

PRINTINGUNITED

DIGITAL EXPERIENCE

Managing Color Expectations

Presented by: David Hunter



AGENDA

Reality of Color Quality Communications today

What is Manufacturing?

Process Control vs. Color Conformance

Moving from Subjective to Scientifically based Communications

Quantifying color expectations

Linking color expectations to print capabilities

Productivity and Profitability

Starts at the Operator- Know when producing waste

Reporting efficiency and effectiveness in print process

Conclusion

ATTEMPTING TO COMMUNICATE COLOR QUALITY TODAY

Ring a bell?

- Proofing “Match”
 - ISO Standards
 - Score Carding
 - G7 Qualification
-
- Let's take a closer look at the reality of each...

REALITY OF PROOF APPROVALS



Approve- How to quantify press match?

- Need press print to assess— no way to quantify match
- Subjective
- Visual eye balling

Doesn't ensure color quality

REALITY OF ISO STANDARDS

Formulas that describe a way of printing...

- ISO 12647-2 to 6 Printing Standards
- ISO 12647-7 Proofing Standards- process control tolerances
- ISO 15339 Printing Standards (based on G7), no tolerances

No Ability to audit ISO print standards in North America




Doesn't ensure color quality

REALITY OF SCORE CARDING

Process Score Cards don't predict color match

- 5 points for each primary within 3 ΔE etc... process control
- 85 points-Good Match? Can't relate to customer expectations
- **Can't compare printers to one another:** only to reference

Doesn't ensure color quality

		
1.1	87.0	✓
5.7	38.2	✗
1.4	84.0	✓
3.4	68.6	✓
1.6	86.6	✓

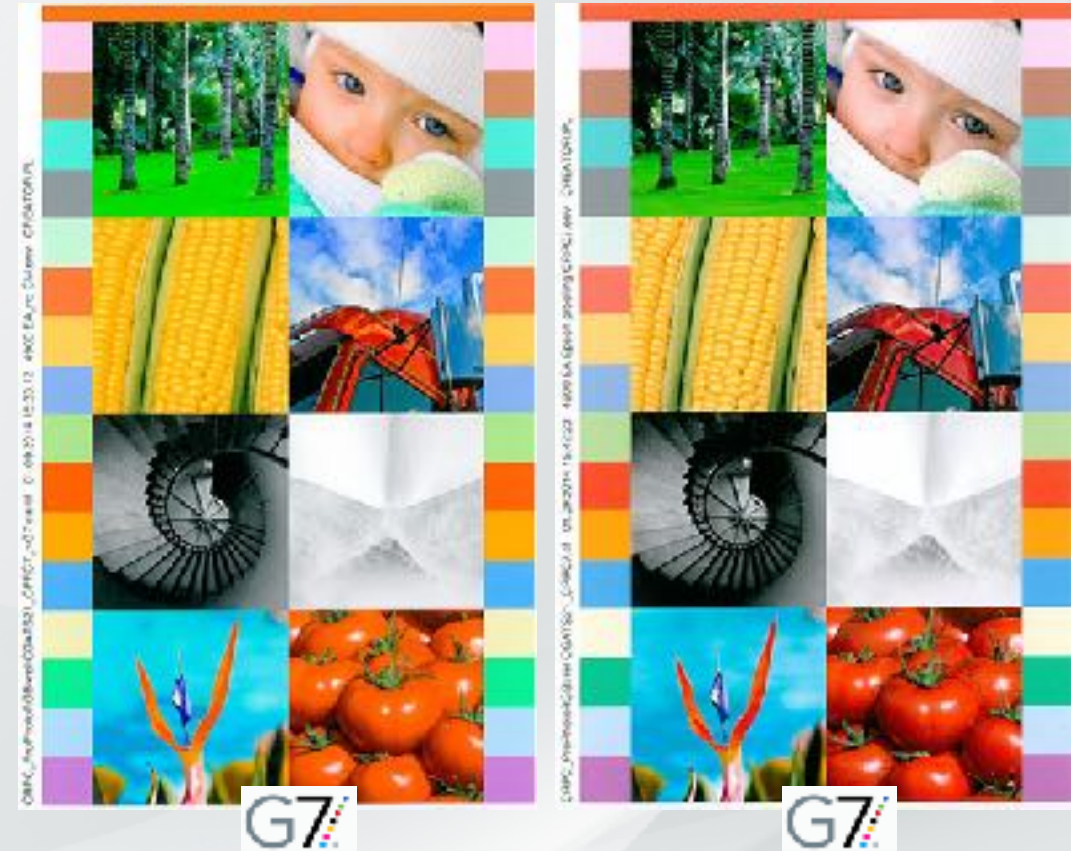
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REALITY OF G7

G7 is a methodology delivering shared common appearance

- G7 never promised color “match”
- G7 Methodology based Gray Balance & NPDC, process control not **color**
- G7 doesn't quantify a color match...

Doesn't ensure color quality



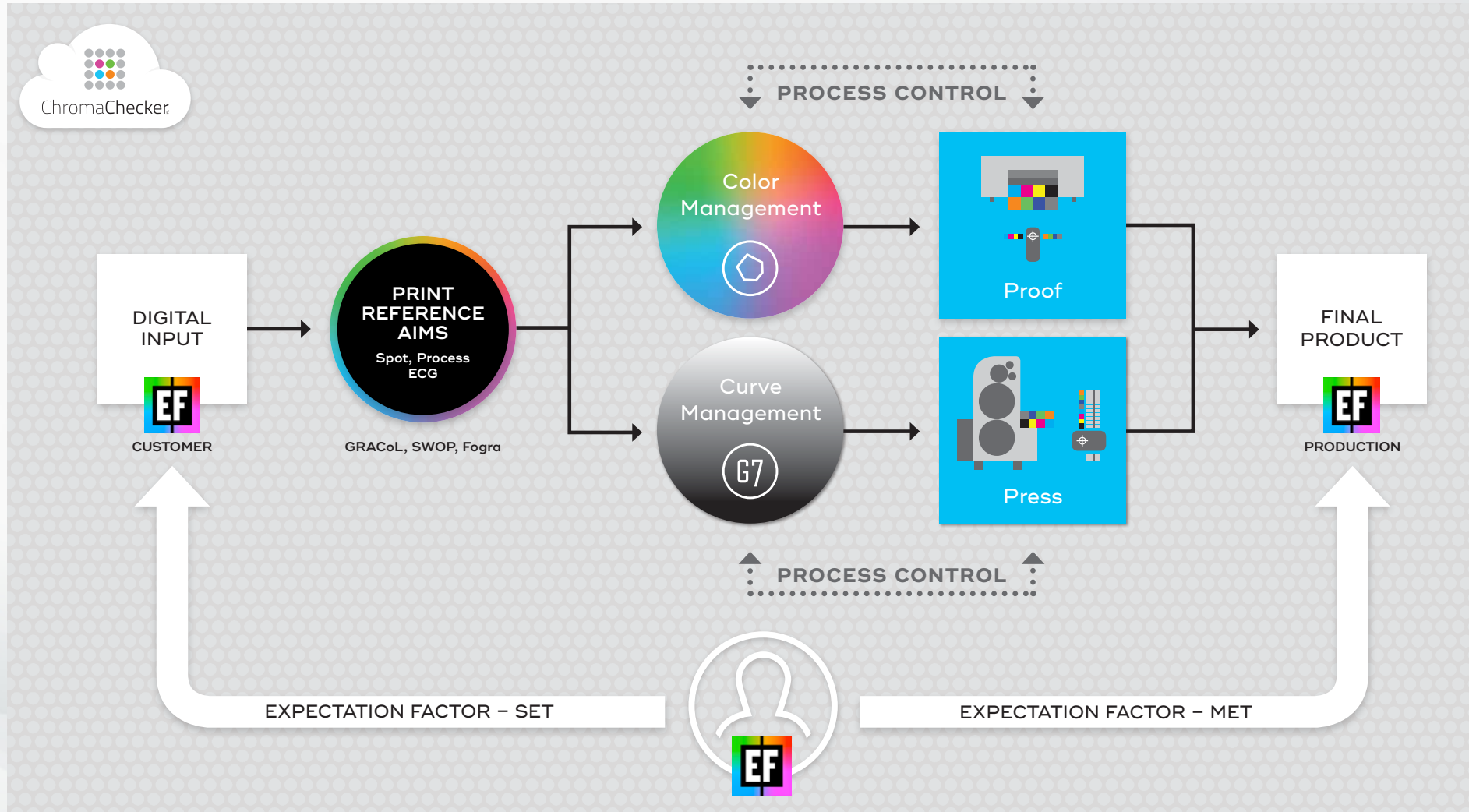
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PROCESS CONTROL VS COLOR CONFORMANCE

What is Manufacturing

- ◆ Taking raw materials and creating products that consistently meet customer **expectations**
- ◆ **Process Control**- Ensuring a process is predictable, stable and consistently operates at a target level of performance, with only normal variation
 - ◆ Proofing, ISO Standards, Score Cards, G7 methodology
- ◆ **Color Conformance**- Manufacturing quality color means meeting a customers color requirements/**expectations**, producing sellable goods
 - ◆ Introducing: E-Factor metric
 - ◆ Depends on Process Control, better the process control, better the E-Factor

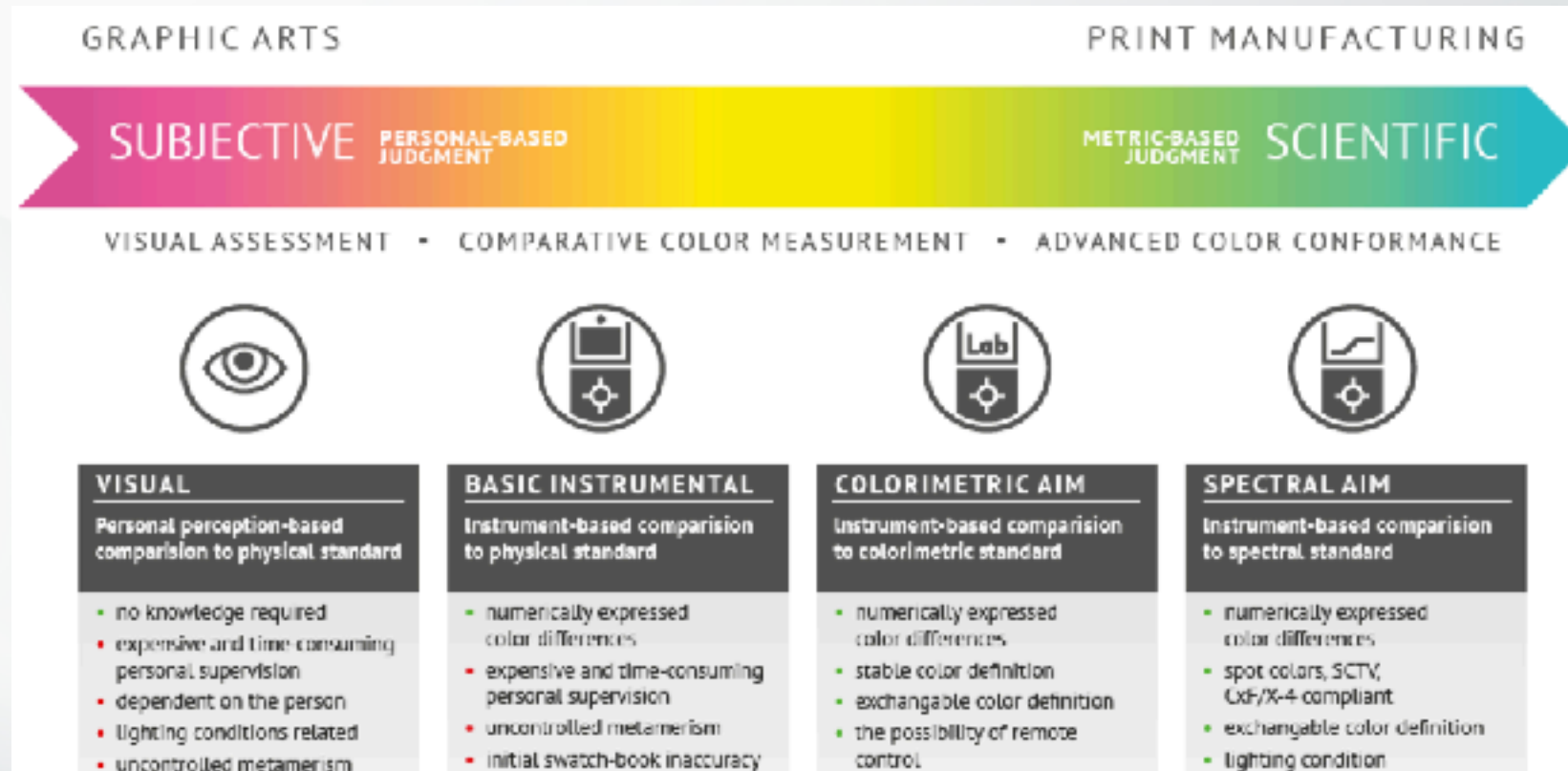
MANUFACTURING- PRODUCTS MEETING CUSTOMER EXPECTATIONS



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COMMUNICATING RESULTS

How does your company do it today?



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CUSTOMER EXPECTATIONS- HOW DO YOU KNOW?

Experience- Multiple Accepted and Rejected Jobs

- ◆ Person at printer that looked at jobs, understand difference

Visual impression



Reference



G7



Actual



G7

Objective numbers

Difference = ?

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CUSTOMER EXPECTATIONS- HOW DO YOU KNOW?

Experience- Multiple Accepted and Rejected Jobs

- ◆ Person at printer that looked at jobs, understand difference

Visual impression



Reference



G7



Actual



G7

Objective numbers

Difference = ?

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CUSTOMER EXPECTATIONS- HOW DO YOU KNOW?

Experience- Multiple Accepted and Rejected Jobs

- ◆ Person at printer that looked at jobs, understand difference
- ◆ Tribal Knowledge- human subjectivity- can't translate
- ◆ Results in rejected jobs- waste, loss of profitability

Visual impression



Reference



G7



Actual



G7

Objective numbers

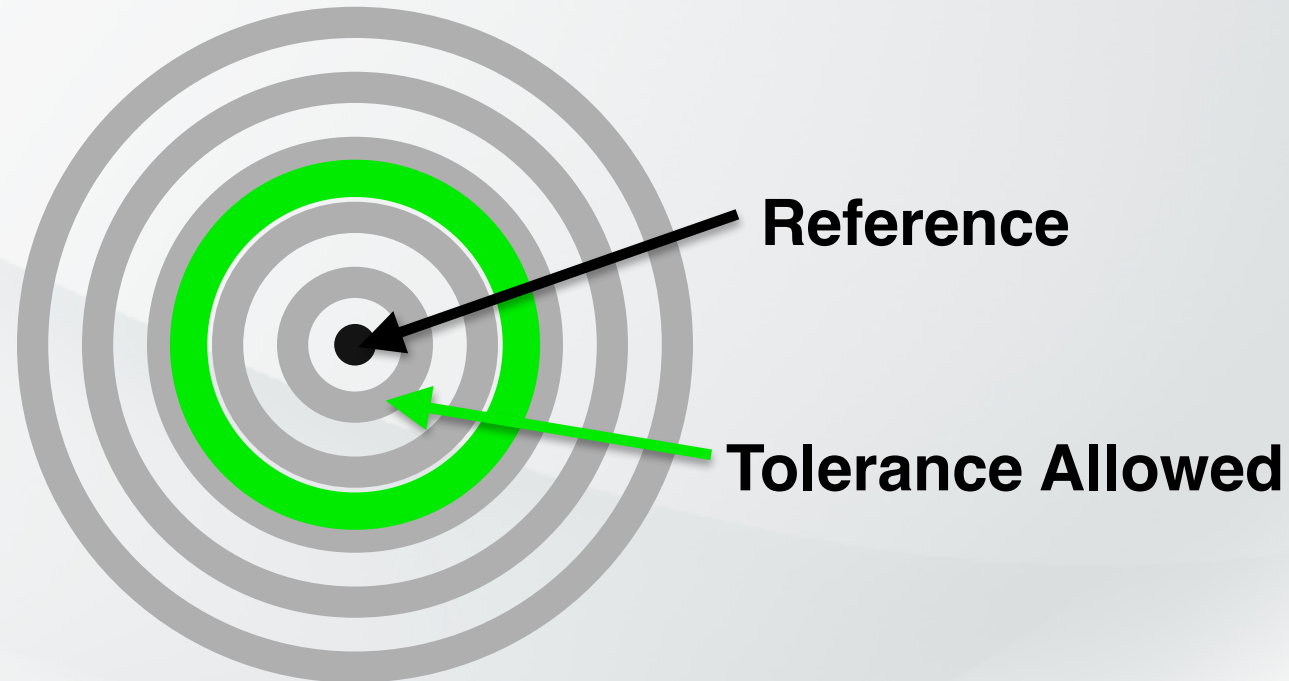
Difference = ?

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WHAT IF?

We Could Use One Number to assess Salability

- Assess customer's Expectations (E-Factor) with number



- If Production is manufactured inside tolerance= Salable!

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WHAT IF? COLOR CONFORMANCE!

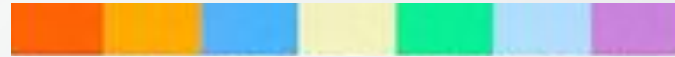
We Could Use One Number to Assess Salability

- Assess customer's expectations with this number
- Use to compare difference between print and reference
- Use to compare any two printing conditions to each other
- One number for operators to know if salable or waste
- Different tolerances for different types of work

MATCHING COLOR, QUANTIFY DIFFERENCES: METRIC

What Type of Color Match?

- Match for specific individual brand colors: Spot Color



- Match between pages and or images: Process Color



G7



G7



G7

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PRINTING COLOR, QUANTIFY DIFFERENCES: METRIC

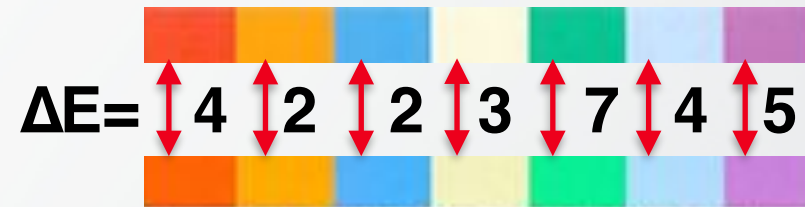
What Type of Color Match?

- Match for specific individual brand colors: Spot Color
 - **ΔE (delta E)** quantifies spot difference
 - Bigger the number, bigger the difference
- Match between pages and or images: Process Color
 - **E-Factor (EF)**- quantifies process color difference
 - Bigger the number, bigger the difference
 - Think ΔE for process colors, same relative difference

MATCHING COLOR, QUANTIFY DIFFERENCES: METRIC

What Type of Color Match?

- Match for specific individual brand colors: Spot Color



- Match between pages and or images: Process Color



G7

EF
= 3



G7

EF
= 6



G7

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TECHNICAL DEFINITION: E-FACTOR CRF 95TH %

95% of colors are within that ΔE , 5% are higher

- Used to quantify page, and image differences (not spot)
- Metric defined and described in 2001 TAGA Paper-Chung
- Compares the patch definitions and sort highest ΔE
 - *CRF at 95th percentile ΔE 2000*
 - *Defined in G7 Color Space tolerances and TR016*



GRACoL2013 vs “Large Format”

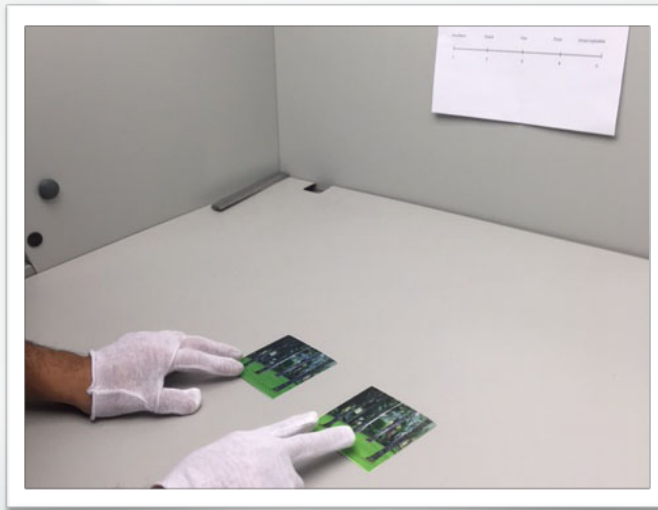
Delta: <input type="text" value="E*"/>	Max error
Formula: <input type="text" value="CIEDE2000"/>	10th perc.: ± 0.32
<input type="checkbox"/> Absolute <input type="checkbox"/> L*a*b* weighted	Median: ± 0.81
<input type="checkbox"/> Separate Neg / Pos stats	90th perc.: ± 1.69
<input type="button" value="Stats report"/>	95th perc.: ± 1.75
	All samples: ± 2.27
	No. samples: 0+84=84

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BUT WHAT ARE CUSTOMER EXPECTATIONS?

Industry Survey (TAGA Research Paper 2017)

- 200+ Industry People surveyed on ranking images with defined E-Factor differences
 - *Provided 80 random paired comparisons, D50 Lighting*
 - *Graded Match: Excellent, Good, Fair, Poor, Unacceptable*



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PRINT BUYERS EXPECTATIONS REVEALED!

Industry Survey

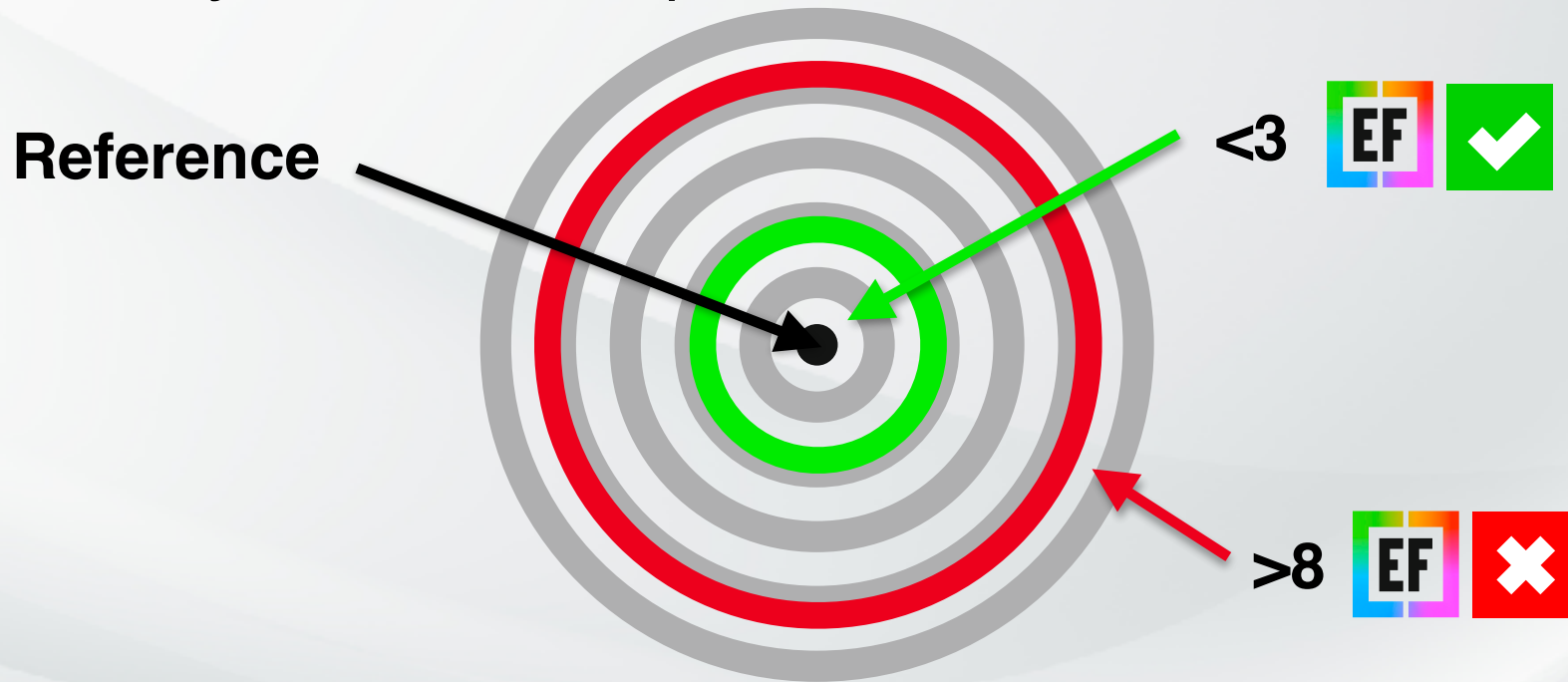
- For first time in Industry, can use “**One**” number to determine if match is acceptable or not most of time
 - *E-Factor: 1-3 = Good or Excellent Match by vast majority*
 - *E-Factor: 4-8 = Disagreement on Acceptability*
 - *E-Factor: 8+ = **Unacceptable by vast majority***

Published TAGA 2017, Chung, Hunter, Federovski, Urbain

BUT IF WE KNOW THE RANGE OF ACCEPTABILITY...

Industry Studies- Print Buyer Expectations

- 83%+ Print Buyers will accept ≤ 3 E-Factor
- 95%+ Print Buyers won't accept > 8 E-Factor



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INDUSTRY RESULTS: COLOR CONFORMANCE

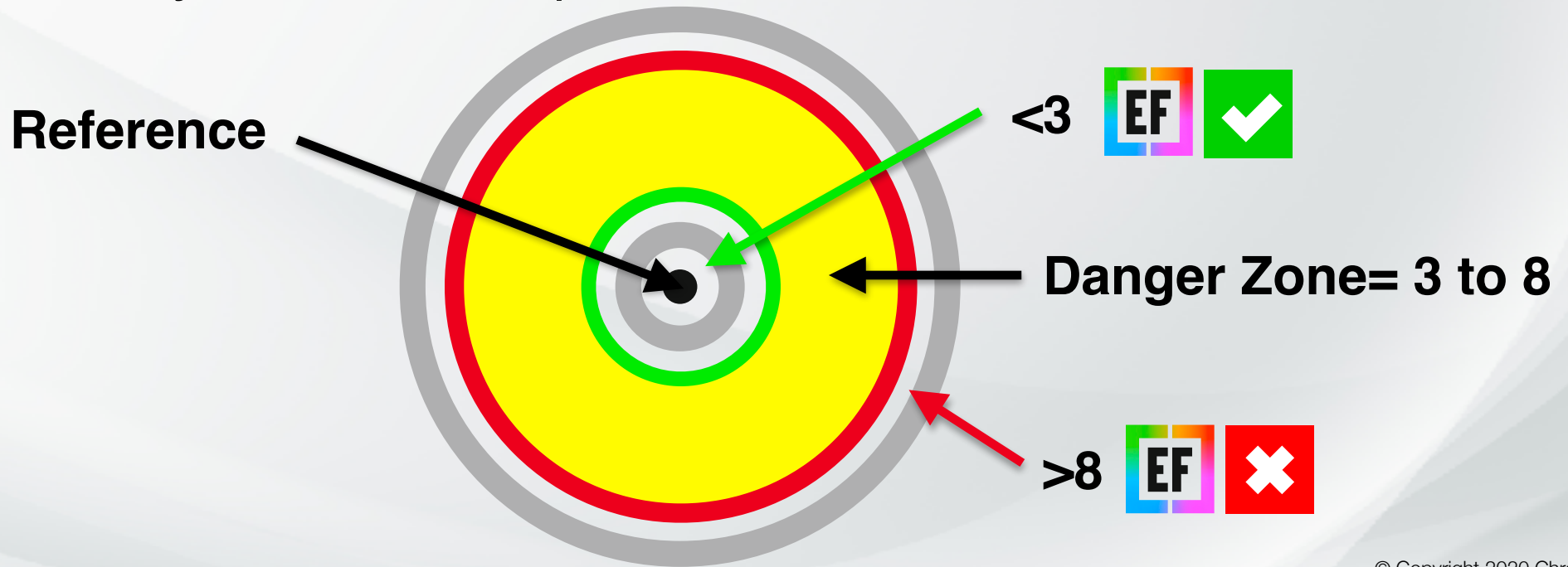
Industry Survey

- For first time in Industry, can use “**One**” number to determine if match is acceptable or not most of time
 - *E-Factor: 1-3 = Good or Excellent Match by vast majority*
 - *E-Factor: 4-8 = **Danger Zone: Unacceptable to some***
 - *E-Factor: 8+ = Unacceptable by vast majority*
- **Danger Zone: *most printing today***
 - *Unknown if Customer will accept, cause customer rejection and need to reprint (costing time and money) killing profitability*
 - *Most printers today manufacture in 4-6 E-Factor= **Danger Zone***

BUT IF WE KNOW THE RANGE OF ACCEPTABILITY...

Industry Studies- Print Buyer Expectations

- 83%+ Print Buyers will accept <3 E-Factor
- 95%+ Print Buyers won't accept >8 E-Factor

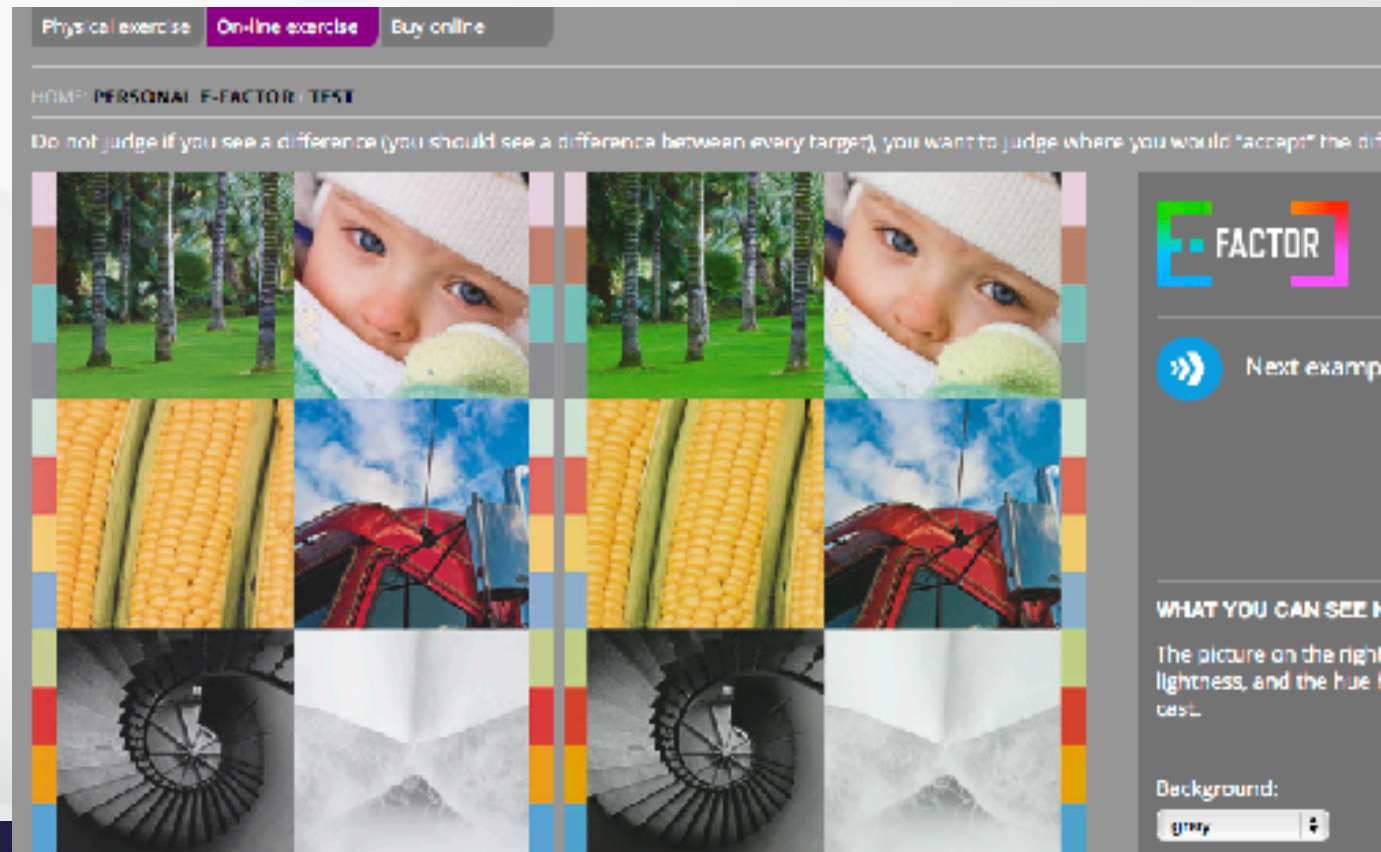


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DETERMINE ANY CUSTOMER'S EXPECTATIONS

Free Web based exercise: <https://chromachecker.com/cee/en/start>

Printed version for \$99



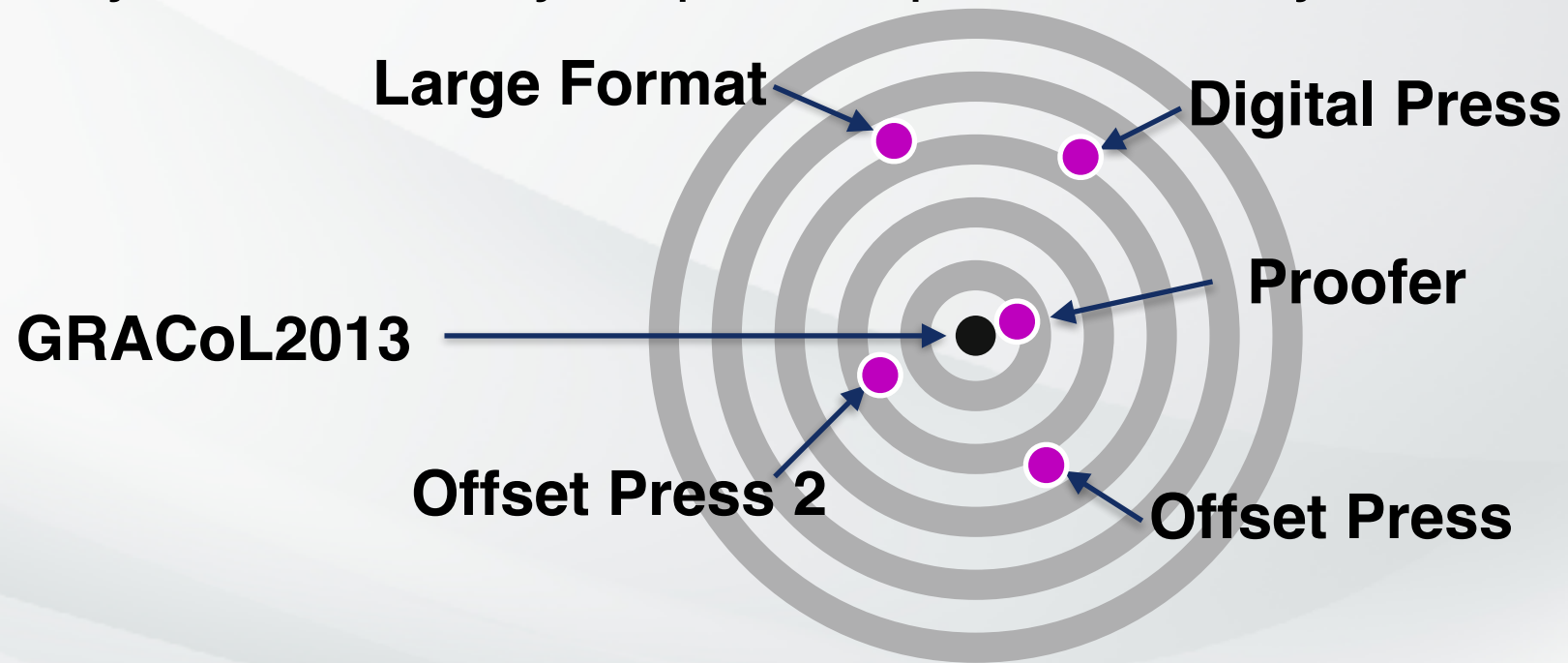
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DETERMINE ANY PRINTING DEVICE'S E-FACTOR



Match Printers to Reference (GRACoL)

- ◆ Each printer is a dart, within E-Factor tolerance?
- ◆ Do you know how your printers perform, every shift?

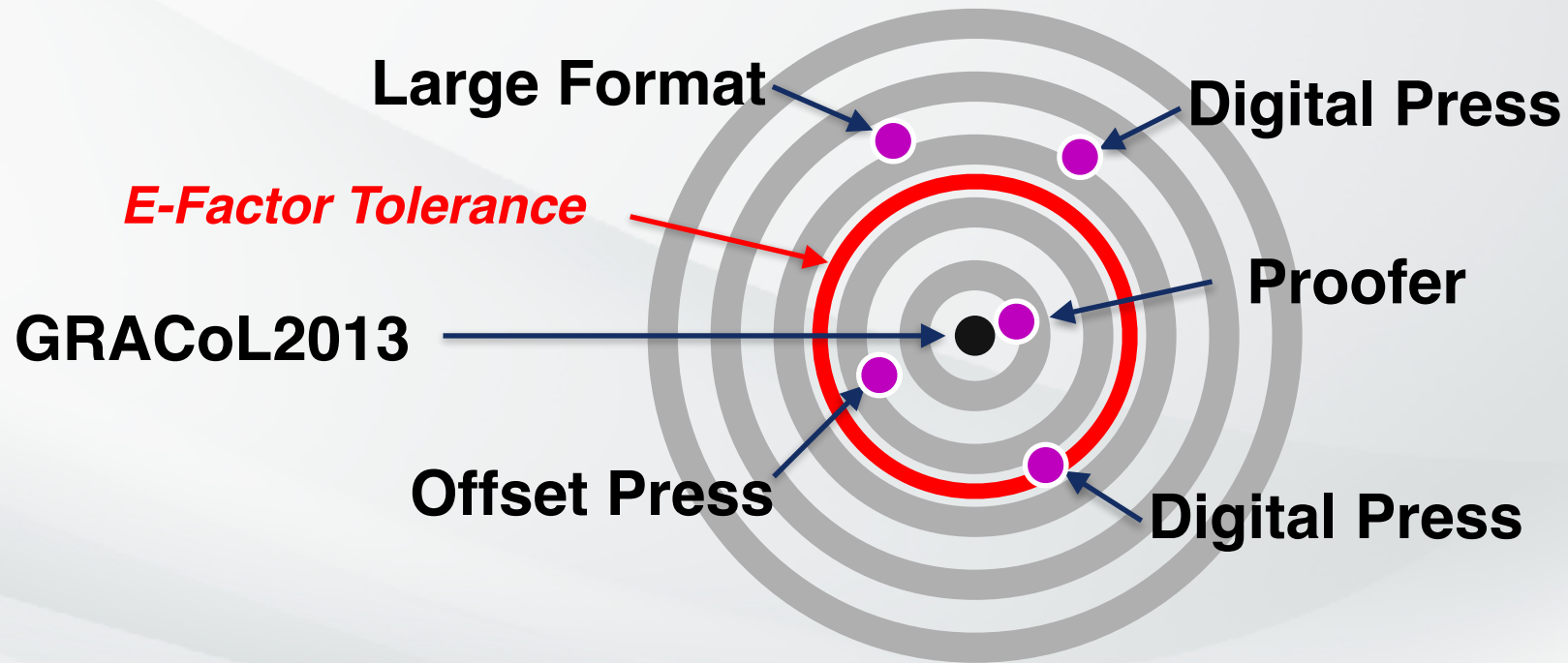


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COLOR MATCH- QUANTIFY HOW CLOSE?

Define Plant Tolerance

- ◆ How close Required? Not only to reference, **but to each other**

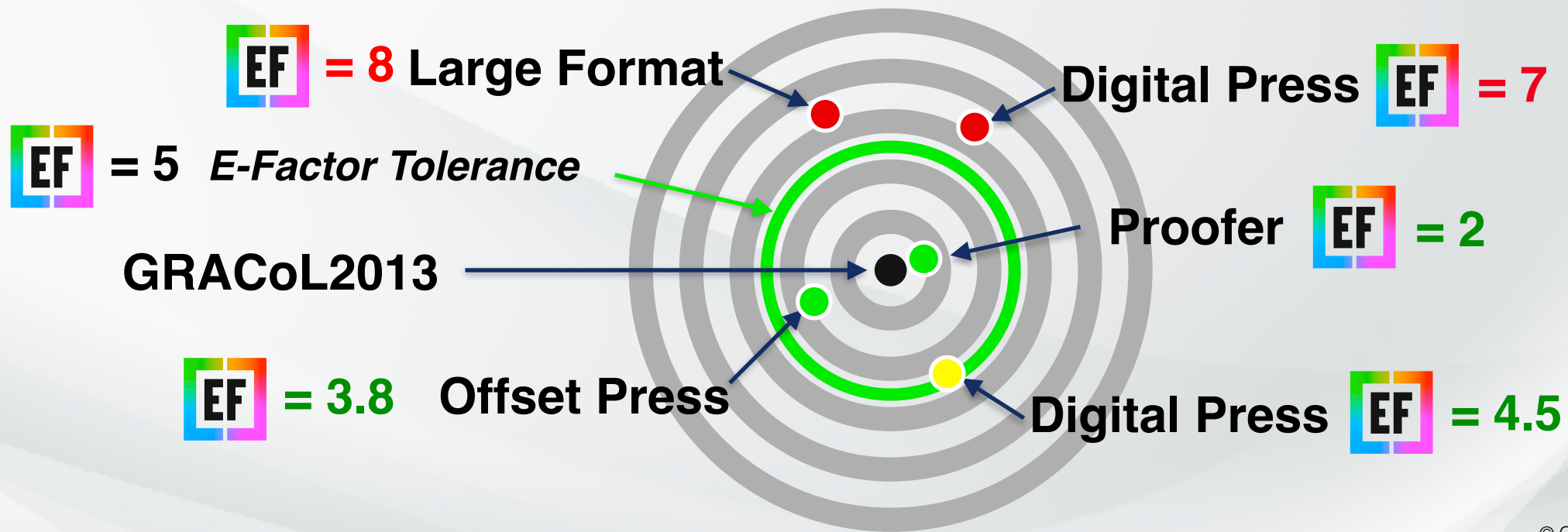


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COLOR MATCH- QUANTIFY HOW CLOSE?

Define Plant Tolerance

- ◆ How close is Required? E-Factor metric...

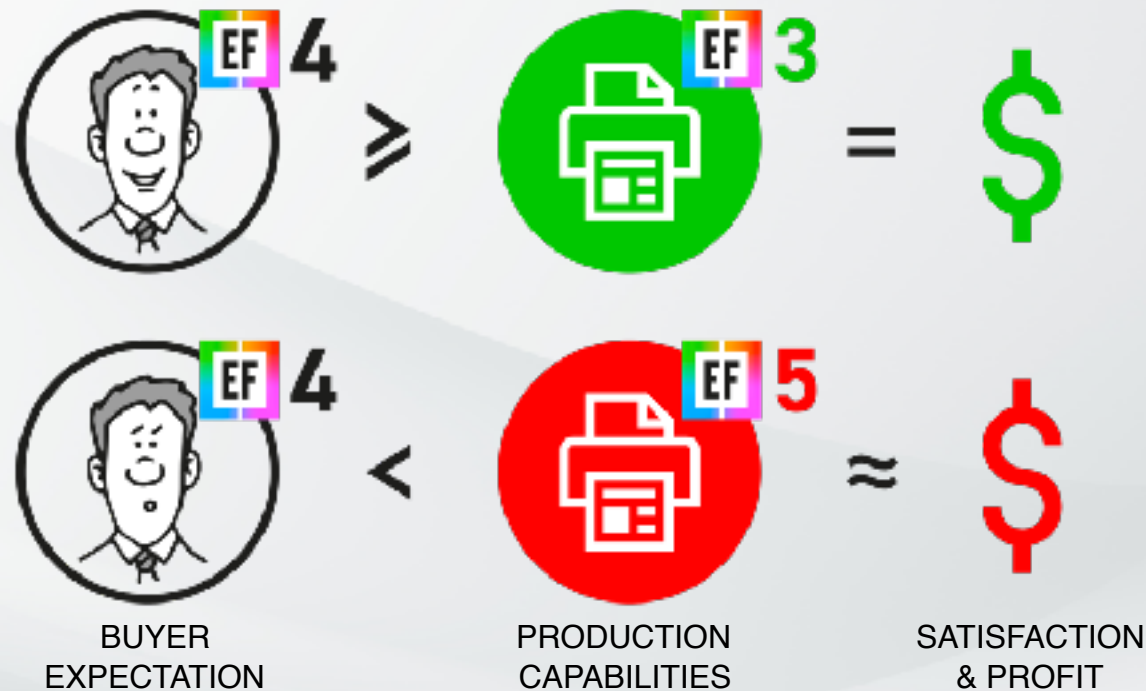


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LINK COLOR EXPECTATION TO PRINT CAPABILITIES

Can Printer meet Customer Exceptions?

Manufacturing: Take raw materials, create a product that *consistently meets customer expectations*



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WHY NOT USE G7 TO DEFINE COLOR MATCH?

Both are G7 Compliant- but NOT ACCEPTABLE

- E-Factor = 7, not acceptable for many people
- Have multiple G7 Proofs, not match
- Not Color Conformance

 = 7

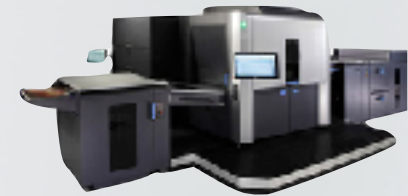


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ACTUAL SAMPLE- HP INDIGO: G7 CURVES VS CMS

Better Process Control, better Color Conformance

- Apply G7 tone reproduction curve
 - *Only affects tonality and gray balance*



- Apply ICC Profiles, or ICC DeviceLinks
 - *Affects Entire color space, CMY tints and Colors*



$$= \text{EF} = 2.7$$

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PRINT MANUFACTURING: SALABLE NUMBER


Road Map to Analytics Based Print Manufacturing



Printing any way,
any day



Printing same way
every day



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PROFITABILITY CRITICAL FOR SUSTAINABILITY

75% Printers operate on less than 2% margin*

- Most Operators don't understand Profitability
 - *Work hourly- do job over- no problem, more hours*
- \$100 waste requires \$2000 additional sales to make up
 - *Every rejected job hurts your company*
- Management to provide tools and education to improve profitability
 - *Help operators be accountable, rewards, feedback*

* 2020 PIA Survey

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OPERATORS INSTANTLY KNOW IF ACCEPTABLE

Print, Measure, Simple Pass/Fail based on Color Conformance

◆ Green is salable, Red is not



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KNOW WHY PRINTER IS NOT SALABLE

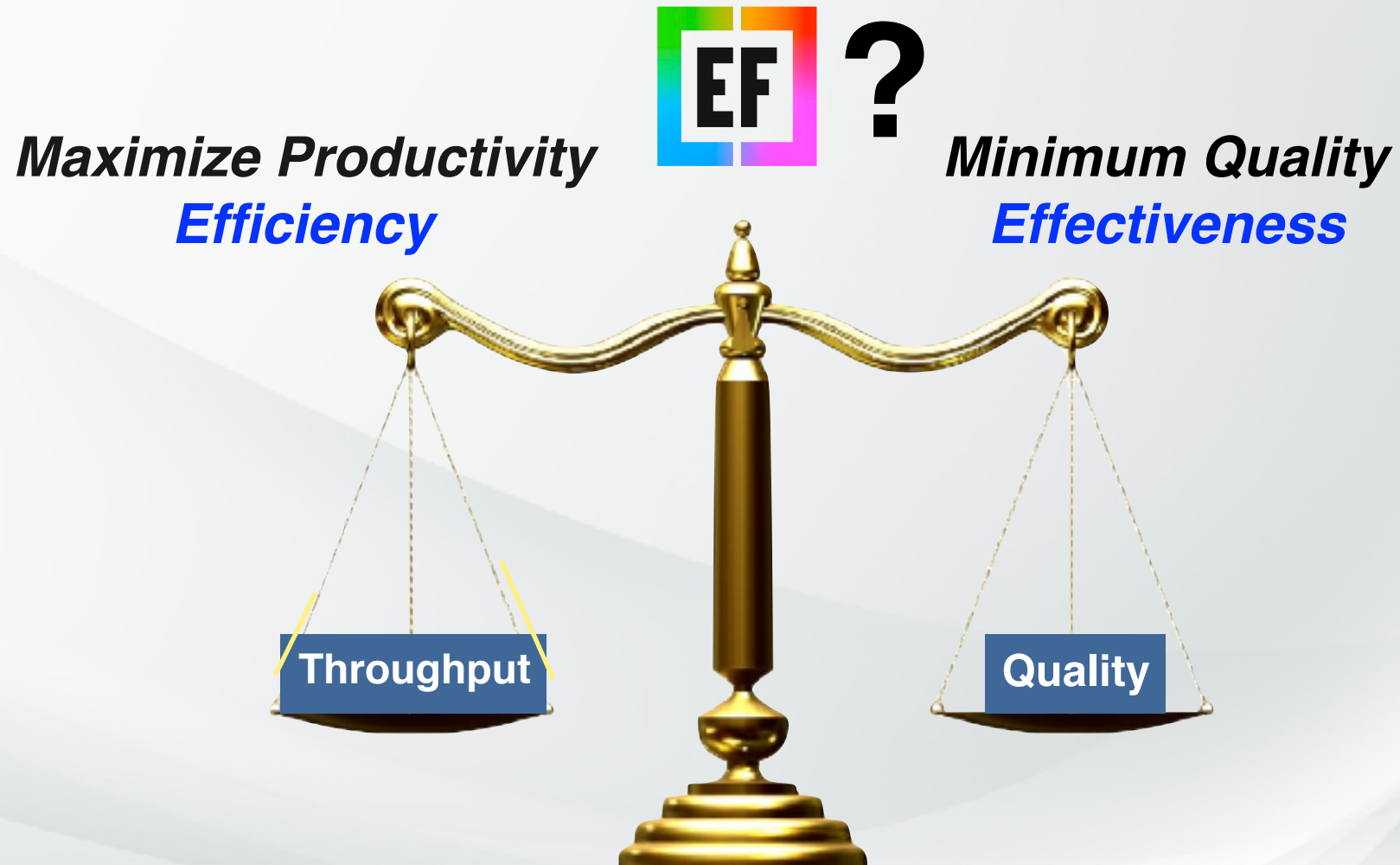
Operator Guidance When Report Fails:

- Offers guidance to correct output to meet targeted color quality conformance
 - Wrong Paper, Wrong settings, Nozzles Clogged, Bad PIP, etc...
 - Different troubleshooting based on technology of Printing Device
- Keep the Printer Printing- Help Operator fix problem



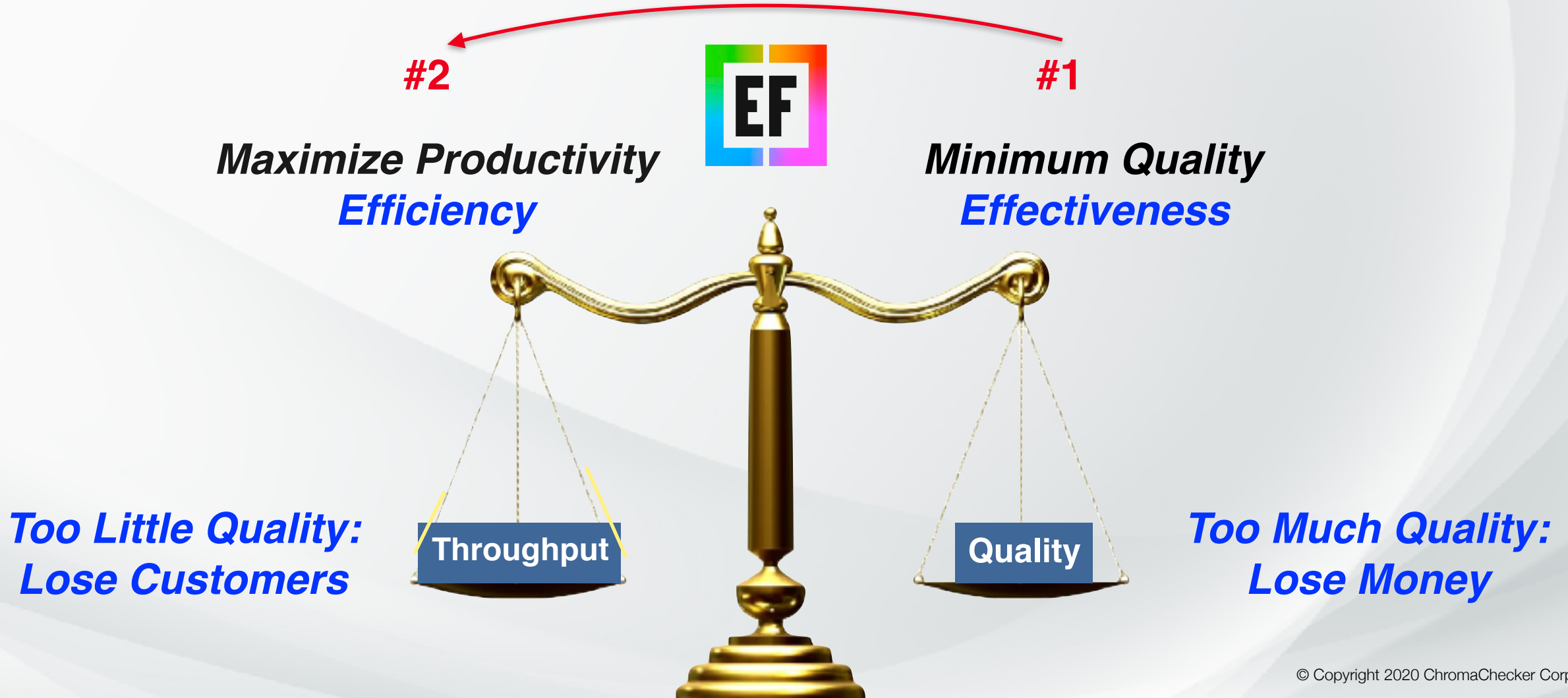
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EDUCATING MANAGEMENT ON QUALITY



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ESTABLISH MINIMUM QUALITY REQUIREMENTS

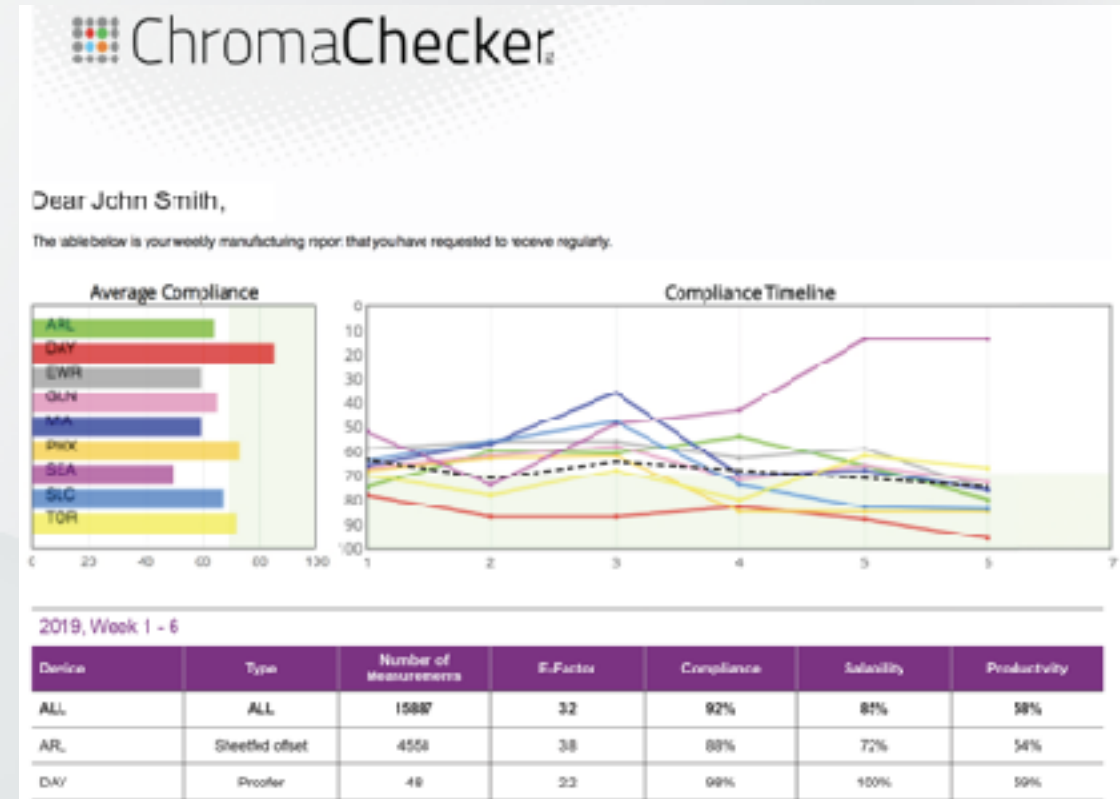


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CONTINUOUS PERFORMANCE REPORTS

Reporting Salability- Continuous Improvement

- ◆ Manager/Operator- KPI:
 - *Dotted line shows average, only get data from their printers*
- ◆ Manager only sees their printers
 - *6 Week trend line- showing improvement (lower is better)?*
- ◆ Company wide initiative
 - *Cloud based, automatically emailed*



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COMPLEX JOBS PRINTED ON MULTIPLE PRINTERS

How close to one another

- ◆ Know Before Job is Printed- Communicate to Customer



Large Format

Digital Press



Large Format

Offset Press



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CONCLUSION

Time to Transition to Print Manufacturing

*Utilize both Process Control and Color Conformance metrics
Efficiently and effectively produce salable goods*

Compliment subjective with scientific approach to communications

*Scientifically quantify customers' color expectations with E-Factor
Concretely know and communicate device capabilities upfront*

Balance Throughput with Quality

*Analyze, optimize, and maintain print ecosystem with data
Employ single digit guidance at management, expert, and operator level
Take full advantage of continuous print process reporting*

Maximize Productivity and Profitability

Produce salable color, first time every time!

RESOURCES- THANK YOU

Helpful links

- TAGA CRF 95th Percentile Research
 - https://chromachecker.com/include/img/PMG/Predict%20Color%20Image%20Match_0804-TAGA2017.pdf
- Online E-Factor Exercise
 - <https://chromachecker.com/cee/en/start>
- Online ΔE Spot color exercise
 - <https://chromachecker.com/colorexercise/en/start>
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