Innovations in Inkjet Analysis

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Abstract

It is a general principle that measurement is key to consistently successful innovation, and this principle certainly holds when it comes to inkjet R&D.

Deconvolving causes of poor performance, like misting, wetting, satellites, and poor sustainability, while in production, quickly becomes very difficult and expensive.

New analysis tools have become available over the last years, however, by which these problems can now be identified and addressed independently. [1]

Drops in flight are not only visualized but repeatably measured, using high speed strobe and cameras, capable of capturing individual drops as small as 10um in diameter, or traveling at speeds over 50 m/s, using a single strobe. [2]

Significant automation is also possible, including analysis of all jets in a row, or analysis of inkjet performance at a range of frequencies. [3]

Over the last year, even newer tools for inkjet R&D have become available, notably now including a fully integrated testing and printing platform, which includes drop watching and analysis, belt printing with print controller, and adjustable ink supply, in a single system.

These new ink development platforms may also include a drop weigh station, X---Y print table including densitometer, laser, and even automated print quality analysis of the final product.

Direct imaging of drop---substrate interaction is becoming available, as well, by using a triggered strobe and motion stage to capture the impact of drops on custom surfaces, or on transparent material.

With these new tools, we can expect inkjet innovation and performance improvement to continue apace, with applications in printed electronics,ceramics, textiles, 3D, medicine, science, and much more. [4, 5]

Our goal in this presentation will be to give an overview of these new innovative techniques, tools, and products for inkjet R&D.

The Process of Inkjet Development

The use of inkjet technology offers considerable and increasing advantages for a variety of applications. Significant advances have been made in inkjet over the last several years, especially in printhead design and in materials science. Companies can leverage these advances, but with any new product, application specific development time, and therefore cost, is of course inevitable.

As in any process of innovation, reliable measurement at every step is essential. If specific causes of poor print performance cannot be identified, identifying a solution becomes far more difficult. By obtaining proper tools and correctly using intermediate measurements, causes of undesirable behaviors can be identified, isolated, and solved. Machine vision tools have become an essential part of inkjet testing.

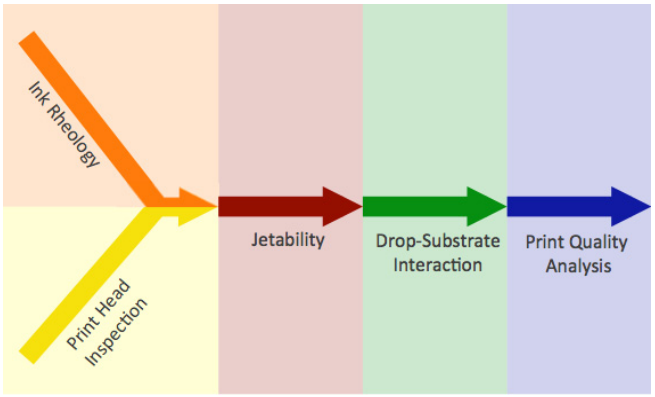

Figure 1 – Key Points of Analysis in Inkjet Development

Machine vision provides invaluable tools at several steps in the process of ink development, to check performance, and identify specific causes of misbehavior.

Drop Watching and Measurement

Apart from suspension of pigment, dye, or functional materials in a carrier fluid, jetability may be the most fundamental property of any ink. Indeed, even before the addition of other materials, a new carrier fluid can first be tested for jetability.

Of course, proper analysis of jetability goes far beyond the simple question of whether ink is dispensed by the head. Poorly jetable ink formulations may dispense, but with large satellites or erratic drop trajectories which would ultimately lead to poor print quality, and malfunctioning electronics.

If surface tension is too low, wetting can become a serious problem as well, primarily impacting sustainability, and causing Jet Out, which is especially devastating to sensitive applications, like printed electronics. Finally, if the drop volume or velocity are significantly outside of the acceptable range, the ink will not perform according to expectations in a printer.

The JetXpert drop watching system has become the industry standard for optimizing ink formulations and jetting parameters in order to solve these kinds of technical challenges.

Figure 2 – JetXpert System for Dropwatching and Analysis

There are several key attributes worth considering when choosing a drop watching system:

1: Single drop imaging

Many drop watching systems have underpowered light sources. To compensate, they sum or average several frames prior to display or analysis. If successive drops vary at all, this leads to a blurry image with no value for analysis, or for checking drop to drop consistency, and sometimes little value even for visualization.

Figure 3 – Dimatix S-Class, Captured with JetXpert

2: Measurement Capabilities

While visualization is helpful, accurate measurement including volume, trajectory, and velocity, is key to the creation of objective performance standards for new inks, and comparison between various waveforms and formulations.

3: Automated analysis.

It's impractical for an operator to be present at the system to run many hours of sustainability testing, to move between hundreds of individual nozzles on the head, and collect accurate date for each nozzle, or to repeatedly test an ink over a large range of frequencies. Automated testing can save many hours of engineering time.

Testing Print Quality

Once the ink has been shown to be sustainably jetable, with acceptable measured attributes, it's time for print testing. Print testing introduces the complication of substrate interaction. It can be done quickly with a hybrid dropwatching/print system, like the JetXpert print station, or on a standalone printer.

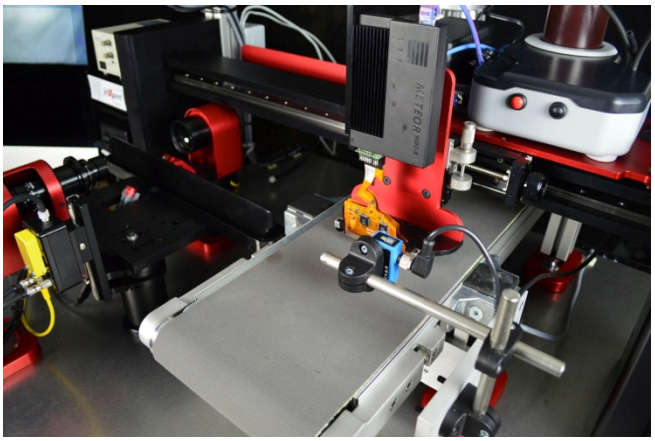

Figure 4 – JetXpert Print Station

It's a good idea to use a target that allows accurate and objective measurements of print quality, so that various printing techniques and inks can be meaningfully compared, and performance can be tracked over time. "It looks good to me" is not an objective, nor quantifiable analysis. Of course, depending on the application, function testing may be important as well.

A variety of methods are available for capturing images, including scanner, overhead camera, linescan, and full motion (which may include xrite and/or laser). In the case of ImageXpert, all of these is controlled automatically through the software on the workstation. Each has its own advantages, and is appropriate for certain applications.

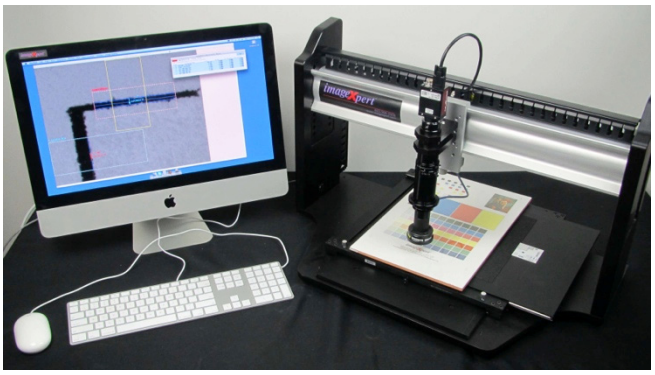

Figure 5 – An ImageXpert Camera System, with Manual Motion

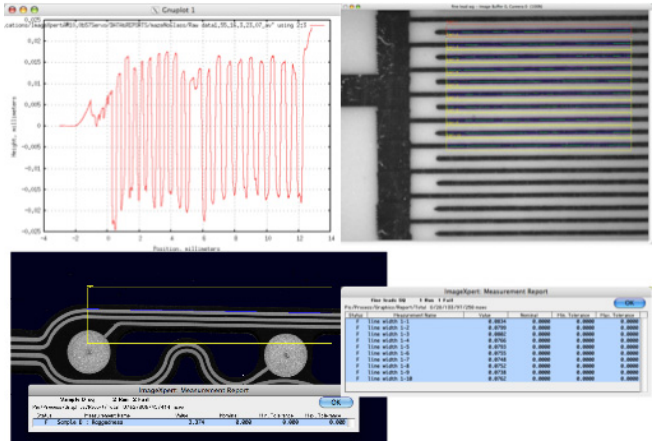

Figure 6 *– Machine Vision Based Inspection, Printed Electronics*

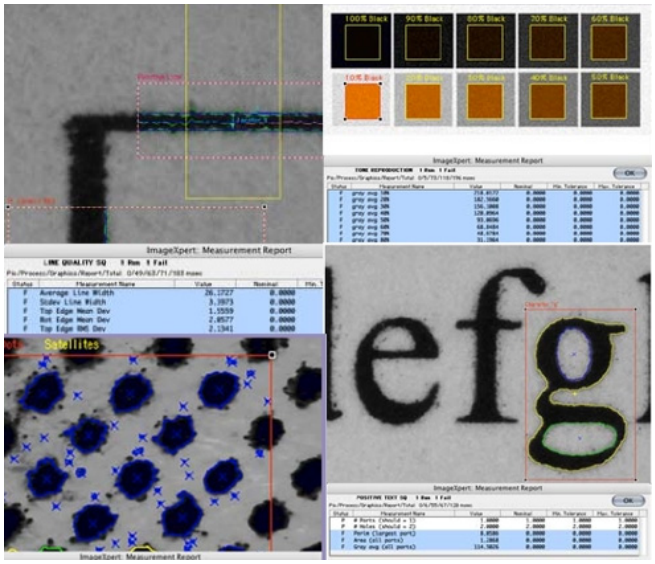

Figure 7 *– Machine Vision Based Inspection, Graphics*

Densitometer and lasers may compliment camera-based analysis. Along with initial print quality, the robustness of a print may also be tested, by subjecting the print to wear or abuse, and then using machine vision, along with functional testing where possible, to quantify the resulting degradation.

Inkjet Development Platform

The purpose of an integrated system like the JetXpert Inkjet Development Platform is to combine any or all of these tools (and others, including a weigh station, if needed), into a complete solution for inkjet development. Having everything in one station, and not having to resituate key pieces of equipment, including the head, print controller, and ink supply saves a great deal of time for the researcher.

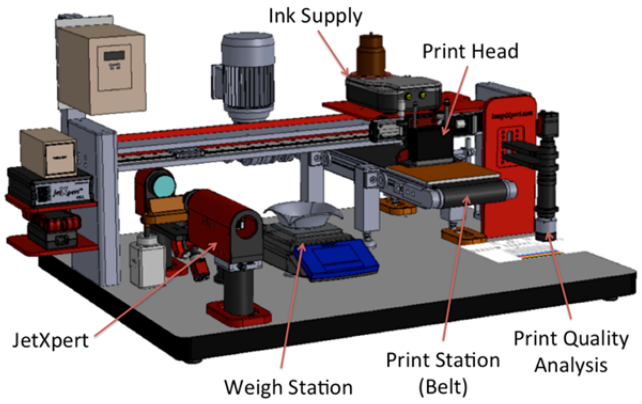

Figure 8 *– JetXpert Inkjet Development Platform*

References

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