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Hiding in Plain Sight: The Army's Search for a Better Camouflage Uniform

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Current Situation, End of the Month, October 2013

Colonel Bob Smith, the Army Project Manager (PM) responsible for uniforms, sat in his office at Fort Belvoir, VA, in disbelief as he read an email from the contracting officer stating that the contract for the Army to purchase the camouflage pattern had never actually been accepted by the contractor. The email came after Colonel Smith asked the contracting officer to send a copy of the signed contract. The contracting officer's response was delayed by several weeks because Department of Defense agencies were resuming operations after being closed October 1–16, 2013, with non-essential federal employees furloughed, because neither an appropriation act nor a continuing resolution had been enacted for Fiscal Year 2014, which began October 1, 2013[1]. On the Friday afternoon before the shutdown, the contracting office reported the successful award of a contract to Crye Precision LLC for its camouflage pattern, commercially known as MultiCam©. Because of Army senior leader and congressional interest, notification of the contract awarded was documented in significant activities reports to the secretary and chief of staff of the Army levels—three levels of command higher than the PM.

Colonel Smith thought about how to notify the Army leaders that the contract had not been awarded and that his team would have to develop options for the Army to consider going forward—significant tasks considering the importance of the Army combat uniform camouflage decision. The Army had completed extensive combat uniform camouflage testing—testing that began in 2009 and a decision process that finally resulted in the selection of a camouflage pattern for Army uniforms and equipment. Colonel Smith started to consider all the information needed to help Army senior leaders make an informed decision: the importance of camouflage to soldier protection and mission effectiveness, camouflage testing basics, the historical testing results, the status of soldier combat uniforms, and the affordability aspects of the decision. First things first—Colonel Smith asked his deputy to immediately draft a notice to inform senior leaders that the previously announced award of the contract was premature.

It's Only Camouflage—How Important Can It Be on the Modern Battlefield?

The protection of soldiers in combat was a top priority for senior leaders in the U.S. Army, the Defense Department, and Congress. The Defense Department committed considerable resources over the years in research and development, which increased the combat effectiveness and safety of the soldiers. The force protection of soldiers was considered as a layered approach. The outer force protection layer for soldiers was situational awareness. The inner force protection layer was personal protective equipment, like helmets and ballistic vests. The middle force protection layer was concealment. Camouflage on combat uniforms remained the most important contribution to the overall concealment of soldiers on the battlefield. Post-combat surveys from soldiers in Iraq and Afghanistan indicated that the

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majority of soldiers viewed better camouflage as a critical component to increased combat effectiveness. Basically, the enemy could not kill what they could not see. Effective combat uniform camouflage remained a significant combat multiplier for soldiers—increasing mission accomplishment.

Army soldiers faced diverse battlefield operating environments in combat operations (see Figure 1). During a single mission, soldiers faced varied terrains across various environmental backgrounds. Each of these environmental backgrounds contained different colors, which required matching colors in the combat uniform for it to effectively conceal a soldier from detection and/or observation. Soldiers who wore combat uniforms and equipment with the universal camouflage pattern (UCP), a three-color digital pattern adopted by the Army in 2005, did not effectively blend into the diverse backgrounds typical in military operating environments. The UCP colors were not earth-tone and were generally too bright—making soldiers easy to detect and providing ineffective concealment.

The Army faced a critical question with respect to providing soldiers with effective camouflage on combat uniforms and equipment—how many camouflage patterns should be adopted? Soldiers operating in diverse operating environments proved that the most effective camouflage pattern matched the colors of the background environment. A "chameleon" camouflage pattern eluded the Army due to low technological maturity—the basic science of changing colors and patterns on fabrics was not well understood and not producible for uniforms. Logistical and affordability considerations limited the Army from adopting a specific camouflage pattern for every combat environment. The Army settled on a strategy considering three camouflage patterns—one suited for the woodland/jungle environments, one suited for desert/arid environments, and a transitional pattern suited for most other environments. The Army Corps of Engineers classified the Army military operating environments across the combatant commands as 44% transitional, 37% woodland/jungle, and 19% desert/arid. A woodland camouflage pattern would be very effective against backgrounds of darker brown and green colors and ineffective in dry arid regions (see Figure 2). On the other hand, a desert camouflage pattern would be very effective against backgrounds of lighter tan/sand colors and ineffective in woodland/jungle terrains. Finally, a transitional camouflage pattern would provide reasonable concealment against a broad range of environmental backgrounds.

Camouflage Testing Basics (refer to Exhibit 2 for more details)

The Army recognized that advancing the science of camouflage testing was important to enabling knowledge-based decisions on the most effective camouflage pattern. It was acknowledged that it was unaffordable to field-test camouflage patterns in every environment. To gain a statistically robust data set to support decision-making, the Army developed a test and evaluation strategy that involved a paradigm shift that relied less on field testing for decision making (see Figure 3). The strategy leveraged four mutually supporting lines of effort. Technical development testing consisted of photo simulation for pattern selection and spectral reflectance measurements to gain insights into the pattern performance in various lighting conditions. Operational field-testing with soldiers consisted of static observation tests for performance confirmation and maneuver tests for both performance confirmation and operational insights.

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Basic Overview of Army Camouflage Uniforms (refer to Exhibit 3 for more details)

After initial training, the Army issued soldiers uniforms and combat equipment, generally referred to as the soldier's clothing bag. Part of this issue to soldiers was the army combat uniform (ACU). The ACU was the uniform that soldiers wore in daily garrison operations when not deployed to combat operations, and came with UCP, costing $90 for a coat/trouser set. Soldiers did not normally deploy with the clothing bag–issued ACU—those were for daily wear in garrison operations and in training

The Army recognized the importance of protecting soldiers from battlefield hazards and included requirements for protection against fire (resulting in the use of flame-resistant fabrics). The Army issued soldiers the Flame Resistant Army Combat Uniform (FRACU) with UCP when soldiers deployed to combat. The cost of a FRACU coat/trousers set averaged $180. In 2010, the Army adopted a pattern specifically for Afghanistan and issued soldiers deploying to Operation Enduring Freedom (OEF) the FRACUs with the OEF Camouflage Pattern (OEF CP). Figure 4 displays a pictorial representation of the uniforms soldiers would have worn in the summer of 2013. Soldiers wore the ACU with UCP in most regions of the world, except in the Middle East. Soldiers wore the FRACU with UCP when deployed to combat operations in Iraq and Kuwait, while soldiers supporting operations in OEF wore the FRACU in OEF CP.

The Army remained very cognizant of the value of the combat uniforms and equipment worn by soldiers and in inventory. For example, based on the number of soldiers, the ACUs and equipment with UCP worn by soldiers was valued at over $3.8 billion (see Figure 5). To support soldiers deploying to Afghanistan, the Army maintained uniforms and equipment with OEC CP with a value of about $1.4 billion. Based on the average monthly demand, the Army spent approximately $39 million per month sustaining UCP uniforms and equipment.

Army Combat Uniform Evolution (refer to Exhibit 4 for more details)

In 2005, the Army adopted the ACU to replace the Battle Dress Uniform and Desert Camouflage Uniform. The ACU was produced with the UCP—a three-color (urban gray, desert sand, and foliage green) pattern. The Army wanted a single combat uniform design with a single camouflage pattern. From after the adoption of the ACU in 2005 until 2009, the Army received overwhelmingly negative feedback from soldiers in Afghanistan about the suitability of UCP for the diverse Afghan backgrounds and environments (refer to Figure 1). As a result, in the 2009 Supplemental Appropriations Act, Congress directed the Army to take action to provide effective camouflage for personnel deployed to Afghanistan. In September 2009, the Army submitted a Report to Congress on Combat Uniform Camouflage that outlined a four-phased approach: Phase I Immediate Action, Phase II Build the Science, Phase III OEF Specific Camouflage, and Phase IV Army Combat Uniform Decision for a Long-Term Multi-Environment Camouflage.

In February 2010, the Army selected MultiCam© as the pattern to be used on FRACUs and equipment for deploying soldiers to Afghanistan. The Army named the commercially available MultiCam© pattern as OEF CP. Due to private licensing agreements that resulted in licensing fees embedded in uniform costs, the Army paid about a 10% premium on every OEF CP camouflaged uniform or piece of equipment compared to UCP uniforms and equipment.

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From July 2012 to March 2013 during Phase IV, the Army conducted the most extensive uniform camouflage testing ever undertaken. The 12 commercial vendors' patterns (four vendors had woodland, transitional, and desert patterns along with a matching equipment patterns), and six reference patterns were tested. The results of this extensive testing showed that all the vendor patterns performed better than UCP—confirming the Army's intent to replace UCP. Additionally, all the vendors' patterns performed similarly in their intended backgrounds—this "tight shot" group gave the Army options and confirmed that overall pattern colors and brightness were more important than pattern design when assessing concealment effectiveness.

In May 2013, Army senior leaders approved the purchase of the non-exclusive government license rights to one of the competing vendors' patterns (the Crye transitional pattern that was visually indistinguishable from OEF CP) offered as an option in the Phase IV contract with the intent to replace UCP across the Army. Because all the vendor patterns performed similarly in testing, the decision was based on other considerations, primarily affordability—the Army could leverage existing inventories of OEF CP equipment and reduce the overall implementation costs to the Army. However, the announcement of the decision was delayed. Army senior leaders were hesitant to announce a uniform change decision during a time of intense budget pressure and with the threat of a government shutdown looming. More importantly, the draft 2014 National Defense Authorization Act (NDAA) was released, and it potentially limited the Army's camouflage flexibility by prohibiting new camouflage patterns.

In August 2013, to avoid the threat of protests by Phase IV vendors and subsequent lengthy contractual challenges and to avoid potential violations of the new statutory restrictions in the pending NDAA, the Army changed its contracting strategy to pursue a sole-source contract for the non-exclusive license rights (i.e., government purpose rights) to OEF CP. Crye indicated to the Army that the price for OEF CP would be similar to the price offered ($200,000) to the Army for the transitional pattern non-exclusive license rights in the Phase IV contract. In October 2013, Crye balked at the terms of the contract proposed by the Army for OEF CP even though the contract terms for the license rights were identical to the Phase IV contract. Crye now wanted considerably more money for OEF CP than it offered for its transitional pattern.

Path Forward, Development of a Strategy, Fall 2013

All this information swirled around in Colonel's Smith head as he prepared to meet in the Pentagon with Army senior leaders. The Office of the Chief of Staff of the Army wanted the following addressed in the meeting scheduled for December 2013:

- How did this happen? What was the impact of the pending NDAA restrictions? What was the impact on the Phase IV contracts?
- What was the schedule and a path toward an Army decision? What were the camouflage options and decision criteria, as well as key program and testing events?

Based on the guidance from leadership, Colonel Smith and his team put together some options for the Army to consider:

- Option 1: Continue to negotiate with Crye for the non-exclusive rights for OEF CP. The initial price quoted started at $65 million but was later reduced to a lump sum of $24 million or 1% royalty on the price of each camouflaged uniform or piece of equipment.

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- Option 2: Exercise the Phase IV contract option for non-exclusive rights to the Crye transitional pattern.
- Option 3: Renegotiate all the Phase IV contract options for the non-exclusive rights for the patterns with all four vendors and try to select a pattern after the renegotiations.
- Option 4: Take a strategic pause and consider existing government patterns and patterns in which the government had license rights.

Colonel Smith asked his team if there were any other options and what the decision criteria would be to compare these courses of action. Performance of the patterns remained the Army's most important criteria. However, cost/affordability was important, as well as schedule, congressional considerations (adherence to law), and litigation considerations such as the chance of protests and lawsuits challenging intellectual property and patent rights (see Exhibit 5 for an explanation of relationship between patterns considered).

Colonel Smith realized this would not be an easy set of meetings. Despite the importance of combat uniform camouflage, efforts to change camouflage faced the challenges that all programs face: a complex, bureaucratic defense acquisition institution (refer to Exhibit 6 for a description of the defense acquisition institution). Any decision to change Army camouflage crossed multiple chains of command with different decision-makers because it affected both uniforms and equipment. Uniform changes were approved by the chief of staff of the Army after an approval recommendation from the Army Uniform Board. But each piece of camouflaged equipment (e.g., cold weather clothing, rucksacks, ballistic vests, helmet covers) had a different program decision-maker—either a program executive officer or the Army Acquisition Executive. Colonel Smith labored over how to pull together this information into a decision and what recommendation he would make when invariably asked by Army senior leaders.

Notes

[1] U.S. Federal government is appropriated money every fiscal year in Appropriations Acts. If an Appropriation Act is not enacted by the start of a fiscal year (1 October), a Continuing Resolution usually authorizes temperately spending at the previous years' levels. The absence of an Appropriation Act and a Continuing Resolution triggers a government shutdown resulting in employee furloughs.

[2] NSRDEC was the center of excellence for uniform research and development—providing expertise in the form of leading researchers and engineers in the areas of textiles, fabrics, and camouflage.

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Appendix 1. Case Study Figures

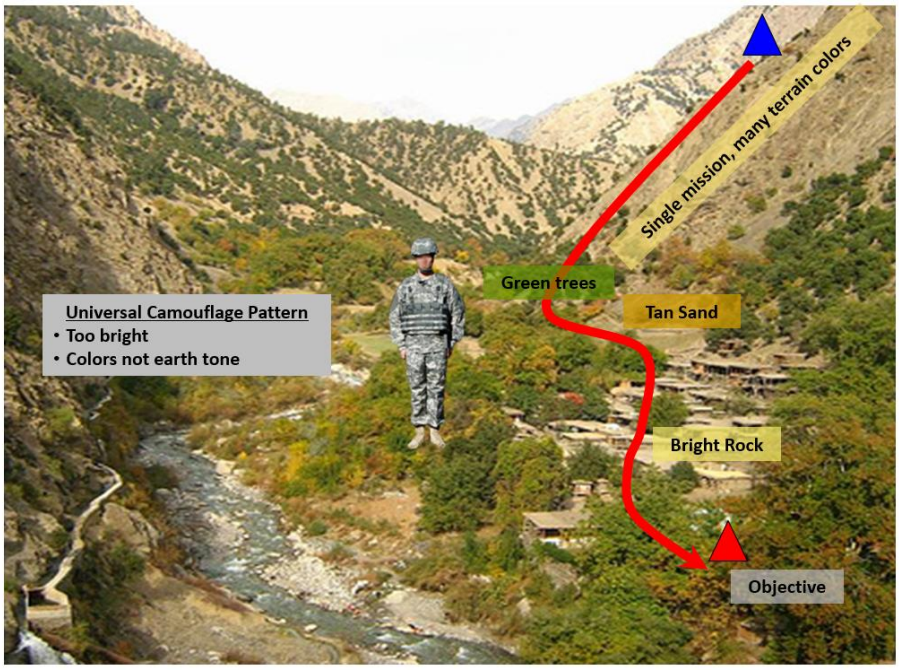

Figure 1. Why the Army Needed a Different Camouflage Pattern

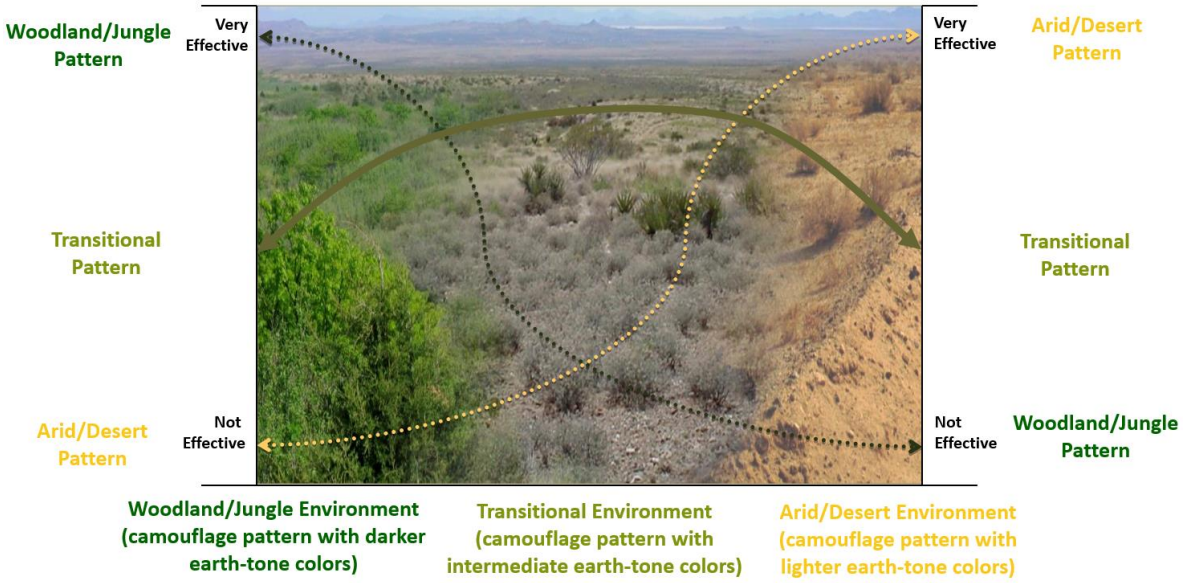

Figure 2. Effectiveness of Camouflage Patterns in Different Environment

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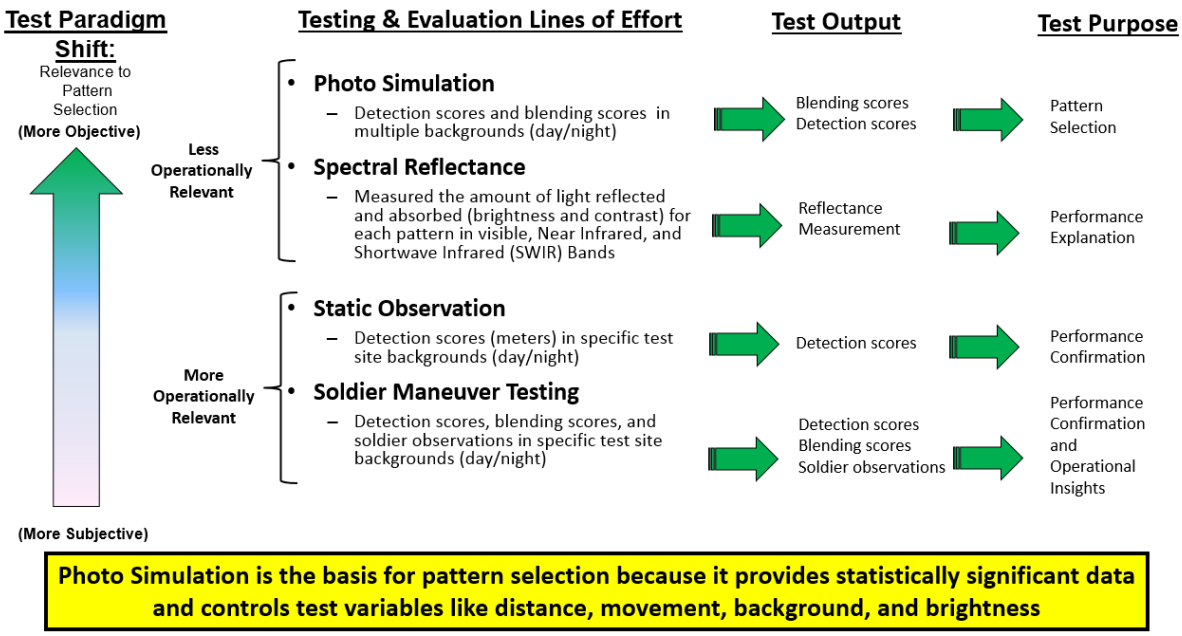

Figure 3. Camouflage Test and Evaluation Strategy

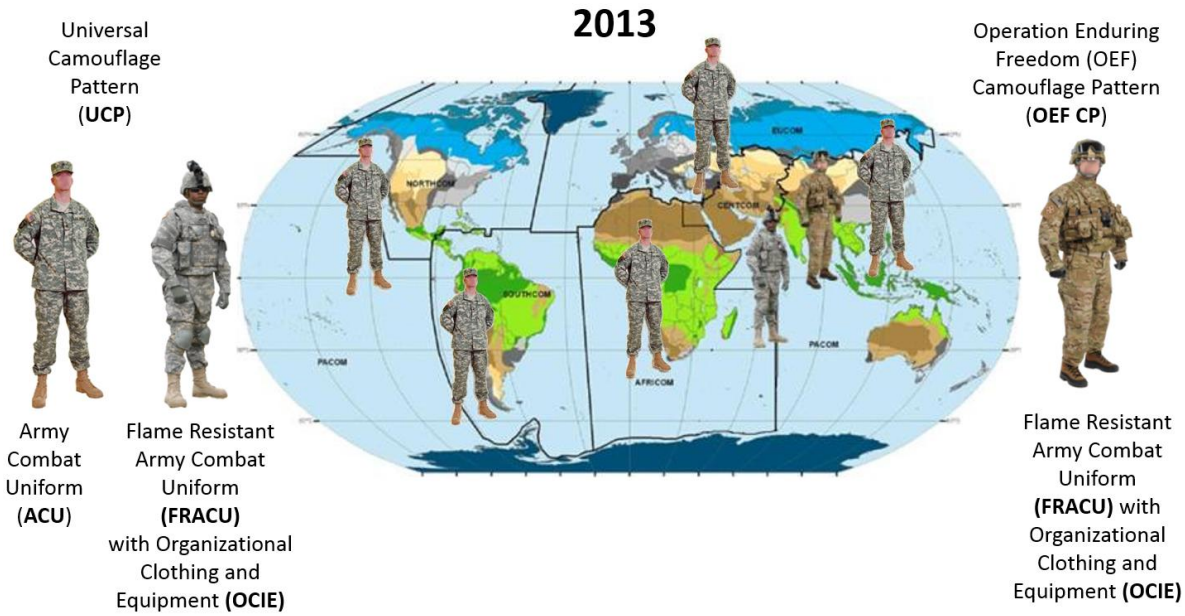

Figure 4. Common Operation Picture for Army Combat Uniforms

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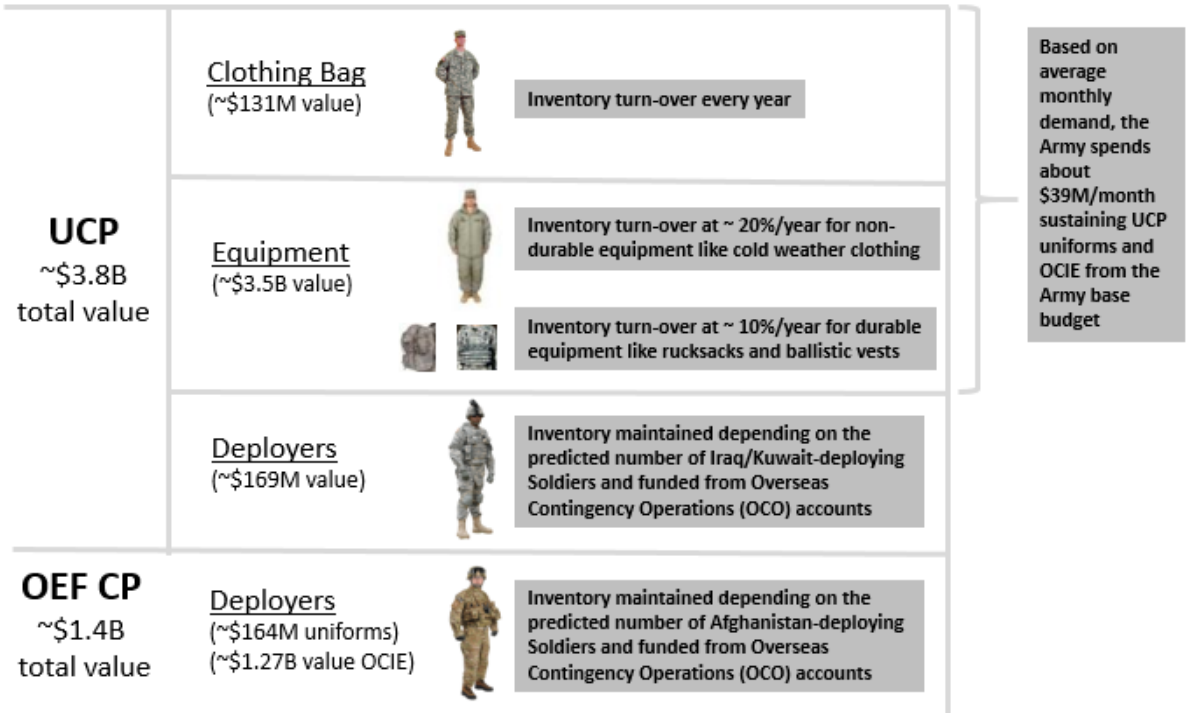

Figure 5. The Value of Camouflaged Army Combat Uniforms and Equipment

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Exhibit 1. Case Study Discussion Questions

- Who are the key stakeholders in combat camouflage uniforms?
- How relevant was the test paradigm shift in this decision?
- What is a realistic test and evaluation strategy and schedule leading to decision in terms of key program and testing events planned by quarter?
- What options should the Army consider?
- What criteria should the Army use to compare options and then select the best path forward?

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Exhibit 2. Camouflage Testing Basics

Normally, operationally realistic field-testing carried the most weight in decision-making over less operationally realistic developmental testing, which might rely on modeling and simulation. For camouflage testing, however, a much more extensive data set could be obtained if computer-based testing techniques were used in which soldiers observed photos of soldiers in camouflaged uniforms in many different backgrounds representing the Army's diverse military operating environments. The main effort for the test and evaluation strategy centered on the use of photo simulation to compare the effectiveness of camouflage patterns. A paradigm shift was required for senior leaders to make a decision based less on field testing and more on controlled photo simulation.

Two different criteria existed to compare the effectiveness of camouflage: detection and blending. Camouflage testing determined detection and blending scores for various camouflage patterns in relevant military operating environments. Detection is the ability to pick out the camouflage pattern measured at different distances, and blending is how well the camouflage pattern matches the background once detected at a specific range (see Figure 6). Photo simulation evaluations allowed for collection of significant data in many backgrounds and controlled variables (such as distance, movement, background, and brightness) so the difference in detection and blending scores could be attributable to different camouflage patterns. The word *simulation* referred to the fact that the technique simulated soldiers being outside at the various sites by looking at computers screens of photos of soldiers in camouflage uniforms. Camouflage pattern selection criteria was based on both detection scores (at ranges to 500 meters during the day and to 250 meters at night) and blending scores (at 50 meters during the day and at 25 meters during the night).

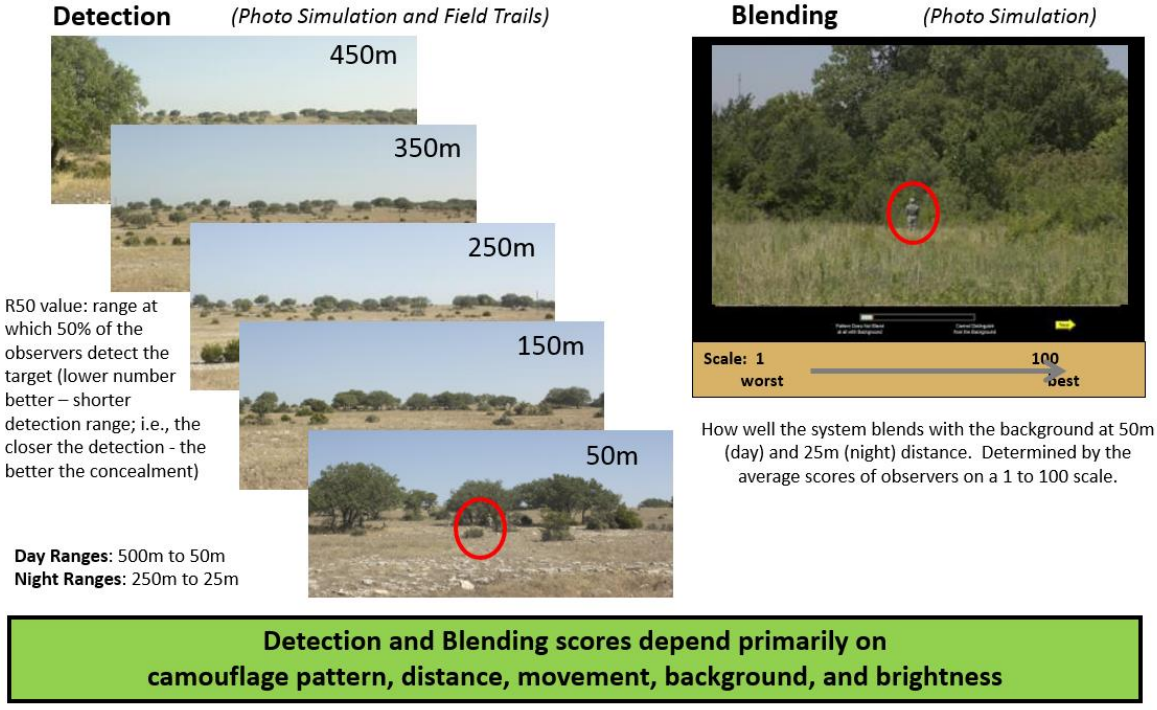

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Figure 6. Camouflage Pattern Testing Criteria

Camouflage pattern testing used a combination of field trials and photo simulation evaluations. The field trials included day and night testing, squad-on-squad battle drill lanes, movement to contact drills, and individual soldier detection/acquisition at varying distances and varying soldier positions (prone, kneeling, and standing). The soldier photo simulation evaluations included feedback from soldiers who assessed the camouflage's detection and blending ability using calibrated images of uniformed individuals in arid, woodland, and transitional backgrounds. Soldiers scored images of camouflaged personnel in outdoor scenes (day and night) on a computer monitor (see Figure 7). Detection scores came in the form of R50 values, which is the range at which 50% of the observers detect the target (lower numbers are better, meaning shorter detection ranges—in other words, the closer the detection, the better the concealment).

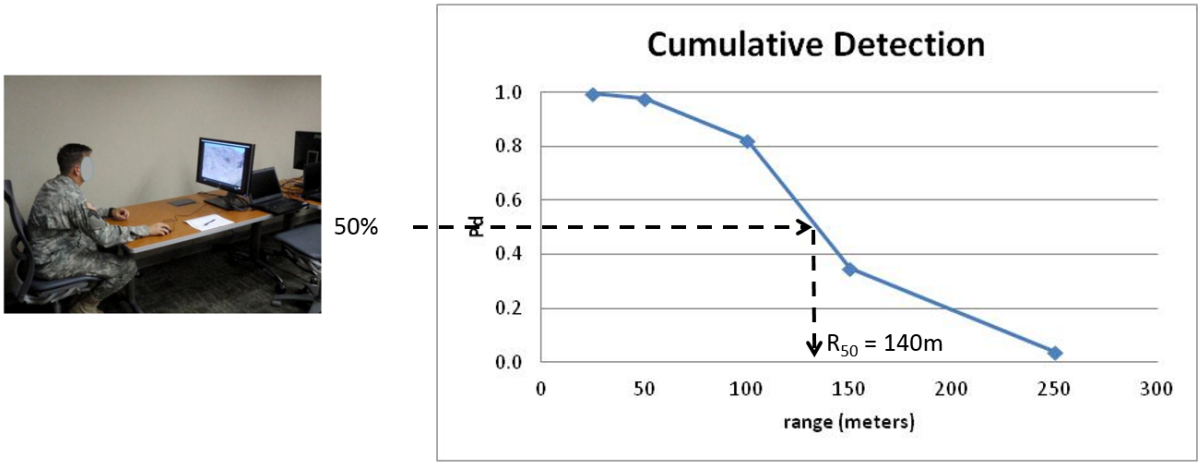

Figure 7. Example Photo Simulation Test and Test Output and the Probability of Detection (Pd) versus Detection Range

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Exhibit 3. Overview of Army Combat Camouflage Uniforms

After basic initial entry training, the Army issued soldiers uniforms and other essential combat equipment, classified as organization clothing and individual equipment (OCIE) and generally referred to as the soldier's clothing bag. Part of this issue to soldiers was the army combat uniform (ACU). The ACU was the uniform that soldiers wore in daily garrison operations when not deployed to combat operations. The ACU fabric was a 50-50 mix of cotton and nylon, and came with the universal camouflage pattern (UCP), selling for about $90 for a coat and trouser set. After they wore out, soldiers used their clothing replacement allowance to buy new sets of uniforms. Examples of OCIE included the seven-layer Generation III Extended Cold Weather Clothing System, the field pack or rucksack, and the ballistic vests—all issued with the UCP.

Beginning in mid-2005, the Army recognized the importance of protecting soldiers from battlefield hazards and included specific uniform requirements for protection against insects (resulting in permethrin treatment) and fire or flame (resulting in the use of flame-resistant fabrics). When soldiers deployed to combat, the Army issued soldiers the Flame Resistant Army Combat Uniform (FRACU) with the UCP. The FRACU was made of 65% rayon, 25% para-aramid, and 10% nylon. The price of a FRACU set of coat and trousers averaged about $180. Soldiers did not normally deploy with the clothing bag-issued ACU—those were for daily wear in garrison operations and in training. In 2011, the Army issued soldiers deploying to Afghanistan for Operation Enduring Freedom (OEF) the FRACUs with the OEF Camouflage Pattern (OEF CP).

Figure 4 displays a pictorial representation of the uniforms soldiers would typically have worn in the summer of 2013. Soldiers wore the ACU with UCP in most regions, except in the Middle East. Soldiers wore the FRACU with UCP when deployed from combat operations in Iraq and Kuwait, while soldiers supporting combat operations in OEF wore the FRACU in OEF CP.

The Army remained very cognizant of the value of the combat uniforms and OCIE worn by soldiers and in the inventory. For example, based on the number of active, reserve, and National Guard soldiers both non-deployed and deployed, the ACUs worn by soldiers in their clothing bag valued about $131 million and turned over every year. The value of equipment worn by soldiers or in inventory with UCP totaled about $3.5 billion and turned over every five to 10 years depending on the durability of the items. Deploying soldiers to Iraq and Kuwait had another $170 million worth of UCP uniforms and equipment. Uniforms and equipment with the UCP totaled over $3.8 billion in value (see Figure 5). To support soldiers deploying to Afghanistan, the Army maintained uniforms and equipment with the OEC CP with a value of about $1.4 billion. Based on the average monthly demand, the Army spent approximately $39 million per month sustaining UCP uniforms and equipment from the Army base operations and maintenance budget for an Army of approximately one million soldiers (active, guard, and reserve components).

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Exhibit 4. Army Combat Uniform Evolution

Figure 8 presents a brief recent history of Army combat uniforms since the adoption of the Army Combat Uniform (ACU) with the Universal Camouflage Pattern (UCP). In 2005, the Army adopted the ACU to replace the Battle Dress Uniform (BDU) with the woodland camouflage pattern and Desert Camouflage Uniform (DCU) with the desert camouflage pattern. The ACU was produced with the UCP—a three-color (urban gray, desert sand, and foliage green) digital pattern. The Army wanted a single combat uniform design with a single camouflage pattern.

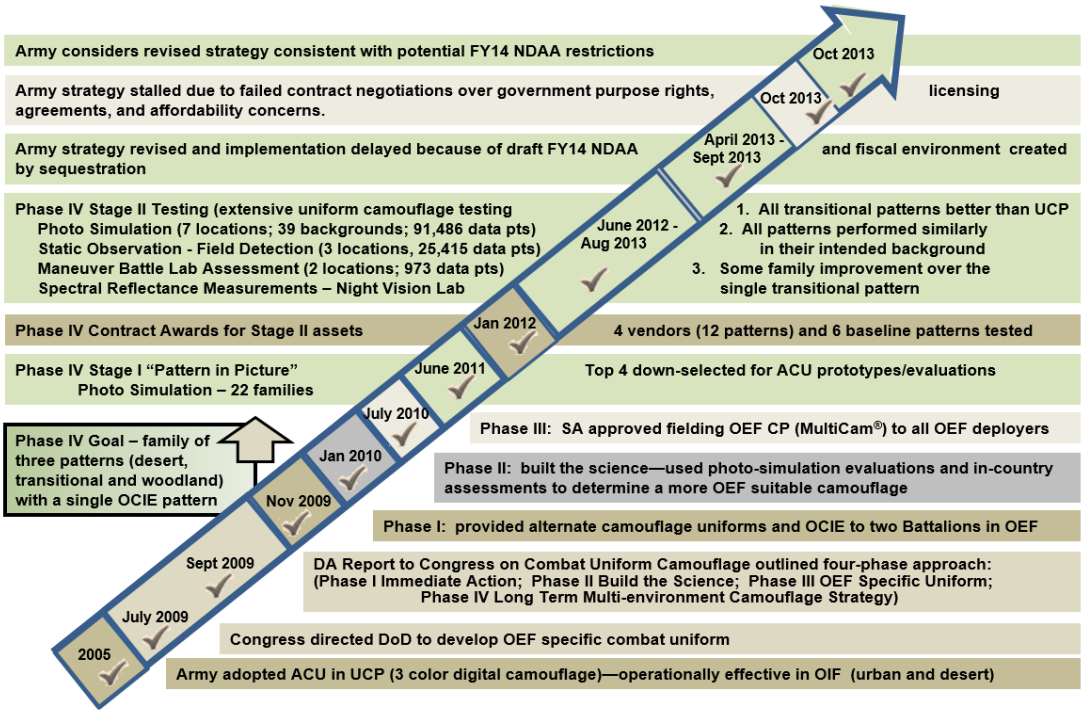

Figure 8. Army Camouflage Uniform Timeline

The Army's decision to adopt a digital pattern (UCP) was influenced by the success of the U.S. Marine Corps digital patterns—MARPAT Woodland and MARPAT Desert. Ultimately, in testing, UCP provided better or equal concealment than other patterns in urban and desert terrains—obviously very important to the Army embroiled in combat operations in Iraq.

From after the adoption of the ACU in 2005 until 2009, the Army received overwhelmingly negative feedback from soldiers in combat operations in Afghanistan about the suitability of the FRACUs in UCP for the diverse Afghan backgrounds, terrains, and environments (see Figure 1). As a result, in the Fiscal Year 2009 Supplemental Appropriations Act, Congress directed the Army to take immediate action to provide effective camouflage for personnel deployed to Afghanistan. In September 2009, the Army submitted a Report to Congress on Combat Uniform Camouflage that outlined a four-phased approach: Phase I Immediate Action, Phase II Build the Science, Phase III OEF Specific Camouflage, and Phase IV Army Combat Uniform Decision for a Long Term Multi-Environment Camouflage.

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In November 2009, the Army completed Phase I by fielding two Army battalions (approximately 2,000 soldiers) with uniforms and equipment in two different patterns. One camouflage pattern was Universal Camouflage Pattern-D (UCP-D)—a variant of UCP with coyote brown color added and less sand color—and the other pattern was commercial camouflage called MultiCam© produced by Crye Precision LLC. MultiCam©—a seven-color pattern that was in use at the time with U.S. Special Forces in Afghanistan—was a variation of the original Scorpion pattern considered by the Army earlier in the UCP decision.

From November 2009 to January 2010, the Army conducted Phase II, which involved soldier feedback of the two fielded patterns (MultiCam© and UCP-D) as well as photo simulation (pattern-in-picture) evaluations by soldiers.

In February 2010, initiating Phase III, the Army selected MultiCam© as the pattern to be used on the Fire Resistant ACU (FRACU) and Organization Clothing and Individual Equipment (OCIE) for soldiers deploying to Afghanistan. The Army named the commercially available MultiCam© pattern as the OEF Camouflage Pattern (OEF CP). Because schedule and speed of delivery was critical, the Army encouraged Crye to enter separate licensing agreements with the companies that printed the OEF CP on FRACUs and OCIE. In July 2010, the Army began fielding uniforms and OCIE in the OEF CP to deploying OEF Soldiers. The Army was not privy to the specifics of the licensing agreements. As a result of these pattern licensing agreements, however, the Army paid about a 10% premium on every uniform or piece of camouflaged equipment that was camouflaged with OEF CP compared to uniforms and equipment with UCP. At the time, schedule and getting updated camouflaged uniforms and equipment to field as quickly as possible trumped affordability concerns—especially considering that uniforms for combat operations in Afghanistan were funded by overseas contingencies operations accounts.

In December 2010, the Maneuver Center of Excellence at Fort Benning, GA, outlined an 18-month-long competitive effort to lead a camouflage integrated product team through the Phase IV effort for the Army's selection of the long-term combat uniform and OCIE camouflage strategy to be effective in desert/arid, transitional, and woodland/jungle environments. The goal was to present the results to Army leadership in the fall of 2012 for a decision.

From January 2011 to June 2011, the Army scoped the Phase IV camouflage effort. Based on work performed by the Natick Soldier Research Development & Engineering Center (NSRDEC)[2] completed in 2009, the Army knew that environmentally specific camouflage patterns outperformed (meaning provided more effective concealment) a single "universal" pattern. The objective of Phase IV was to develop a "family" of three uniform camouflage patterns with a single coordinated pattern for OCIE to provide effective concealment across the globe in woodland/jungle, transitional, and desert/arid environments. Five families of patterns (four commercial vendors and one NSRDEC submission) performed as well as or better than the legacy family of patterns. The four down-selected vendors included Crye Precision LLC, Kryptek Inc., Atlantic Diving Supply (ADS) Inc., and Brookwood Companies Inc. It is noteworthy that three patterns were visually similar in appearance: OEF CP (a baseline pattern), the transitional pattern proposed by Crye, and the transitional pattern submitted by NSRDEC named ScorpionW2. Each of these patterns was developed, changed, and optimized independently

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from the same base pattern called Scorpion—a pattern developed by Crye in the early 2000s under contract with the U.S. Army (see Exhibit 5 for a description of the relationships and differences between the Scorpion, MultiCam© (OEF CP), Phase IV Crye transitional, and ScorpionW2 camouflage patterns). All three patterns performed similarly in testing, which served as a built-in, internal verification of the validity of the testing.

In January 2012, Phase IV contracts were awarded to the four down-selected vendors to produce fabric for test articles (for both uniforms and equipment) for the second stage of Phase IV, which would include field testing, extensive photo simulation evaluations, and lab testing. The contracts included firm fixed price options for the government to procure the non-exclusive license rights for each of the proposed camouflage patterns. The competitive range to buy the license rights from the four vendors for a single camouflage pattern ranged from $25,000 to $2.1 million. Crye offered the set of patterns for $600,000 ($200,000 each for three patterns—woodland, desert, and transitional), ADS offered the set for $533,000 ($133,000 each for four patterns—woodland, desert, transitional, and equipment), Brookwood offered the set for $100,000 ($25,000 each for four patterns—woodland, desert, transitional, and equipment), and Kryptek offered the set for $6.3 million ($2.1 million each for three patterns—woodland, desert, and transitional). Each of the four vendors signed a non-exclusive license agreement that provided the Army the option to obtain (for a single lump sum) the rights to use the material for the production of patterns for printing on an unlimited number of uniforms, individual equipment, and unit-level equipment for U.S. government purposes (e.g., Army, Navy, Marine Corps, Air Force, and Coast Guard, including their active and reserve components) excepting foreign military sales with successive renewable 10-year periods.

From July 2012 to March 2013, the Army conducted the most extensive uniform camouflage testing ever undertaken. The 12 commercial vendors' patterns (each of the four vendors had a woodland, transitional, and desert pattern along with a matching transitional OCIE pattern) and six reference patterns (government baseline patterns) were printed on fabric, and the fabric was assembled into uniforms and OCIE (see Figure 9).

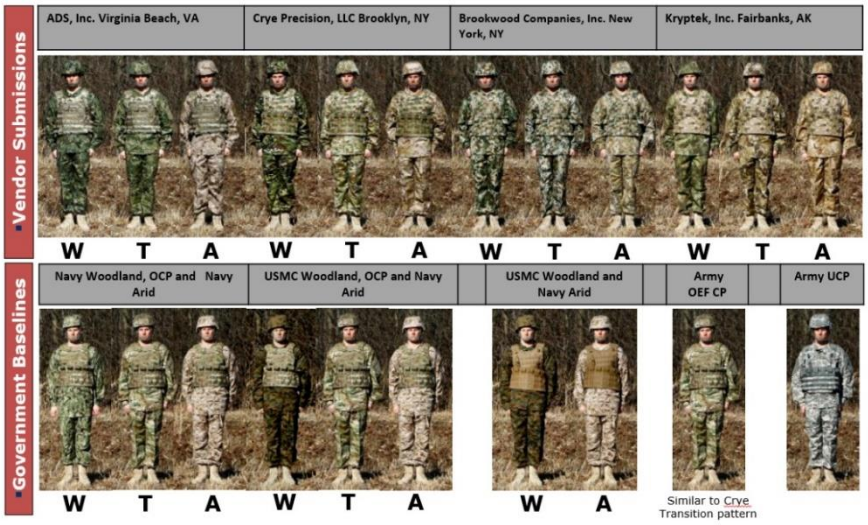

Figure 9. Phase IV Camouflage Patterns Tested (W refers to woodland, T refers to transitional, and A refers to arid)

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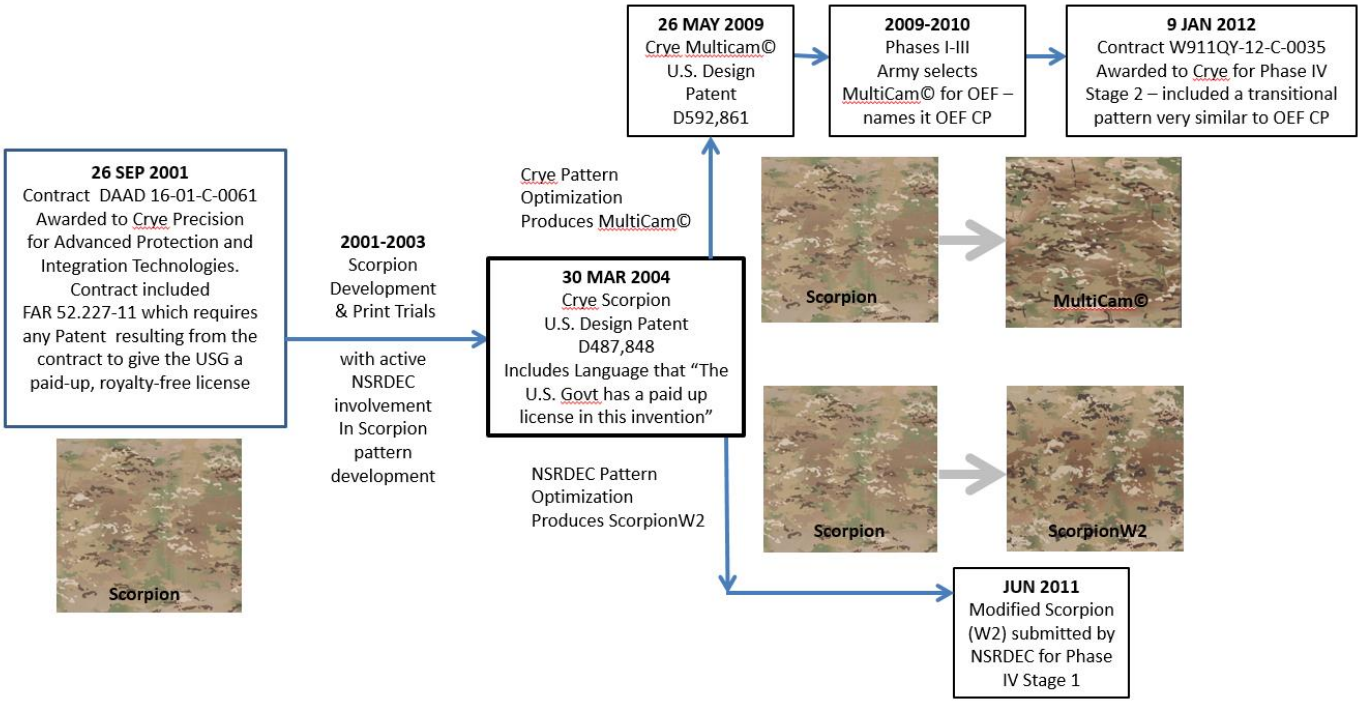
The results of this extensive testing showed that all the vendor patterns in their intended backgrounds performed better than UCP—confirming the Army's intent to replace UCP. All the vendors' patterns performed similarly in their intended backgrounds—this "tight shot" group gave the Army many options and confirmed that overall pattern colors and brightness was much more important than pattern design when assessing concealment effectiveness.

Exhibit 5. Scorpion Camouflage Pattern Background



Timeline of Scorpion Pattern Derivatives

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Exhibit 6. U.S. Defense Acquisition Institution—Decision Framework

Within the U.S. Department of Defense (DoD), the development, testing, procurement, and fielding of capability for the warfighter operated within a decision-making framework that is complex. Within the private sector, similar frameworks existed. The U.S. defense acquisition institution had three fundamental support templates that provided requirements, funding, and management constraints. The executive branch, Congress, and industry worked together to deliver capability with the program manager (PM) as the central person responsible for cost, schedule, and performance (see Figure 10).

Figure 10. Defense Acquisition Institution

The government PM was at the center of defense acquisition, which aimed to deliver warfighter capability. The PM was responsible for cost, schedule, and performance (commonly referred to as the "triple constraint") of assigned projects—usually combat systems within the DoD. The executive branch of government provided the PM a formal chain of command in the DoD. The PM typically reported directly to a program executive officer, who reports to the service acquisition executive (an assistant secretary for that service—either Army, Navy, or Air Force), who reported to the defense acquisition executive (the under secretary of defense for acquisition, technology, and logistics). Depending on the program's visibility, importance,

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and/or funding levels, the program decision authority was assigned to the appropriate level of the chain of command.

Programs within defense acquisition required resources (for funding) and contracts (for execution of work) with industry. Congress provided the resources for the defense programs through the annual enactment of the Defense Authorization and Appropriation Acts, which became law and statutory requirements. The PM, through warranted contracting officers governed by the Federal Acquisition Regulation, entered contracts with private companies within the defense industry. Other important stakeholders included actual warfighters, the American public, the media, and functional experts (like engineers, testers, logisticians, cost estimators, etc.), as well as fiscal and regulatory lawyers.

As a backdrop to this complicated organizational structure for defense PMs, there were three decision support templates: one for the generation of requirements, a second for the management of program milestones and, and a third for the allocation of resources. Each of these decision support systems was fundamentally driven by different and often contradictory factors. The requirement generation system was driven primarily by a combination of capability needs and an adaptive, evolving threat. The resource allocation system was calendar-driven by Congress writing an appropriation bill—providing control of funding to the Congress and transparency to the American public and media for taxpayer money. The defense acquisition management system was event-driven by milestones based on commercial industry best practices of knowledge points and off-ramps supported by the design, development, and testing of the systems as technology matures.