SMART SOFTWARE

Eric Worrall explains how data processed by Artificial Intelligence is helping to create new software that will improve the accuracy of print job costing

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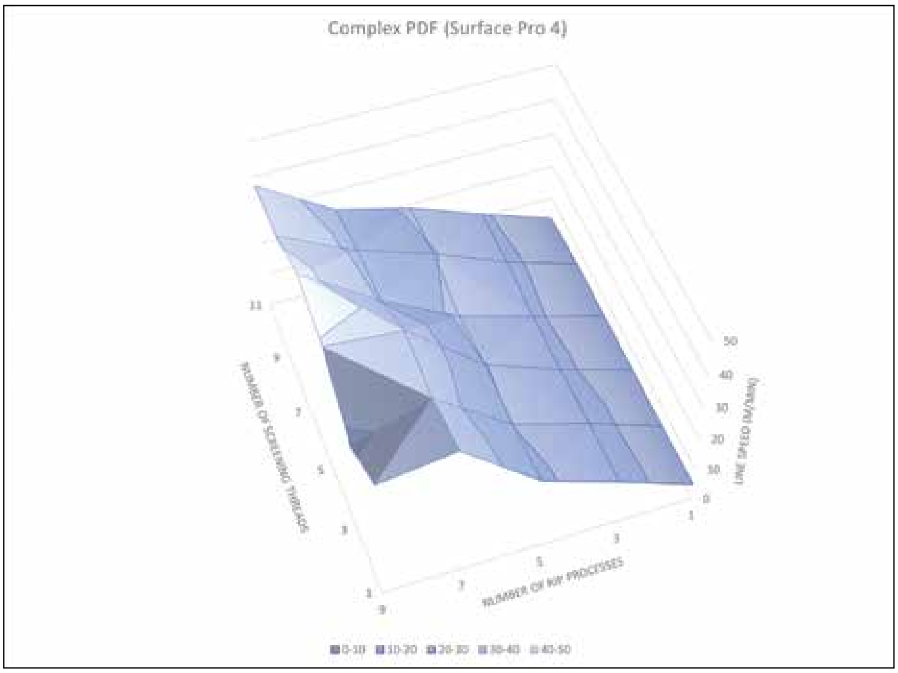
As digital printers advance to become faster, wider and higher resolution, supporting extended colourants and a growing range of drop sizes, the raster data rates required to drive them at full-rated line speed is becoming a print industry barrier. With the addition of both fully variable data with mass personalisation and automated smart factories, this barrier becomes even more evident.

Workflows that use intermediate files on disk have already hit this 'data rate' barrier but even without that bottleneck, printer manufacturers require the right combination of print job, software and PC hardware to rise to this challenge whilst keeping their total bill of materials within commercial bounds.

In this article, we will discuss the complexities of selecting the software and hardware components at the heart of a workflow designed to process PDF jobs in real-time to stream data directly to the printhead electronics. We will show why we felt it was important to develop a series of tools to probe this 'data rate' barrier in a more scientific way – and getting help from artificial intelligence.



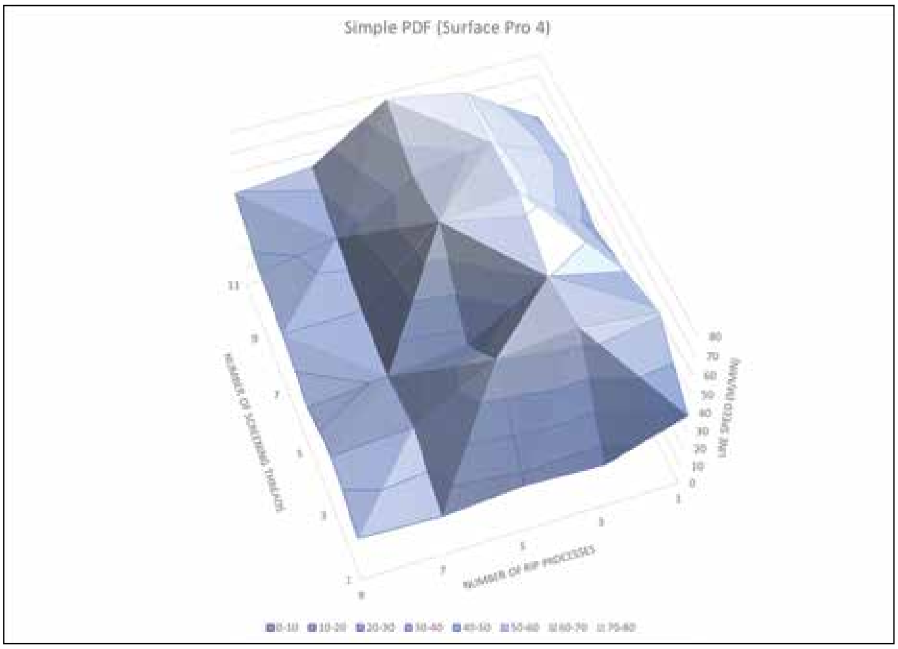


Figure 1: Charts showing two different PDFs that have run through a RIP and halftone screener on a Microsoft Surface 4 laptop

COMPLEXITY OF PDF

As we move forward into the mass personalisation era, most digital print workflows will be driven by page description languages (PDLs). The most common PDL used to drive digital inkjet printers today is PDF (ISO-32000). Building a page using a combination of vector and raster elements can be a very efficient way to communicate information; however, it leads to unpredictable print speeds. Two pages can look identical both before and after printing but the objects that create the page can vary hugely in complexity and therefore RIPping time. Once a page is RIPped to continuous tone it then needs to be halftone screened. The halftone screening performance is dependent on the size of the images produced by the RIP and not the complexity of the objects in the original PDF.

Figure 1 shows two different PDFs that have run through a RIP and halftone screener on a low powered "Microsoft Surface 4" laptop. The experiment measured the theoretical average press speed for a roll fed press printing a 13ins wide media with a single colourant and a 2-bit screen. It then varied the number of processes given to the RIP (pages in parallel) and the number of threads given to the halftone screener. This experiment used a PDF with relatively complex objects and another with very simple PDF objects.

The results show both what you would expect as well as areas that require more experimentation. For instance, the complex PDF scales with the number of RIP processes.

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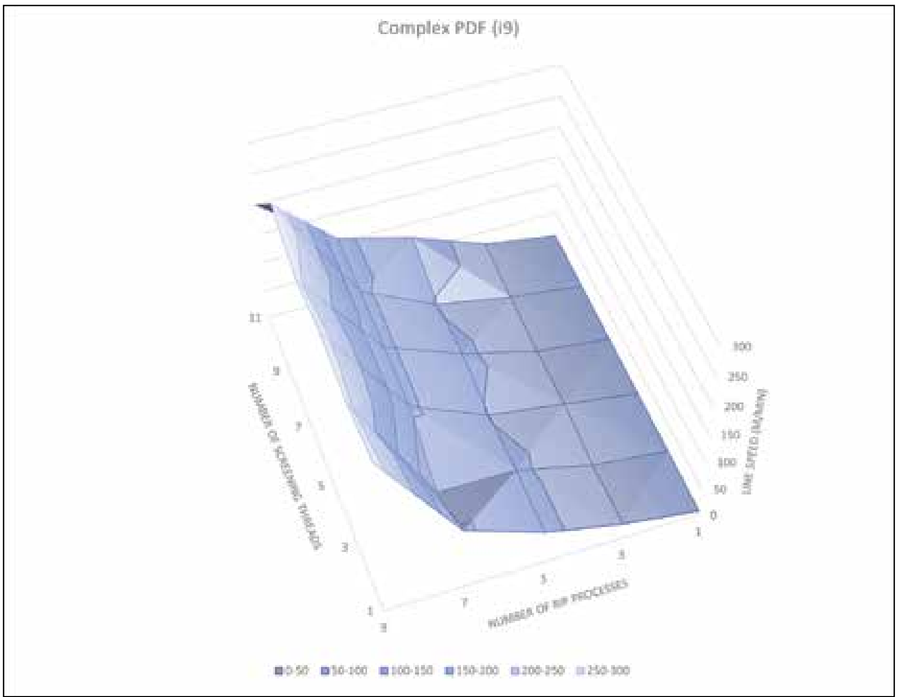

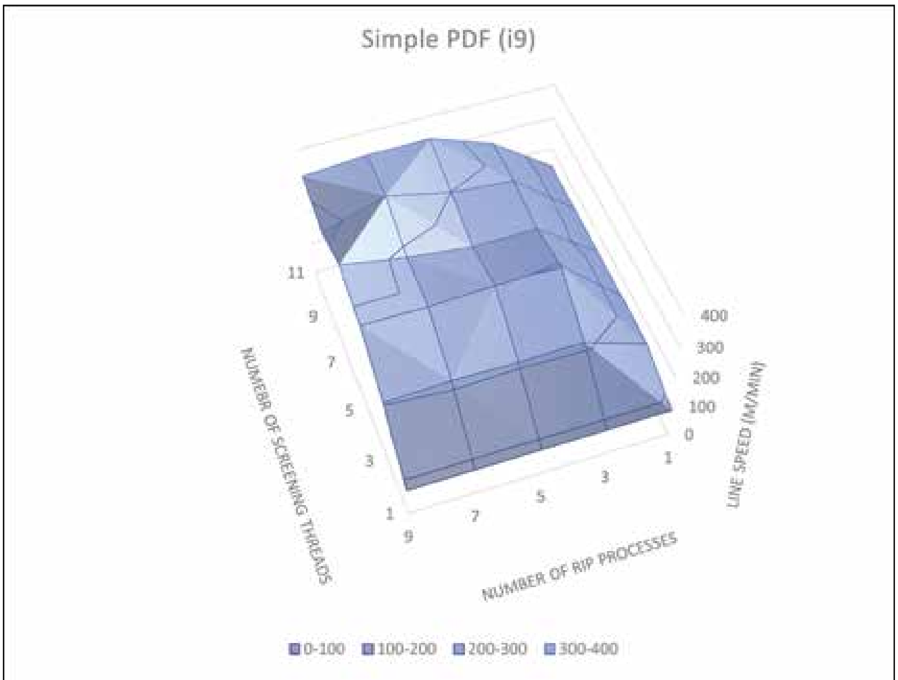

Figure 2: Results from the same test that have been run on a more powerful computer; in this instance a PC based on an Intel Core i9-9980XE Extreme Edition Processor

"We use artificial intelligence to learn from the data and create models that can be downloaded into the software"

Adding more screening threads does not impact the line speed significantly. The RIPs are working hard to get raster data to the halftone screening thread which is then processing it very quickly. Adding additional screening threads just leads to screening threads waiting for the RIPs.

However, in the simple PDF the observation is reversed. The RIPs can get through the pages very quickly and the rasters start to stack up. The work that the screener threads are doing is a lot more than the RIPs, for this PDF. Adding more screener threads allows the screeners to keep up with the RIPs leading to higher line speeds.

CAPABILITY OF PC HARDWARE

Looking at the simple job test results further we can see that the overall system slows down when there are more than three RIP processes. Monitoring the memory usage during the test gives us some insight into what may be happening. It appears that the RAM was not large enough to deal with the amount of data being created. When the RAM was full, the additional RIP processes hurt print performance.

If you run the same test on a much more powerful PC, e.g. a PC based on an Intel Core i9-9980XE Extreme Edition Processor, the results are as shown in **Figure 2**. Obviously the first thing to note is the overall line speeds are much higher as you would expect with a faster CPU. It also has faster memory and a lot more of it.

Again, the complex PDF is RIP process bound with very little impact from having extra screening threads. However, as the number of RIPs increases for the complex PDF, it does not show the slowdown in line speed. This could be the impact of having more and faster RAM. If the PDF had more image data than vector, would fast memory be more important than clock speed? If the job had more complex vector data and transparency, would the clock speed be the most important PC capability?

So, we cannot just look at PDF complexity, we need to look at the PC capability as well to understand the complete picture. We need to look at the impact of operating system, RAM speed, clock speed and cores. If you add in two CPUs then you have two memory pools (one per CPU). What happens if the Screener and the RIP are running on different CPUs? What is the impact of that on the line speed?

SCIENCE AND AI

We understood that we needed to be able to run repeatable experiments rapidly and collect data in a controlled way. We have built a tool called Direct Benchmark which can run experiments on different PCs looking at combinations of PDFs, software configuration and PC capabilities. Direct Benchmark has been connected to an Azure cloud data store which allows us to see all the data in one place. We use artificial intelligence (Artemis) to learn from the data and create models that can be downloaded into the software. These models can be used to configure the software intelligently; and predict an achievable line speed given a particular PDF complexity and PC capability; predict required PC capability and hence cost for a bill of materials for a given market. We believe breaking through the data rate barrier requires the application of science and AI at the heart of a smart software approach. ■

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