

ACHIEVING CYBER DEFENSE SITUATIONAL AWARENESS: A COGNITIVE TASK ANALYSIS OF INFORMATION ASSURANCE ANALYSTS

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A Cognitive Task Analysis (CTA) was performed to investigate the workflow, decision processes, and cognitive demands of information assurance (IA) analysts responsible for defending against attacks on critical computer networks. We interviewed and observed 41 IA analysts responsible for various aspects of cyber defense in seven organizations within the US Department of Defense (DOD) and industry. Results are presented as workflows of the analytical process and as attribute tables including analyst goals, decisions, required knowledge, and obstacles to successful performance. We discuss how IA analysts progress through three stages of situational awareness and how visual representations are likely to facilitate cyber defense situational awareness.

INTRODUCTION

In response to computer viruses, network intrusions, and denial of service attacks, government agencies and large corporations have established network monitoring centers to detect and defend against security breaches in their critical information infrastructure. The US Department of Defense (DOD), which invests more resources in cyber defense than any vertical industry, refers to its cyber defenders using the terms information assurance (IA), computer network defense (CND), and defensive information operations (DIO) analysts.

These analysts comb through thousands of intrusion detection system (IDS) alarms during a single work shift to find real attacks amidst a preponderance of false alarms. They review massive amounts of packet data to identify suspicious and anomalous activities that were undetected by the IDS. They may also engage in forecasting new threats and predicting the activities of known attackers. They strive to attain and maintain situational awareness (SA) of the networks they defend and the attackers that attempt to gain access.

Our research used a cognitive task analysis (CTA) approach to gain insight into the work processes, cognitive skills, and tools that IA analysts rely on to achieve SA and the cognitive challenges and obstacles that impede SA. This paper highlights some findings of a full report; interested readers may contact the authors for further information.

RELATED WORK

Kilcrease, Kosakowski, Ruefle, and Zajicek (2003) categorized cyber defense activities to assist organizations in setting up and staffing Computer Security Incident Response Teams (CSIRTs). As the term "response" implies, Kilcrease et al. focused on how incident responders coordinate and

analyze incidents that have already been detected. Although neither intrusion detection nor cognitive challenges was their main focus, their report offered a categorization of CSIRT functions that guided our early research.

Alberts, Dorofee, Kilcrease, Ruefle, and Zajicek et al. (2004) extended the work of Kilcrease et al. by documenting workflows considered to be best processes for effective incident management. Their models represent what incident response "should be" and do not necessarily represent the actual experiences of most IA analysts. By comparison, our CTA documented "what is," illuminated the cognitive processes that underlie the work processes, and identified opportunities to improve SA.

Biros and Eppich (2004) studied rapid intrusion detection analysts in the US Air Force, using CTA, and identified five requisite cognitive abilities: recognizing non-local Internet Protocol (IP) addresses, identifying source IP addresses, developing a mental model of normal, and sharing knowledge. We used their work as a starting point for an analysis of additional roles beyond rapid intrusion detection and beyond the Air Force.

METHOD

Participants

We interviewed and observed 41 analysts from one commercial and six DOD organizations responsible for network security. Participants varied in level of expertise from novice to expert and represented a variety of IA roles including all of the analysis roles described below.

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Neurotechnology in National Security and Defense James Giordano, 2014-09-25 Neurotechnology in National Security and Defense Practical Considerations Neuroethical Concerns is the second volume in the Advances in Neurotechnology series It specifically addresses the neuroethical legal and social issues arising from the use of neurotechnology in national security and defense agendas and applications Of particular concern are the use of various neurotechnologies in military and intelligence operations training acquisition of neurobiological and cognitive data for intelligence and security military medical operations warfighter performance augmentation and weaponization of neuroscience and neurotechnology The contributors discuss the neuroethical questions and problems that these applications generate as well as potential solutions that may be required and developed The book examines how developments in neurotechnology in national security and defense agendas are impacted by and affect ethical values and constructs legal considerations and overall conduct of the social sphere Presenting an integrative perspective leading international experts lay the scientific groundwork and establish the premises necessary to appreciate the ethical aspects of neurotechnology in national security and defense It is not a question of if neurotechnology will be used in such ways but when how and to what extent Therefore it is imperative to foster a deeper understanding of neurotechnology the problems and debates arising from its use in national security and defense and how such issues can and should be addressed In doing so we can guide and govern the use of these innovative neurotechnologies in ways that uphold ethical accountability

The Handbook of Task Analysis for Human-Computer Interaction Dan Diaper, Neville Stanton, 2003-09-01 A comprehensive review of the current state of research and use of task analysis for Human Computer Interaction HCI this multi authored and diligently edited handbook offers the best reference source available on this diverse subject whose foundations date to the turn of the last century Each chapter begins with an abstract and is cross referenced

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Research Product - U.S. Army Research Institute for the Behavioral and Social Sciences, 1999

A Review and Annotated Bibliography of the Literature Pertaining to Team and Small Group Performance (1989 to 1999) Andrew S. LaJoie, 1999 The military along with private industry is relying more on small teams of specialized individuals who work together to achieve a common goal Examples of these teams include emergency medical teams aircrews decision making teams industrial project teams Special Forces teams weapon system crews and everyday work teams Training and military doctrine has been evolving to reflect this emphasis on teamwork The purpose of this annotated bibliography is to review literature published over the last ten years concerning team and small group performance Specifically the articles reviewed in this report represent a sampling of the research published in the social sciences including psychology sociology and business The team and small group literature reviewed

includes examples of the many types of teams mentioned earlier A summary and integration of this work is provided In general the research suggests that there are several components which contribute to the successful performance of teams and that some of these components can be explicitly trained Several training models are discussed Stinet **Applied Concept Mapping** Brian Moon,Robert R. Hoffman,Joseph Novak,Alberto Canas,2011-04-11 The expanding application of Concept Mapping includes its role in knowledge elicitation institutional memory preservation and ideation With the advent of the CmapTools knowledge modeling software kit Concept Mapping is being applied with increased frequency and success to address a variety of problems in the workplace Supported by business application case studies Applied Concept Mapping Capturing Analyzing and Organizing Knowledge offers an accessible introduction to the theory methods and application of Concept Mapping in business and government The case studies illustrate applications across a range of industries including engineering product development defense and healthcare The authors provide access to a free download of CmapTools courtesy of the Institute for Human and Machine Cognition to enable readers to create and share their own Concept Maps Offering examples from the United States Canada Australia Spain Brazil Scotland and The Netherlands they highlight a global perspective of this dynamic tool The text is organized into three sections Practitioners Views supplies narratives guidance and reviews of applications from career Concept Mappers Recent Case Studies and Results presents in depth examinations of specific applications and their results Pushing the Boundaries explores what s possible and where the boundary conditions lie Applied Concept Mapping facilitates the fundamental understanding needed to harness the power of Concept Mapping to develop viable solutions to a virtually unlimited number of real world problems **Expertise Out of Context** Robert R. Hoffman,2007-05-22 Researchers have revealed that real expertise while applied to well defined tasks with highly circumscribed contexts often stretches beyond its routine boundaries For example a medical doctor may be called upon to diagnose a rare disease or perform emergency surgery outside his or her area of specialization because other experts are not availab Work Design Adedeji B. Badiru,Sharon C. Bommer,2017-07-12 Work is all around us and permeates everything we do and everyday activities Not all work is justified not all work is properly designed or evaluated accurately or integrated A systems model will make work more achievable through better management Work is defined as a process of performing a defined task or activity such as research development operations maintenance repair assembly production and so on Very little is written on how to design evaluate justify and integrate work Using a comprehensive systems approach this book facilitates a better understanding of work for the purpose of making it more effective and rewarding **Handbook of Human Systems Integration** Harold R. Booher,2003-07-07 A groundbreaking look at how technology with a human touch is revolutionizing government and industry Human Systems Integration HSI is very attractive as a new integrating discipline designed to help move business and engineering cultures toward a more people technology orientation Over the past decade the United States and foreign governments have developed a wide range of tools techniques and technologies aimed at

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Table of Contents Cognitive Task Analysis Defense Technical Information Center

1. Understanding the eBook Cognitive Task Analysis Defense Technical Information Center
 - The Rise of Digital Reading Cognitive Task Analysis Defense Technical Information Center
 - Advantages of eBooks Over Traditional Books
2. Identifying Cognitive Task Analysis Defense Technical Information Center
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Cognitive Task Analysis Defense Technical Information Center
 - User-Friendly Interface
4. Exploring eBook Recommendations from Cognitive Task Analysis Defense Technical Information Center
 - Personalized Recommendations
 - Cognitive Task Analysis Defense Technical Information Center User Reviews and Ratings
 - Cognitive Task Analysis Defense Technical Information Center and Bestseller Lists
5. Accessing Cognitive Task Analysis Defense Technical Information Center Free and Paid eBooks
 - Cognitive Task Analysis Defense Technical Information Center Public Domain eBooks
 - Cognitive Task Analysis Defense Technical Information Center eBook Subscription Services
 - Cognitive Task Analysis Defense Technical Information Center Budget-Friendly Options

6. Navigating Cognitive Task Analysis Defense Technical Information Center eBook Formats
 - ePub, PDF, MOBI, and More
 - Cognitive Task Analysis Defense Technical Information Center Compatibility with Devices
 - Cognitive Task Analysis Defense Technical Information Center Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Cognitive Task Analysis Defense Technical Information Center
 - Highlighting and Note-Taking Cognitive Task Analysis Defense Technical Information Center
 - Interactive Elements Cognitive Task Analysis Defense Technical Information Center
8. Staying Engaged with Cognitive Task Analysis Defense Technical Information Center
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Cognitive Task Analysis Defense Technical Information Center
9. Balancing eBooks and Physical Books Cognitive Task Analysis Defense Technical Information Center
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Cognitive Task Analysis Defense Technical Information Center
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Cognitive Task Analysis Defense Technical Information Center
 - Setting Reading Goals Cognitive Task Analysis Defense Technical Information Center
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Cognitive Task Analysis Defense Technical Information Center
 - Fact-Checking eBook Content of Cognitive Task Analysis Defense Technical Information Center
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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