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Graphic technology — Analysis of a method for predicting print image quality for prints from high-speed inkjet printing system from combinations of paper properties

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Foreword

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This document was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Inkjet printing is a non-contact digital printing method that creates text or images by accurately ejecting tiny droplets of ink onto a printing substrate. Advanced digital printing technologies called high-speed inkjet printing systems are made to produce high-quality results quickly on a range of substrates. These systems combine the flexibility of inkjet technology with production-level speeds, often exceeding hundreds of meters per minute, making them ideal for large-scale applications such as transactional documents, direct mail, packaging, and book printing. Currently there is a strong growth in the market share for inkjet printing.

The careful selection and compatibility of inks and substrates are critical to the efficient operation of high-speed inkjet printing devices. Inkjet printing, as opposed to conventional printing methods, entails ejecting tiny ink droplets onto the substrate at high velocities and speed, often without making any contact. Regarding material interaction, drying performance, adhesion, print quality, and long-term durability, this non-impact approach offers both advantages and limitations.

Colour consistency, optical density, edge definition, and rub resistance are all determined by the interaction between the substrate surface and ink chemistry. Manufacturers are increasingly working together to create integrated ink-substrate systems, which match certain ink sets with printing substrates, in order to maximize performance. This alignment reduces trial-and-error in industrial environments and ensures reliable performance across long production runs.

An ad hoc group focused on high-speed inkjet printing with printing heads covering the full width of the substrate and using water-based inkjet inks. Although the method was developed based on this technology, it is likely to be appropriate for all inkjet technologies.

Water based ink jet inks contain a large percentage of water which need to be either absorbed by the substrate surface in a defined manner to ensure high image quality and text reproduction or be kept on the surface of the substrate for rapid evaporation by heaters within the press (or a combination of both). There have been numerous specialized paper developments to support high-speed inkjet printing. These increase paper manufacturing costs through development of printing system (printing head technology and ink) specific ink receiving layers. For this and other reasons, many users of high-speed inkjet printers wish to use papers already on the market and typically developed for conventional printing.

Since inkjet ink interaction with paper is very different from that in conventional printing processes, different paper properties need to be considered compared to conventional printing. Knowledge on paper properties influencing inkjet ink and paper interaction is limited and dependent on ink formulation which varies between different system providers.

Therefore, an industry group was formed to perform a joint project to improve understanding of the interaction of inkjet ink and paper. The aim was to develop an ISO document to improve the process of selection of conventional paper grades for high-speed inkjet printers by having additional information on papers. During this, project partners chose 20 paper grades showing both good and bad print quality on different high-speed inkjet presses. A set of paper properties was identified by the industry group as being most likely to influence print image quality based on the experience of group members. The paper samples were pooled, and each partner performed measurements on one or more of these paper properties. These papers were later printed on high-speed inkjet by some of the members of the industry group and the quality of the prints were evaluated according to these partners print quality requirements. As expected, no single paper property can be identified as being related to print quality. The investigation showed that combinations of paper properties can be used to predict good inkjet print quality through statistical analysis even without a scientific understanding of the interactions occurring between paper and ink.[9] This statistical method makes it possible to predict print quality without specifying either the interaction between paper and ink, or the printing conditions (such as printer setting) nor the evaluation method of image quality (criteria of visual assessment). In other words, this can be called a "black box approach." See Figure 1.

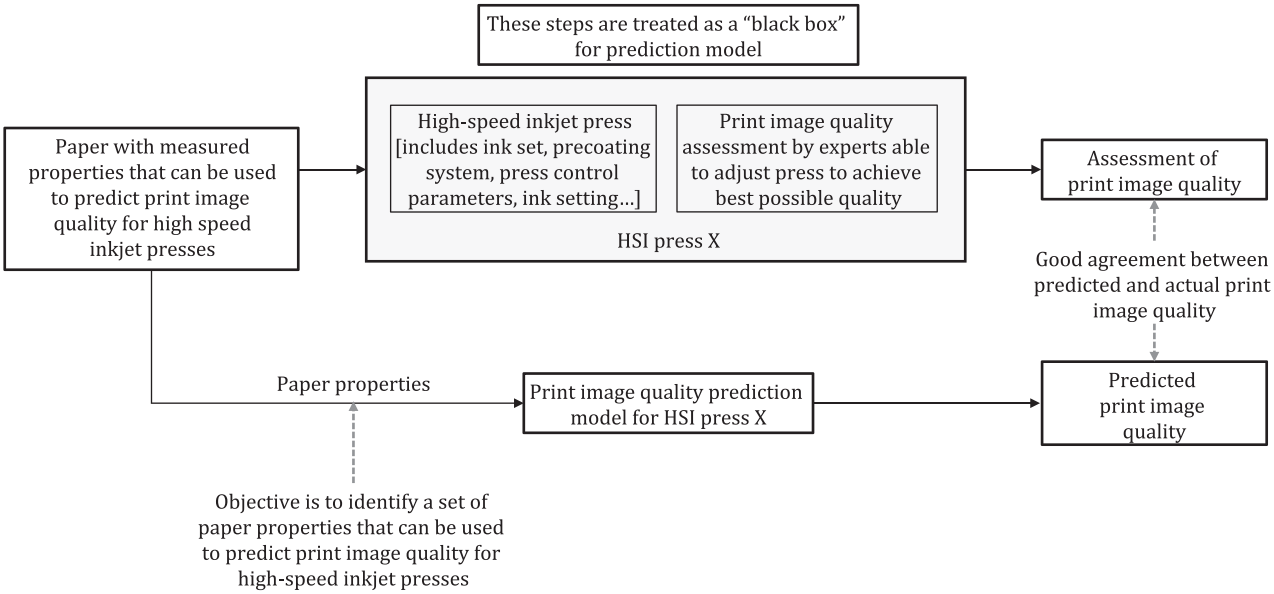

Figure 1 — Black box approach to prediction of print image quality

The "black box approach" is not an approach specifically adopted for this prediction method. Prediction using statistics is a method of predicting an event by analysing available data. Particularly, when the causal relationship between the available data and the event to be predicted is complex (not scientifically or theoretically clear), the black box approach is used, and the prediction results are obtained probability of the prediction.

Typical examples include complex systems such as demand forecasting in markets, stock price forecasting, weather forecasting and drug efficacy testing. In these examples, it is difficult to identify the cause of the results. However, using statistical analysis of the data, when certain patterns can be found in the data, a specific outcome with a high probability can be found. In other words, while science places emphasis on "why something happens" (causality), if the "reproducibility of patterns" between data and outcomes can be identified through statistical analysis, "what is likely to happen" can be predicted without knowing "why it happens" or "what operations were performed."

This document describes a set of paper property metrics that can be provided by paper manufacturers to enable reliable high-speed ink jet printing on paper developed for standard conventional printing (particularly lithographic printing). Paper measurement international standards developed by the paper industry are referenced in those metrics. These data can be provided in addition to those data already communicated according to ISO 15397. Further, this document provides an overview of prediction methods.

It is anticipated that press manufacturers will use this test method to test their digital presses and where that is done the technology used (ex. UV cured etc) can be identified so that other manufacturers can use these results as the starting point for testing.

The method described in this document is a screening method, and further validation can still be required for the selected media, not only in terms of image quality but also in other attributes such as reliability, image permanence, transfer, etc.

In addition, although this prediction method was validated using standard-frequency water-based inkjet printing on coated and uncoated papers, a black-box approach (based on statistical principles) suggests that it will also work in systems employing high-frequency piezo systems with matched low-surface-tension ink formulations.

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1 Scope

This document presents an analysis of a test method and procedures for predicting print image quality for prints from high-speed inkjet printing systems. Results from an initial set of tests are reported.

Based on this method, a set of paper properties and their ISO related standards is given, in addition to those presented in ISO 15397.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
contact angle
angle between a plane solid surface and the tangent drawn in the vertical plane at the interface between the plane solid surface and the surface of a droplet of liquid resting on the surface

[SOURCE: ISO 15989:2004, 3.4]

3.2
hygroexpansivity
change in length that occurs in a given length of paper or board when the relative humidity with which it is in equilibrium is raised from a specified lower relative humidity to a specified higher relative humidity

Note 1 to entry: The change in length is expressed as a percentage of the given length when the paper or board is in equilibrium with 50 % relative humidity. A contraction of the test piece is regarded as negative hygroexpansivity.

[SOURCE: ISO 8226-1:1994, 3.1]

3.3
Parker Print-surf roughness
PPS
mean gap between a sheet of paper or board and a flat circular land pressed against it under specified conditions

Note 1 to entry: It is expressed in micrometres and calculated based on the airflow between the measuring land and the test piece.

[SOURCE: ISO 8791-4:2021, 3.1, modified — original term was print-surf roughness]