Print head optimization;
exploring trade-offs between quality and productivity

Marc Geilen (m.c.w.geilen@tue.nl)

Joost van Pinxten (j.h.h.v.pinxten@tue.nl)

1 Subject

We want to investigate the impact of reconfiguration of the print head of a printer on productivity and quality. Stringent productivity targets force engineers to look at ways to improve productivity, without losing (too much) product quality. Reconfigurations during operation generally improve quality, but cost time and hence, productivity. On-line reconfiguration of a print head can sometimes be avoided by tolerating small deviations from the optimal configuration within an acceptable working range for a particular product [1].

Océ printers have high productivity requirements. Their large-scale production printers print thousands of duplex images per day, such as on-demand books (for on-line book stores), or transaction printing of bank statements on different kinds of media.

The printers can process similar sheets at very high throughput, but on-line reconfiguration occurs when the type of media changes between sheets and the current set-point of the print head cannot satisfy the printing requirements for a sheet. The reconfiguration leads to a time penalty and too many of those penalties will be detrimental to the productivity of the printer.

(a) Print head　　　　　　　　　　　　　　　(b) Paper path

Figure 1: Large-scale production printers

To avoid reconfiguring the print head too often, the printing specifications are defined to allow certain ranges of the configuration parameters, for instance, the height of the print head relative to the thickness of the media. This allows the printer to select any appropriate printing setting in the allowed range, which may also reside in the specification range of subsequent sheets, avoiding additional reconfigurations in the future. It is however also requested that the print head produces consistent quality over print jobs, while larger distances between actual and optimal configurations may lead to small reductions in print quality.
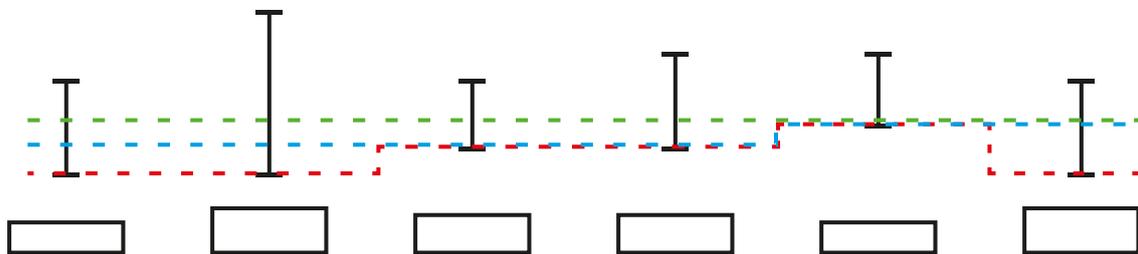

Figure 2: Three print head scheduling strategies

Figure 2 shows three different head movement strategies for a sequence of six sheets of different media. The sheets (rectangles) have an allowed range of the print head height (the vertical lines above them) according to the type of media. The print head has to be inside the range, but lower values in the range produce better quality prints. The green dashed line represents the

strategy to use a height where the print head does not have to reconfigure, at the cost of some quality. The blue line has only one height adjustment, and improves the quality for the first four sheets, but increases the printing time compared to the first strategy. The red line always takes the minimum of the range (optimal configurations), maximizing the quality, but at the same time also increasing the number of reconfigurations and reducing productivity.

In this assignment you will model the quality versus productivity trade-off that emerges from the scheduling freedom of the print head range. The first step is to model the quality and productivity depending on reconfiguration strategies, and define and study the trade-off space. The second step is to find the optimal trade-offs and scheduling strategies that lead to these trade-offs, for given specification ranges and sequences of sheets and their media types.

2   About Océ

Océ Technologies, a Canon Group company, is an international leader in digital document management and printing for professionals. Many Fortune 500 companies and leading commercial printers use Océ solutions for wide format printing, high-speed production printing and document-related business services. Océ employs 4,000 specialists at innovation and technology centres in Europe, North America and Asia. Through its own Research & Development (R&D), Océ develops core technologies and the majority of its own product concepts.

3   Assignment

The assignment of this Master Project is to model and optimize the print head scheduling freedom of a large-scale production printer using trade-off analysis: searching for Pareto-optimal solutions.

The following steps are suggested:

1. Get familiar with the print head problem domain, and the trade-off analysis.

2. Develop a model to support the quality and productivity goals.

3. Use the models to find Pareto-optimal solutions to the scheduling problem

4. Experiment with different optimization techniques (i.e. discrete Model-Predictive Control and Integer Programming models, or heuristic algorithms)

5. Optionally, integrate the trade-off scheduling solution into an existing sheet scheduling algorithm.

4   I want to know more!

The project is hosted by the Electronic Systems (ES) group, Electrical Engineering department. The project will be carried out at Océ in Venlo.

If you are interested in this topic for a Master Graduation Project, please contact Joost van Pinxten (`j.h.h.v.pinxten@tue.nl`) and Marc Geilen (`m.c.w.geilen@tue.nl`) for more information.

References

[1] P. Vestjens, J. Kandelaars, and J. van Pinxten, "Printer with height adjustable print head," Patent Application WO 2016/162 321 A1. [Online]. Available: https://lens.org/ 020-998-830-115-470