An Evaluation to Identify Best Printing Process and Substrate for Newly Developed Color Vision Deficiency Diagnosing Tool

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One in every group!

71st Annual Technical Conference · Minneapolis, MN · 2019
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3,40,000 SCHOOLS
12,000 INDUSTRIES
460+ CAMPS/MONTH

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Why the color of facebook logo is blue?
What connects them all?

CVD – Color Vision Deficiency / Daltonism / Color blindness
Content Overview

01 Why?
Purpose of this project

02 Background
Brief of CVD, Existing detection tools & issues

03 Print & Substrate Analysis
Cost Effective, Durable, Accurate & Faster detection tool
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Why?

- Mohan Venkat
- Dream is to become fighter pilot
- Rejected due to CVD
- Studied optometry to make sure no other children faces such scenario
- Identified issues with existing CVD detection tools.
Purpose of our research

- To identify the **best printing process & substrate** for newly developed **Daltons Pseudo Isochromatic plates** for detecting color vision deficiency by analysing **durability, cost effectiveness and repeatability of** different printing processes and substrates.
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What is color vision deficiency?
One in every group!

Pingelap
Daily challenges of CVD Individual!
Existing Diagnosing tools! Ishihara PIP plates

- Pseudoisochromatic plate – 1917 by Shinobu Ishihara. 38, 24 & 14 plates
- The copunctual points build the source for this type of colour vision test
- Other well known pseudoisochromatic test plates are the 24 HRR plates by Hardy, Rand and Ritter
- Vanishing design, Transformation design, Hidden digit design & Classification design
Limitations with existing PIP tool!

- Durability for Indian conditions
- Same pattern existing for over 100 years
- Misleading test results - memorise
- Expensive screening tool
- Long time required for evaluation
- Aging of the tool and misleading diagnosis
- Pirated tool & not validated
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Design of Pseudo Isochromatic Plates

- A random pattern of gray level dots is first put together.

- A digit pattern is then added which is defined by yellow/blue variation only. Since most people with red/green colorblindness can see yellow/blue they will be able to see the digit 5 in this test pattern.

- Another digit pattern which is defined by red/green variation is added. Here is the pattern composed of the random brightness pattern and the red/green pattern.

- Finally all three are added: People with red/green deficiency will not be able to see the red/green pattern and will see the 5. People with normal vision will see both the patterns, but since the red/green is stronger than the yellow/blue, the normal person will see the digit 6.
Analysing various substrate materials under different testing parameters

<table>
<thead>
<tr>
<th>SUBSTRATE NAME</th>
<th>DURABILITY</th>
<th>PRINT SURFACE QUALITY</th>
<th>LOW IMPACT SCRATCH RESISTANCE</th>
<th>ASSESSMENT OVER COLORVISION DEFICIENT SUBJECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>coated art board 300 GSM</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Uncoated smooth board 300 GSM</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Uncoated ivory texture board 250 GSM</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Synthetic polyester(PET) film 125 microns</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Synthetic polyester(PET) film 200 microns</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

Table 1.1 Analysing various substrate materials under different testing parameters
## Analysing Different Types of Printing Processes

<table>
<thead>
<tr>
<th>PRINTING TECHNOLOGY</th>
<th>PRINT SURFACE QUALITY</th>
<th>COST EFFECTIVENESS</th>
<th>REPEATABILITY (Color consistency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Electrophotography</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Liquid Electrophotography</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>UV Inkjet</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
</tbody>
</table>

Table 1.1 Analysing various substrate materials under different testing parameters
Pictures of various substrate Materials printed by dry electro photography process

Fig 1.1 Ivory 250GSM
Fig 1.2 Smooth 300 GSM
Fig 1.3 coated art 300 GSM
Fig 1.4 PET 125 microns
Fig 1.5 PET 200 microns
Water durability test

- Fig 1.6 PET 200 microns – water durability test (Sheet is immersed in distilled water for 48 hours)
Low impact scratch resistance test

- Fig 1.7 PET 200 microns – low impact scratch resistance test (cotton swab is rubbed continuously over the printed surface for a minute)
Initial Results

- Based on our evaluations, we found ‘dry electro photography’ technology as the best method to print Daltons Pseudo isochromatic plates on ‘synthetic polyester (PET) film 200 microns’.
- Optometrists from Elite school of Optometry, Chennai have further validated the newly printed Daltons pseudo isochromatic plates by comparing with Ishihara pseudo isochromatic plates.
Initial Validation results

- Validation of the chart was done against Ishihara’s PIP by two masked examiners for 1019 school children aged between 11 – 17 years (Mean ± SD: 14 ± 2 years) as part of a school eye health program.

- The sensitivity and the specificity of the Dalton’s PIP was found to be 98.40% (95% CI: 97.42 - 99.08) and 94.12% (95% CI: 71.31–99.85) respectively and the positive and negative predictive values were 99.90% and 100% respectively.
Conclusion

- This study presents the results that the color vision deficiency testing tool could be best printed under dry electro photography on synthetic polyester (PET) film 200 microns substrate.
- Further, this study would be highly beneficial for future researches on the printing requirements for medical grade tests.
- The outcomes of newly developed Dalton’s pseudo isochromatic plates were really encouraging among the Optometrists & Ophthalmologists of India as this tool will be highly beneficial in detecting color vision deficiency for large populations in minimal time.
Help children choose their career

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4.6 An estimated MILLION people in India
suffer from Corneal Blindness, which is curable.

Donate Eyes, Light someone’s life.