Collective Training – The Training Needs Analysis Challenge

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ABSTRACT

Training Needs Analysis (TNA) is the UK Ministry of Defence (MoD) instantiation of the Systems Approach to Training for use in the Acquisition process. It is derived from the long established SAT process used for the development of individual training. A current concern for the MoD is how this process can be applied to collective training in the light of current acquisitions such as the Carrier Strike capability for the Royal Navy. The aim of this paper is to identify how the current TNA process can be enhanced to cater for collective training by incorporating additional models and tools to facilitate the analysis process.

Evaluation of collective organizations and tasks shows that the key additional elements which must be catered for in the TNA process are command and control, communication and teamwork. These are found to be consistent across the land, maritime and air domains. The analytical approach must embrace both the interactions between individuals and teams and the cognitive nature of these additional elements.

We demonstrate that a range of human factors methods which have proven utility in the military domain can be identified as potential methods for inclusion in a "Toolbox" of methods for collective TNA.. In addition, models of command and control can be identified which may facilitate the development of generic training requirements for collective training. We also identify that further research is required to determine the exact nature of the contribution made by live training if an efficient and effective balance between live and synthetic training is to be achieved when determining training options for the collective domain.

ABOUT THE AUTHORS

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INTRODUCTION

The Systems Approach to Training (SAT) is a process with a well established pedigree in the military domain. In fact it is fair to say that the military are probably the leaders in the field, with training playing such a pivotal role in military activity. In the UK Ministry of Defence the instantiation of the SAT process in the acquisition cycle is referred to as Training Needs Analysis (TNA). The key components of the process are shown in Figure 1.

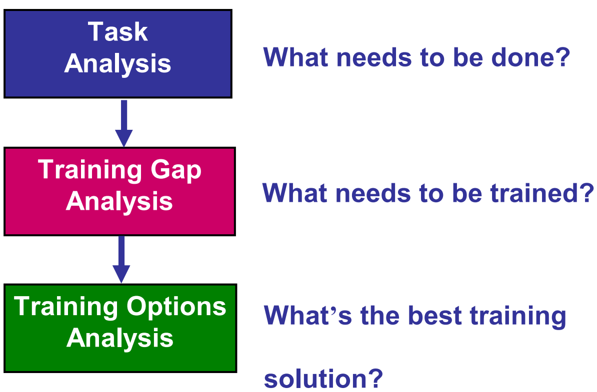

Figure 1 The Training Needs Analysis Process

First, a task analysis is conducted to determine what trained capability is required. A gap analysis is then conducted to determine the delta between current capability and the required capability, as it is this delta that determines the requirement for any additional training solution. The final stage is training options analysis which identifies the optimal potential training solution.

A question that has been raised within the Royal Navy (RN) is how should TNA be conducted for collective training? The context for this question is the introduction of the Carrier Strike capability, which includes the procurement of a new carrier and new aircraft and the formation of a new battlestaff. The development of suitable collective training solutions has a central role to play in delivering this new capability.

This paper sets out to explore the nature of collective tasks and the associated training requirements and to then suggest how the repertoire of techniques used in TNA can be extended to fully cater for the requirements of collective training. Firstly, the nature of collective tasks is explored. This is followed by a consideration of significant issues related to collective training solutions that affect the analysis process. Finally, the development of a collective training TNA process is discussed.

COLLECTIVE TASKS

To gain an insight into the nature of collective tasks and the required training an infantry battle group is used as an example. The structure is considered from the bottom up. This example from the land domain is then compared with the maritime and air domains.

At the lowest level of decomposition we have the individual infantryman represented in Figure 2. During initial training, each soldier is trained in a set of skills. An illustrative subset of these skills is firing a rifle, throwing a grenade and digging a trench

Figure 2. Individual Infantryman

We would rarely if ever deploy a single infantryman to achieve a military effect (though snipers might dispute this!). Typically, the smallest sub group would be the infantry section. If we simply group eight infantrymen together, as depicted in Figure 3, we simply get eight lots of the individual capability, that is to say the capability to fire eight rifles, throw eight grenades or dig eight trenches. Whilst this is more useful than the capability provided by the single infantryman, arguably it is not much more useful.

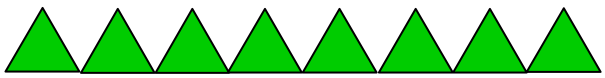

Figure 3. Eight Infantrymen

What fundamentally alters the capability provided by the 8 infantrymen is the addition of the section commander and his second in command, as illustrated in Figure 4.

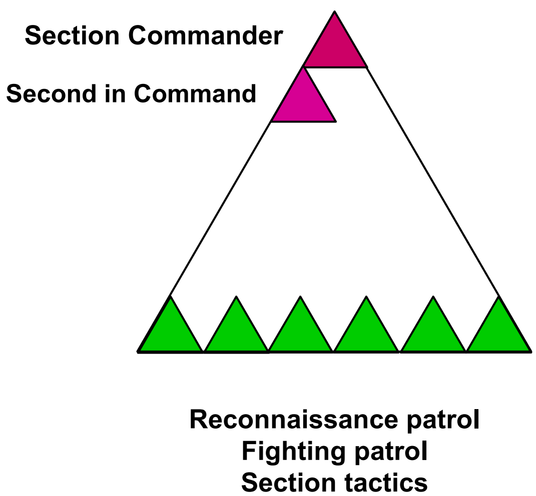

Figure 4. Infantry Section

With a section commander and second in command in place, the eight soldiers can now undertake reconnaissance patrols, fighting patrols and other section tactics. From a TNA perspective the question is “What has changed?”. Of course, what they are adding to the mix is a level of command and control and with it a requirement for communication.. Two additional training requirements emerge. Firstly, the commander and second in command need to be given an appropriate understanding of section tactics and to be taught how to execute command and control. This would include decision making, albeit at a simplistic level such as deciding what formation to use to progress across a given type of terrain. Secondly, the members of the section need to be trained how to operate as a group under the direction of their immediate commanders to execute the various section tactical maneuvers. Communication and interaction with others forms a part of both types of training.

A greater military effect can be achieved by aggregating infantry sections. Using the same logic as before, combining three sections would simply provide three sets of capability to undertake section tactics. It is the addition of the platoon commander, as shown in Figure 5 and the platoon sergeant that provides a far more potent capability. This additional element of command and control enables platoon tactics to be employed.

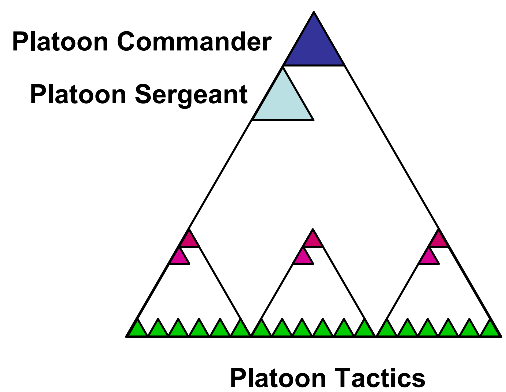

Figure 5. Infantry Platoon

Again, from a TNA perspective the question is “What has changed?” The platoon commander and the platoon sergeant need to be trained in platoon tactics and in the exercise of command and control in the platoon context. The entire platoon needs to train to execute platoon tactics. As the aggregation grows in size the interactions become more complex by virtue of there being more components that need to communicate with each other to coordinate their actions. Also the level of decision making required at the command level becomes more sophisticated.

Figure 6 shows the next level of aggregation, the infantry company. The addition of the company commander, the second in command (2ic) and the company sergeant major provide a much more potent capability than simply the aggregation of three platoons. The additional training requirement is that of the tactical training of the commanders and the training of the entire formation in the execution of those tactics.

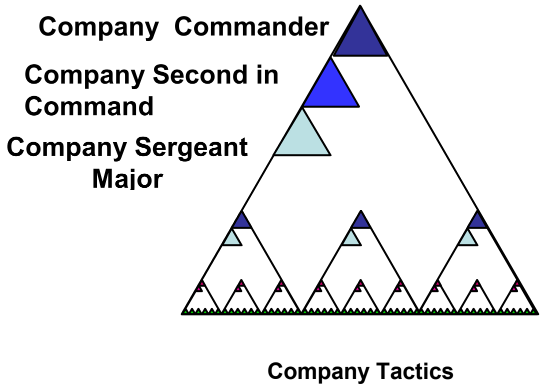

Figure 6. Infantry Company

A number of observations can be made about the structure developed so far. The diagrammatic representation is useful, as it explicitly exposes the layered structure of the organization. In Figure 5 we can see three layers of command and control above the bottom layer of infantrymen. In fact almost a third of the people in the organization are in a command and control position. What this simple representation does not expose is the nature and direction of the communications interactions between and within the layers.

Each level of command as you work up the structure is responsible for increasing levels of tactical problem solving and decision making. A point worth noting is that the structure is homogenous in so far as every individual in the company is an infantryman by training and role. Higher-level commanders will have had experience of the lower levels of command.

At the next level of aggregation the composition changes. Figure 7 shows the organization of 1st Battalion Royal Irish in the Battlegroup formation in which they deployed to Iraq. Whilst the core of the battle group was 5 infantry companies, they were supported by a battery of artillery and a Royal Engineer squadron. It also had an organic logistics echelon of 150 personnel. The disparate nature of the components means that the commanders now become responsible for integrating and coordinating elements from different domains to their own, that is to say infantry commanders are now responsible for tasking artillery, communications and engineer elements for example. It becomes apparent from examining this structure that as the size of the organization grows so the overhead in terms of staff required for the command and control function increases. At the levels above a battlegroup the command staffs or "battlestaffs" may number upwards of 50 to 100 or more people.

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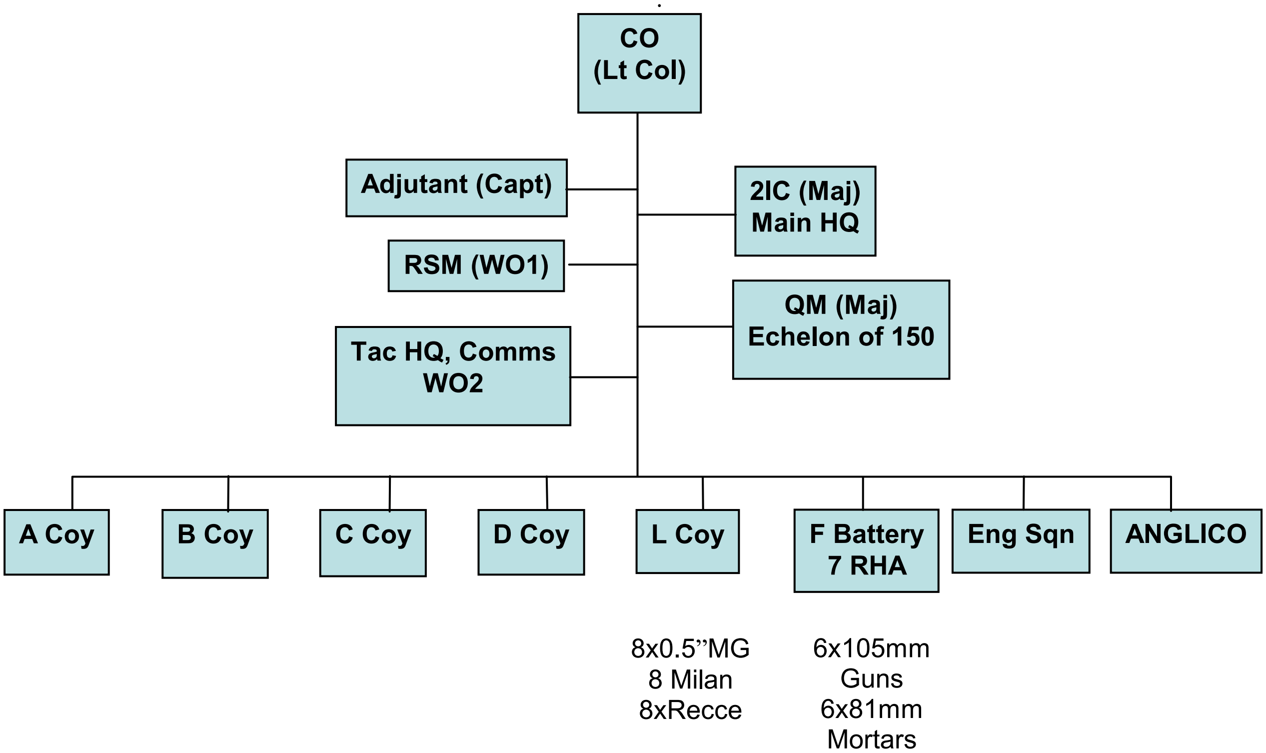

Figure 7. 1 Royal Irish (1,225 strong Battlegroup)

The challenge for TNA is how to deal with the scale and complexity of such large organizations. Whilst the size of the problem is not directly proportional to the number of people in the organization (of the 1200 in the battle group shown in Figure 5, many such as the infantrymen in each section are in the same role). There is an issue of how to divide and conquer such a problem with many people in different but related roles.

Before considering the issues of task analysis for such a large organization in more detail, it is useful to compare the land domain with the maritime and air domains to determine if the nature of the problem is the same across all domains.

In the maritime domain the obvious difference is that the smallest component that can act independently is the individual vessel. Typically the personnel on a warship are organized into teams or departments based on specialization. The warfare team is one such component and is responsible for the management of the sensors and operation of the weapons systems. There is a command hierarchy within this team. Other teams on the ship include the mechanical engineers responsible for the propulsion system and weapons engineers responsible for the maintenance of the sensors, weapons and other electrical systems. One could broadly characterize the ship's complement as being divided into two groups; those that get the ship to where it needs to be in a serviceable state to engage in warfare and those that conduct the warfighting. Another to be considered is that different ships are designed for different roles such as antisubmarine warfare, air defence or littoral warfare. Aggregations of different types of ships are put together to deliver required effects. A typical example would be a carrier strike group, with the carrier as the Flagship carrying both the battlestaff responsible for the command and control of the group and the air assets providing the strike capability. From a TNA perspective, this structure is similar to that of the larger scale structure in the land domain in that there heterogeneous components with layers of command and control.

Air domain operations are typically focused around fixed operating bases on which the operational planning and command staff and the considerable number of engineering, logistics and other support staff are based and from which the warfighting component (the aviators) are launched. Fighter and bomber aircraft typically operate in groups and airborne command and control from Airborne Warning and Control System (AWACs)is often deployed. Command and control is challenging because of the high speed and three dimensional nature of the battlespace. An air battlestaff would be responsible for command and control of a range of disparate air assets in theatre. The TNA challenge is similar to that for the land and maritime domains.

In summary, collective tasks have a number of components that are not generally present in individual tasks. A collective organization will have a command structure and the command team will need to be trained in team problem solving and decision making and in the execution of command and control. Furthermore, interaction and communication with others are cornerstones of producing a collective effect. Finally the scale and complexity of the tasks that a collective organization can undertake will be significantly greater than for any individual.

TRAINING OPTIONS ANALYSIS

Training Options Analysis (TOA) is the final stage of TNA and is illustrated in overview in Figure 8.

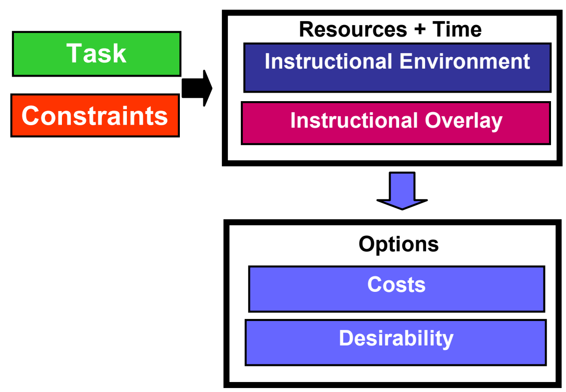

Figure 8 Training Options Analysis

Taking into account the nature of the tasks to be trained and any constraints such as cost time and resource availability, TOA seeks to identify appropriate instructional environments and overlays to deliver the required training. The nature of instructional environments has been considered in detail in Pike and Huddlestone (2007). The critical point is that instruction in its broadest sense is a process based upon interactions between students, instructors and systems. For an instructional environment to be effective it must support each interaction at the necessary level of fidelity. By identifying the resources and time required for alternative options the relative cost of alternative solutions can be determined. These can be weighed against the perceived efficacy of alternative solutions to enable the selection of an optimal solution. Challenging questions for training options analysis in the collective domain include determining the appropriate balance between live and synthetic training, providing useful training experiences for all participants in collective training and developing training where the training task may not be completely understood. These are considered in turn

Live Synthetic Balance

One question which is frequently asked but much less frequently answered is "What should the balance be between live and synthetic training?" In the general sense, live refers to the live environment. In flying training this would refer to flying the actual aircraft. The term "live" in the military context is more problematic when it comes to the use of weapons. Since killing people in training is to say the least morally unacceptable, the term "live" typically refers to field exercises where weapons effects are simulated. The relationship between live and synthetic training is illustrated in Figure 9. The principal drivers for using simulation are generally cost, safety and resource availability. Simulation can also offer superior facilities for controlling the training environment, performance measurement and the provision of After Action Review.

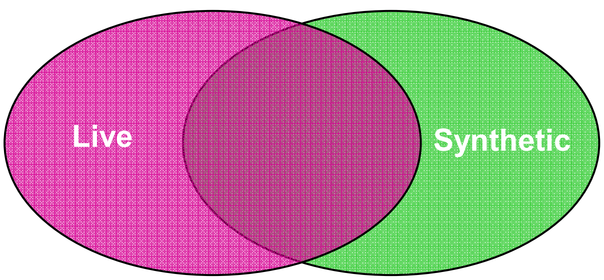

Figure 9 Live Synthetic Balance

Some aspects of training can only be trained using simulation. A simple example would be the training of pilots to handle engine fires. It would be ridiculous and potentially fatal to start an engine fire in flight. Discussions about the balance between live and synthetic training usually fall into the overlapping zone where the training could be conducted in either the live or the synthetic environment.

As the capabilities of simulation have improved there is an ever increasing pressure to move from live to synthetic training. Figure 10 provides a more accurate view of the balance between live and synthetic training as it is currently perceived, especially by those responsible for delivering training with ever diminishing budgets. It is actually live training which is becoming ever more difficult to defend. Field exercises are inordinately expensive compared with simulation. Also, there are significant environmental pressures to reduce the use of resources such as training

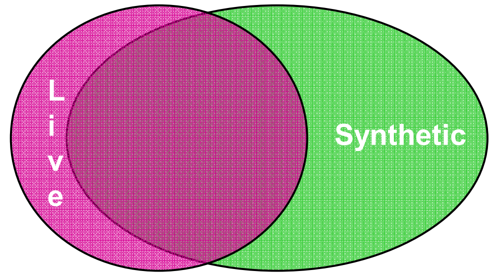

Figure 10 Revised Live Synthetic Balance

areas and low flying areas. The majority of the research effort in this field is focused on the capabilities of simulation. What appears to be unexplored is what is unique about live training that cannot be replicated in simulation. There is a good deal of opinion expressed about this subject. Commonly, the frictions of war are cited, that is to say the practical difficulties encountered with the environment such as dealing with tiredness, adverse weather and terrain and the practical difficulties of maintain communications and situational awareness. One could argue that unless research effort is expended on examining this issue we will discover what has been lost by not training in the live environment when it is too late, in combat. The challenge for TNA is to determine the fidelity requirements for the interactions between people, systems and the environment. This is particularly challenging in the collective training domain because of the sheer scale and complexity of these interactions.

Worms' Eye and Gods' Eye views of Training

If field exercises are conducted as a section, as a platoon, as a company and as a battlegroup, what are the differences in experience that an infantryman in a platoon would have? When operating in a section, platoon or company it is possible to see the other components that you are operating with and easily understand the impact of their activities and your own and visa versa. As scale increases, this becomes more difficult to perceive. The question becomes "what is gained from operating within a larger context?". Looking at the problem from the top down, such as from a battlestaff perspective, what difference does it make if there are troops on the ground at the lowest level? What is the training advantage above and beyond having the lower order components simulated? This is not to suggest that there is no advantage, but that it needs to be clearly understood to ensure that an effective mix of training options are exploited. It could be argued that the worse combination is to have thousands of troops on the ground (training fodder) simply to produce training events every few days for a battlestaff to react to.

Heretical View - Experimentation

A somewhat radical or even heretical view concerning the use of simulation when considering the introduction of a new capability might be to suggest that simulated environments should be constructed to allow experimentation to determine how a task should be carried out. The challenge with a new capability is that, if we only know how equipment operates rather than how to exploit its capability, doctrine may well be undeveloped or immature and that a detailed task analysis may not even be feasible. This would shift the focus of TNA from trying to precisely capture processes not yet envisaged in detail, to capturing the nature of the scenarios that the capability is aimed at. This would provide a training capability which is more exploratory in nature.

COLLECTIVE TNA METHODOLOGY

To be effective, a TNA methodology for collective training must take account of the significant attributes of collective tasks and elicit all of the essential information required to facilitate the development of effective training options. Therefore, it must facilitate the analysis of command and control and teamwork, taking into account both the cognitive nature of these tasks and the central role of interaction and communication. In this section each of these requirements are considered in turn. In addition the unique contribution of the Mission Essential Competencies approach is evaluated for its relevance to TNA in the collective domain.

Mission Essential Task Lists

Mission Essential Task Lists (METLs) are a common way of describing the tasks that a unit or formation is required to undertake in order to carry out a specified range of missions. The Joint Mission Essential Task List (JMETL) Development handbook recommends the construction of a Matrix to cross refer tasks to missions. Thus METLs may provide a start point for the task analysis within TNA. METs are relatively high level descriptions of activity. Examples at the divisional level in the Land domain might be "Conduct a deliberate attack" or "Conduct area defense". Each MET will decompose into a number of sub-task elements. There could be common sub-components across METs. In the cases of conducting a deliberate attack and conducting area defence, planning is likely to be a common function. Figure 11 illustrates this point, showing three mission essential tasks that overlap.

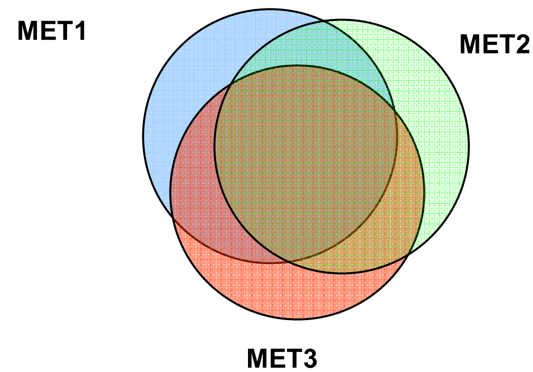

Figure 11 Mission Essential Tasks

This is significant because there is the possibility of considerable duplication of effort. Therefore, the potential nature of such overlap needs to be considered further in devising a TNA approach for Collective training. As the central features of all collective activity are the requirements for command and control and teamwork, these merit further consideration in this respect.

Command and Control and Teamwork

There has been much research into the nature of effective command and control and teamworking. A multiplicity of models have been produced as a consequence. One potentially fruitful avenue to be explored for TNA in the collective domain is to determine if such models can be exploited to aid the analysis process. One could argue that if there are generic elements that can be identified for command and control and teamwork, one should be able to develop a generic set of skill descriptions that are applicable across collective activities. Whilst these may well need to adapted to any given context it should save much reinvention of the wheel in the analytical process.

The challenge is to reconcile the various models that are available. Work has already been conducted in this area. One example is the Military Command Team Effectiveness: Model (NATO, 2005) shown in overview in Figure 12. Of particular interest for TNA are the team and task processes that are identified and elaborated within the model (details shown in the "speech bubbles" in Figure 12) as they may provide a

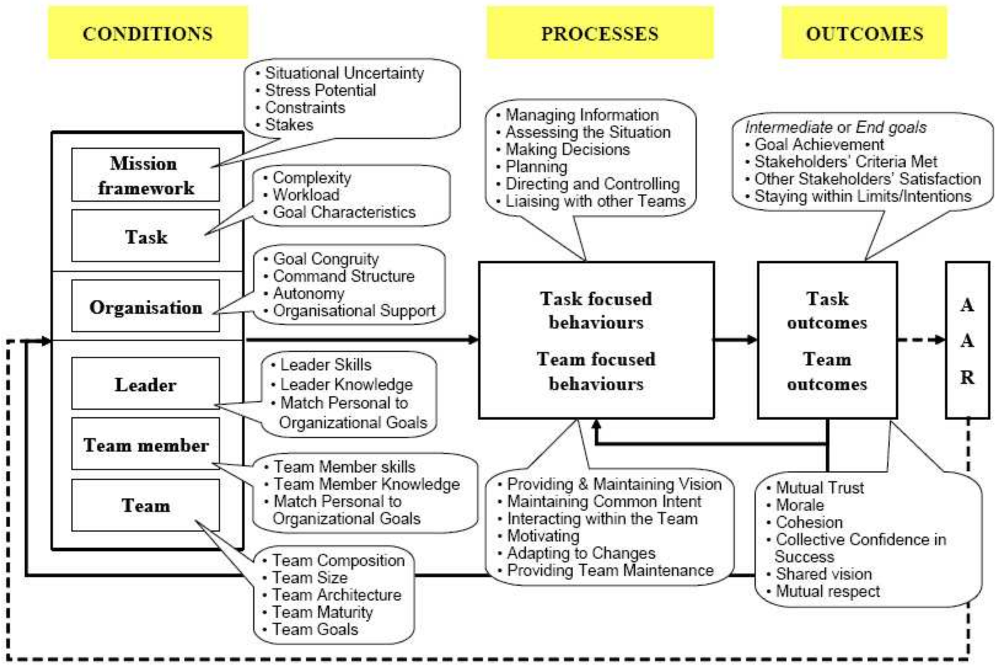

Figure 12 Military Command team Effectiveness Model (NATO, 2005)

framework for the analysis of command and control and teamwork

Cognitive Task Analysis

Given that command and control and teamwork have a significant cognitive component, it is reasonable to assert that Cognitive Task Analysis (CTA) should have a place within TNA. Numerous CTA methods have been developed in recent years (for an overview of leading methods the reader is referred to Stanton, Salmon, Walker, Baber and Jenkins, 2005). Of the various methods available, one in particular deserves further consideration. In a recent review of the use and suitability of CTA methods for the defense domain, Cognitive Work Analysis (CWA) was identified as being particularly suitable because of its adaptability (Baber, Borras, Hone, MacLeod, McMaster, Salmon and Stanton, 2005). CWA, or more specifically the first stage of CWA, Work Domain Analysis (WDA) has been used for training analysis on a number of occasions. Naikar and Sanderson (1999) describe its application in the development of F/A -18 training in Australia. Table 1 shows a sample of the output for each level of WDA along with descriptions of the utility of data that can be derived from each level.

WDA produces an abstraction hierarchy. The levels of the hierarchy are shown in the first column of Table 1, with examples in the second. The highest level describes the functional purpose(s) of the system. Naikar and Sanderson (1999) suggest that this level provides the training objectives and design objectives for training devices. The next level of decomposition is the priorities and values of the system which describe how success would be determined and therefore inform the development of performance measures and the nature of data capture required. The third level of abstraction is the set of functions that have to be carried out to achieve the overall system purpose. This level of analysis also provides information about the nature of scenarios that have to be provided in training, since opportunities to practice these functions must be present. Thus, in the example in the table, to achieve the purpose of “initiation of offensive action” is to achieve the “nullification of enemy air attack”, one has to be capable of “weapons delivery to surface and air targets”.

What is notable about these first three stages of analysis is that they are technology agnostic. That is to say, the elements identified are independent of the nature of the system to be used. They would be valid whether one was to use an F/A-18 or a rock and a catapult (though personally we would rather have an F/A-18 than a catapult to see off a supersonic bomber!).

Table 1 Sample of the F/A-18 Work Domain Analysis (adapted from Naikar and Sanderson , 1999)

Functional Structure	**F/A-18 work domain analysis**	**Training Needs**	**Functional specifications**
Functional Purpose	Initiation of offensive action	Training Objectives	Design Objectives
Priorities and values	Nullification of enemy air attack	Measures of Performance	Data Collection
Purpose-related Functions	Weapons delivery to air and surface targets	Basic Training Functions	Scenario Generation
Physical Funtions	Supersonic cruise	Physical Functionality	Physical Functionality
Physical Form	Air and surface threats	Physical Context	Physical Attributes

This has a particular significance when conducting TNA activity early in the acquisition cycle when alternative equipment options for satisfying a capability requirement are still on the table. It is possible to start TNA earlier in the cycle than might otherwise be possible.

The final two stages of analysis, physical functions and forms, are concerned with how the purpose-related functions map onto the systems to be used. Physical functions are functions provided by the system, such as supersonic cruise for an F-18. Physical form refers to the nature of the physical objects within the system and the environment within which it operates, such as air and surface threats which are physical objects in the environment within which an F-18 operates. This analysis also provides information relevant for the determination of the levels of functional and physical fidelity required for the training system (essential information for training options analysis).

The Naikar and Sanderson (1999) example demonstrates that WDA can be applied effectively in an individual training analysis situation. However, before recommending its use in the collective training domain one needs to consider if the technique is amenable to be being scaled up for use in such large scale applications. A recent study by Salmon, Stanton, Jenkins and Walker (2006) employed this technique successfully for the evaluation of the relative merits of confederated versus federated training solutions for training RN battlestaffs. This would suggest that WDA has potential for future use in the collective training domain.

Modelling Interactions

Effectively capturing the nature of interactions with collective organizations requires an appropriate set of methods. An exemplar of how human factors methods can be combined for this purpose is the Event Analysis of Systematic Teamwork (EAST) method developed by Stanton et al (2005) A flowchart depicting the EAST procedure is presented in Figure 13. They describe it as using "*a combination of human factors methods to form a comprehensive methodological framework for analysing collaborative activity in complex socio-technical systems*". The methodology comprises three layers: data collection, data analysis and data representation. Salmon, Stanton, Walker, Jenkins, Rafferty, Ladva and Beond (2006) have demonstrated its utility in the military domain in their evaluation of electronic, radio and paper methods of command and control. The method takes a toolbox approach. A broad range of tested and established methods are assembled and sequenced so that a wide range of problems can be tackled by appropriate selections of methods from the toolbox.

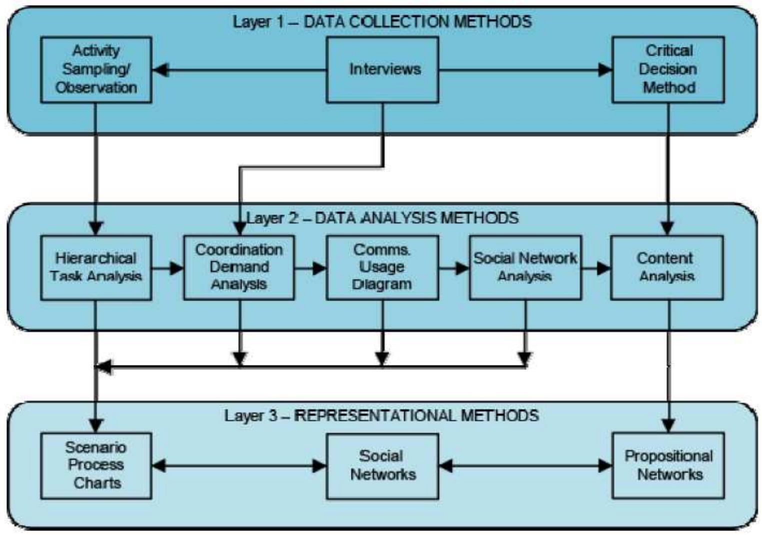

Figure 13. The Event Analysis of Systematic Teamwork (EAST)

Mission Essential Competencies.

The Air Force Research Laboratory has made a significant contribution to training analysis and development with the introduction of the Mission Essential Competencies (MEC) approach. This has been characterized as a work analysis method (Alliger, Beard, Bennett, Colegrove and Garrity, 2007). It consists of both a set of outputs, of which MECs represent the highest level, and a process. A MEC has been defined formally as "higher-order individual, team, and inter-team competency that a fully prepared pilot, crew, operator, or team requires for successful mission completion under adverse conditions in a non-permissive environment" (Alliger et al, 2007). The format is a brief statement with clarifying text, start and stop conditions and a purpose statement. They give the following example for AWACS:

"*Detects entities in area of interest* – Includes al air and surface tracks, and emitters of interest.

> Start: When systems operational.
> Stop: When systems powered down.
> Purpose: Assist in contributing entities to Single Integrated Operational Picture (SIOP) (e.g.using onboard and offboard sensors)" (p14)

Colegrove and Alliger (2002) observe that, in many cases, they are job-contextualised and less general than competencies found in business environments. MECS can apply to more than one crew position and this is captured in MEC/crew position matrix.

Further decomposition of MECS yields supporting competencies and underpinning knowledge and skills. The final MEC output is a set of experiences. These are defined as developmental events that occur in training and at other times in the career of a warfighter that facilitate the learning of knowledge or skills, or practicing an MEC or a supporting competency. Examples cited include flying over mountainous terrain, live weapons employment and operations against air or ground adversary jamming (Alliger et al 2007).

The MEC development process consists of a mix of Subject Matter Expert (SME) workshops and surveys. In an initial workshop for a given mission type, SMEs evaluate a range of instances of that mission to develop a list of tasks. This intermediate product is used to facilitate further discussion to elicit knowledge, skills and supporting competencies. Following the workshop the facilitators develop draft MECs. A second workshop is then held for the SMEs to review and revise the MECs as required and to develop the list of experiences. A survey is then conducted of a broader range of SMEs. The last stage is a final SME workshop to interpret the survey results and identify training gaps. (For a full description of the process see Alliger et al (2007))

From the above description one can see that MEC approach blends traditional task analysis with the development of a competency framework. One might argue that since it produces a set of competencies and a list of required knowledge and skills, it does not have much to offer that is new. We believe that this suggestion misses the key contributions that this approach makes. Firstly, the format of MECs themselves provides a much richer description than one typically finds in task statements or training objectives. Secondly, and very importantly, the elicitation of experiences provides vital information for training development. We would contend that one of the most difficult aspects of training design is the development of meaningful and credible learning events in an appropriate learning environment to elicit the required acquisition of skills and knowledge and motivate the student. The considerable insight that the SMEs provide in identifying significant developmental experiences is not replicated in any other training analysis technique that we have seen.

There are some caveats that need to be considered. Firstly, in the majority of cases the teams to which this technique has been applied so far are relatively small (eg an AWACS crew). This raises the question of scalability. Secondly, MECS have so far been developed where there is an extant training system and where the platforms concerned have been in use for some time. The scalability issue is being explored as AFRL are currently applying the MEC approach to Air Operations Centre (AOC) training (Alliger, Garrity, Morley, Rodriquez, Beer and, McCall, 2003). The AOC is a battlestaff organization so the lessons learnt from this experience will be directly relevant to this work. Application of the technique to a new capability for which the platforms do not yet exist is uncharted territory.

CONCLUSIONS

Critical analysis of the nature of military collective organizations and the tasks that they undertake in the land sea and air domains reveals that TNA for collective tasks must address issues that do not typically arise in individual training. Command and control, teamwork, communications and interactions between individuals and teams must all be considered and the cognitive nature of these tasks addressed. We have shown that there are both a range of Human Factors methods that could be applied to these problems, and models of command and control and teamwork that can be exploited for such analysis. It could be possible to produce a Collective TNA Toolbox of methods that is suitably flexible to facilitate collective TNA across all domains and levels of training. In addition, research is required into the exact nature of the contribution made by live training if the appropriate balance between live and synthetic training is to be achieved.

REFERENCES

Alliger, G., Garrity, M.J., Rodriquez, D, Beer, L., & McCall, J.M (2003) Competency-based Definition of Work and Performance for Command and Control. Proceedings of 25th I/ITSEC Conference, Orlando Fl

Alliger G.M., Beard R, Bennett W., Colegrove C.M., & Garrity M., (2007) Understanding Mission Essential Competencies as a Work Analysis Method. AFRL Report AFRL-HE-AZ-TR-2007-0034

Baber, C., Borras, C, Hone, G., MacLeod, I., McMaster, R., Salmon, P.M., & Stanton, N.A. (2005) Cognitive Task Analysis: Current use and practice in the UK Armed Forces and elsewhere, HFI DTC Report HFIDTC/WP2.3.1/1

Colegrove, G.M., & C.M.Alliger, (2002) Mission Essential Competencies: Defining Mission Essential Competencies n a Novel Way. Paper presented at the NATO RTO Studies, Analysis and Simulation Panel (SAS) Symposium. Brussels, Belgium

Naikir, N. & Sanderson, P.M., (1999) Work Domain Analysis for Training System Definition, *International Journal of Aviation Psychology, 9(3),* pp271-290

Pike, J. & Huddlestone, J.A. (2007) Instructional Environments - Characterising Training Requirements and Solutions to Maintain the Edge, Proceedings of the 29th I/ITSEC Conference, Orlando Fl.

Salmon, P.M., Stanton, N.A., Jenkins, D.P. & Walker, G.H. (2006) An Assessment of the Benefits of Confederated Versus Federated Naval Training Systems Using WESTT and Cognitive Work Analysis. HFI DTC Report HFIDTC/WP1.3.4/1

Stanton, N.A., Salmon, P.M., Walker, G.H., Baber, C., Jenkins, D.P. (2005) Human Factors Methods, London, Ashgate.

Salmon, P.M., Stanton, N.A., Walker, G.H., Jenkins, D.P, Rafferty, L., Ladva, D., & Beond, A.(2007) Gold Command Wall Evaluation; EAST Analysis of Electronic, Radio and Paper Methods of Command and Control, HFI DTC Report HFIDTC/WP1.3.4/1