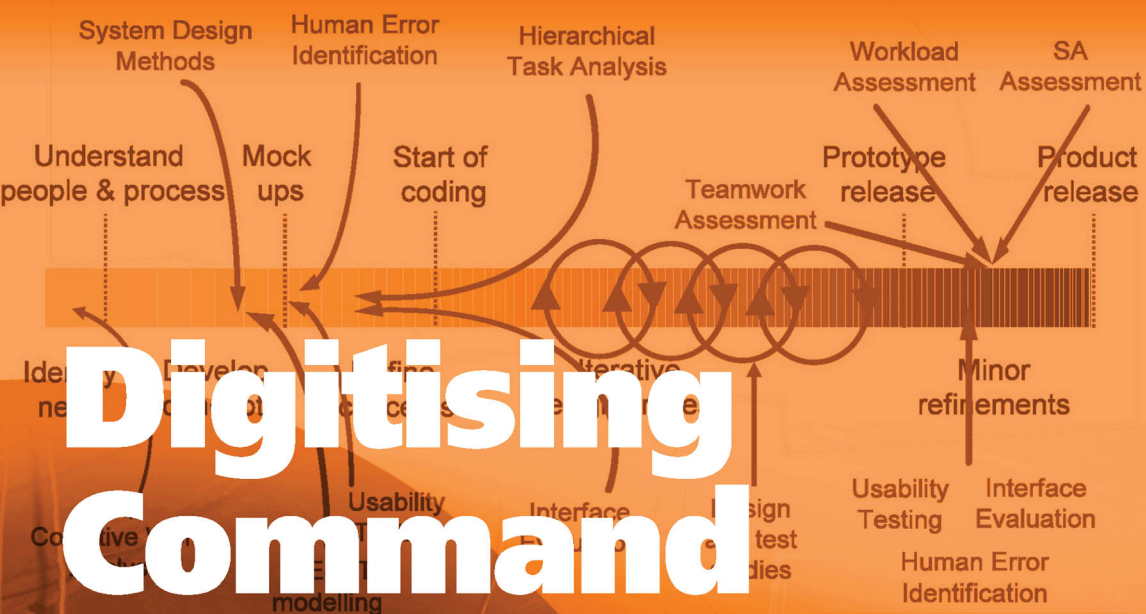


HUMAN FACTORS IN DEFENCE



# Digitising Command and Control

A Human Factors and Ergonomics Analysis of Mission Planning and Battlespace Management

**Neville A. Stanton**

**Daniel P. Jenkins**

**Paul M. Salmon**

**Guy H. Walker**

**Kirsten M. A. Revell**

**Laura A. Rafferty**



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# DIGITISING COMMAND AND CONTROL

# Human Factors in Defence

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A Human Factors and Ergonomics Analysis of Mission Planning and  
Battlespace Management

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Further information on the work and people that comprise the HFI DTC can be found on [www.hfidtc.com](http://www.hfidtc.com).

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# Glossary

3D	Three dimensional
AH	Abstraction Hierarchy
AoA	Avenue of Approach
BAE	Battlefield Area Evaluation
Bde	Brigade
BG	Battle Group
BS	British Standard
C2	Command and Control
CAST	Command Army Staff Trainer
CCIR	Commander's Critical Information Requirements
CDM	Critical Decision Method
CO	Commanding Officer
CoA	Course of Action
Comms	Communications
CoS	Chief of Staff
COTS	Commercial-off-the-Shelf
CPX	Command Post Exercise
CRI	Colour Rendering Index
CSSO	Combat Service Support for Operations
CWA	Cognitive Work Analysis
dB	decibels
DP	Decision Point
DSA	Distributed Situation Awareness
DSO	Decision Support Overlay
DSOM	Decision Support Overlay Matrix
EEM	External Error Mode
EEMUA	Engineering Equipment & Materials Users Association
EN	European Standardisation
EXCON	Experimental Control Centre
FRAGO	Fragmentary Order
GUI	Graphical User Interface
HCI	Human Computer Interaction
HEI	Human Error Identification
HF	High Frequency
HFI DTC	Human Factors Integration Defence Technology Centre
HQ	Headquarters
HTA	Hierarchical Task Analysis
Hz	Hertz
IR	Information Requests
ISO	International Standards Organisation
ISTAR	Information, Surveillance, Targeting, Acquisition and Reconnaissance
LOP	Local Operational Picture



MoD	Ministry of Defence
MP/BM	Mission Planning and Battlespace Management system
MWL	Mental Work Load
NAI	Named Area of Interest
NATO	North Atlantic Treaty Organisation
NEC	Networked Enabled Capability or Network Centric Warfare
OCOKA	Observation, Cover and Concealment, Obstacles, Key Terrain and Avenues of Approach
OODA	Orientate, Observe, Decide and Act
Op Order	Operational Order
OpsO	Operations Officer
OSPR	Own Situation Position Report
PMV	Predicted Mean Vote
PPD	Predicted Percentage Dissatisfied
RFI	Request For Information
SA	Situation Awareness
SCADA	System Control and Data Acquisition
SHERPA	Systematic Human Error Reduction and Prediction Approach
SME	Subject Matter Expert
SNA	Social Network Analysis
SOI	Standard Operating Instruction
SOP	Standard Operating Procedures
SUDT	Staff User Data Terminal
TAI	Target Area of Interest
UDT	User Data Terminal
UHF	Ultra High Frequency
UK	United Kingdom of Great Britain
USA	United States of America
VDT	Visual Display Terminal
VHF	Very High Frequency
VUDT	Vehicle User Data Terminal
WDA	Work Domain Analysis
WESTT	Workload, Error, Situation awareness, Time and Teamwork method
WO	Warning Order

# About the Authors

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# Preface

This book aims to show how Human Factors and Ergonomics can be used to support system analysis and development. As part of the research work of the Human Factors Integration Defence Technology Centre (HFI DTC), we are often asked to comment on the development of new technologies. For some time now we have looked in-depth at Command and Control activities and functions. The reader is guided to our other books on Modelling Command and Control, Cognitive Work Analysis, Distributed Situation Awareness and Socio-Technical Systems (all published under the *Human Factors in Defence* series) for a fuller appreciation of our work. The research reported in this book brought all of these areas together to look in-depth at a proposal for a new digitised system that would support Command and Control at Brigade Headquarters and below. For us it was a good opportunity to apply the methods we had been developing to a system that was in development. The pages within this book show you how we went about this task and what we found.

It is often the cry of Human Factors and Ergonomics that we are not asked for our involvement in system development early enough. In the past we have written books on Human Factors Methods (published by Ashgate and others), which explain how to apply the methods to system design and evaluation. Here we were given the opportunity, although we also feel that involvement when the system was being tested was too late, as we would have preferred to have been involved in system concept, design and development. Nevertheless, it is pleasing to have been involved in the testing phase, so that any shortcomings could be addressed in subsequent design.

As with all projects of this nature, we have gone to great pains to disguise the system under test for reasons of commercial confidentiality. This means that we are not allowed to disclose the name of the products nor any screen shots of the equipment. We have redrawn all the pictures and removed any reference to the company involved. It is a pity that such steps are required and we wish organisations could be more open about the testing of their products. Any short-term pain would turn into longer-term gain for the products, the users and the organisations involved.

As the contents of this book show, we started our analysis by understanding how mission planning and battlespace management works with traditional materials. The research team not only observed people conducting the tasks but also undertook the training in those tasks themselves. There is much insight to be gained through participant-observation, more than mere observation allows. It also enhanced the understanding of our subsequent observations, because we had performed the tasks for ourselves.

People may approach this book with many different requirements, goals and agenda. For those who want an overview of Human Factors Methods, we recommend chapter two. For those who want to understand mission planning processes, we recommend chapter three. If you are interested in any particular method, read the overview in chapter two, then chapter four for Cognitive Work Analysis, chapter five for Hierarchical Task Analysis, chapter seven for Social Network Analysis, chapter eight for SCADA Analysis, chapter nine for Usability Analysis and chapter ten for Environmental Analysis. For those interested in collaboration and communication in military headquarters, we recommend chapters three, six and seven. Finally, for those interested in our recommendations for future design of digital Command and Control we recommend chapter eleven. We have tried to write each chapter as stand-alone, but accept that people may want to dip in and out of chapters to suit their particular needs. We also feel that this book serves as a perfectly compatible accompaniment to any of our other books on Human Factors Methods, Modelling

Command and Control, Cognitive Work Analysis, Distributed Situation Awareness and Socio-Technical Systems. This book brings all of the topics presented in the previous books together to focus on the analysis of a mission planning and battlespace management system.

# Chapter 1

## Overview of the Book

This book presents a Human Factors and Ergonomics evaluation of a digital Mission Planning and Battlespace Management (MP/BM) system. Emphasis was given to the activities occurring within Brigade (Bde) and Battle Group (BG) level headquarters (HQ), and the Human Factors team from the HFI DTC distributed their time evenly between these two locations. The insights contained in this volume arise from a wide-ranging and multi-faceted approach, comprising:

- observation of people using the traditional analogue MP/BM processes in the course of their work to understand how analogue MP/BM is used in practice;
- constraint analysis (Cognitive Work Analysis, CWA) of the digital MP/BM system to understand if digital MP/BM is better or worse than the conventional paper-based approach;
- analysis of the tasks and goal structure required by the digital MP/BM, to understand the ease with which the activities can be performed and identify the likely design-induced errors;
- analysis of Distributed Situation Analysis (DSA), to understand the extent to which digital MP/BM supports collaborative working;
- analysis of the social networks that the digital system allows to form spontaneously (to understand the way in which people choose to communicate via voice and data);
- assessment against EEMUA 201 (Engineering Equipment & Materials Users Association) to understand if digital MP/BM meets with best Human Factors practice in control system interface design;
- assessment against a Usability Questionnaire, to gauge user reactions about the ease or difficulty of using the digital MP/BM system); and
- an environmental survey, to understand the extent to which the Bde and BG environment within which people are working meets with British Standard BS/EN/ISO 11064 Environmental Requirements for Control Centres.

A brief summary of the chapters of the book are presented next, with the detailed description of methods, approach, findings and recommendations within the main body of the book.

Chapter two presents an overview of the Human Factors and Ergonomics discipline and the methods associated with it. The discipline is introduced with a few examples of how it has contributed to improved display and control design. This is consistent with the overall aim of improving the well-being of workers, as well as their work, and the general goal of improved system performance. Two examples in particular resonate with the purpose of this book, both taken from aviation over 60 years ago but still with relevance today. Safety of systems is of major importance in Human Factors and safety critical environments have much to gain from its application. Human Factors and Ergonomics offers unique insights into the way in which people work, through the understanding of the interactions between humans, technology, tools, activities, products and their constraints. This understanding is assisted through the application of Human Factors and Ergonomics methods, which are also introduced. Some of these are pursued through