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Automated CtP calibration system in an offset printing workflow

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Abstract

Although offset printing has been and still is the most common printing technology for color print productions, its print productions are subject to variations due to environmental and process parameters. Therefore, it is very important to frequently control the print production quality criteria in order to make the process predictable, reproducible and stable. One of the most important parts in a modern industrial offset printing process is Computer to Plate (CtP), used for printing plate production. One of the most important quality criteria for printing is to control the dot gain level. It is crucial to have the dot gain level within an acceptable range, defined by ISO 12647-2:2013. This is done by dot gain compensation methods in the Raster Image Processor (RIP). Dot gain compensation, which is also referred to as CtP calibration is, however, a complicated task in offset printing because of the huge number of parameters affecting dot gain. The conventional CtP calibration methods for an offset printing process, which are very time and resource demanding and hence expensive, mostly use one to five dot gain correction curves as the maximum. The proposed CtP calibration method in this paper calibrates the dot gain according to ISO 12647-2:2013 recommendations fully automatically parallel to the print production. Besides that, there is no limitation of the number of the needed dot gain correction curves. This automated CtP calibration method, which is much more efficient and economically beneficial compared to conventional CtP calibration methods, also makes the printing production very accurate in terms of dot gain value.

Keywords: workflow control system, printing process variables, ISO 12647-2:2013, dot gain compensation, raster image processor

1. Introduction and background

One of the most important parts in a modern industrial offset printing is Computer to Plate (CtP), which exposes the printing plate directly from digital data. In the modern industrial offset printing, the printing plate has been made by CtP since the end of the 20th century.

The calibration of computer to plate means correcting dot gain shift by generating a compensation curve. The CtP calibration is not to be misunderstood with linearization of a CtP. The linearization of a CtP is the adjustment of laser beams (focus, intensity, etc.) and the setting and adjusting of the plate developing machine. The CtP linearization has to be checked regularly (e.g. weekly) and is done independently of CtP calibration (Kipphan, 2001). The calibration of CtP is necessary for a precise color prediction in the printing process (Mittelhaus, 2000); CtP calibration is also a necessary basic condition for a successful color management process (Homann, 2007). Since color management is not a part of CtP calibration it is out of the scope of this paper.

One of the most important quality criteria for printing is to control the dot gain level. Dot gain refers to an important phenomenon that causes the printed elements to appear larger than their reference size sent to the CtP. Dot gain shift is defined as the difference between the printed tone value and the ISO recommended tone value for print. The ISO recommended tone values for print and their tolerances for an offset printing process are described in ISO 12642-2:2013 (International Organization for Standardization, 2013). Therefore, CtP calibration means correcting dot gain shift by a generated compensation curve. The Dot Gain Compensation Curves (DGCCs) are used in the Raster Image Processor

(RIP) of a CtP. ISO 12647-2:2013 describes eight different Print Conditions (PCs). For each PC eight print substrates (PS1 to PS8) are possible. Five different Tone Value Increases (TVIs), named A to E are also assigned, dependent on the printing substrate and the halftoning method (FM or AM screening). The description in ISO 12647-2:2013 is very clear, easy and understandable, but keeping the dot gain within the demanded range for all the productions is very difficult in practice. There are two main reasons for that. Firstly, the needed test prints for generating a DGCC are very time demanding and expensive. Secondly, the offset printing is not stable and the generated DGCC should be controlled and if necessary renewed and replaced regularly. Because of that, printing companies usually work only with a few DGCCs but the combination of consumables and printing processes result in a high number of different printing workflows requiring a higher number of DGGCs. Any printing workflow is more or less different to the other one and demands its specific DGCCs in order to be in the range of ISO 12647-2:2013 recommended tone value.

In literature, three different methods for calibration are identified. While two of them make use of one dimensional transforms for each printing channel, the third method makes use of multi-dimensional transforms in the form of International Color Consortium (ICC) device link profiles (McDowell, 2007). The method recommended to be used in the proposed automated CtP calibration system in this paper belongs to the first category, which uses the TVI (dot gain) curves.

In Gu (2008), some methods regarding linear adjustment of digital proof and CtP output process for packaging offset have been discussed. Leng (2009) has reported a research on characteristic curve for CtP, to provide reference for dot gain compensation of CtP plate making. Fogra has also published their own guidelines for CtP acceptance test (Schmitt, Ondrusch and Rauh, 2010). There have also been patents proposing different methods for dot gain (or CtP) calibration (Fisher, Koifman and Weiss, 2003; Hendersson, 2013; Hauck, 2012; 2013).

Although the CtP calibration has been discussed in many reports and scientific articles, it is still a complicated and time demanding task in practice. One of the reasons is that there are many different parameters, such as printing substrates, inks, dampening solutions, plates, temperature, humidity, etc., that affect the quality of the offset print productions. In practice, some of these parameters are grouped (for example printing substrates) to reduce the number of combinations. This might cause the dot gain to be out of the allowed range. A suggested solution is to use a practically applicable automated CtP calibration system that takes into account all combinations of parameters affecting dot gain.

This paper describes a novel automated CtP calibration system for a modern and economical offset printing process. The proposed system is a concept, which produces, renews and uses the exactly needed DGCCs, taking into account all consumables and all offset printing processes. All the DGCCs for the different consumables and offset printing processes are saved in a data base. The Workflow Control System (WCS) in a control unit controls the workflow. The concept is based on three requirements which are necessary for this automated CtP calibration system.

First in this paper, the three necessary requirements for the automated CtP calibration are explained, in Section 2. Other important requirements such as the Print Quality Program, available measuring devices, etc., are also explained. In Section 3, the work principle of the WCS is described. For defining a print job according to the ISO definition for the printed tone values the WCS has to make a choice between generating a new DGCC or just using an existing DGCC or renewing an existing DGCC. From now on in this paper, these three choices are called DGCC-Generation, DGCC-Usage, and DGCC-Renewal.

2. Necessary requirements for automated CtP calibration

The requirements for realizing an automated CtP calibration system can be divided into three groups, to fulfill the minimum requirements on an automated CtP calibration system for a modern and economical offset printing process. The first requirement is the controlling of print quality conditions in order to avoid variation in the printing process. The automated CtP calibration system is designed to use and renew DGCCs parallel to the printing production and without a separate print test. There are two types of methods to generate DGCCs, iterative (Hauck, 2013) and non-iterative ones (Hauck, 2012). The iterative methods for generating the DGCCs require a number of iterations, which make them inappropriate to be used in the automated CtP calibration system. Hence the second requirement is a non-iterative method to generate DGCCs. The third requirement is the workflow networking, controlling and managing.

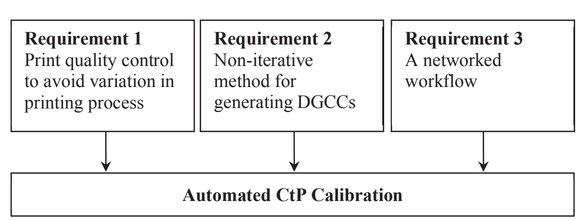

Figure 1: Three necessary requirements for Automated CtP Calibration

Figure 1 demonstrates these three necessary requirements for an automated CtP calibration system. These three necessary requirements are described in detail in the following three sub-sections.

2.1 Print quality control

A high number of parameters, such as consumables, the mechanical condition, maintenance and service of a printing machine, its setting and its adjustment by the operators, and temperature and humidity in the print room, influence the printing process and thereby the printed tone values. Offset printing is surely one of the most sensitive printing processes. Because of this fact the printing process should be controlled very often and carefully. An uncontrolled printing process is subject to relatively high variations.

Hence the first and a very important requirement for the automated CtP calibration workflow is the Print Quality Control (PQC). It includes the check of different target values in printing process and the check of different print quality criteria regarding the stability and reproducibility. Generating a DGCC and thereby a CtP calibration only makes sense in a stable and reproducible printing process. Therefore, for an automated CtP calibration system, a print quality control program is needed to check different print quality criteria before starting the calibration. Target ink value, tone values, maximum mid-tone spread, slurring, register variation and doubling (Hauck and Gooran, 2011a and 2015), and also ink trapping (Hauck and Gooran, 2011b and 2013) are the most important criteria that should be within the acceptable range and stable before and during the CtP calibration.

A print PQC-program suggested in this paper contains two separated modules. The first module of the PQC-program checks the print quality criteria according to ISO 12647-2:2013, and compares their values with a table containing the allowed tolerances for each print quality criterion. If during the production phase all values of the print quality criteria are within their acceptable range, then the program sends a message to the Work Control System (WCS). The WCS then sends a permission to generate a DGCC. If the print quality values are outside their acceptable range, the calibration procedure is interrupted, see Section 4 for more details. The second module of the PQC-program generates a DGCC using a non-iterative method.

2.2 Non-iterative dot gain compensation method

As known, the mathematical function characterizing dot gain is not linear and almost all existing methods for generating a DGCC for offset printing process are iterative (Hauck, 2013). This means that the generation of DGCC is in action in a loop until the printed tone values are within the ISO 12647-2:2013 tolerance range. As mentioned earlier in this section, an iterative method for generating a DGCC cannot be used in this system. The second requirement for an automated CtP calibration workflow is therefore a non-iterative method for generating a DGCC (Hauck, 2012).

2.2.1 Measuring devices

Printing companies employ densitometer(s) and/or spectrometer(s) to control the printing process. For both densitometry and spectrometry there are two types of instruments. The first type only measures a spot. The other type called scanning densitometer or scanning spectrometer measures a number of spots which together build a bar like a print control bar. Figure 2 shows these two different layouts needed for an automated CtP calibration workflow. Figure 2(a) shows a standard layout with a print control bar only and Figure 2(b) shows the same layout with a print control bar in (1) and an additional bar (2) in Figure 2, to be used to measure the printed tone values.

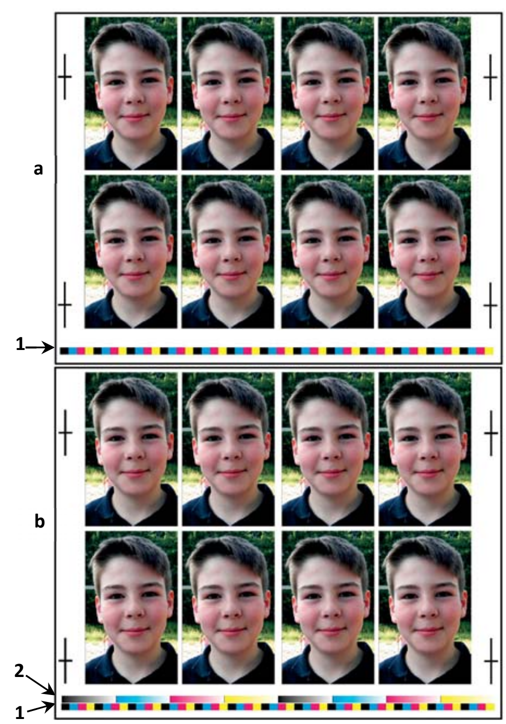

Figure 2: (a) standard layout with the print control bar (marked 1), (b) the same layout with the second bar for measuring the printed tone values (marked 2)

Scanning densitometers or scanning spectrometers are just the notation of such an instrument that is able to measure color bars and is not the same as scanners used in image capturing. Online and inline measuring devices are commonly used in the graphic industry for industrial and economical printing processes. The additional bar shown in Figure 2(b) is needed for generating a DGCC in the proposed automated CtP calibration system. Hence the workflow with an automated CtP calibration system also needs a scanning spectrometer (online or inline). While for an online scan-spectrometer the operator has to take the sheets from the machine to the measuring device to be measured, in an inline scan-spectrometer the printed sheets are measured automatically in the machine during the printing production. However, an automated CtP calibration system can employ both types (online or inline) of spectrometers. It is however important that the measuring instrument can automatically scan a color bar. For example, the online scan-spectrometer ColorPilot (manroland) is able to scan two stacked color bars, see Figure 2(b). This scanning spectrometer was successfully tested for this purpose. However, any other online spectrometer that is able to scan two stacked color bars can be used as well. Another advanced print quality measuring device is proposed in Gugler and Hauck (2012).

2.2.2 Imposition program and templates

Imposition programs, for example Heidelberg Prinect Signa Station (Heidelberg, 2018a) or Kodak Preps (Kodak, 2018) are important programs for prepress, press, and post press. Normally, imposition defines the position of pages after folding a printing sheet for producing books. An imposition program might even be used in case there is no sheet folding, e.g. for packaging sheets or labeling sheets. An imposition program can employ different types of templates. A template contains a predefinition of the position of a print control bar, the register marks, and of course the reserved area for printing the layout of a job (Kipphan, 2001). In an imposition program it is possible to define the position of a printing control bar and all needed marks only once. Then all needed marks and the print control bar are set automatically by the imposition program. Hence for a standard print job without the generation of a DGCC the Template-I in Figure 3 is chosen as usual. For an automated CtP calibration at least two different templates are necessary for plate imaging. Figure 3 shows these two needed templates, where 1, 2, 3, and 4 show the print control bar, the tone value wedge (DGCC-bar), the reserved area for print layout and the register marks, respectively. Template-II in Figure 3 is needed if a DGCC has to be generated and therefore the DGCC-bar will be needed on the production sheets, more details in Section 4. Observe that Template-II contains all elements of Template-I plus a DGCC-bar. Hence in Template-II the size of the reserved area for print layout is 3–5 mm shorter in print direction than in Template-I. However this is no problem because the paper companies sell papers in standard sizes, which mostly are 5 mm to 50 mm larger than the size of the print layouts. Exceptions are some packaging, label-printing and book-printing companies which use the entire surface of the paper.

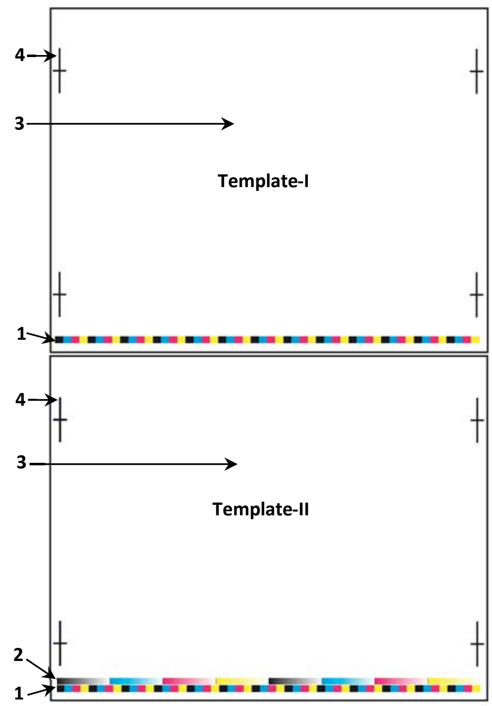

Figure 3: Template-I is the standard print template with one print control bar (1), Template-II has one additional bar, the stacked bar (2) which is the tone value wedge for generating a Dot Gain Compensation Curve

2.2.3 Dot Gain Compensation Curve Data Base

Most printing companies only use a small number of DGCCs (only one to five DGCCs). This is because of the complexity and the high cost of manually generating a DGCC and the fact that handling and managing more than five DGCCs without a WCS is practically impossible. Consequently, a big part of the print products cannot be printed with the completely correct TVI recommended by ISO 12647-2:2013.

As mentioned in Section 1, a huge number of DGCCs can be necessary in a printing workflow dependent on the number of combinations of consumables and printing workflows in a printing company. As will be demonstrated later in Figure 6(2), the DGCC Data Base (DGCC-DB) is a component of this automated CtP calibration system; DGCCs are saved and then loaded to be used dependent on the combination of consumables and printing workflows. The advantage of using DGCC-DB is that it is possible to save a large number of DGCCs. The managing (saving, overwriting, and calling) of the DGCCs in DGCC-DB has to be done via the WCS.

2.2.4 Renewal date for a Dot Gain Compensation Curve

A generated DGCC should be renewed after three to six months. The reason is that the quality of consumables and the print machine setting slightly change over the time and the climate in the printing room also changes in different seasons. These factors might cause a dot gain shift after a few months since the involved parameters were adjusted. Therefore, it is necessary to save the date of generating a DGCC and specify a date for the earliest (e.g. three months after the generation of the DGCC) and the latest (e.g. six months after generating the DGCC) renewal of DGCC. An already existing DGCC should be renewed between the earliest and the latest date. These dates are set in WCS as setting parameters. Figure 4 demonstrates the time bar of DGCC with three different points of time; namely the generation of a DGCC, the earliest date for renewing and the latest date for renewing a DGCC.

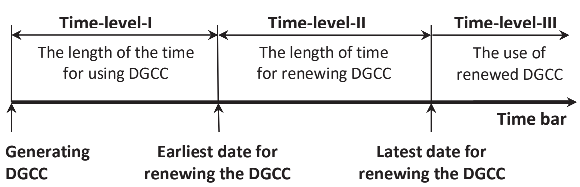

Figure 4: The time bar for generating, using, and renewing a Dot Gain Compensation Curve

These three points of time result in three different time corridors (Time-level-I to Time-level-III). A time-level is the time corridor (limit) between two points of time. For example, Time-level-I is the time corridor from generating a DGCC to its earliest time for renewal. The other time-levels have their own time corridor as shown in Figure 4.

2.2.5 Nomenclature of Dot Gain Compensation Curves

As mentioned before, in a printing company the number of necessary DGCCs depends on the number of combinations of consumables and print workflows, which can result in a high number of combinations. Hence for managing the DGCCs in the workflow it is necessary to have a distinct nomenclature for a generated DGCC. A useful DGCC-denotation should contain the information about the consumables, printing workflow and renewal date of a DGCC. Figure 5 demonstrates the coding of a DGCC nomenclature as an example in which part (a), the first number, demonstrates the used printing substrate group from the eight PSs according to ISO-12647-2:2013 description.

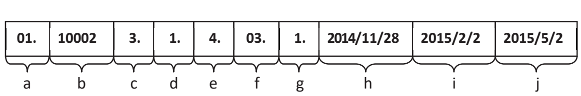

Figure 5: The nomenclature of a DGCC

In Figure 5, the five digits of part (b) specify the nomenclature of the used ink dependent on its color, fabrication and type. The next number in part (c) demonstrates the used printing plates dependent on their fabrication and types. Part (d) demonstrates the used blanket dependent on its fabrication and type. Part (e) demonstrates the dampening concentrates dependent on its fabrication and type. Part (f) demonstrates the printing machines (for example 03 in Figure 5 means the third printing machine in the print department). Part (g) demonstrates the print workflows (for example 1 for conventional printing, 2 for UV printing, 3 for alcohol reduced printing and so on). The dates in part (h) to (j) demonstrate the date of generating the DGCC, the earliest date for renewing the DGCC and the latest date for renewing the DGCC.

The demonstrated nomenclature can vary and be expanded dependent on the workflows in different printing companies. The WCS generates the numbers of nomenclature for a DGCC. The nomenclature of DGCC is saved together with DGCC in DGCC-DB. When a specific DGCC is needed, the WCS searches for it in the DGCC-DB using its nomenclature.

2.3 Networked workflow

The third requirement for an automated CtP calibration system is a networked workflow. Figure 6 shows the needed networked workflow for an automated CtP calibration system.

The demonstrated networked workflow contains the following components: (1) an extended Management Information System (MIS), or alternatively a WCS of printing machine manufacturer can also be used. In this paper, the term WCS is used for this module; (2) DGCC-DB, (3) RIP, (4) layout and print data, (5) imposition program with at least two different templates, (6) CtP, (7) printing plates, (8) printing machine, (9) press control desk with an integrated scan-on-line-spectrometer. The press control desk is the central part for controlling and commanding the printing machine. Item (10) is printed sheet to be measured and (11) PQC program including the non-iterative method for generating a DGCC. The (1), (2) and (11) are the novel parts in this workflow; all other parts are state of the art.

In such a networked workflow the WCS firstly checks if the needed DGCC already exists (see Section 3.1) in the DGCC-DB (Section 2.2.3). Therefore the WCS generates a list of consumables and the print workflow and builds a notation for needed DGCC (Section 2.2.5).

There are more scenarios possible to choose a DGCC which are explained in detail in Section 3.1.

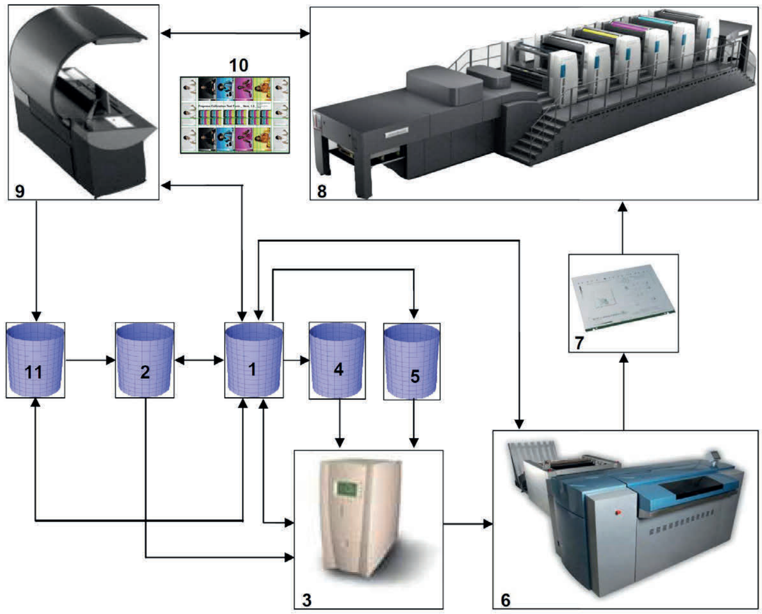

Figure 6: The networked workflow for an automated CtP calibration: (1) extended MIS or alternatively a WCS, (2) DGCC-DB, (3) RIP, (4) layout and print data, (5) imposition program, (6) CtP, (7) printing plates, (8) printing machine, (9) press control desk, (10) printed sheet, (11) PQC program

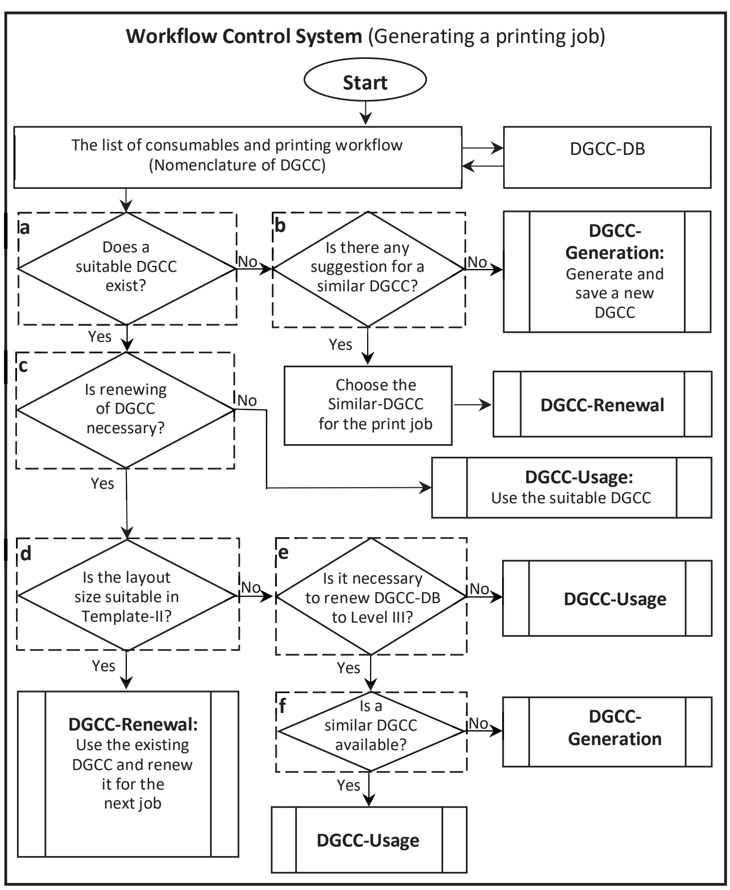

Figure 7: Job generation in the WCS and choosing one of three possible choices (DGCC-Generation, DGCC-Usage and DGCC-Renewal)

3. Workflow Control System

For controlling a workflow with automated CtP calibration, a MIS can be used, but a better alternative is a WCS. The problem with some MIS is that an inconsistency between the systems and the components of a workflow still exists (Kühn und Grell, 2004). Because of this a WCS would work absolutely satisfactorily with prior matched workflow components (e.g. a specific RIP); WCS is the logical and neuronal head of a workflow. All communications and logical processes are controlled here. The needed commands and the order of operating and the definition of procedural hierarchy are managed by the controller. The WCS is best integrated in print machine manufacturers' network system or alternatively in a MIS. Examples for the network system of printing machine manufacturers are printnetwork system (manroland, 2018) developed by manroland and Prinect system (Heidelberg, 2018b) developed by Heidelberg.

In the printing workflow, if a job has to be printed with a suitable DGCC, the WCS first builds a list of demanded consumables and printing workflow and denote this list according to the nomenclature of DGCCs and searches for a DGCC or a similar DGCC in the DGCC-DB. There are therefore three possible scenarios:

1. DGCC-Generation: If in the DGCC-DB neither the DGCC nor a similar DGCC exists, a new DGCC has to be generated and saved in the DGCC-DB. This is explained in Section 4.1.

2. DGCC-Usage: If in the DGCC-DB the needed DGCC exists, then it can be used for the print production. This is explained in Section 4.2.

3. DGCC-Renewal: If in the DGCC-DB a DGCC at Time-level-III in Figure 4 or a similar DGCC exists, then it can be used for the print production but it has to be renewed during the print production. This is explained in Section 4.3.

After generating a job, the WCS has to decide on one of these three choices mentioned above in order to send the right DGCC to the RIP. The working principle of the WCS for this decision is demonstrated in Figure 7.

As mentioned before, the WCS makes a list of all needed consumables after generating a job. Then the information of this list is compared with the existing nomenclatures in DGCC-DB and then the decision in the step (a) is made (Figure 7).

If there is no suitable DGCC, then a similar DGCC (Section 4.3.1) is searched in the step (b), Figure 7. Depending on the result of decision (b) either the DGCC-Renewal or the DGCC-Generation related to the job is carried out. In the decision (a), if a suitable DGCC is available, then the step (c) will be executed.

If the answer in the step (c) is "no" then the DGCC-Renewal related to the job generation of WCS and needed DGCC has to be activated. If the answer in the step (c) is "yes", then the decision in the step (d) has to be started. Now in order to generate a DGCC, Template-II has to be used. Hence the WCS checks if the reserved area is suitable for setting the print layout in Template-II (Section 2.2.2). If yes, then the DGCC-Renewal starts. Otherwise the decision in the step (e) is made to check whether the already found DGCC can still be used (Figure 4, Time-level-II). This results in the DGCC-Usage. Otherwise, if the DGCC is old and cannot be used (Figure 4, Time-level-III), the decision in the step (f) has to be executed. For this decision the WCS has to check if a similar DGCC is available or not. If a similar DGCC is available, then the DGCC-Usage, otherwise the DGCC-Generation will be performed.

4. Generating, using or renewing a Dot Gain Compensation Curve

As explained in Section 3, dependent on the needed consumables, printing workflow and the availability of a DGCC, the WCS decides on one of three choices: generating, using, or renewing a DGCC, as demonstrated in Figure 7. In this section, all these three possible choices and the corresponding processes are described.

4.1 Dot Gain Compensation Curve Generation

As discussed in Section 3.1, at the beginning of managing a printing job the WCS searches for an existing or similar DGCC in DGCC-DB dependent on consumable and workflow list. If there is no existing or similar DGCC or the existing or similar DGCC is in Time-level-III, the WCS will order the DGCC-Generation. A short time after using the system in the production, the generating procedure occurs less frequently compared to the DGCC-Usage or DGCC-Renewal. Figure 8 demonstrates the flowchart for the DGCC-Generation, i.e. the generation of a new DGCC and its saving in the DGCC-DB. If the WCS decides for the DGCC-Generation, then the imposition program will receive an order to use Template-II (Figure 3). After the halftoning and plate making through CtP, the printing can start. When the make-ready is finished, the production phase can start. In the very beginning of starting the system, there is still no DGCC available, and hence a printing test is needed for generating an initial DGCC before the production phase. For an exact generation of the DGCCs the printing process should be reproducible and the process variation (like target value variation, tone value variation or register variation) should be within the tolerance ranges (Figure 1, Requirement 1). Hence, before the DGCC can be calculated, the stability of the printing process has to be checked. The DGCC-bar has to contain the elements allowing to check the stability of the printing process (Hauck and Gooran, 2011a; 2011b; 2013; 2015). In case of variation, the calibration process is to be interrupted and optimized. After the make-ready and stabilization of the printing process the DGCC-bar is measured for the evaluation and calculation of the DGCC. This workflow works economically, if the printing process is controlled and stable. During the production the operator of the printing machine has to take several printing sheets and measure them for controlling the printing machine and the inks. An inline spectrometer does this procedure automatically. If the variation in the printing process is within the tolerance range, then the measuring system will get permission to measure the DGCC-bar.

It is also possible to measure several printed sheets (commonly 5 to 10) to build an average value. For the calculation of DGCC in this automated workflow a non-iterative DGCC generating method is absolutely necessary (Figure 1, Requirement 2). The generated DGCC is saved in the DGCC-DB after generating a meaningful nomenclature. After having saved the new DGCC the WCS gets a feedback that the DGCC is saved, and the process will then successfully terminate.

4.2 Dot Gain Compensation Curve Usage

As discussed in Section 4.1, in the case of DGCC-Usage a DGCC can be used without the need to be renewed (Figure 4, Time-level-I). The WCS decides to use an existing DGCC and does not generate a new one. Figure 9 demonstrates the flowchart for the DGCC-Usage. For the DGCC-Usage, the imposition program receives an order from the WCS to use Template-I, see Figure 3(a).

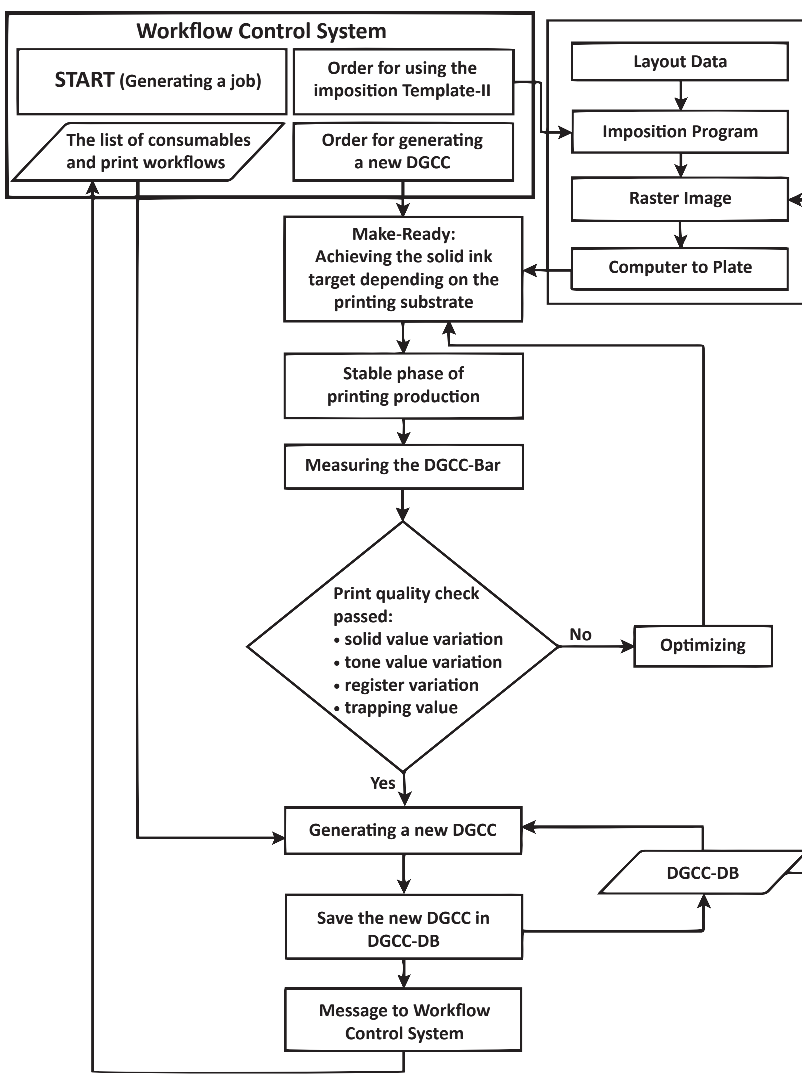

Figure 8: Generating and saving a new Dot Gain Compensation Curve

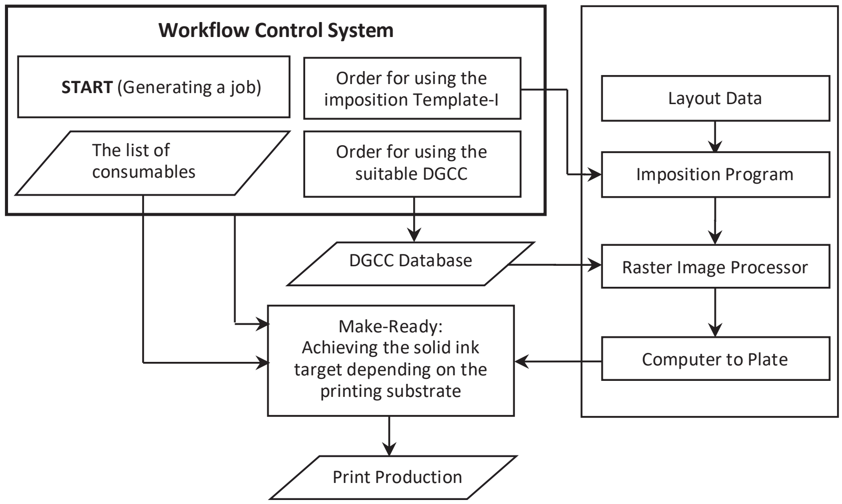

Figure 9: Using a suitable Dot Gain Compensation Curve

The WCS gives an order for the export of DGCC-Data from the DGCC-DB to the RIP. After the halftoning and plate making the make-ready at the printing machine can start. After the make-ready phase is finished, the printing production phase can start.

4.3 DGCC-Renewal

The WCS chooses the DGCC-Renewal if an existing DGCC is to be used for generating a new DGCC according to the used consumable and workflow in the printing production. The chosen DGCC can be an exactly needed DGCC according to the consumable and workflow list of WCS which is renewed (Figure 4, Time-level-II) or the chosen DGCC is just a similar DGCC. Hence in the latter case for the future need of an exact DGCC a new one has to be generated during the printing production. Figure 8 also demonstrates the flowchart for the DGCC-Renewal. The imposition program receives an order for using Template-II (Figure 3). The chosen DGCC is exported from DGCC-DB to the RIP. After the halftoning and plate making through the CtP the make-ready at the printing machine can start.

When the make-ready is finished, the printing production phase starts. As mentioned before, for an exact generation of the DGCC, the printing process has to be checked to make sure that the printing process variation is within the tolerance range. If this requirement is fulfilled, then the measuring system can measure the DGCC-bar.

Similar to the DGCC-Generation the non-iterative method calculates a new DGCC. After generating the new DGCC it is saved in DGCC-DB. For the Time-level-II (as demonstrated in Figure 4) the new DGCC replaces the old one in DGCC-DB. The WCS then gets a feedback that the process was successfully terminated.

4.3.1 Using Similar Dot Gain Compensation Curve

There are different priorities for the list of the used consumables and processes. For example, the most important priority for a DGCC is the group of printing substrates and the fabrication of the inks. Surely the type of the blanket or plate is also important, but not as important as the paper class and the fabrication of the ink. Dependent on the workflow and production, some consumables in the workflow can play a very important or a less important role in the printed tone values. This is important for searching for a similar DGCC in DGCC-DB if an available DGCC does not exist. The use of a similar DGCC reduces the number of the first choice of WCS for defining a print job (if in the DGCC-DB neither the DGCC nor a similar DGCC exists, a new DGCC is generated and saved in the DGCC-DB).

To clarify how to find a similar DGCC in DGCC-DB, an example is given. Assume that for a workflow manager the type of the substrate and the ink properties are the most important parameters. When searching for a DGCC in the DGCC-DB, the WCS checks if there is a DGCC generated using the same type of paper and ink. If so, then it checks for other parameters, such as plate. If, for example, the plate is not the same for this existing DGCC, it can still be considered to be a similar DGCC, because the plate is not of the higher priority.

5. Summary and discussion

To realize an automated CtP calibration workflow three requirements have to be fulfilled. The requirements are the controlling of print quality in order to avoid variation in the printing process, the non-iterative generation of DGCCs and the networked workflow. The first two requirements are realized and successfully applied.

The most parts of the third requirement are also state of the art, and only the WCS is to be developed. Hence this system is still not available. This paper described the needed control and the necessary logical communication between the workflow of the prepress and press.

There are three possible choices for a WCS in order to use a DGCC at the beginning of job definitions. These three choices are generating a new DGCC, using an available DGCC, and the combination of using and generating a DGCC (for example the renewal of a DGCC).

The suggested workflow allows to considerably reduce the costs and the time needed for generating or renewing the DGCCs. This system is useful for all printing companies which want to produce predictably, reproducibly and thus economically. The proposed automated CtP calibration workflow will facilitate a printing workflow with most productions following ISO-12647-2:2013 standard which will further increase the print quality. Furthermore, an automated CtP calibration workflow enormously reduces the work of the staff at the prepress, press, and quality management. It saves time and costs.

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Abbreviations

CM	Color Management
CtP	Computer to Plate
DGCC	Dot Gain Compensation Curve
DGCC-DB	DGCC Data Base
ICC	International Color Consortium
MIS	Management Information System
PC	Print Conditions
PQC	Print Quality Control
PS	Print Substrate
RIP	Raster Image Processor
TVI	Tone Value Increase
WCS	Workflow Control System