Universal Camouflage For The Future Warrior

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Supporting Science and Technology Directorate

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The Science Behind the Warrior: Yesterday, Today and Tomorrow
Outline

- Objective
- Current Camouflage
- Approach
  - Pattern Development
  - Color Development & Optimization
- Field Evaluations
  - Test Methodology
  - 3 Phases of Evaluations
    - Near Infrared (NIR) Results
    - Pattern Modifications
  - System Level Field Evaluation
- Data Analysis
- Conclusions
Objective

Develop Improved/universal Camouflage (Vis & NIR Properties) Pattern(s) That Address the Changing Threat(s) to the Warfighter in Support of the Future Force Warrior (FFW) Program and Army Transformation.

Woodland

Urban

Desert
The ensemble will be the foundational centerpiece for the human interface, load bearing, electronics hardware linkages, and multiple levels of protection.

**Major Thrust Areas:**

- Textile Materials Integration
- Electrotextiles
- Flame Protection
- Signature Management
Current Camouflage Protection
Approach — Pattern & Color Development

- Evaluated Commercial & Military Patterns
  - Design Considerations

- Designed and Down-selected to 2 Camouflage Patterns
  - 1 design with 2 variations
  - Out of the box design

- Selected Colors for 3 Terrains (Woodland, Desert, Urban)
  - Terrain Spectral Data

- Optimized Colors by Selecting Common ground shade color in all patterns.
  - Green — Light Tan
  - Minimize logistic issues (uniforms, equipment)
Developed 3 patterns with 4-color combinations (woodland, desert, urban, and desert/urban).

<table>
<thead>
<tr>
<th>Terrain</th>
<th>Colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland (W)</td>
<td>Tan*, Green, Brown, Black</td>
</tr>
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</table>

* Common Color
Field Sites/Installations

Ft. Lewis, WA
Yakima, WA (YTC)

Ft. Irwin, CA (NTC) 3x

Ft. Polk, LA 2x

Ft. Benning, GA 2x

*Fifteen (15) evaluations total
**PURPOSE:** To visually evaluate the camouflage effectiveness of various patterns in a field environment.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Camouflage Print Type</th>
<th>Terrain</th>
<th>Dates</th>
<th>NIR Testing</th>
<th># Candidates Evaluated</th>
<th>Backgrounds</th>
<th>Observer Station Ranges from Target (Meters)</th>
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<tbody>
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<tr>
<td>IV</td>
<td>FFW System Ensemble</td>
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<td>Yes</td>
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<td>90</td>
</tr>
</tbody>
</table>

W – Woodland, U – Urban, D – Desert
Field Evaluation Plan – Cont.

- Camouflage Evaluation Scale Ratings based on:
  - Blending
  - Brightness (Phase I)
  - Contrast (Phase I)
  - Detection (Phase I)

- Random Order User Evaluation
  - Evaluated 4 – 13 patterns
  - Trained Military Soldiers
- Various backgrounds (3 – 4) at several distances (1 to 3), consisting of various orientations (standing, crouched, prone).

<table>
<thead>
<tr>
<th>Phase</th>
<th>Target Postures - Observer’s View of Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Standing Back View</td>
</tr>
<tr>
<td>II</td>
<td>Standing Back View</td>
</tr>
<tr>
<td>III</td>
<td>Standing Back View</td>
</tr>
<tr>
<td>IV</td>
<td>Standing Back View</td>
</tr>
</tbody>
</table>

Field Evaluation Plan – Cont.
Field Evaluation Plan – Cont.

- Phase I –
  - Day only
    - Evaluation of each candidate one at a time
    - Side-by-side/forced comparison

- Phase II, III –
  - Day and Night
    - Evaluation of each candidate one at a time

- Phase IV –
  - Day
    - Evaluation of each candidate one at a time
    - Side-by-side/forced choice comparison
  - Night
    - Evaluation of each candidate one at a time
1st Phase Of Evaluations

- **Eliminated:**
  - Shadow Line (Woodland, Desert, Urban, and Desert/Urban).
  - All Over Brush (Urban and Desert/Urban).

- **Accepted:**
  - **All Over Brush**
  - **Woodland**
  - **Desert**
  - **Track**
  - Woodland
  - Desert
  - Woodland Desert
  - Urban
  - Desert/Urban

### Pattern Changes Within Phases: Track Design

<table>
<thead>
<tr>
<th></th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III ( Mods )</th>
<th>Phase IV ( System )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Woodland Track</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td><strong>Desert Track</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td><strong>Urban Track</strong></td>
<td>![Image]</td>
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<tr>
<td><strong>Desert/Urban Track</strong></td>
<td>![Image]</td>
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## Pattern Changes Within Phases

### Brush Design

<table>
<thead>
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<th>Phase II</th>
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<th>Phase IV (System)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland Brush</td>
<td><img src="image1.png" alt="Pattern" /></td>
<td><img src="image2.png" alt="Pattern" /></td>
<td></td>
<td><img src="image3.png" alt="Pattern" /></td>
</tr>
<tr>
<td>Desert Brush</td>
<td><img src="image4.png" alt="Pattern" /></td>
<td><img src="image5.png" alt="Pattern" /></td>
<td></td>
<td><img src="image6.png" alt="Pattern" /></td>
</tr>
<tr>
<td>Urban Brush</td>
<td><img src="image7.png" alt="Pattern" /></td>
<td><img src="image8.png" alt="Pattern" /></td>
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<td></td>
</tr>
<tr>
<td>Desert/Urban Brush</td>
<td><img src="image9.png" alt="Pattern" /></td>
<td><img src="image10.png" alt="Pattern" /></td>
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</tr>
</tbody>
</table>
Print Production – Near Infrared Results (NIR)

- **Acceptable** Colors:
  - Black
  - Medium Gray
  - Medium Tan

- **Unacceptable** Colors:
  - All remaining colors.

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</table>

* Common Color
Down Selected – Phase II to III

- **Desert Brush**
  - Desert Brush Modified

- **Woodland Track**
  - Woodland Track Modified

- **Urban Track**
  - Urban Track Light Modified
  - Urban Track Dark Modified

- **Contractor-Developed**
  - Contractor-Developed Modified
Down Selected – Phase III to System Level

- Desert Brush
- Woodland Track Mod
- Urban Track
- Contractor-Developed Mod
System Level Evaluations

Urban Environment

Woodland Environment

Desert Environment

Desert Brush
Contractor-Developed Mod
Woodland Track Mod
Urban Track
Data Analysis - Day

Camouflage Effectiveness Test Results (Phase IV - System Level Testing)
Overall Mean Blending Ratings in Woodland, Desert, & Urban Terrains During Daytime Visual Testing

Ratings of "Blending with the Background"
(0="Does not blend at all" - 100="Blends Completely")

Evaluation Terrain & Location
- Desert Brush
- Woodland Track Mod
- Contractor Developed Mod
- Urban Track

- Desert Fort Polk
- Desert NTC
- Urban Fort Polk
- Urban Fort Benning
- Woodland Fort Polk
- Woodland Fort Benning
Data Analysis - Night

Camouflage Effectiveness Test Results (Phase IV - System Level Testing)
Overall Mean Blending Ratings in Woodland, Desert, & Urban Terrains During Nighttime IR Testing

Ratings of "Blending with the Background" (0 = "Does not blend at all" - 100 = "Blends Completely")

- Desert Brush
- Woodland Track Mod
- Contractor Developed Mod
- Urban Track

Evaluation Terrain & Location:
- Desert
- Urban
- Woodland

Ft. Polk
NTC
Ft. Polk
Ft. Benning
Ft. Polk
Ft. Benning
## Camouflage Effectiveness Test Results - Daytime Results

Relative Performance of Uniform Mean Rating vs. Mean of All Uniforms by Each Test Site (day)

*Order of Columns Left to Right* Based on a Uniform’s Overall Mean Rating Across all Conditions

<table>
<thead>
<tr>
<th>Uniform Type</th>
<th>Site</th>
<th>Desert Brush</th>
<th>Woodland Track Mod</th>
<th>Contractor Developed Mod</th>
<th>Urban Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polk</td>
<td>Site</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polk</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Benn</td>
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<td>NTC</td>
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<tr>
<td>Contractor Developed Mod</td>
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</tr>
</tbody>
</table>

**Data Analysis – Mean Rating**

- Mean Rating
- Point Difference of Uniform Mean from Site Mean

**Diagram:**

- Site Mean
- Difference from Site Mean

*Test Sites: Polk, NTC, Benn*

*Uniform Types: Desert Brush, Woodland Track Mod, Contractor Developed Mod, Urban Track*
Data Analysis

- Highest mean blend rating of the four systems tested (Combining all terrains and day/night testing) – Desert Brush Design

  - Significantly (statistically) better overall mean daytime visual rating than all other designs tested.
    - There were no significant differences between Woodland Track Mod, Contractor-Developed Pattern Mod, and Urban Track in daytime visual testing.

  - Received the highest mean daytime visual ratings, versus the other 3 designs, in 4 out of 6 of the terrains used in testing.

- Received the most number of mean background ratings (14) in the high performing range\(^1\), and the least number of mean ratings (1) in the low performing range\(^2\).
  - All camouflage designs were evaluated in a total of 24 backgrounds by the observer groups, in both day and night conditions, producing 48 total mean ratings.

\(^1\) Ratings falling above 70 on a 100pt scale from “Does not blend at all” to “Blends Completely”.
\(^2\) Ratings falling below 30 on a 100pt scale from “Does not blend at all” to “Blends Completely”.
Data Analysis Cont.

- Desert Brush’s highest ratings were in Desert and Urban environments.
  - The contractor-developed pattern mod design received the highest ratings in woodland environments, but was rated low in Desert and Urban terrains.

- Woodland Track Mod received ratings typically several points lower than Desert Brush.

- Urban Track was typically the 3rd or 4th worst performer in each site (with the exception of one urban site where it tied with desert brush for the highest rating).

- Nighttime (NIR) testing showed no significant or notable differences in the performance of the four camouflage designs.
Conclusions

Desert Brush –
Best Overall Performing Camouflage Design in System Level Testing

- Desert Brush is *Significantly Better* than the Other Three Systems.
- Desert Brush has *Enhanced Performance in the Visual Spectrum*.
- Acceptable NIR Performance Across All Three Terrains for All Four Systems.
  - No statistical difference in nighttime performance among all four systems.
- Best to Worst: Desert Brush, Woodland Track Mod, Contractor-Developed Mod, and Urban Track.
Acknowledgements

Natick Soldier Center
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Battle Lab Integration Team (BLIT)

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TRADOC Soldier Manager (TSM)

US Army Soldiers
(Fort Lewis, YTC, NTC, JRTC, Fort Benning)
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