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Comparison of Adversarial Crew Cognitive Walkthrough vs Cued Debrief Recall Techniques for Eliciting Information in a D^{3}M environment

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Abstract

In helping the Commonwealth of Australia acquire an Airborne Early Warning and Control (AEW&C) platform DSTO must provide advice on human engineering for a system yet to exist in its physical form, and which may involve an adversarial agent. Cognitive Work Analysis (CWA) adopts a formal modeling framework, and is therefore particularly valuable for influencing specifications in the "upstream" phase of design. Traditional knowledge elicitation techniques for CWA appear to be limited. Two new techniques for knowledge elicitation of intentional systems in the upstream phase of human system integration design are discussed. These were the Adversarial Crew Cognitive Walkthrough and the Adversarial Crew Cued Debrief Recall. Tentative conclusions are that the ACCW procedure is a more effective and time-efficient procedure for eliciting knowledge about intentional systems that include an unpredictable adversary.

1. Introduction

Advocates of human-centered design argue that the needs of users should be addressed as early as possible in the design process. A practical limitation, however, has been the difficulty for human engineers (HCI experts, cognitive engineers, etc) to gain access to the earliest stages of design. This has been particularly problematic for large-scale defense systems where the focus in requirements analysis, tender evaluation, detailed specification and design tends to be on core technical capabilities rather than on human-system integration.

Since 1998, Australia's Defence Science and Technology Organisation (DSTO) and the Swinburne Computer Human Interaction Laboratory (SCHIL) have been collaborating on ways to address issues of human-system integration on Australia's Airborne Early Warning and Control (AEW&C) project at the upstream stages of its design (Sanderson, Naikar, Lintern, & Goss, 1999; Sanderson & Naikar, 2000; Naikar & Sanderson, 2000). We have adopted cognitive work analysis (CWA) as an analytic framework (Rasmussen, Pejtersen, & Goodstein, 1994; Vicente, 1999; Sanderson, 1998). CWA is an interdisciplinary, systems-oriented approach to the analysis, modeling, design, and evaluation of human-machine systems that is based in the work of Jens Rasmussen. The characteristics most relevant to our work on AEW&C are as follows:

- CWA allows design of new systems to proceed relatively independently of previous technical solutions. Therefore it is neither normative nor descriptive but instead might be called "formative" because it points to the future *form* of an interface, that will in part *form* human behavior. Because AEW&C is quite different from pre-existing AWACS platforms and ground-based air defence environments a formative approach is valuable.
- CWA aims to design interfaces that are uniquely suited to support human activity in situations previously unencountered, particularly where there may be high risk. Because AEW&C is partly intended to give Australia a strategic edge in situations of uncertainty where there might be adversaries, this property is valuable.
- CWA models not just activity, but also the context in which activity takes place. This arises from a recognition that the ecology in which humans act exercises a strong determining role in the possibilities for action. Since a key role of AEW&C will be to reduce uncertainty about its environment, this property of CWA is also particularly valuable.

We have found CWA helpful in the evaluation of tenders for AEW&C (Naikar & Sanderson, 2000) and in analyzing how complex patterns of parallel activities might be modeled formatively (Sanderson & Naikar, 2000). To do this we developed detailed formal models of the work domain of AEW&C and of the control tasks—and temporal coordination of the control tasks—that AEW&C crewmembers must manage. However our models were developed from documents and from interviews with subject matter experts (SMEs) rather than by more "situated" techniques requiring SMEs to deal with a confronting situation as it unfolded. Our goal in this overall program of research is therefore twofold:

- We wish to test the adequacy of our work domain analysis (WDA) and control task analysis (CTA) models by seeing if functions, priorities, processes, tasks and activities elicited with situated techniques are covered by our existing models, or if the models need to be extended. *The more general theoretical goal is whether CWA is an effective technique for modeling systems that are largely intentional in nature and involve an intelligent adversary.*
- We wish to use "situated" techniques to examine issues relating to AEW&C crew structures such as the roles that crewmembers should have, how they should communicate with each other, the organizational structures that should guide their interactions with each other, where they should be positioned, and how they should be trained for their respective roles. *The more general theoretical issue is the degree to which CWA through its formative nature can help provide solutions on crewing issues so far upstream in the design process.*

The present paper does not provide answers to these questions, which will require an extended series of investigations to resolve fully. However it presents details of two low-cost knowledge-elicitation environments we have developed to immerse SMEs in air defense tasks very much "upstream" in the system development lifecycle, and to extract important early information related to human-system integration.

2. Background

2.1. Crew Cognitive Walkthrough (CCW)

We developed the Crew Cognitive Walkthrough (CCW) procedure to perform walkthroughs of crew interactions and information exchange with RAAF air defense SMEs with AWACS experience. CCW is based on the Cognitive Walkthrough technique of Lewis, Polson, Wharton and Rieman (1990), Polson, Lewis, Rieman and Wharton (1992), with the exception that the walkthrough questions focus on processes of group interaction and communication factors just as much as individual cognitive factors. The advantage of this technique for the procurement of design specifications is that it can be used "upstream" on the basis of a relatively crude knowledge of human-system integration solutions. For this reason it is a particularly suitable technique for eliciting information about design requirements for systems that are yet to exist in their "physical" state.

Several limitations with the CCW technique were identified. First, the SMEs designed the scenarios that they played out, as is quite usual for the CW technique. However, because the aim of the simulations was to reflect a distributed, dynamic decision making (D^3M) task, then having the SMEs know what was to happen was quite artificial. The SMEs were found to lapse into a "comfort zone" where they played out the scenario as if all of their actions had the desired consequences and nothing unpredicted was assumed to have occurred. Second, the SMEs played against an "enemy" whose actions were entirely known to them. The enemy was only assumed to be present, and SMEs knew the enemy's actions and intentions. Third, the CCW failed to capture the uncertain nature of real world D^3M tasks. Finally, the SMEs never put themselves in a situation that they could not handle with the resources they had. The result of these limitations was that the range of information gathered is potentially limited. SMEs played within a context that good planning would achieve, but which may not be representative of real world contingencies and the "fog of war". Certainly, these scenarios were not representative of extreme or surprising circumstances. However an important goal of CWA is to design human-machine systems that support workers in dealing with unpredicted events in their environment. We believe that a procedure for simulating air defence tasks requires the addition of an active unpredictable human adversary.

The idea of juxtaposing a domain of risk (in this case, an adversary) and a domain of mitigation (in this case, own forces) in a CWA analysis is not new (Moray, Sanderson, & Vicente, 1992; Hajdukiewicz, Burns, Vicente & Eggleston 1999). We intend to explore this issue further by increasing the fidelity of the adversary in the knowledge elicitation process. We hope to strengthen our air defense WDA and CTA with information that fully encompasses any further constraints and affordances that are introduced by having (1) an adversarial agent with unknown intentions play against the SME and/or (2) the SME manage resources to meet the challenge posed by that agent.

2.2. Air Defence Simulation Software

Given the limitations of the CCW technique we needed to explore a solution for generating an environment that would support knowledge elicitation of crew coordination in a task involving an adversarial agent. The need to represent an adversary led us eventually to adopt a war-gaming Commercial-off-the-Shelf software (COTS) solution. Without computational support, orchestrating the activities of one side against the other becomes overwhelming. The use of computer-based microworlds for assessing team performance in both military and otherwise similar multi-agent environments has a well documented history (c.f. Bowers, Salas, Prince, & Brannick, 1992; Hollenbeck, Major, Sego, Hedlund, Ilgen & Phillips 1997; Swezey, Streufer, Satish & Siem 1998). However the development of such microworlds is generally time consuming and not cost-effective. Recently, Steele, Pollack, Thomas and Lee (2000) proposed that "Real Time Strategy" games provide a useful tool for investigating issues concerning interface design for non-deterministic multi-agent systems. Although the purpose of the current research is not to influence interface design, but rather to elicit knowledge about human-system integration, the advantages simulated D^3M environments for cognitive engineering research is amply demonstrated. Even a COTS software tool may have an acceptable level of ecological fidelity and validity, in which case it can save the researcher the time and money associated with developing their own software solutions. Jane's Fleet Command (JFC) air defence game was chosen as an appropriate COTS tool for our needs. As well as providing an ecologically valid air defence environment, JFC has multiplayer capabilities and a flexible mission editor where scenarios can be custom designed by the research team.

2.3. Adversarial Crew Cognitive Walkthrough (ACCW)

To address the limitations described above a new procedure, the Adversarial Crew Cognitive Walkthrough (ACCW) was developed as being more representative for eliciting information concerning D^3M task environments. Someone other than the SMEs, who provide the walkthrough information on the AEW&C side, plays out an adversary in the ACCW independently. The SMEs are therefore freed from the dual burdens of (a) designing the scenario and (b) simulating enemy actions. The ACCW provides the opportunity for the researcher to create surprises, extreme conditions, uncertainties, and so on, without the SMEs knowing in advance. In the ACCW, the conjecture is that a wider range of issues (due to the addition of an adversary, and probe questions about the adversary and the participants own reactions in relation to the adversary) will emerge to support modeling, namely; (a) the resulting Work Domain Analysis (WDA) will cover the AEW&C work domain in more representative instantiations (combat, uncertainty, greater exercise of priorities, criteria, functions, properties, resources, etc…) and (b) the resulting Control Task Analysis (CTA) will provide insight into how action is decided under extreme or surprising circumstances and in the "fog of war".

One potential concern with using any walkthrough technique for eliciting information from a D^3M task was the seemingly reactive nature of this technique. If people are really engaged in fighting an adversary then more true to life considerations come into play than would be the case if they were interrupted. Thus the question is posed; "will the stop and start nature of the walkthrough procedure, in some way, cause the participants to act differently than they would if the flow of the simulation was uninterrupted?" The classic argument against using a walkthrough procedure in this context is that asking the participants questions "on the fly" will change the way that they are naturally thinking about the task, and that they will somehow adjust their behavior. In this sense, the information elicited may be distorted by the fact that their decision processes have been somehow altered.

2.4. Adversarial Crew Cued Recall Debrief (ACCRD)

To address the immediate concerns, a technique that is non-intrusive and that does not disrupt the dynamic nature of D^3M tasks needs to be used. Until recently, the lack of suitable investigative methodologies for capturing data in field settings has prevented the investigation of work environments involving the processes of controlling complex command and control environments. A recent technique addressing this problem is the Cued Recall Debrief (Omodei, Wearing & McLennan 1997). This method involves a two-stage process. Firstly, the subject wears a lightweight head-mounted video camera, as a non-intrusive method for the recording of sequences of events in the simulated D^3M task. A head-mounted camera is used as it captures the events as the subject sees them from their "own point of view". This enables the subject to become fully re-immersed during the replay of events, cueing the comprehensive recall of psychologically relevant experiences. Secondly, the subject uses the video replay as a stimulus to recall all mental events (e.g. thoughts, , uncertainties, constraints upon action, etc…), which occurred, and to verbalize these onto a second videotape. The main advantage of this technique is that it does not interrupt the natural flow of events of the simulation in order to elicit information from the subjects.

3. Method

3.1. Participants

There were four male participants, three of which were active members of the League of Ancients War Gaming Club. They were expert players of COTS war games and board games that required development of a war strategy. The fourth participant was a PhD student in the School of Information Technology, who also had past experience with COTS war games (e.g. "Command and Conquer" and "Star Craft").

3.2. Design

The design of the experiment was a between-subjects comparison of the ACCW and the ACCRD) techniques. There were two participants in each condition.

ACCW	ACCW – P1 ACCW – P2
ACCRD	ACCRD – P1 ACCRD – P2

3.3. Equipment and Materials

The experiment took place in the Swinburne Computer Human Interaction Laboratory (SCHIL) Usability Laboratory (UL). The SCHIL UL consists of one control room and two adjunct observation rooms. They are both observable from the control room through one-way mirrors and audible through a microphone.

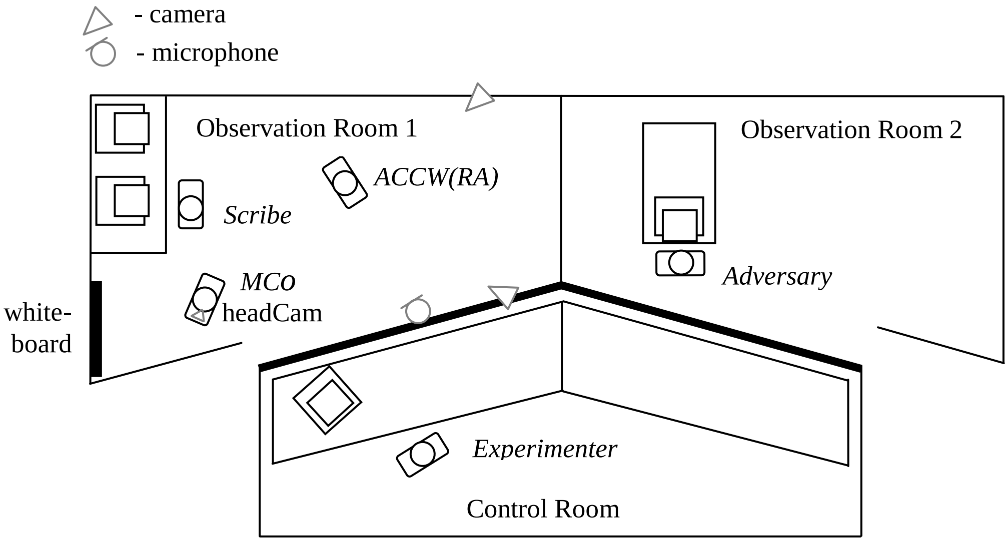

Figure 1. Layout of the SCHIL Usability Laboratory for the ACCW and ACCRD procedures.

Figure 2. Left picture shows view from Control Room into Observation Rooms. Centre picture shows MCo conferring with Scribe. Right picture shows a debriefing session in a separate area.

The data from Observation Room 1 was recorded constantly and could be heard and viewed instantly in the control room by the Experimenter. A video monitor in the control room captured four images. Two cameras were on either side of Observation Room 1. One camera was trained on the whiteboard where all the strategic moves delegated to crew by the participant, who played the Mission Commander (MCo), were marked throughout the game. The second camera captured the general activity of Observation Room 1. The third video image was from the participant's HeadCam (a lightweight miniature head camera that was worn by a participant on the head and pointed at the direction in which they were looking) to capture their point of view. The fourth video image was a scan conversion of the Scribe's screen as the Scribe carried out the MCo's commands during the game.

A research assistant ACCW(RA) sat in Observation Room 1 on the left to ask questions during the Cognitive Walkthrough procedure. The adversary was situated in Observation Room 2 on the right, in order to be physically separated from the participant. In all four sessions the MCo and the scribe played the game against the adversary in real time. The JFC game was used to simulate an air defence world. Custom scenarios were designed by the research to simulate typical demands that would be placed on a MCo.

A whiteboard on the wall of Observation Room 1 had an area defined for each of the MCo's three crewmembers. It had white magnetic squares prepared with names of assets that were potentially available to the MCo. There were also squares with typical commands that the MCo might give to his simulated crewmembers. Blank squares were provided so that the MCo could record any other commands he wished to give to the crew. The whiteboard provided a log of the MCo's interactions with crewmembers. Although not fully exploited in this preliminary study, since we were not formally evaluating a particular crewing structure, skills, or cabin layout, the ACCW technique provided the means to trace the effects of particular crewing structures, skills, or cabin layout on important measures of effectiveness.

3.4. Procedure

The procedure for the ACCW and ACCRD techniques was the same for the first three steps but diverged thereafter, as shown in Figure 3.

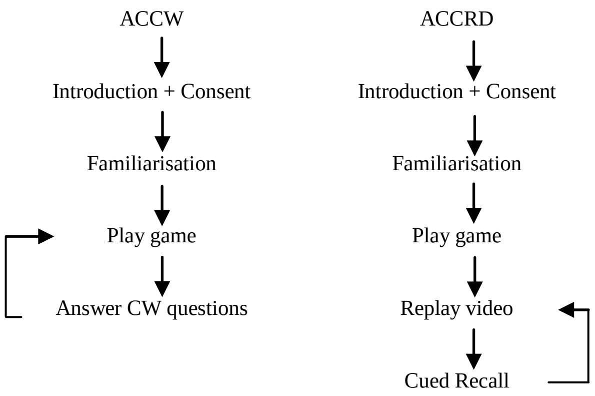

Figure 3. ACCW and ACCRD techniques.

Introduction and Consent. Participants were given an introductory explanation of the experiment and procedure after which they signed a consent form. They were shown around the Laboratory and given a more detailed brief about the JFC game and the ACCRD or ACCW procedure.

Familiarisation. Participants were given 10 -15 minutes to familiarise themselves with the experimental setting and the JFC game itself. After this time every subject claimed to understand the function of the whiteboard, the JFC display interface and the roles of the MCo and the Scribe.

Game play. The participant played the role of an MCo of an AEW&C aircraft. A mission brief advised him about three developing situations.

1. The MCo's country is accused of manufacturing chemical weapons, hence, political tension is high. Priority should be given to enemy contact on an intercept with chemical factories. The MCo is allowed to fire if fired upon, although advised to avoid engagement if at all possible.
2. Drug traffickers are in the area. The MCo is free to engage with them as he sees fit.
3. There are numerous civilian air corridors surrounding the MCo's country, therefore the MCo should identify any contact before engaging them.

The MCo was to imagine that he had under his command three subordinate air defenders on the AWACS platform: Sensor Operator (radar, ESM, etc.), Fighter Controller 1 and Fighter Controller 2. His role as MCo was to delegate tasks and responsibilities and to assign assets to his crew. The MCo noted their decisions by making them explicit on the whiteboard.

The MCo had a Scribe who was entering the commands that the participant had issued into the Jane's Fleet Command game. The Scribe executed the MCo's commands as effectively as possible, effectively carrying out the roles of the three assumed crewmembers. However the Scribe was not a part of the air defence crew and could not unilaterally make decisions or carry out actions that have not been explicitly assigned to the assumed crew. The scribe was permitted to supply routine information about equipment capabilities.

ACCW method. In the ACCW sessions participants played the JFC game and at semi-regular intervals the game was paused to ask the CW questions by ACCW(RA). CW was introduced every time during the game when significant episode question activity had taken place. At that time the game was paused and the experimenter would ask the participant a series of eight questions:

1. What is your adversaries' disposition at this time?
2. What is your best guess of your adversaries' intentions at this time?
3. What are the strategic and tactical priorities you are operating under at this point?
4. What functions and operations are ongoing at this point on both sides?
5. How intense was workload for each of your crewmembers at this point?
6. What physical processes, systems, or features of the world are you exploiting at this point?
7. What could go wrong at this point that you are aware of?
8. What constraints are operating on you or your adversaries' activities or intentions at this time?

Then the game was unpaused and the participant continued the mission until the next CW episode.

ACCRD method. In the ACCRD method the participant played the JFC game with no interruption until the end. In a separate laboratory area, the experimenter replayed the video collected from the session with images from HeadCam, the whiteboard and the screen capture of the JFC game visible to the MCo. The participant was asked to review the video, to pause it and recall what were they doing or thinking whenever they liked. The participants were shown the CW questions (see above, as for CW procedure) to use as possible guidance. However they were told they were not required to use the questions. They were told they could comment on any other relevant issues as well.

4. Results

The video of both the ACCW and ACCRD sessions was analyzed using the MacSHAPA program (Sanderson, Scott, Johnston, Mainzer, Watanabe & James 1994) in order to assess the quantity of information elicited as a function of the time taken to collect the data. The video was also analyzed for the quantity and quality of statements made by participants. Finally, RAAF SMEs made informal observations on the two procedures.

4.1. Timing Data

The ACCW technique takes an average of 1h 42m for completion, 38m (37%) of which is spent in talk. In contrast, the ACCRD technique takes an average of 3h

28m, 1h 7m (32%) of which is spent in talk. Immediately below is a graph generated by the MacSHAPA program, that illustrates the temporal sequencing of periods of playing the game and answering walkthrough probes (ACCW), and watching the video replay and cued recall (ACCRD). Note that the ACCRD was preceded by 1h 20m of game play for ACCRD participant 1, and 50m of game play for ACCRD participant 2 (the JFC game crashed after this amount of time for participant 2 and results have been prorated to take this into account).

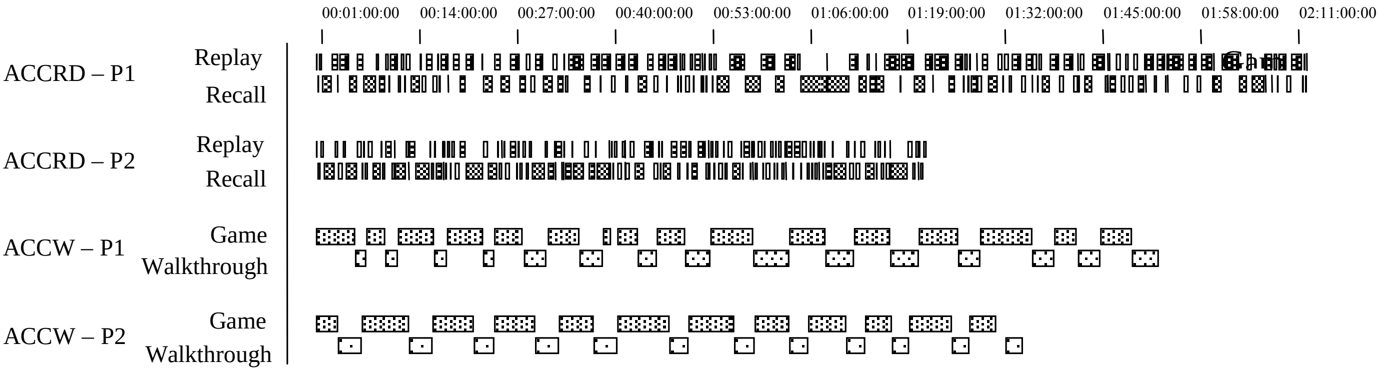

Figure 4. Timeline report from MacSHAPA for all four participants. Time runs left to right.

4.2. Coding Analysis

Comments made by participants were divided into two main categories of interest, comments made about their side (M), and comments made about their adversary (T). These categories were further divided into three sub-categories relating to; (1) the situation (MS, TS), (2) intentions (MI, TI) and (3) constraints upon action (MC, TC). A third category, 'Miscellaneous', was also divided into three subcategories; (1) comments about the crew complement members workload and task distribution (CC), (2) comments made about being surprised about unexpected events (SU), and (3) aspects of the physical world being exploited as the game was played (EX). For the ACCRD and ACCW the coding categories were analyzed using both raw scores and the scores as a proportion of the total number of analyzed utterances for each subject. Because proportions and raw scores produced very similar patterns of results, raw scores were used for subsequent analyses.

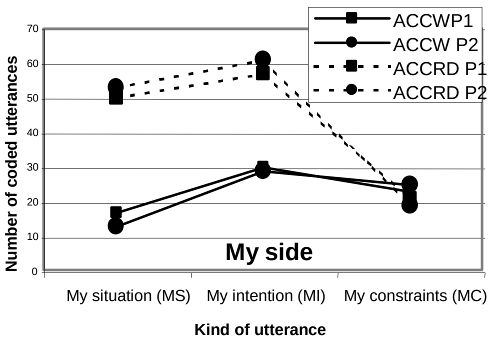

Figure 5. Distribution of comments made about own forces

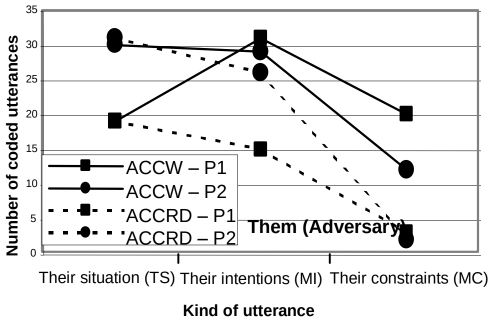

Figure 6. Distribution of comments made about adversary's forces

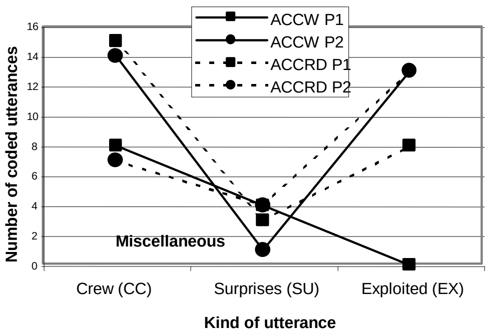

Figure 7. Distribution of miscellaneous

The distribution of comments participants made about their side, the adversary, or about the other three categories is shown in Figures 5, 6, and 7.

The ACCW process results in an approximately equal number of statements in each category of interest (comments about self and comments about adversary), due mostly to the structured questioning at regular intervals. There were between 12 and 31 statements in each of the MS, MI, MC, TS, TI, and TC coding categories. For the ACCRD there were between 2 and 53 statements in each of the MS, MI, MC, TS, TI, and TC coding categories. The ACCRD leads to more statements overall about one's own activities and around the same number of statements about the adversary as the ACCW. Also there are markedly more statements about one's own situation and intentions for the ACCRD than for the ACCW, and if anything slightly fewer statements about the adversary's intentions and constraints.

Figure 7 shows the distribution of comments made about the miscellaneous categories of; comments about the crew complement members' workload, and task distribution (CC), comments about being surprised by unexpected events (SU), and comments about the aspects of the physical world being exploited as the game was played (EX). Comments pertaining to these categories did not greatly differ across the ACCW and ACCRD procedures. It should be noted that there was one outlier in the "aspects of the physical world being exploited" (EX) category, as the participant understood this category to relate to the aspects of the SCHIL UL environment as opposed to physical aspects simulated in the JFC air defence game.

4.3. SME feedback

Following the collection of data from the pilot study, the two RAAF Air Defence subject matter experts who had previously experienced the CCW technique had the opportunity to sample the ACCW and ACCRD procedures in the simulation as described, with the mission brief we had developed for prototyping, and to provide informal comments.

Both SMEs commented that both adversarial versions were much better than the non-adversarial CCW. They claimed that the presence of an adversary took the predictability out of the simulation, which was far more realistic for them. The SMEs liked both the ACCW and ACCRD procedure, and felt that each technique was worthwhile for eliciting knowledge about their thought processes. One SME commented that the timing of the ACCW probe questions needed to be carefully considered. He felt that if the questions were asked at the end of a significant event rather than at the beginning or during the middle, then the technique would seem far less reactive and intrusive. However the SMEs also felt that it was ecologically valid to ask questions during the scenario, as this often happens in real air defence environments. Therefore our earlier concerns that the walkthrough procedure would be too "reactive" and intrusive on thought processes carry less weight in this context.

With respect to the methodology of the simulation, both SMEs disliked the layout of the whiteboard. They felt it should be redesigned to reflect the information they required. One SME wanted to have a sketchpad on which to write notes as the mission scenario played out, which would be rather like the tools and artefacts that he would create for himself on an air defence platform. Both SMEs felt that they were required to micromanage too much, and that they needed extra help. One suggestion was that we include three levels of hierarchy in the simulation; three participants playing MCo**,** Fighter Controller, and Fighter Pilots. Minor details, such as firing missiles, would be handled by the fighter pilots, allowing the MCo to concentrate on the tasks that are only relevant to his role. However there is a limit to the number of participants that is practical.

The SMEs felt it unnatural not to have a mission-planning phase before the scenario began. They felt as if they were just being "dropped" into the middle of a mission, and that a large amount of their initial time was spent gaining situation awareness and intelligence that they would normally have prior to the mission. For research purposes we could use a mission-planning phase to elicit knowledge about the participant's expectations prior to the mission, and to see how these expectations affect the way in which the participant's work when unexpected or disruptive events occurred.

Despite these methodological problems, the overall comments about both the ACCW and ACCRD procedures were positive and encouraging, and both SMEs felt that each technique provided rich and useful information. They did not feel that the limitations of the JFC game invalidated it as a basis from which to elicit knowledge and build models that would help to design future air defence systems.

5. Conclusions

Our conclusions are tentative given our low participant numbers to date and the fact that we are at an early stage in our research program. However there were quite impressive similarities between the two participants in each condition despite slight differences between the elicitation techniques of the ACCW RAs and the ACCRD interviewers.

At present, ACCW is probably the more effective technique for eliciting work domain characteristics and control tasks relating to the adversarial nature of air defence. In half the observational time of the ACCRD technique the ACCW delivers as many if not more statements about adversary situation, intention, and constraints, and about own constraints. The relatively smaller amount of information provided under the ACCW procedure about own situation and intentions could be rectified—if needed—by adding ACCW questions specifically probing these areas.

Further analysis is under way on a more detailed comparison of statements from ACCW and ACCRD conditions with a view to how well each technique would help CWA analysts build WDA and CTA models. We are taking current versions of the WDA and TC-CTA for our air defence domain (Naikar & Sanderson, 2000; Sanderson & Naikar, 2000) and are classifying participant utterances as lying either (1) within the work domain and control task categories we have, or (2) outside current categories, necessitating new categories that SMEs deem to be important. We will determine whether ACCW- or ACCRD-generated statements are more effective in both accounting for and extending the analyses already performed. Once these issues have been decided, we will take the final technique back to SMEs in the AWACS and air defence domains for further investigations relating to AEW&C.

In summary, we believe the ACCRD and ACCW techniques are compatible with the *formative* characteristics of CWA outlined at the start of this paper (Sanderson, 1998). CWA should aid in the design of systems in a way that is relatively independent of previous technical solutions. In the investigation reported here, with the help of JFC we were able to capture enough of the air defence work domain to be plausible to RAAF personnel. In addition, CWA takes into account not just activity but the *context* in which activity takes place. Not only were we able to produce valid and engaging control tasks, but we did this against a valid representation of the work domain and without assumptions about the immediate physical support systems and layout. As details of physical systems to be implemented and layout become available during design, the constraints they impose and their implications for interactive systems design and crew structures and training can be investigated using either the ACCW and ACCRD technique or a combination of the two.

The ACCRD and ACCW techniques supported by a D^3M microworld appear to be effective in turning participants' minds to situations previously unencountered. Developing interfaces that aid human adaptation under such circumstances is an objective of CWA (Rasmussen et al., 1994; Vicente, 1999). Compared with CCW, the ACCRD and ACCW techniques clearly improved the degree of engagement experienced by SMEs. Moreover, the ACCW demonstrated that directed questioning could probe participants' knowledge of boundary conditions and constraints in a time-effective way. Full confirmation will depend upon the next phase of research.

Given that the CCW technique has already shown that complex crewing issues can start to be examined, we are optimistic that the ACCRD and ACCW techniques will be very useful human engineering tools whether or not one is using a CWA framework.

6. Acknowledgments

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