

Visual Comparison of Screening Quality in Digital Printing Systems

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Survey Overview

The task for this work was to get a view of the visual quality of digital print systems in respect to different screening systems. The print samples have been evaluated for the grade of viewable screening artefacts and detail reproduction that got disturbed by screening artefacts like rosette structures or granularity. It is important to understand, that this work is not an overall quality evaluation. The study was based on a master thesis at the university of applied sciences (Prof. Dr. K. Haller) and was supported by NexPress AG, Kiel but not influenced.

Experiment Setup

The author organized from August 2001 to February 2002, over 12000 paired comparisons in two surveys to figure out the quality comparing to viewable screening- and overprint- structures.

31 people participated on two surveys to judge 7 print samples from 9 print engines with different variations of printing conditions, all done with four process colors. The observers can be divided in three groups (ad. agency employees, unskilled observers and prepress- and print-experts).

For this purpose two test series have been carried out as follows:

Survey a (Survey for master thesis)

Machine	Screening System
Quickmaster Di Pro	175 lpi IS-Y fine 175 lpi HQS
74 Karat	175 lpi
NexPress 2100	Classic Optimum Line
Xerox DC 2060	200 point 200 line
Xeikon DCP/50D	Sofokles Combined
Indigo UltraStream	150 lpi 250 lpi

Survey b (Follow up survey)

Machine	Screening System
Quickmaster Di Pro	150 lpi IS-Classic 175 lpi IS-Y fine 200 lpi IS-Classic
NexPress 2100	Classic Optimum
Xerox DC 2060	150 point 200 point
Xeikon DCP/50D	Combined
Indigo Platinum	145 lpi 195 lpi
Speedmaster DI	175 lpi
HP 5000	FM

Color patches were placed on the test page to get an impression for overprint based rosette structures. Text and line fields can be judged for sharpness and resolution. Granularity or mottle are easy to detect at the single color- and three color overprint- vignettes.

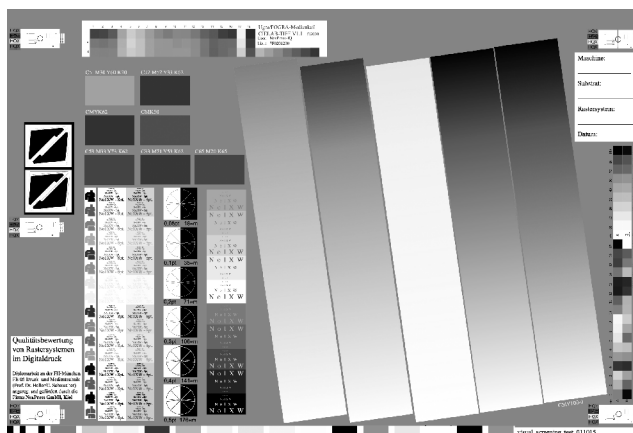


Figure 1. Testpage 1

The most interesting task, to look for visibility of rosette structures or granularity in overprint images could be proofed in four different motives. Especially the "Textile" motive was very sensible for moiré structures.

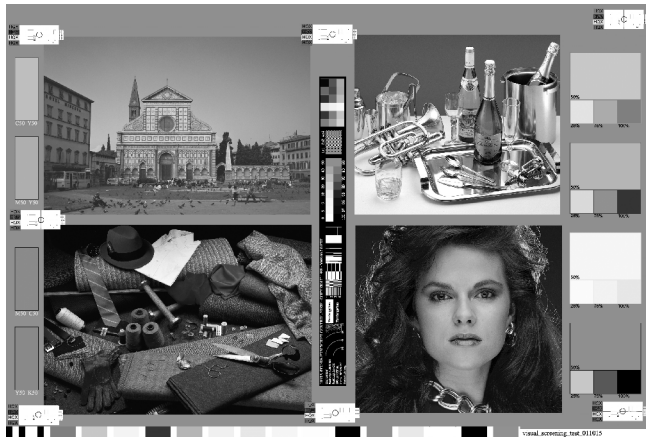


Figure 2. Testpage 2

The test pages were printed on all printing systems under optimal conditions on glossy or semi glossy paper without use of color management to be sure that all overprint patches are printed with same CMYK dot sizes.

The cut images were mounted anonym on neutral gray pasteboards and judged in paired comparison method.

Every observer judged over two print samples to find out which one he prefers for the criterion of visible screening structures. After repeating this task for every possible print sample combination, a matrix was completed and a PV-Index was calculated.

Looking at all numbers from all observers an average value and standard deviation was calculated. That displays the PV-Index in a weighted rank order.

In this paper only a selection of the results can be presented. "Patches" and the motives "Pigeon" and "Silver" where chosen, because the author thinks they are the best representatives for sensitivity.

Motive: "Patches"



Figure 3. Motive "Patches"

The patch CMK 50 (Cyan, Magenta, Black = 50%) proved to be critical, both for rosette structures and granularity, which showed up as a kind of mottle. The structures

of the FM screening (HP 5000) appeared significantly in the lighter tones e.g. C5 M30 Y60 K20. The observers were requested to evaluate their general impression over the whole motive.

The motive "Patches" was judged in survey a and also in the second one. It is worth mentioning that the Quickmaster DI Pro print in 175lpi HQS screening had a very strong screen pattern and due to this it was badly evaluated. The high standard deviations for the Karat are remarkable, as seen frequently in other motives too. Depending on the viewing distance the smoothness of the tints was good evaluated, or the clearly viewable rosette structures were lower ranked. Therefore the Karat was strongly based on the personal evaluation emphasis. Also the Xerox DocuColor with 200lpi line screen shows a big standard deviation, which could be explained by the fact that it does not show rosette structures but a kind of mottle, which not everyone recognized.

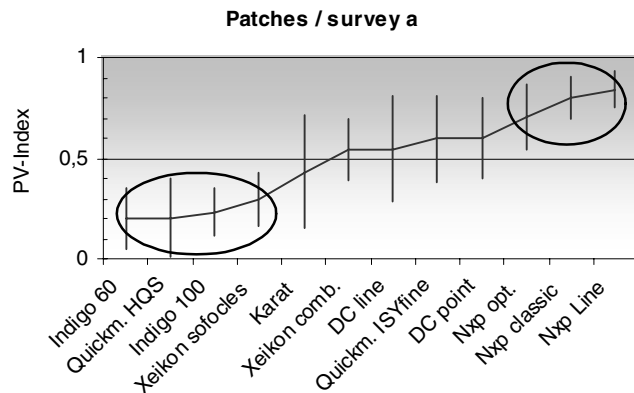


Figure 4. Evaluation survey of a Motive "Patches" with N=25 observers

The samples can be divided in three groups, the front runners represent the three NexPress systems. As middle zone we can characterize Karat, Xerox 200 line and point, Xeikon combined and Quickmaster Di Pro with 175 lpi IS Y-fine. Quickmaster Di Pro with 175lpi HQS, Indigo Ultra 150lpi and 250lpi as well as Xeikon Sofokles form therefore the lower part of the rank order.

The different groups judged very similar except both Xerox and the Xeikon combined prints, these were evaluated better by the unskilled observers. The experts evaluated Quickmaster IS Y-fine and Karat as better. The unskilled observers favor the color patches without rosette structures, and the experts are accustomed to the rosette structures and faces the Xerox and the Xeikon(Sofokles) machine with their mottle more critically.

In survey b the systems with fine screenrulings are as expected best. Interesting is the extremely good ranking of the HP system. Here it should be mentioned, that this FM system would have been lower ranked with a lighter more FM critical sample choice. Again we can divide into three

quality groups. Speedmaster DI, Quickmaster IS classic 200lpi, NexPress classic and the HP 5000 system are in the top group. Middle rankingzone are Xerox 200 point, Xeikon combined, Quickmaster IS Y-fine 175lpi and NexPress optimum. The bottom of the rank order are Xerox 150 point, Indigo Platinum 145lpi, Indigo Platinum 195lpi and Quickmaster IS Classic 150lpi.

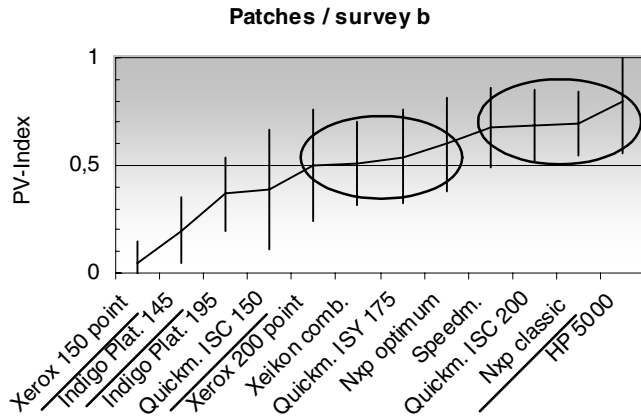


Figure 5. Evaluation survey b of Motive "Patches" with N=20 observers, 150lpi systems are underlined

Motive: "Pigeons"



Figure 6. Motive "Pigeons" with regions of interests

The motive "Pigeons" proved as very interesting, because the observers were able to recognize rosette structures and detail reproduction in the hotel front, the trees and the door very easily. A further focus point represented naturally the blue gradient in the background, which is almost predestinated to recognize structures.

Here the differences in individual samples are so small that a strict ranking is not possible for the most engines. But an organization into ranges is permissible. Thus Indigo Ultra 150lpi and 250lpi, Karat and Quickmaster Di with HQS form relatively clearly the bottom in this group. The middle range is represented by the Xeikon Sofokles. Xerox 200 point, Quickmaster Di with IS Y-fine 175lpi, Xeikon combined, Xerox 200 line, NexPress optimum, NexPress classic and NexPress line form the broad top group. Some values should be discussed about there plausibility. It is remarkable that also in this motive the Karat machine was

evaluated with large deviations. One reason for are the extremely clear rosette structures in all tonevalues. The partial quite good evaluation can be accredited to the even gradient in the sky, which is felt, besides the extreme structures, as pleasant. Further the Xerox DocuColor showed a high standard deviation. Here it proofed during the questioning, that it was a problem for the observers whether the mottle, which arose strongly, should be evaluated as a screening effect or not. Also the different observer groups came to different conclusions. So the unskilled observers categorized the Xerox sample with point screening better than the other groups.

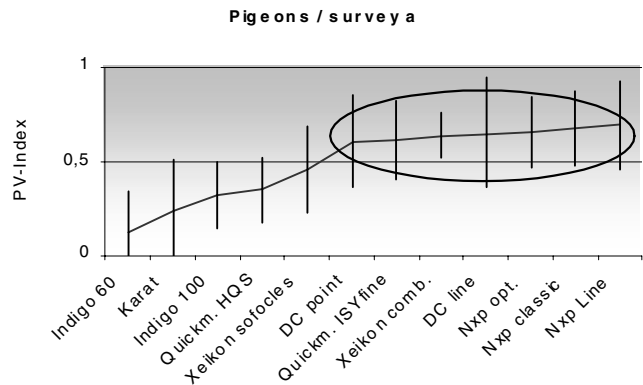


Figure 7. Evaluation survey of a Motive "Pigeons" with N=25 observers

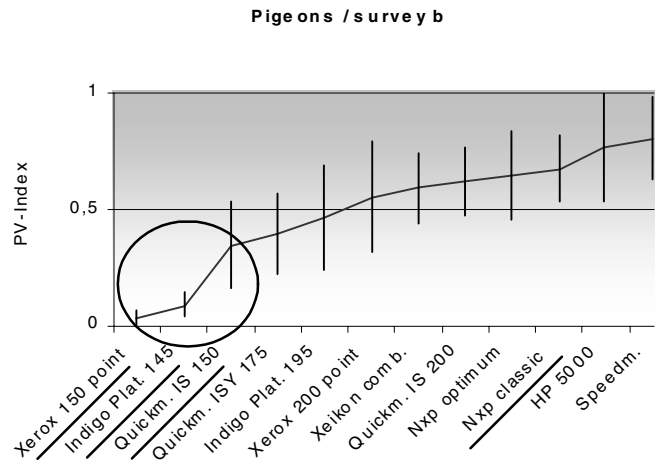


Figure 8. Evaluation survey b of Motive "Pigeons" with N=20 observers, 150 lpi systems are underlined

In survey b three groups can be categorized. Quickmaster IS Classic 200lpi, NexPress optimum, NexPress classic, HP 5000 and Speedmaster DI would lead the field. Middle range are Quickmaster IS Y-fine 175lpi, Indigo Platinum 195lpi, Xerox 200 point and Xeikon combined. Xerox 150 point, Indigo Platinum 145lpi and Quickmaster IS Classic 150lpi are at the bottom of the ranking scale.

Motive: "Silver"



Figure 9. Motive "Silver" with regions of interests

The motive "Silver" showed an interesting effect. The visual impression reacts in the neutral and silver tones extremely sensitively to color fluctuations, but the screening evaluations were done surprisingly consistent for all observers.

The motive Silver renewed the fact that the Karat prints were difficult to judge. It showed in the background particularly extreme structures, however some observers felt confident by a good visible detail reproduction. At the two print samples of the Xerox DocuColor system we see again the problem of mottle as mentioned above.

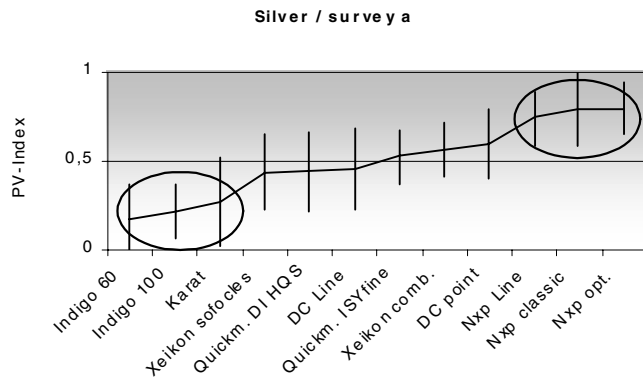


Figure 10. Evaluation survey of a Motive "Silver" with N=25 observers

When the results got split up in three groups again. Indigo Ultra 150lpi, Indigo Ultra 250lpi and Karat would settle the lower range of our scale. Xerox 200 point and line, Xeikon Sofokles and combined, Quickmaster DI Pro with HQS 175lpi and Quickmaster IS Y fine 175lpi are classified in the middle ranking range, slightly topped by the NexPress variants. The unskilled observers liked the Xerox 200 line more than the other observer groups.

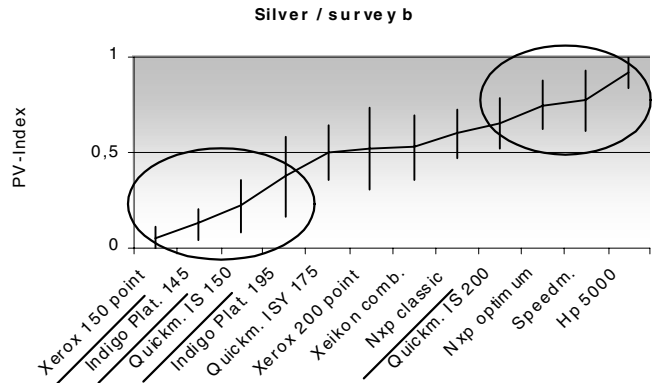


Figure 11. Evaluation survey b of motive "Silver" with N=20 observers, 150lpi systems are underlined

In survey b the Xerox 150 point, Indigo Platinum 145lpi and 195lpi as well as Quickmaster DI Pro IS Classic 150lpi formed the bottom of our rank order. Quickmaster DI Pro IS Y-fine 175lpi, Xerox 200 point, Xeikon combined and NexPress classic can be ed in the middle zone. Top group can be called Quickmaster DI Pro IS Classic 200lpi, NexPress optimum, Speedmaster DI and HP 5000.

150lpi Systems

Four systems with 150lpi got evaluated in survey b. These are: Xerox 150 lpi, Indigo Platinum 145lpi, Quickmaster Di IS 150lpi and NexPress classic. The astonishing fact that the conventional offset systems got lower ranking than the NexPress system with 150 lpi let us take a more exact look at the print samples. Indigo Platinum and Quickmaster had very strong rosette structures and therefore got bad evaluated. Xerox suffered from big artifacts. NexPress classic didn't show viewable rosette structures, like the other NexPress samples or Xerox in 200 point or line. So it can be said that systems with sharp edged dots produce good viewable rosette structures, and systems with dry toner particle clouds (instead of sharp dots) produce dots which can not be focused by the human eye. Therefore the rosette structures are not viewable. That produce a sharp picture reproduction that does not suffer from screening artifacts.

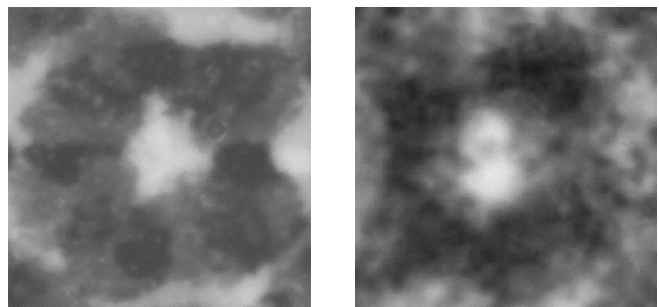


Figure 12. (left) sharp and viewable Quickmaster Di 150lpi offset rosette, (right) blurred NexPress classic rosette

Summary

Best characteristics in resolution fields showed the offset systems. This became clear at the investigations of the motive "Circles" and "Text", whereby in the text fields the NexPress machine was in the leading group too. In the vignettes the conventional printing machines were best, but as in the resolution fields it is only a small gap to the NIP systems. In the images "Patches", "Silver", "Pigeons" and "Textile" got the offset systems with comparable screenings lower ranking than some of the NIP systems. Thus the statement is, that the digital systems do at least print in the images as good as offset systems with same screening, some do better. They partially obtain amazing, nearly halftone like illustrations, which show a detail reproduction, which was not reached by some conventional systems. To the results of the NIP systems should be said, that the NexPress machine convinced in all tests. If the evaluations in survey a got compared with the publication date of the engines, a clear connection can be recognized. As oldest machines Indigo UltraStream and Xeikon stand usually at the end of the rank order, followed by the newer Xerox, and the recently released NexPress. If this trend continues further, it will be interesting how good the new Xerox IGen 3 will be, which is still in the development phase. At this criterion it is disappointing that the new Indigo Platinum in survey b could not convince. Remarkably is the good evaluation of the HP system in survey b. That's a proof of the potential of the Inkjet systems, which however still has strong restrictions in speed and substrate choice. Further interesting will be which multi color development will show up, because the screening solution of a more than 4 color system is excitingly. For the master thesis samples from the new Océ 7-Color machine (CPS 700) were available, but these were not used for the evaluation, because at this time the quality of the print samples were not satisfying and not comparable to the other systems that got evaluated.

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Biography

Christian Schowalter received his degree in Print- and Media techniques from the university of applied sciences Munich in 2002. His internship and work time at the FOGRA (Research association of printing) prepress-department improved his skills in color management and Image Quality. From August 2001 to January 2002 he wrote his Master thesis at the NexPress AG, Kiel. At the moment he fulfills his alternative civilian service until March 2003.

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