METOC Human-system Information Interaction

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Award #: N0001400WX20823
http://www.nrlmry.navy.mil

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **SEP 2000**	2. REPORT TYPE	3. DATES COVERED **00-00-2000 to 00-00-2000**

4. TITLE AND SUBTITLE **METOC Human-system Information Interaction**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Research Laboratory, Code 7540,,Monterey,,CA,93943**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**7**	

LONG-TERM GOALS

My long term goal is to improve the effectiveness of METOC information flow to the tactical users.This infromation flow includes both the data flow from the data sources to the METOC forecasters and the environmental impact information flow to the warfighters.

OBJECTIVES

Improve the workflow of METOC human-system interaction for generating useful MEOC products to warfighters. Develop a prototype information interaction system to create a more efficient system for METOC personnel to present concise tactical weather information to the warfighters. Specifically, prototype the information interaction system for the STRIKE warfare users. Improve visualization tools for presenting tactical information and provide guidance to information delivery.

APPROACH

A team of cognitive scientists, METOC researchers, and system engineers take the iterative observe-and-build-and-test approach to the problem. We apply this approach to a series of experiments where teams of forecasters, working in a simulated carrier METOC office (CV-METOC), attempt to provide a pre-strike mission briefing package. We will observe the two-person forecast team in scenario based simulation producing the weather forecast for the mock strike mission. We use cognitive research tools to analyze the observations during the experiment. We construct the information flow model from the analyses of the observations, and we test our hypotheses in the following experiments. We also develop visualization tools for assisting the information flow and generating tactical products.

WORK COMPLETED

This research project is a collaborative effort among several research groups specialized in cognitive research, meteorological and oceanographic information systems, and Strike mission planning research. During this past year, we have analyzed the observations collected during the 1999 Experiment conducted in July 1999. The analyzed result was used as the base to formulate our hypotheses for the 2000 Experiment, which was conducted in July 2000.

1999 Experiment Analysis

We observed that all forecasters made their forecast decisions from their mental understanding of the weather system. Their forecasts are quantitative, but their mental model is qualitative in nature. From the detailed analysis, we suggested that METOC forecasters formulate their mental models and make their forecast in four distinct steps:

1) Initializing their mental model with large-scale weather picture particularly significant weather events,

2) Constructing Qualitative Mental Model (QMM) with weather and trends in their region of responsibility (most difficult task),

3) Verifying and adjusting QMM against other information sources (satellite image, another forecaster, text forecast, etc.), and finally

4) Constructing the weather forecast itself.
The details of this work/information flow has been documented and published.

2000 Experiment

The 2000 Experiment had two separate parts. They were conducted simultaneously from two locations using the same strike scenarios. The Experiment was conducted at NPMOC San Diego and aboard USS Carl Vinson. At NPMOC San Diego, based on our 1999 Experiment conclusions, we tested the hypotheses that 1) forecasters extract a quantitative forecast from their QMM, and 2) usage of certain tools (mesoscale weather prediction model) can improve the work/information flow. We successfully observed three teams of forecasters and technicians building first a mission planning brief and later a strike briefing for simulated strikes on Port Angeles, Washington and the bridge to Whidbey Island for a total of six sessions. In addition, we observed an “expert” from the center at NPMOC prepare a strike brief. Two of the teams were from the U.S.S. Constellation, which was in port in San Diego after its recent deployment. One team was from the METOC center at NPMOC. The NPMOC Science Officer played the role of INTEL by providing pre-scenario briefings and on-call support during the exercise. NPMOC San Diego also provided regional center responses to the forecast teams’ weather questions and queries. The observation methodology included video cameras recording of computer screens used by the forecaster and the technician, voice input of their current tasks (provided by forecasters and technicians themselves), notes taken by the observers regarding the task functions, real-time task recording of their computer interface activities, and eye –tracking recording in an attempt to capture the forecaster's cognitive processing from the computer screens. In preparation of the experiment, we created a strike specific visualization aid to test if it could help the forecasters gathering strike specific information. In addition, we created a draft of workflow checklist to test if forecasters should follow the checklist item during the course of forecasting. We observed that the experience dictates the tools the forecaster uses. The more experience forecasters used the mesoscale model more skillfully, and validated their mental model from various information sources.

We also conducted the experiment aboard aircraft carrier U.S.S. Carl Vinson (CVN 70). As the experiment carried out at NPMOC San Diego, we also successfully observed six teams of forecasters and technicians building strike briefings for the same scenarios. The teams were formed from the meteorology and oceanography division (i.e., the "OA" division) aboard the VINSON. There were three different forecasters and eight different technicians employed in different teaming combinations. The observations were taken in their normal operating environment in the OA division spaces on the third deck in the island of the VINSON. After some experimentation we believe that we developed a successful methodology and that we know how to deploy with the VINSON at sea. It is a difficult task because the space is very noisy with more than seven possible computer screens to monitor.

The VINSON environment is very different than the NPMOC San Diego study. There are more technicians involved that require more coordination. It is also clear that forecasting is a continuous process and the specific air strike components are better integrated when the forecasters have this continuous process already in place.

While there are a number of analyses that are on going, we observed that the use of the recently deployed mesoscale atmospheric model (TAMS/RT) improved when high-level guidelines are provided that specifically call for the use of a mesoscale atmospheric model. However, while local observations are used to validate the mesoscale model, forecasters still need to consider the relationship of the large-scale initialization to the mesoscale models in order to properly forecast using the mesoscale model.

RESULTS

This important collaboration brings together researchers from many disciplines to study the critical problem of information flow from METCO to Strike planners by focusing on the nature of workflow.

In the 2000 Experiment, we have progressed our research through carefully designed steps. We have advanced our theory on the METOC workflow, and we have fitted our observation methodology for use on board an aircraft carrier.

The objectives of 2000 Experiment at NPMOC San Diego were to validate workflow concept through QMM and to test if mesoscale weather prediction models are useful for forecasters to get tactical weather information. We believe that the workflow model will be the key for building the future METOC information infrastructure. During the experiment, our observations have suggested several significant improvements in the METOC information flow. We believe that 1) data/information staging for the forecasters is a key area for improvement of the workflow, 2) the modified checklist approach can help forecasters to make the proper "Verify and Adjust" step in the QMM, and 3) our scenario based observation methodology is a very good method for discovering workflow problems in other disciplines.

The primary objective of the 2000 Experiment on board U.S.S. Carl Vinson (CVN 70) was to develop and test a methodology for observing Navy weather forecasters produce information to support a simulated air strike mission. The VINSON is currently at the dock in the Bremerton Naval shipyard during re-fit and offered a convenient opportunity. Previous Human-Systems Information Interaction studies have occurred in a very controlled environment at a regional METOC center. The VINSON study begins to address the issues of the real-world forecaster who is constrained in space, time, and information sources. Our intent is to conduct observations during the VINSON's work-up towards deployment and study the forecaster in near combat conditions. This study is the first of several to follow over the next nine months.

IMPACT/APPLICATION

The single most important accomplishment was the validation of the workflow process through the concept of Qualitative Mental Model (QMM). Though the concept of the QMM for the 1999 Experiment is still valid, the details of this concept will need to be modified. During 2000 Experiment, we observed that forecasters carried this mental model with them. We observed that all forecasters could recall details of their weather forecasts including quantitative values. But, they could not recall the tactical information very well. When the default forecast values were provided, forecasters did not pay any attention to those default values.

Using the checklist to capture the QMM can help, but it must be modified for the following reasons.

1) On board ship, forecasters make about 20 briefs a day. This means that they are constantly under pressure to produce a "forecast" for a specific need. The "initialize" and "build a QMM" steps are not clearly separated. The "Verify and Adjust" step is repeated all day long.

2) Forecasters and technicians do work as a team, and they constantly interrupt each other to exchange information. Each interruption will need some re-focus time for the forecasters to get back to the task at hand.

3) In addition to the interruptions, the web pages do not appear instantly when needed. Forecasters do not have the time or the patience to wait for the specific page to appear on the screen. They often seek the required information from other web sites, or they initiate the acquisition of other required information. The net result is that they have wasted some of their valuable time.

The above three observations suggest that we cannot make a rigid checklist describing the QMM for the forecasters to step through. Instead, we suggest that the checklist be re-directed or re-formatted into a series of reminders. So, the checklist will be flexible enough to fit the METOC workflow. To cut down the information-seek time, we suggest that the data or web site content to be pre-staged for the forecasters. While there are a number of analyses still on going, the workflow information interaction model begins to take shape.

TRANSITIONS

Analyses of the workflow that is used to generate forecasts for strike warfare, and elements of the interaction model will be used in the 6.3 Environmental Visualization (EVIS).

The analysis of the regional center web sites has been shared with the METOC community.

RELATED PROJECTS

- Personal Simulation System, NRL, $200K/yr, 10/1998 - 9/2001 (Ballas)
- Neural Network Declutter Tool: Incorporating Cognitive Models into Decision Support Systems, ONR, $457,502, 4/2000 – 10/2002 (Marshall)
- Measuring and Understanding Cognitive Workload, MURI, AFOSR (subcontract with George Mason University), $210K/yr, 5/1997 – 4/2002 (Marshall)
- Shipboard Tactical Atmospheric Forecast Capability, SPAWAR, $450K/yr, 10/1/97-9/30/04 (Cook)

PUBLICATIONS

Trafton, G., S. Kirschenbaum, T. Tsui, R. Miyamoto, J. Ballas, and P. Raymond (2000). Turning pictures into numbers: Use of complex visualizations, International Journal of Human Computer Studies Special Issue on Empirical Evaluation of Information Visualisations (accepted for Nov 2000 issue).