PROCESS STANDARD DIGITAL – PRINTING THE EXPECTED

establishing and implementing typical guidelines

ProcessStandard Digital fogra PSD

Highlights

For later reading

PRINTING THE EXPECTED

- **Not just THE EXPECTED, but across**
  - Different printing technologies
  - Different substrates
  - Production batches
- **Example in LFP**
  - WALL -> Free-PVC Wallpaper
  - CAR DOOR
    - BODY ->Self-adhesive Vinyl (SAV)
    - WINDOW ->Oneway View SAV
  - FLOOR -> Floor graphics SAV
  - GLASS -> Wasn't suppose to be in the picture

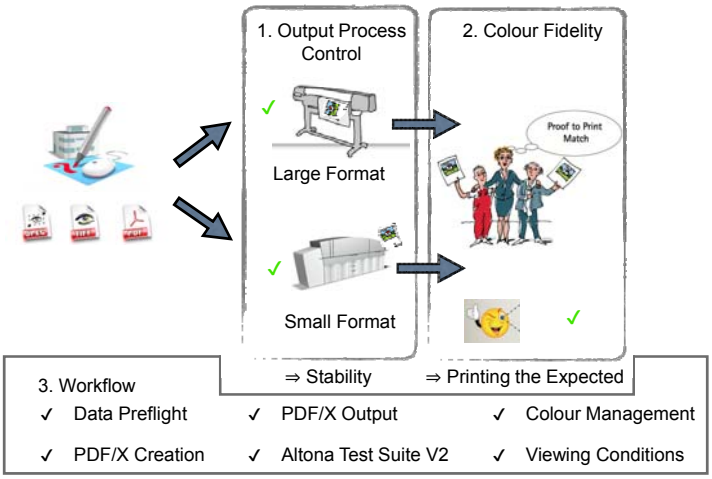
2

PSD – CODE OF PRACTICE

- **PSD guidelines have been published by Fogra in 2012**
  - Online version is free of charge (http://www.fogra.org/en/fogra-fogracert-en/print/processstandard-digital/psd-downloads-e/psd-downloads-en.html)
- **Digital Printing Working Group (Committee)**
  - Creating, promoting and encouraging the standardization and evolution of vendor neutral digital printing
  - Discussion and further development
- **PSD & ISO/TS 15311 – interplay and use case dependent facilitation of the standards**
  - ISO 15311-1 is at CD stage, -2 / -3 (ISO/TS track)
  - PSD will reflect the ongoing developments ("Living document")

3

HOW PSD IS ADDRESSING DIGITAL PRINTING NEEDS



4

DATA EXCHANGE WITH PDF/X - PREPARING THE EXPECTED

- **PDF/X is the ideal data exchange format for the printing industry**
- **The purpose of PDF/X is to facilitate graphic content exchange**
  - Specific requirements linked to production workflow needs
  - PDF/X-4 it is a desirable choice due to its features
- **Goal: AUTOMATIZATION**
- **PDF/X Profiles**
  - Creation
  - Preflight
  - Correction (Fixing)
- **PDF/X Output**
  - Proper RIP – workflow settings (ex. overprint options)
- **Your digital file data will output as good as it was created and processed !!!**

5

PDF/X "PLUS" PROFILES

- **ISO 15930-X**
  - PDF/X standards specifies minimum requirements
  - Job and / or output specific needs are not covered by the standard scope
- **Based on graphic industry's best practices in order to complement the standard and define the much needed parameters**
  - Ghent Working Group – GWG, www.gwg.org

Ghent Workgroup

BEST PRACTICES FOR PUBLISHING AND PACKAGING WORKFLOWS

  - PDF/X-Ready, www.pdfx-ready.ch

THE OFFICIAL WEBSITE PDFX-ready

- **Fogra web site**
  - http://www.fogra.org/en/fogra-research/wc-digital-printing/digital-printing-current-projects/consolidating-standardization/research-topics/preflight-check/data-preflight.html

6

PDF/X "PLUS" TESTING

- **An aid to determine whether your workflows is behaving in conformance with the PDF/X standards**
  - Ghent PDF Output Suite 4.0
  - PDFX-ready Output Test v3
  - Altona Test Test Suite 2 – Technical Page 2

- **External evaluation and certification of your PDF/X workflow**
  - For data creators

fogra cert
PDF/X Creation | 99999

  - For data processing

fogra cert
PDF/X Output | 99999

7

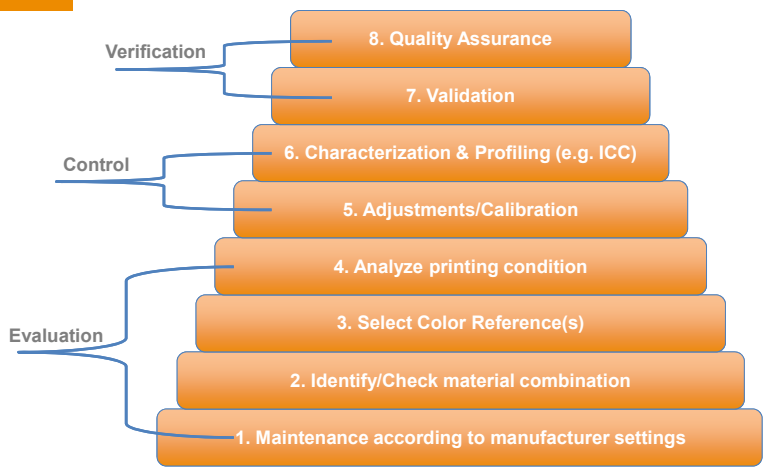
PRINTING THE EXPECTED = MEASURE AS WE SEE

- **The printing condition**
  - Digital press and its printing technology
  - Colorant
  - Substrate
  - Printing mode (LFP)
- **Tools**
  - Measuring instruments
  - Measuring protocol
  - Charts and strips
  - Profiling application
  - Validation application
- **Visual judgment**
  - Standard D50 viewing booth (P1/P2) or light box (T1) as described by ISO 3664:2009
  - Additional illuminants to evaluate colour metamerism/inconstancy

"Where you can measure, there is no need for dispute" – Prof. Dr. Joh. Albrecht, Fogra News Nr. 87, P. 2, 1976

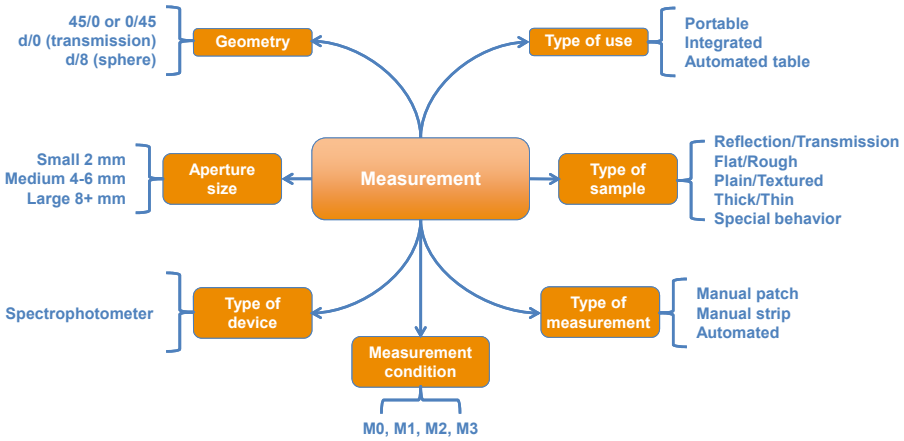
8

PSD – PROCESS CONTROL PYRAMID



9

CHOOSING THE RIGHT MEASURING INSTRUMENT



MEASURING PROTOCOL – BASED ON ISO 13655:2009

- **Data**
  - Spectral whenever possible
  - No OBA's or media relative evaluation setup -> M0=M1=M2 by scope
  - M1 whenever possible, but when using any M standard to exchange data, it is essential to agree on a particular M standard before measuring data
- **Backing**
  - Mostly measured on white backing
  - All the printing condition (reference profiles) are generated based on measurements done on white backing
  - Black backing is viable as an option for measuring special substrates (mesh, one-way view, textiles with lower opacity) due to better visual correlation
  - Side-by-side comparison between thick and thin substrates
- **Data quality and consistency**
  - Averaging and smoothing

11

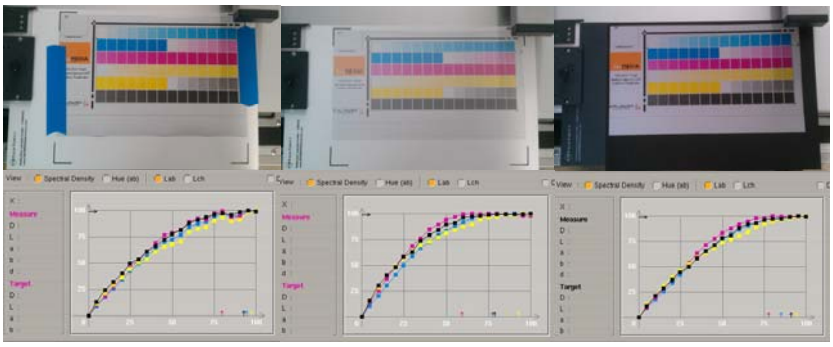
INSTRUMENT PERFORMANCE AND STABILITY

- **All measurement devices show random and systematic errors**
- **Such errors can't be corrected by the user, but they can be detected**
  - Check precision
    - Short and long term repeatability
  - Check accuracy
    - How it agrees with other devices
- **Periodical measurement of a stable material**
  - Monitor and record the results
- **A measuring device is only as good as its maintenance status**
  - Preventive maintenance
  - Recalibration and recertification in due time by manufacturer service

12

BACKING COUNT TOWARD MEASURE AS WE SEE

- One-way View SAV, Mesh substrates



w/ Liner
Self Backing

w/o Liner
On White Backing

w/o Liner
On Black Backing

13

CHARTS DESIGN

- From MediaWedge 3 LFP design experience:

- All strip mode scanning devices are continuously illuminating the target and takes up to 200 measurements per second
- Wider patches => Lots of measurements and averaging
- Big enough ΔE* between adjacent patches eliminate the need for contrast bars
- Same chart can be read by almost all measuring devices
- Patch height should only count towards intended devices maximum aperture and to make chart less affected by miss positioning

14

1. MAINTENANCE AND BASIC SETUP

- **A printing system is only as good as its maintenance status**
  - Regular service maintenance
    - Manufacturer periodically recommended operations
    - Environment conditions of both printing system and substrates used
  - User operations
    - LFP
      - Nozzle status check – certain close range viewing applications are sensitive to missing nozzles
      - Print heads alignment (in-between and height)
    - EP
      - Density control and evenness
      - Gamma (LUT) adjustments
      - Color registration
- **Good knowledge of the printer front panel and functions**
- **If unsure, use default settings as starting point and tweak from there**

15

2. IDENTIFY AND CHECK MATERIAL COMBINATION

- **Factor in both printability (testing & setup) and runnability (production)**
- **Select the proper substrates recommended for the used printing technology**
  - Not all substrates are suitable for all printing technologies
  - Even if printability may be achieved, runnability may be an issue
- **Choose the desired print mode(s), speed vs. quality (LFP)**
- **Understand specific parameters for Printer (hardware) and Workflow (software)**
  - Set a minimum printability level to qualify a substrate, then push the parameterization to find its limit
  - Use printer vendor and substrate vendor knowledge base
  - Simplify things – categorize substrates and their parameters
- **For drying/curing printing systems, the temperatures applied during pre-printing, printing and post-printing stages are very important for both printability and runnability**

16

3. SELECT COLOUR REFERENCE(S)

- **The achievable colour gamut results from the substrate and ink interaction and performance**
  - The typical reference printing condition (exchange space) used - FOGRA39 (ISO_coated_v2.icc)
  - While data may be supplied in different colour space, the focus should be on CMYK data
  - Rel. Colorimetric +BPC rendering is most useful
- **Modern workflows gives full control over RGB, CMYK, Gray, N-colour colour management settings for vector/bitmap**

Caldera colour Configuration
- Input to Simulation
- Simulation to Output

17

4. ANALYZE PRINTING COMBINATION

- **Relevant considerations**
  - Closest match of the color reference
  - Stable gamut based on proper ink limits – no print defects to affect image quality
  - Ink limits (per channel and total) affects the ink consumption – factor in the economical aspect of the printing
  - Smooth gradations
  - Print run stability
- **Understand how your colorant setup affects the printing**
  - Light & Dark inks share the same channel
  - Additional inks are used to extend the color gamut (OG or RGB) either in a direct N-color system or in a LUT conversion system
  - Special inks (White, Metallic, etc.) are used for special effects in print
  - Wider gamut = better coverage of spot colors
  - Simplify things, usually same printing resolution with different number of passes means the same amount of ink

18

5. ADJUSTMENTS/CALIBRATION

- **This stage is the first and most important part of the resulting media set**
- **It is foundation on which the ICC color profile will rely and is directly linked to the output quality**
- **Parameters to set**
  - Ink Limit per Channel (LFP)
    - Obvious physical limit or workflow tool automated suggestion (starting point)
    - Analogy to offset over and under inking
  - Linearization
    - Optimal/defined behavior between paper and solid for each channel by meanings of ISO Status density, spectral density or colorimetrical TVI
    - Actual linearization may be different from the meaning of the “Linearization”
  - Total Ink Limit (LFP)
    - No ink amount behind this value
- **The process is influenced by the driving RIP workflow, so while the general concept may be applied independently, in particular each workflow may have different approach and tools**

19

6. CHARACTERIZATION & PROFILING

- **Use ISO 12642-2 chart IT8.7/4 (random layout preferred) or the Universal LFP based IT8.7/4**
  - From the reference file any custom layout may be generated if necessary
- **As per any printed chart in the process control, print it repeated over the entire width of the substrate for practical reasons**
  - Automated measuring devices are highly recommended to avoid mistakes and errors (chart contains 1617 patches, 1680 for Universal LFP)
  - Average with optional interpolation and smoothing
- **This is your characterization data set for the selected printing combination, basically a fingerprint of your printing system for the chosen parameters**
- **Our printing condition becomes a fully characterized printing condition**

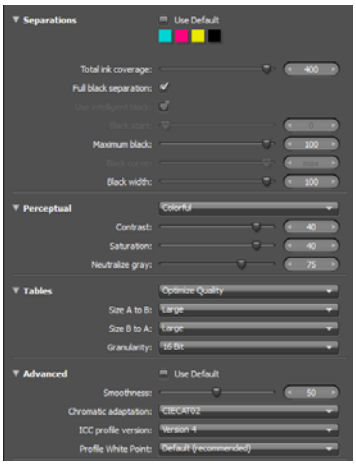
20

PROFILE GENERATION

- **Second stage of the media set based on previously made adjustments and calibration**
- **Any modification on the previous stage requires re-printing and re-measuring of the profiling chart (except re-linearization)**
- **Typical ICC Output Profile will be generated, but Device Link Profile may be also used**
  - Profile generation parameters
  - May be optimized thru iterative printing and measurement
- **Lighting**
  - Usual D50
  - Custom light may be used (e.g. Backlit application)

21

PROFILE SETTINGS

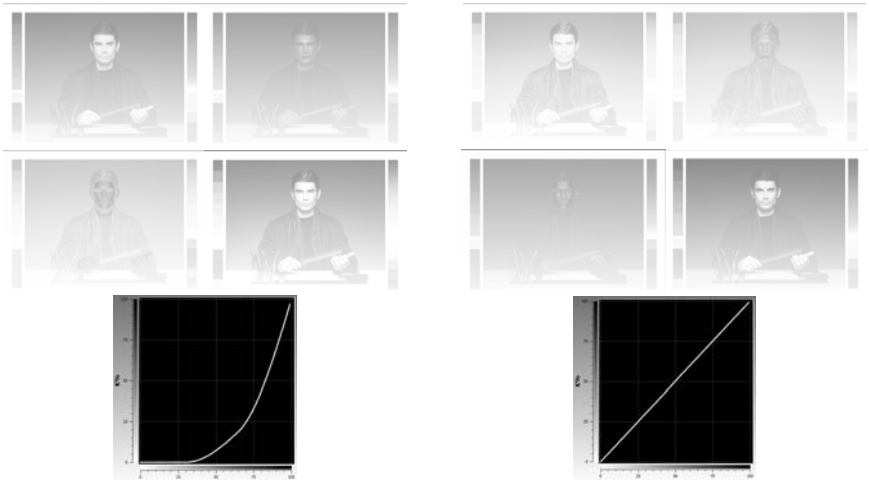


X-Rite i1Profiler

- **Separation**
  - Total ink coverage
  - Black start
  - Maximum black
  - Black curve
  - Black width
  - Other specific profiler settings
- **Profile size and quality**
  - Use 16 bit quality
  - Use Large, more interpolation points = larger profiles
- **Others**
  - ICC profile version – use v4
  - Chromatic adaptation – use CIECAT02

22

GCR VS. MAX K



23

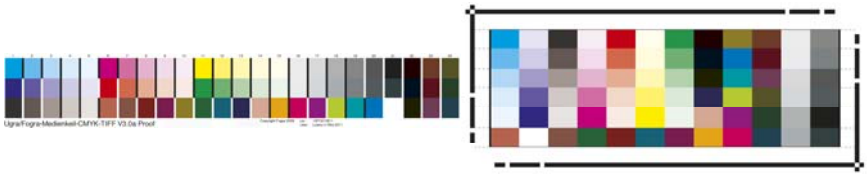
MAX K - FULL BLACK SEPARATION (LFP)

- **PRO's**
  - Best neutral visual pleasing grey ramp under any illumination
  - Least amount of ink used in calculation based on K channel, hence contribute towards reducing ink consumption
  - Very good image contrast also related to K channel
- **CON's**
  - May lead to loose some tones in the light area, irrelevant for small drop size ink
  - Black dots may be seen in light areas that may be visually disturbing for sensitive applications (e.g. backlit), irrelevant for small drop size ink
- **Overall it is the best balanced separation setup for a wide range of applications**

24

7. VALIDATION

- **Topics to check:**
  - Stability of the printing system for a given printing condition (device mode 1:1)
  - Deviation from aim values of the printing condition to be simulated
  - Summed up = total quality
- **Tools:**
  - Control strip or chart
  - Measuring device
  - Proper identification of the test jobs = job ticket
  - Pass/Fail tolerances adapted from already established Validation Print tolerances for the purpose of internal warning tolerances



25

8. QUALITY ASSURANCE

- **Periodically calibration or re-calibration recommended**
  - If it fails a new characterization may be required
  - Monitor and record the Pass/Fail evaluation for tracking purposes, it will show up trends useful to fix issues before they become problems
- **Track other variables like environment temperature and humidity**
  - Monitor your substrates supplier new batches
- **Put all the know-how into simple and well designed SOP for this purpose, it will save a lot of time and money when it comes to corrective actions**
  - In order to facilitate a proper understanding of “what we see” tag one copy of the print run with a proper job ticket
  - Store safely this proper identified copy for each major job in order to deal with later complains in a professional objective matter
- **Define the evaluation method (side-by-side or media relative) and the colour accuracy tolerances based on the appropriate reference set**

26

SIDE BY SIDE EVALUATION

- **This approach is similar with the contract proof or validation print application**
- **It is intended to be used for type of substrates that "look and feel" color and appearance wise similar as the simulated printing condition substrate**
- **Requires an 1:1 output or a simulation with absolute colorimetric intent (with or without white point simulation)**
- **PRO's**
  - Very good visual match with a proof or conventional printed sheet
- **CON's**
  - Limited application considering the wide variety of substrates used in digital printing
  - Only works properly if the color gamut of the source is at least within the destination

27

MEDIA RELATIVE EVALUATION

- **In digital printing nobody wants to see something printed where the input document shows C=M=Y=K=0**
- **Requires an 1:1 output or a simulation with relative colorimetric intent (with or without black point compensation)**
- **PRO's**
  - Best balanced approach considering the wide variety of substrates used in digital printing
  - Allows the printing of the same data across different digital LFP technologies and substrates
- **CON's**
  - Problematic if requires a very good visual match with a proof or conventional printed sheet
  - Transformation is limited to color gamuts that are similar in size and shape by means of evaluating the pertinent lightness difference in the black and white points

28

REPORTING PROTOCOL

Print created by:	Dorin Pitigoi	Date:	07.01.13 / 18:04
Last calibration:	20.07.12	Workflow:	Caldera v9
Measuring device:	X-Rite i1Pro2	Measuring conditions:	45/0, D50, 2, M0, WB
Printing condition:	FOGRA39	Reference profile:	ISOcoated_v2.icc
Printer:	HP Designjet L26500	Colorant:	HP Latex Inks HP 792
Substrate:	HP Photo-realistic Poster Paper	Output profile:	Designjet-L26500_HPPRPPHP2_600_CMYKcm_12pB.icc
Printing mode:	CMYKcm 600 12-pass-Bi	Intent:	Absolute colorimetric

	Measured		ISO 12647-7 [CPC]		ISO 12647-8 [VPC]	
	ΔE*ab	ΔE*00	Tolerance	Actual	Tolerance	Actual
Paper White (max.)	1,0	1,0	3	OK	3	OK
All patches (average)	2,0	1,0	3	OK	3	OK
All patches (max.)	7,0	5,0	6	not OK	8	OK
Primary colors (max.)	3,1	2,3	5	OK		
Hue difference ΔH (max. CMYK)	2,8		2,5	not OK		
Hue difference ΔH (average gray)	0,8		1,5	OK		
Chromaticness difference ΔCh (average gray)	1,1				2,5	OK
Hue difference ΔH (max. CMYRGB)	3,0				4	OK
			FAILED		PASSED	

	Measured		ISO 15311 Side-by-Side [PSD]				ISO 15311 Media Relative [PSD]			
	ΔE*ab	ΔE*00	Tolerance			Actual	Tolerance			Actual
			A	B	C		A	B	C	
Paper White (max.)	1,0	1,0	2	3	4	A				
All patches (average)	2,0	1,0	2	3	4	A	1,5	2,5	4	A
All patches (max.)	7,0	5,0	6	7	8	A	5	7	10	A
Primary colors (max.)	3,1	2,3								
Hue difference ΔH (max. CMYK)	2,8	-								
Hue difference ΔH (average gray)	0,8	-								
Chromaticness difference ΔCh (average gray)	1,1	-	2,5	3,5	4,5	A				
Hue difference ΔH (max. CMYRGB)	3,0	-	4	5	6	A				
			Minimum quality level rules							
			PASSED QUALITY A				PASSED QUALITY A			

29

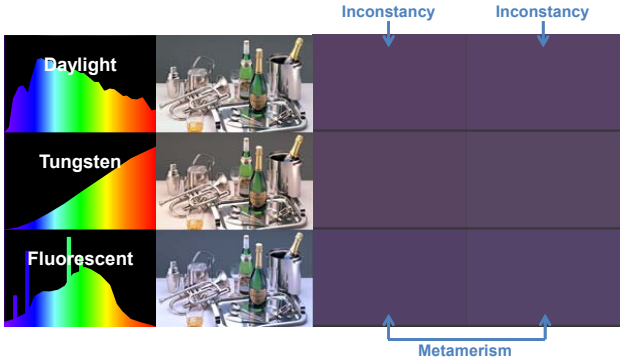
SPOT COLOURS HANDLING

- **Spot colours are used mostly as solids, compared to tone values or overprints with other colors**
- **Sources**
  - Spot colours libraries – make sure that there is consistency between the file reference and the available library (example 364 C, Pantone vs. Pantone+)
  - Physical sample thru measurement – same considerations as any measurement
  - Digital file container consisting of physical aspects and specific information of the colour – CxF/3, CxF/X
  - With the addition of CxF/X-4 complete characterisation (solid, tones, opacity) allows reliable printing and proofing of products designed using spot colour inks
- **How to print The Expected**
  - Unambiguous communication of colour specification and tight measurement protocol
  - Accurate characterization of the output printing condition
  - Check if in-gamut colour and tweak either the reference (media dependent reference) or the output mapping (media dependent CMYK+ recipe) for a best match (smallest ΔE*00) colour reproduction for a given printing condition

30

VISUAL COMPARISON AND APPRAISAL

- **The best viewing condition for the visual assessment of colour is that in which the product will be finally seen, but such an opportunity is very rare**
  - For critical purpose of colour comparison and appraisal, an ISO 3664:2009 compliant viewing booth/illuminaire shall be used
  - From other industries best practices, additional illuminants should be used for informative checking of metamerism and inconstancy



31

PSD IN PRACTICE – HYBRID WORKFLOW (ACTUAL CASE)

- **POS/POP production using conventional (screen) and digital (LFP) printing technologies**
- **Scope of the project**
  - Brand colour matching between conventional (spot colour) and digital printing (process CMYK) not only under D50, but also A and TL84 on various substrates
- **Tools**
  - iCQ and eXact for standard definition and Pass/Fail analysis
  - i1Profiler and i1Pro2/iO2 for advanced profiling and optimization of digital printing conditions
- **Achievements**
  - Dependent standards definition for various digital printing conditions
  - Max 2,5 ΔE*00 difference between Master Standard reproduction (screen) and Dependent Standard reproduction (digital) under any of the 3 illuminants checked

32

PSD IN PRACTICE – LFP WORKFLOW (ACTUAL CASE)

- **Print on demand interior decoration using digital (LFP) printing technologies on wallpaper, SAV and Canvas**
- **Scope of the project**
  - Reduce ink consumption, increase colour accuracy (reproduction quality) and colour consistency (day-to-day, press-to-press)
- **Tools**
  - i1Profiler and i1 iSis for advanced profiling and optimization of digital printing conditions, built-in HP spectrophotometer for process control
  - i1Pro2 and 3rd party tool for QA check of PSD quality levels conformance
- **Achievements**
  - 3% to 19% ink usage reduction dependent on the substrate used due to excellent MaxK profiling generation provided by i1Profiler
  - Colour accuracy level increased by one level (from B to A on SAV and Canvas, from C to B on wallpaper, ABC based Fogra PSD evaluation)
  - Average 1,5 ΔE*00 colour consistency between runs and presses (sampling)
  - Bonus: productivity increase due to faster printing speed possibility

33

APPLYING PSD IN BRIEF

- **PSD concept correctly implemented as industrial procedure works very nicely for any application**
  - Applications produced in hybrid workflows (mixture of conventional and/or digital printing technologies) - printing the expected
  - Digital produced applications are no longer limited only to traditional applications – garments textile and interior decorations
  - Spot color reproduction requires similar level of quality control as already established color critical reproduction applications
- **Demonstrate that you understand customer expectations**
  - Improve colour communication throughout the production chain
  - Implement objective means for your process control and quality assurance

✓

34

Thank you for your attention
Q & A

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Contributor to WG 2 (Prepress data exchange), WG 3 (Process control and related metrology), WG 13 (Printing Conformity Assessment Requirements), TF 3 (Workflow standards roadmap), JWG 14 (Print quality measurement methods)

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35

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