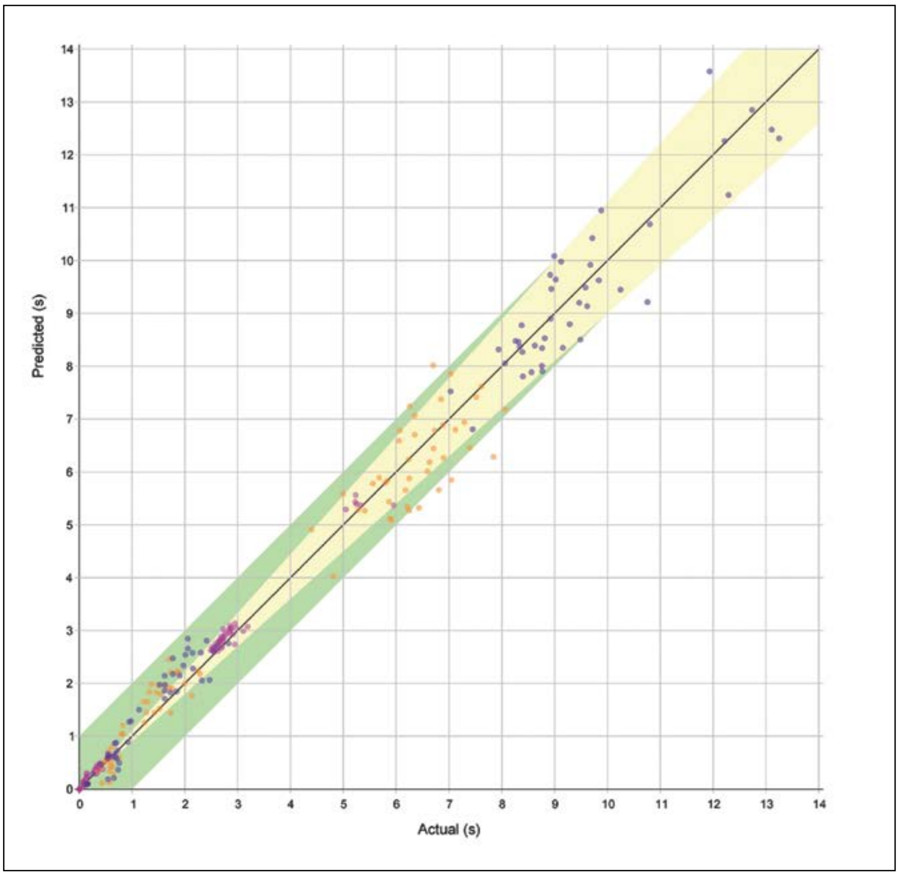
USING AI TO MODEL RIP PERFORMANCE

David Stevenson, Product Manager at Global Graphics Software, reflects on the content of his *Specialist Printing Worldwide* article in 2022 and the developments the company has made in the past year

David Stevenson, Product Manager, Global Graphics Software



Convergence of the machine-learning model

Stevenson's article discussed the problem of under-run when an inkjet press is driven directly by a RIP (raster image processor) without any intermediate offline storage. The need to analyse a PDF was identified: the aim being to determine before the job is printed, at what line speed a press could be run so that the RIP could keep up. Stevenson also discussed Global Graphics Software's novel approach to applying artificial intelligence (AI) methodology to the problem.

At that time, the project was still in the research and development phase. One year on, the fruits of that effort are evident. Global Graphics Software has been granted a patent on the application of AI to model RIP behaviour. This enables accurate estimates of the length of time needed to render a given job. The additional insight into RIP behaviour this provided allowed for new capabilities to 'tune' the RIP settings – on a job-per-job basis – to achieve required line speeds without altering the job. The technology Global Graphics Software developed has been launched and delivered to its original equipment manufacturer (OEM) customers.

"The need to analyse a PDF to estimate the time it would take to RIP was identified"

AI APPLICATION

A RIP plays a critical role in converting PDFs, which are primarily vector-based and device-independent, into raster images suitable for printing or display on specific output devices. It interprets, rasterises and optimises the

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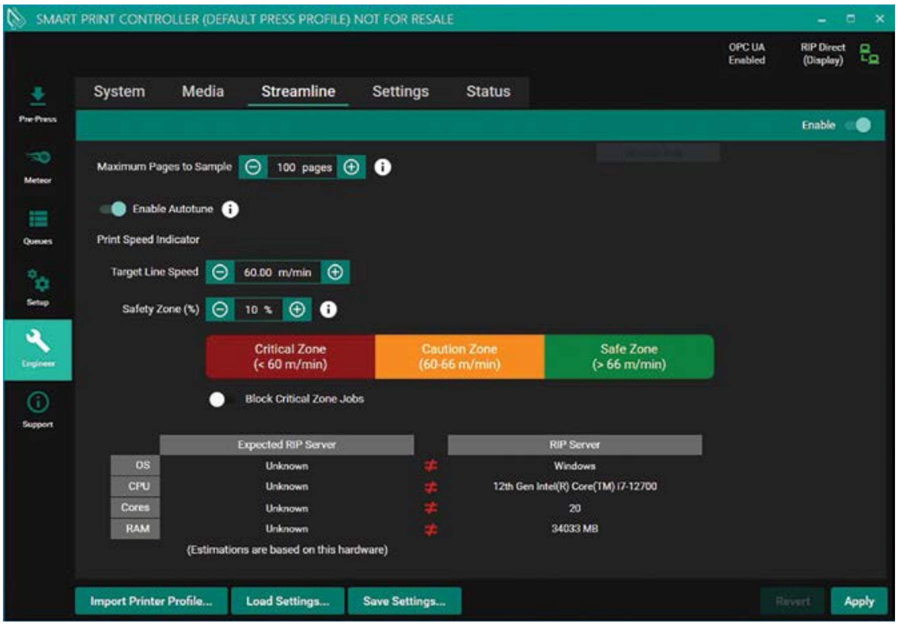
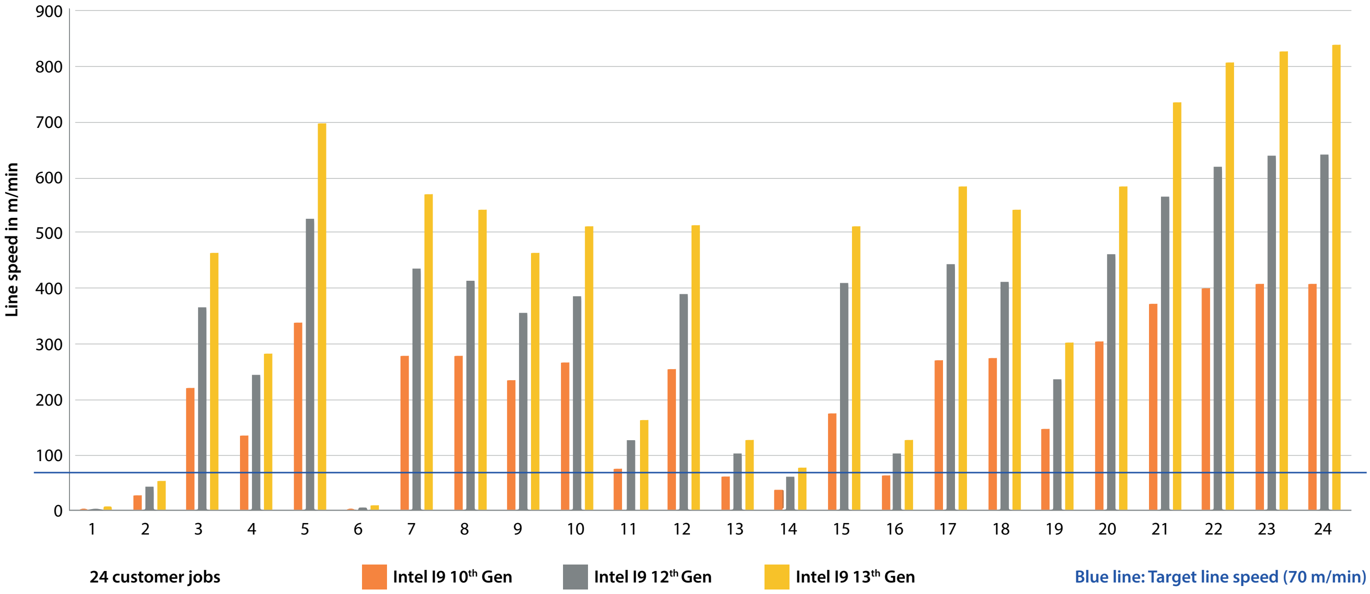


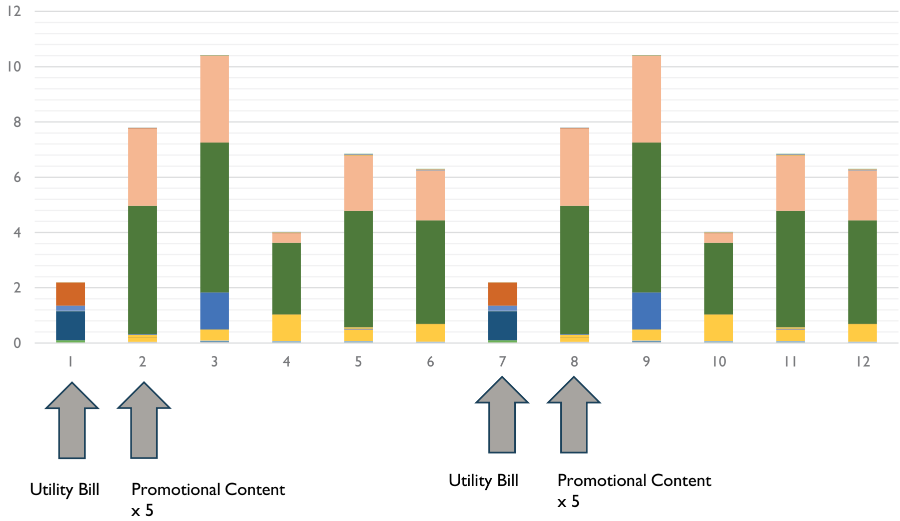
Autotune configuration controls



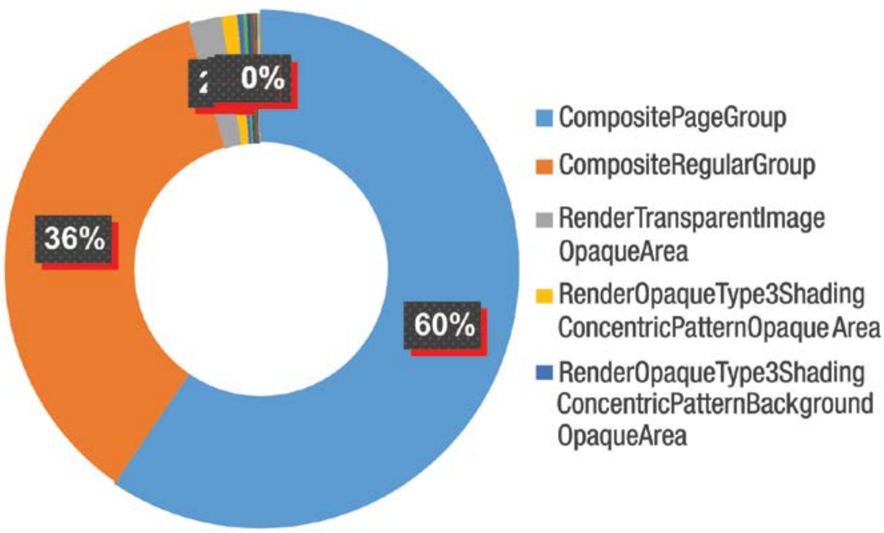
RIP performance measurement on various Intel i9 Generations

content while handling issues such as fonts, colour management and resolution, to ensure accurate and high-quality output.

To model Global Graphics Software's RIP behaviour, they begin by generating a huge number of pages with a specific combination of PDF features seen in typical print jobs. These are run through the RIP and timings are taken, producing a huge dataset. To make sense of these data, a machine-learning algorithm – specifically back propagation – is applied to tease out the weights required to predict the observed times. Back propagation is a process for fine-tuning the internal parameters of a neural network, by means of iterative adjustments to the weights, based on the errors observed during training. It allows the network to learn patterns and relationships in the data. The resultant model then has the capability to make predictions on new, unseen data. Thus, it is possible to apply the same analysis to a PDF, that the system has never seen, to yield a reasonably accurate estimate.



Fingerprint report showing typical analysis of a trans-promo job



Breakdown of operations

"A RIP plays a critical role in converting PDFs"

The chart on page 12 shows the result of the training process. Each dot represents a PDF job that has been analysed and estimated, then plotted at the intersection of the predicted time (y-axis) versus the actual time (x-axis). The aim is for the dot to be plotted on or close to the 45° line originating bottom left. This means that the estimate corresponds with the actual time recorded.

AUTOTUNE TECHNOLOGY

A RIP is a complex software system. The company's Harlequin RIP® has – over the many years of development it has undergone – acquired optimisations. These include caching of images or re-using previously rasterised content. Certain features must be turned on for the RIP to make use of them. The analysis can then be leveraged to decide which per-job optimisations should be turned on, or off, to guarantee the fastest processing. This technology is called Autotune. Besides associating RIP instructions with the job, Autotune can also apply a PDF optimiser to pre-process it. This means that the work of the RIP can be simplified and, therefore, speed can be increased.

The screen on page 12 shows a practical implementation of estimation, with a job falling into one of three categories. Firstly, green for yes – the RIP will be able to keep up with the desired line speed. Secondly, amber – to indicate to proceed with caution. Thirdly, red – meaning that the RIP will not be able to keep up. The operator can then choose to take remedial action. The last resort is to RIP ahead to disk and print later from offline storage.

"Autotune can also apply a PDF optimiser to pre-process it"

CPU AND MEMORY ARCHITECTURE

Another unexpected finding is that different central processing units (CPUs) and memory architectures can have an effect on RIP performance. The graph at the top of the previous page demonstrates this. One might expect each successive CPU increment to simply be faster than its predecessor. This is broadly true, but is a more nuanced process. Some jobs seem to suit one CPU/memory architecture better than another and, in extreme cases, an earlier processor generation can outperform its successor for that particular job. A simple, linear scaling cannot be applied to extrapolate one machine architecture to another. Knowing this, the estimation model is built on exactly the same hardware on which the RIP software will eventually be installed.

Once an estimation model exists, an incoming PDF can be predicted very quickly. This is accomplished by identifying the operations required to successfully render the objects that make up the page. It is then a relatively simple task to sum the weights for those operations for a page and a complete document.

FINGERPRINT REPORTING

Besides estimation, the analysis yields other benefits. Charting the contribution to overall RIP time offers a visual representation of the work of the RIP. This is known as an analysis 'fingerprint' report and is presented in a custom PDF.

The fingerprint report of a typical trans-promo job on the previous page shows the variable – ie personalised – page comes first, followed by promotional material, the pages of which vary in complexity. However, over the job, the same pattern of pages is repeated over and over.

Occasionally, this analysis reveals unexpected characteristics such as spending a disproportionate time image processing. This is because the images are excessively high in resolution for their actual print size. The 'fingerprint' report also charts the time spent on particular operations as a pie chart, shown on the previous page.

"Once an estimation model exists, an incoming PDF can be predicted very quickly"

SUMMARY

In summary, the integration of AI, the development of Autotune and the nuanced understanding of CPU architectures collectively represent a significant leap forward in optimising RIP performance. This journey has not only addressed the challenges of under-run, but also paves the way for more efficient, adaptable and intelligent printing processes. ■

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