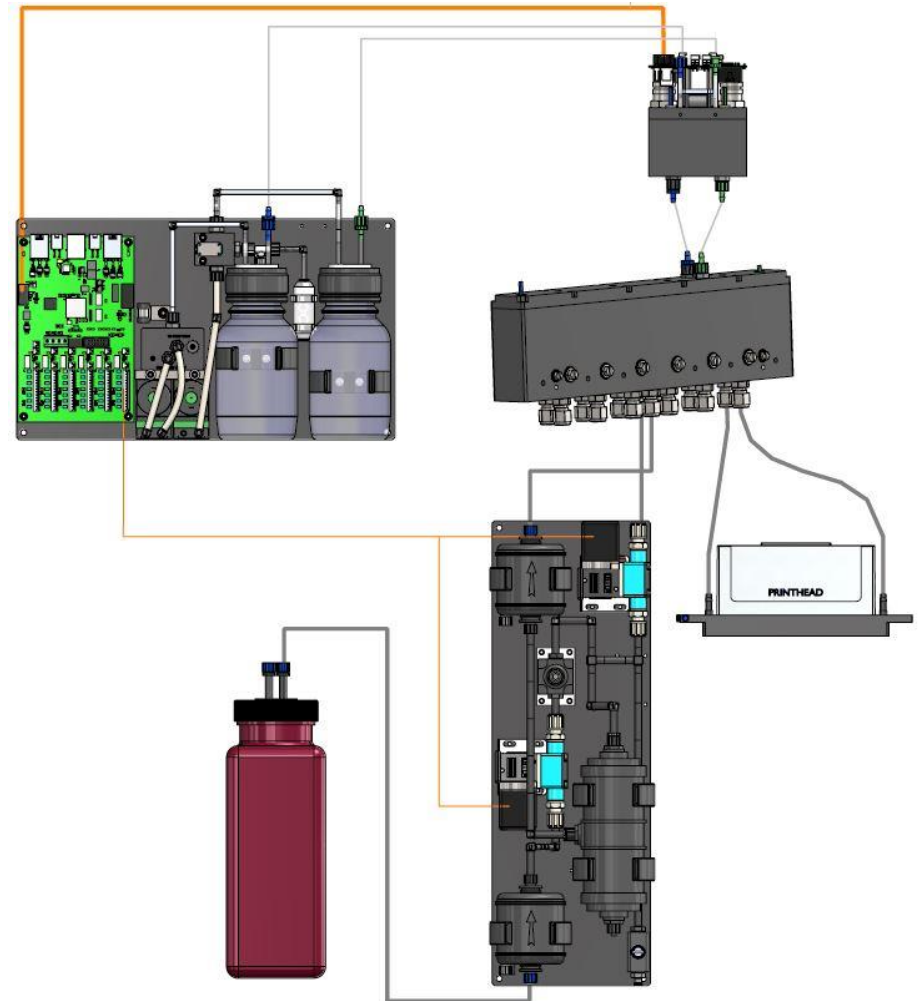
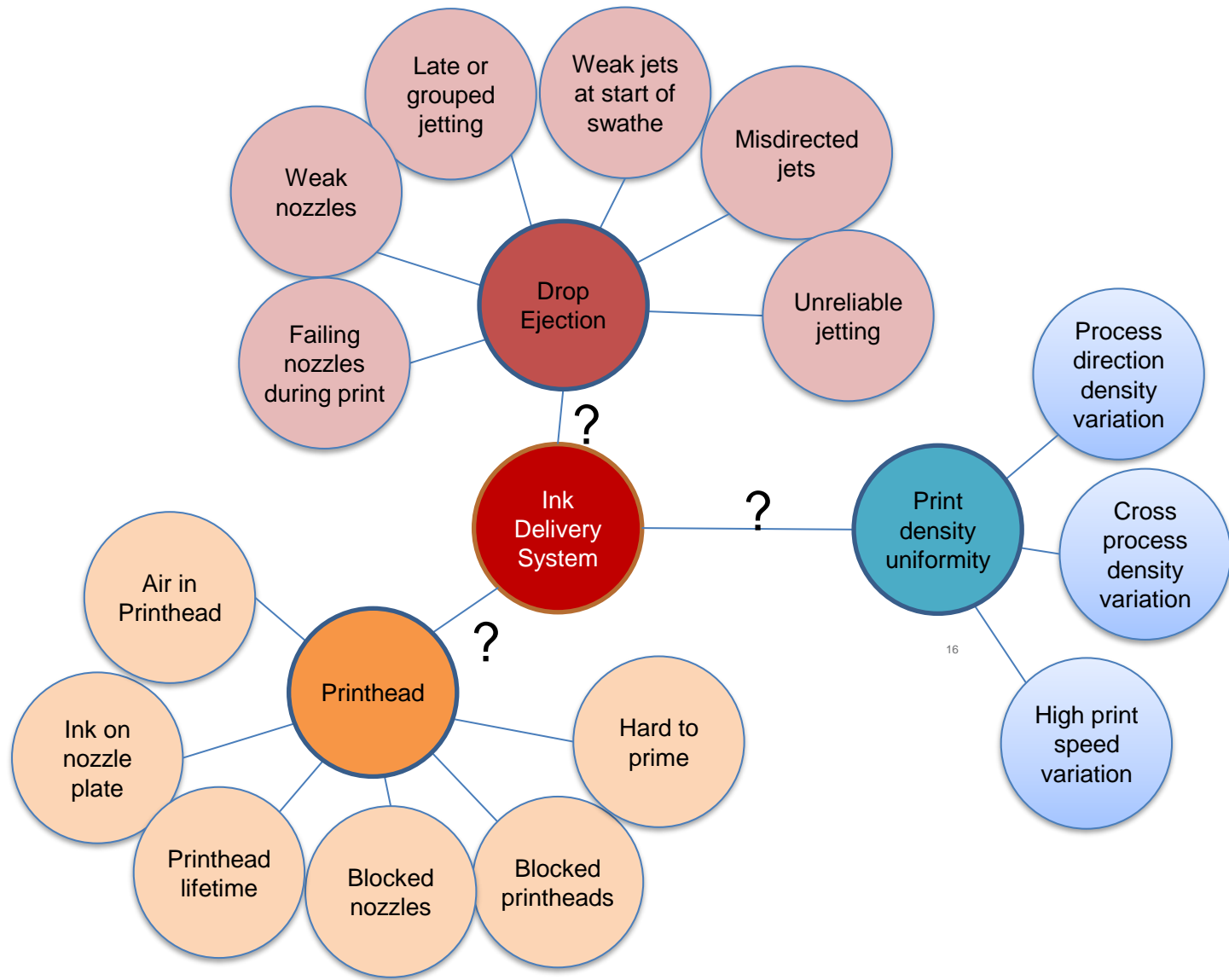


Image source: Separel web site

Typical IDS Issues



Common Issues Attributed to IDS



System Design & Integration

- IDS components are more than just a simple kit of parts
 - Critical building blocks
 - Overall printing system designs can have a significant impact on the specifications of the IDS parts used and their operational performance and durability
- **Materials compatibility**
- **Printhead choice**
- **Module placement**
- **Pipe diameter & length**
- **Fixtures & fittings**
- **Heater location**
- **Movement**
 - Scanning systems
 - Energy chains
- **Operating environment**
- **Fluid choice**
- **Pressure drop**
- **Consumable life & access**
- **Appropriate parts**
 - Stresses to components
 - Lifetime performance



Looking After an IDS

- **Scheduled maintenance**
 - Record when units are commissioned and parts changed
 - Ink conditioning parts – filters and degassers
 - Mechanically active parts – pumps, valves and solenoids
- **Fluid care**
 - Only use in-date inks
 - Verified materials compatibility
- **Avoid physical damage**
 - Any possible trapping or pulling of pipes and wires
 - Positioning of parts to reduce any impact risk
- **Use in a controlled environment**
 - Avoid temperature and humidity extremes
 - Avoid significant electronic noise
 - Reduce exposure to contamination

Where is the Vacuum Leak?



Importance of Diagnostics

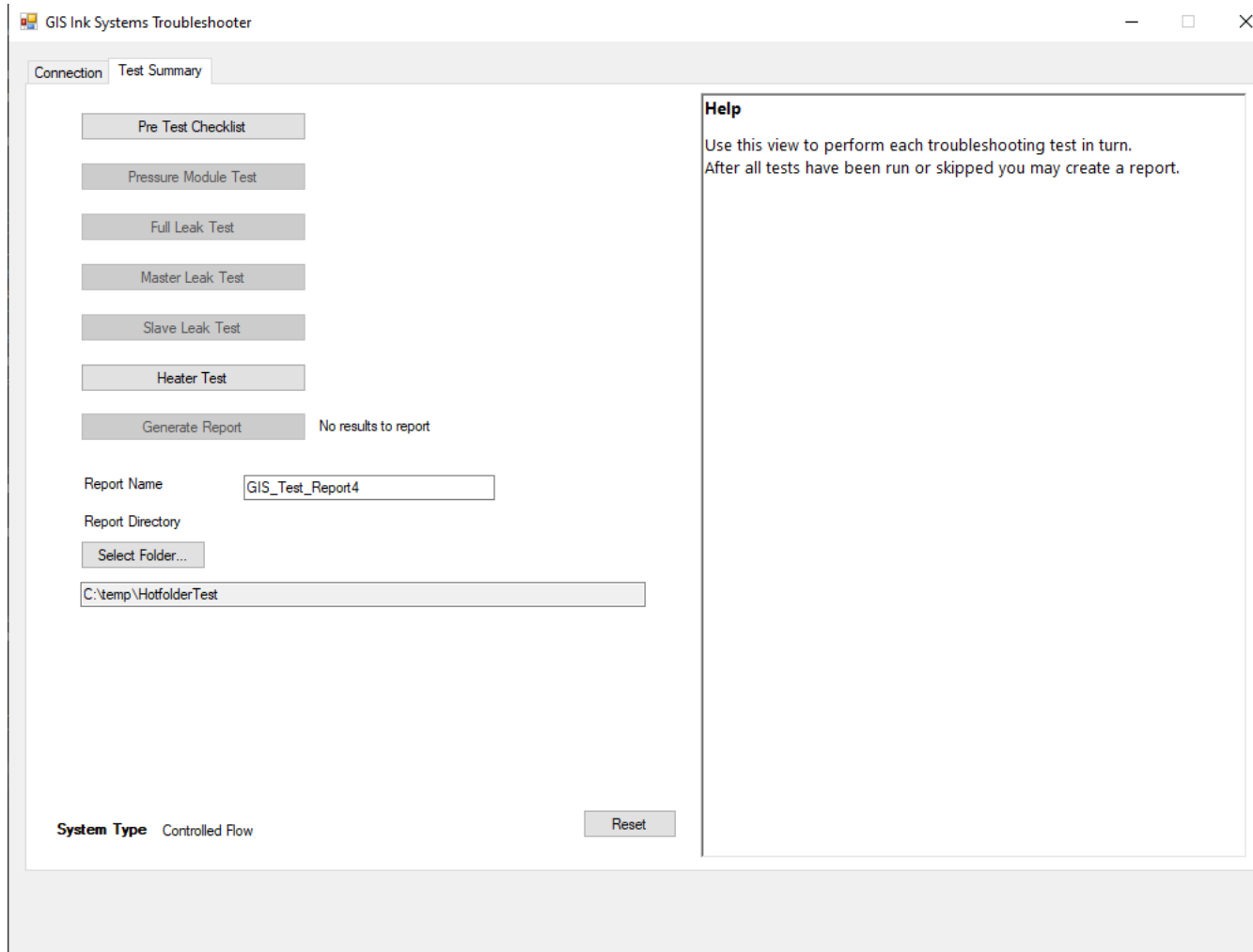
- **Fixing the fault quickly and correctly is essential**
 - Downtime means lost revenue for press owner
 - Supplier costs to send engineer and support on-site
- **Systems can be very large, and isolating a fault can be very time consuming – for example**
 - Label presses typically 80+ printheads
 - CMYKW /WW / VOG
- **Ideally a system needs a user interface (UI) that helps customers and support engineers to diagnose problems and solve them quickly**

Importance of Diagnostics

- **Troubleshooting requires a lot of knowledge of the system**
 - How can I isolate an air leak?
 - How do I make sure I don't make the problem worse?
 - How do I prevent misdiagnosis?
 - Many faults have similar symptoms.....
- **All this under time pressure to find a solution and get press running again**
- **Need simple procedures to diagnose and fix a fault**



GIS Ink System UI – Test Selection



- The user can choose which tests to run
- Normally tests will be run from start to finish

GIS Ink System UI – Test Result

GIS Ink Systems Troubleshooter

Connection | Test Summary | **Master Leak Test**

Master Leak Test

Commands

Run Vac1 Test Pressure Module Test, tubes disconnected

Messages

R101: P1 Leak Fail

Pressure P1	-178	192.168.1.174	Master Ch. 1
Pressure P2	-927		

Final Result

View Console StateP1NoTubesLeakTest

Leak found on Master or tubing to pneumatic tanks

- A leak was found when just the master was tested and all slaves were disabled
- This indicates a leak either on the pressure module or on the tubing between the pressure module and pneumatic tanks
- Disconnect all the pneumatic tubing from the bottle, and place caps on all the pneumatic connections on the bottle
- The pressure module will be retested on its own, to determine if the leak is in the tubing or on the pressure module

Cancel Skip Done

- The UI has identified a leak on the system: instructions are given to help isolate it

Summary

- **Insure against future problems by careful design and planning**
 - Materials compatibility, correct components, follow ink and printhead manufacturer guidelines etc.
- **Over-specify on prototypes**
 - Simplify and cut cost when application is proven
- **Recirculating/controlled flow printheads increasing – and high pressure systems**
 - Advantage of greater stability and control
- **Training and maintenance will improve lifetime and consistency of use**
- **System diagnostics and troubleshooting tools can be key to solving problems quickly and decreasing press downtime**

- **Acknowledgements**

Thank you to the GIS Ink System Team for their help in preparing this presentation



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