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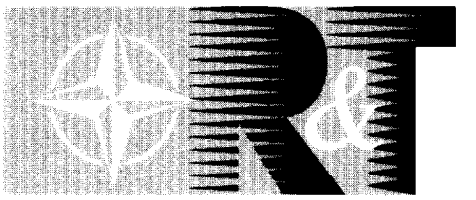

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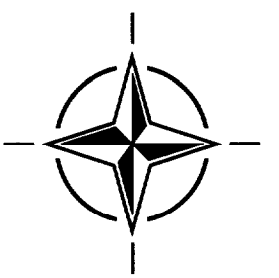
RTO MEETING PROCEEDINGS 45

Search and Target Acquisition

(Recherche et acquisition d'objectifs)

Papers presented at the RTO Workshop organised by the Systems Concepts and Integration Panel (SCI), held in Utrecht, The Netherlands, 21-23 June 1999.



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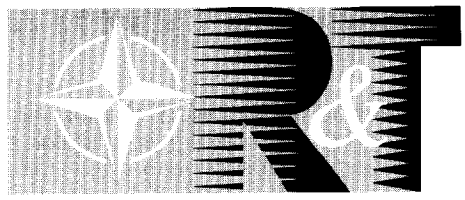

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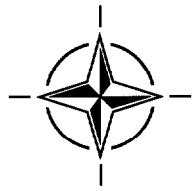

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Search and Target Acquisition

(RTO MP-45)

Executive Summary

Background. Standardized methods are needed to evaluate the effectiveness of camouflage, concealment and deception (CCD). CCD refers to all detection avoidance techniques, including netting, painted patterns, terrain cover, smoke and obscurants, shape-modifying applique, low-emissive paints, advanced contrast reduction materiel, and other technologies.

The SCI-12 Working Group was established to address this need. The scope was limited to defeating imaging, man-in-the-loop systems, specifically the unaided eye, direct view optics and electro-optical imagers. Non-imaging sensors and automatic target detection were not addressed. To facilitate the objective evaluation of alternative methodologies, researchers from the NATO countries were invited to apply their preferred methods on a standard set of 44 images of military vehicles in operational poses for which human observer search and target acquisition performance data were available. The results were reviewed at a June 1999 workshop in Utrecht, Netherlands.

The goal was to define measurement methods and signature metrics that are highly correlated with operational effectiveness, NOT to predict search time and probability of detection. Search time and probability of detection will be different in different military situations due to threat observer factors independent of the CCD signature (e.g., the relative penalty for missed detection versus false report, time pressure, fatigue, workload, familiarity with the terrain, prior expectations, etc.). Other criteria included low burden, repeatability, applicability during both design iteration and prototype evaluation, and robustness over CCD techniques, targets, and terrain.

Findings and Recommendations. At the present time, man-in-the-loop assessment is the only robust and effective method to evaluate CCD. Computational signature analysis methods are not sufficiently mature; they do not represent the range of significant visual and cognitive processes driving target acquisition performance.

The recommended approach is to evaluate target conspicuity using a standardized procedure to measure the ***visual lobe*** in off-axis detection, and ***response time*** in foveal examination. The visual lobe is the largest angle between the target and eye fixation at which the target can be discriminated. The visual lobe may be zero for hard-to-detect targets, and additional time is spent on foveal examination. Response time is measured for the entire test, then data analysis extracts the time spent on foveal examination.

Tests have shown that *(1)* target conspicuity is highly correlated with search time and probability of detection, and *(2)* target conspicuity measured in the laboratory is highly correlated with the corresponding measurements made in the field. Actual targets and sensors are used in the field. Photographic, synthetic or hybrid images with simulated sensor effects are used in the laboratory.

The procedure is simple and fast. It is stable with small number of observers. Minimal special equipment is needed. The procedure is well-suited to use during the design process to evaluate CCD alternatives, to support development and selection of robust and effective equipment, and to optimize CCD in the field.

Search and target acquisition field tests are orders of magnitude more costly and time consuming, yet provide assessment only for limited terrain and seasonal conditions. They require fielded equipment and can not support the early design process. Field test conditions are sufficiently unlike military operations that the results are not reliable predictors of effectiveness in real military operations.

Unresolved Issues. The committee did not produce standards or guidelines for *(1)* synthetic (simulated) images, *(2)* image capture in the field, *(3)* synthetic target insertion into captured images, or *(4)* image presentation in laboratory tests. These issues warrant further consideration.

Recherche et acquisition d'objectifs

(RTO MP-45)

Synthèse

Préambule. Des méthodes homologuées sont nécessaires pour évaluer l'efficacité des techniques de camouflage, dissimulation et déception (CCD). Le terme CCD englobe l'ensemble des techniques de prévention de la détection, comme les filets, les motifs peints, le masquage par le terrain, la fumée et les obscurcissants, les plaques de blindage dissimulant les formes réelles, les peintures à émissivité réduite, le matériel avancé de réduction de contraste et autres technologies.

Le groupe de travail SCI-12 a été créé pour répondre à ce besoin. Le mandat a été limité à la neutralisation des systèmes d'imagerie où l'homme est dans la boucle, et en particulier l'oeil nu, les optiques à vision directe et les systèmes à imagerie électro-optiques. Les capteurs sans imagerie et la détection automatique d'objectif n'ont pas été examinés. Afin de faciliter l'évaluation objective des méthodologies de remplacement, un certain nombre de chercheurs des pays membres de l'OTAN ont été invités à appliquer leurs méthodes préférées à un jeu standard de 44 images de véhicules militaires dans des configurations opérationnelles pour lesquels des données relatives aux performances d'observateurs humains en recherche et acquisition d'objectif étaient disponibles. Les résultats ont été étudiés lors d'un atelier organisé au mois de juin 1999 à Utrecht, aux Pays-Bas.

Cet atelier avait pour objectif de définir des méthodes de mesure et des paramètres de signature en corrélation étroite avec l'efficacité opérationnelle, et non de prévoir les temps de recherche et la probabilité de détection. La probabilité de détection et les temps de recherche sont différents selon la situation militaire, du fait de certains facteurs affectant les observateurs et indépendants de la signature CCD (par exemple la pénalisation relative liée à une détection manquée par rapport à une fausse indication, les contraintes temporelles, la charge de travail, la familiarité avec le terrain, les attentes etc.) Parmi les autres critères pris en compte il faut citer la facilité d'emploi, la capacité de répéter les opérations très rapidement, la capacité de les appliquer durant les itérations des étapes de conception et durant l'évaluation des prototypes, ainsi que la robustesse face au CCD ennemi, aux types d'objectif et aux types de terrain.

Conclusions et recommandations. Pour l'instant l'évaluation de type « homme dans la boucle » est la seule méthode sûre et efficace pour l'évaluation du CCD. Les méthodes informatisées d'analyse de la signature ne sont pas encore suffisamment au point; elles ne couvrent pas encore suffisamment l'éventail des processus visuels et cognitifs qui déterminent les performances en acquisition d'objectif.

L'approche préconisée est donc d'évaluer la perceptibilité de l'objectif suivant une procédure homologuée de mesure du ***lobe visuel*** lors d'une détection excentrée, et du ***temps de réponse*** pour l'examen fovéal. Le lobe visuel est le plus grand angle entre l'axe oeil-objectif et la direction du regard à laquelle il est possible de faire la discrimination de cet objectif. Le lobe visuel peut être de zéro pour les objectifs difficiles à détecter, et une période supplémentaire est alors nécessaire pour l'examen fovéal. Le temps de réponse est mesuré pour toute la durée de l'essai, puis le temps passé à l'examen fovéal est extrait par analyse des données.

Les essais ont permis de démontrer que *(1)* il existe une forte corrélation entre la perceptibilité de l'objectif et le temps de recherche, ainsi qu'avec la probabilité de détection, et *(2)* qu'il existe également une forte corrélation entre la perceptibilité de l'objectif mesurée en laboratoire et les mesures correspondantes effectuées sur le terrain. Des objectifs et des capteurs réels ont été utilisés sur le terrain. Des images photographiques, synthétiques ou hybrides, avec des effets simulés de capteurs ont été utilisés en laboratoire.

La procédure est simple et rapide. Elle est stable avec un nombre réduit d'observateurs. Elle nécessite un minimum de matériel spécialisé. La procédure est bien adaptée aussi bien pour l'évaluation de variantes de CCD lors du processus de conception, que pour le développement et le choix d'équipements robustes et efficaces et pour l'optimisation du CCD sur le terrain.

Les essais sur le terrain de la recherche et l'acquisition d'objectif sont beaucoup plus longs et coûteux, et ne donnent des évaluations que pour un nombre limité de terrains et de conditions saisonnières. Ils nécessitent un matériel qui doit être déployé sur le terrain et ne sont pas applicables lors des phases initiales de la conception. Enfin, les conditions dans lesquelles les essais sur le terrain sont effectués sont suffisamment différentes de celles des opérations militaires pour disqualifier les résultats en tant qu'indicateurs fiables d'efficacité en situation réelle.

Questions en suspend. Le comité n'a pas fourni de normes ni de directives en matière *(1)* d'images synthétiques (simulées), *(2)* d'images captées sur le terrain, *(3)* d'incrustation d'objectifs synthétiques dans des images saisies, ou *(4)* de présentation d'images pour essais en laboratoire. Ces questions mériteraient donc un examen ultérieur.

Contents

SESSION II: TARGET ACQUISITION MECHANISMS
Chairman: Ian Moorhead (UK)

SESSION III: SIMULATION ISSUES
Chairman: Mark Rodgers (UK)

† Paper was not presented at the Workshop.

Theme

The focus of the Workshop is on methods to evaluate the effectiveness of signature reduction countermeasures such as Camouflage, Concealment, and Deception (CCD). There are two different main approaches to evaluating CCD: (1) *observer experiments* and (2) *computational methods* using image analysis. While such analyses may extend to both imaging and non-imaging systems with and without a man in the loop, this workshop focusses on image-forming systems in which a *human* provides the primary *information processing*. The efforts concentrate on the visual and electro-optical signatures of the targets and their associated CCD treatments.

TOPICS

The following topics are addressed:

- methods to evaluate the effectiveness of CCD to increase survivability;
- search and target acquisition models incorporating CCD;
- computational target signature metrics;
- the design and evaluation of CCD equipment and techniques.

Acknowledgements

The Systems Concepts and Integration Panel wishes to express its thanks to the National Authorities of The Netherlands for the invitation to hold this workshop in their country.

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14. Abstract

This volume contains the Technical Evaluation Report, the Keynote Address, and the 26 unclassified papers, presented at the Workshop on Search and Target Acquisition, that was organised by the Systems Concepts and Integration (SCI) Panel 12 (the former RSG-2), on "Camouflage, Concealment and Deception Evaluation Techniques", and that was held in Utrecht, The Netherlands, from 21-23 June 1999.

The papers presented covered the following headings:
- search performance predictions
- target acquisition mechanisms
- simulation issues

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