Title of Paper
"Towards a Model of Capability Trading for UK Defence" [15 words max]

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Topic 11 C2 Assessment Tools and Metrics

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Biography

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Abstract [200 words max]
"Trading" is the defence term for altering the Balance of Investment (BOI) between military capability components to maximise effectiveness. Trading is a social activity, and as such the trading activity needs to consider the individual's contribution as well as the activity process itself. The trading process has taken place in the military domain for many years and is well documented and traceable. However, the effectiveness of the process and the success of the trading decision are less well observed and documented. Military capability is delivered using a combination of factors (e.g. equipment, training, logistics and information). In the UK military context, these factors are collectively known as the Defence Lines of Development (DLOD).

Trading is the mechanism used to adjust the levels of investment in each of the DLODs to achieve the required military capability outcome in the most effective way. This paper examines the problem space of trading and outlines the findings of an initial exploration of the practical experiences of trading practitioners, using personal confidence rating as a metric. An emerging model is proposed, which could be used for low fidelity long-term projections of trading decisions in support of long term BOI assessment (198 words).

START OF PAPER

The Research Environment

The defence domain is an area that has been academically reviewed in depth especially in areas such as campaign planning and gaming; however, there are a number of areas which would benefit from a higher level of scrutiny; these include capability management, trading and acquisition. In particular, previous evaluations of defence processes in trading have been largely empirical and have raised issues as selected by the researchers.

Bath (2002) examined the trade-off of sensor performance factors within various platforms; this was taken further by Clark (2005) who focussed on the trade off of sub-system performance within an aircraft platform. It is clear that the research to date has been biased to certain areas by the source of industrial funding. Military aircraft get a high level of scrutiny both at a platform level (Clark, 2005), long term maintenance (Hockley, 1998) and on equipment selection (Middleton et al, 2006). Walmesley and Hearn (2004) conducted an interesting BOI study of armoured combat support vehicles using traditional operational analysis methods, but did not go as far as addressing the trading and decision making aspects. Mavronocolas *et. al.,* (2006) used the Nash equilibrium solution concept of two-player gaming to explore the effect of unilateral strategies of two player trading on the mutually dependent outcome of the price of defence.

A few studies conducted outside of the UK have taken a more holistic view of the national problem of funding provision and the competing claims on resource. Ozsay (2002) gave a frank view of the Turkish budgetary trading process between the various government departments. Gates (2002) examined the defence environment in the future, with a projection of how the economic dynamics of the customer supplier relationship would work with the increase in world collaborative politics. Berkok (2005) continued this work looked at how budgetary reductions have an effect on the behaviours and priorities of defence contributors to combined forces operations worldwide.

None of the previously cited work examines the effect of the person who is involved in the process, and who is one of the key links in the success or failure of the endeavour. The view of the individual provides the focus of the current paper rather than the more traditional approach on historical defence analysis methods. In this paper, a view of defence from the people who have had experience of the activity will be given especially within the context of examining the trading process and assessment of achievement.

This research aims to gain a deeper valid understanding of complex systems that involve humans, using a grounded theory methodology (Glasner and Strauss, 1997; Strauss and Corbin, 1994, p273-85) of the verbal construct of trading participants. This qualitative approach has been adopted in order to highlight some of the views expressed by the individuals involved in the trading process, and their positions in respect to human inquiry. The work of Helen Fox (1994) and Moore and Smith (1994) have exemplified this approach arguing that *'the ideas of the individual need to be taken seriously'* (Fox, 1994). The challenge is then to let the data speak for itself in order that '*the unexpected and the serendipitous have the chance to emerge, illuminate and challenge'* (Moore and Smith, 1994).

All the contributors were asked open questions on what they found to be useful in the trading process, to describe their experiences and to suggest areas that could be improved. These interviews were made anonymous and then transcripted before being used as a basis for analysis. Direct quotes from individuals have been used in this paper and are shown in italics attributed to their anonymous identifier.

Significant claims, concerns and issues of participants will be discussed. The paper will explore the extent to which, in their reflections and learning, individuals can enhance the current trading practices both in exposing the issues and in constructing a solution.

Context of UK Defence Trading

In the last five years, the approach of the UK Ministry of Defence (MoD) to the provision of capability has changed radically and comprehensively. At the start of 2006, the Defence Industrial Strategy (DIS) White Paper (The Stationery Office, 2005) was presented to Parliament as a wide reaching discussion paper on the defence domain and how it should operate. Historically, the MoD had only seen its role as 'customer' and so was driven by time, cost and quality (performance). Therefore, in its assessment of success, it had concentrated on a small part of the delivery lifecycle and only examined the success criteria for moving through the process. Once the project reached the operational implementation stage, its progression to that point was considered to be an achievement of success even although the content of the project could be less than expected.

In the summer of 2006, the UK launched the Defence Acquisition Change Programme (DACP). This was in order to deliver the internal, structural, organisational, process, cultural and behavioral changes to facilitate good Through Life Capability Management (TLCM), as identified in the DIS and recommended in the Enabling Acquisition Change (EAC) report (McKane, 2006). The DACP was formed to build on the success of previous acquisition reform programmes to deliver better quality long term capability for the UK armed forces.

In 2007, Dstl initiated a package of studies in the area of capability assessment that included success and efficiency of trading as a route to that success. Dstl are looking

at success across the whole life of a capability, which is termed Through Life Capability Management (TLCM). This work requires a long term examination of the decision making process and its implications on long term financial metrics, BOI and capability delivery.

Trading is the mechanism for handing over dependencies to other equivalent bodies that are more appropriate to their delivery, and *vice versa*. Along the delivery process, there are a number of points at which trading occurs. Currently no assessment for the success of this process, or the documenting of the transfer, exists, but good trading can have a profound effect on the success of a project.

Good trading results in parts of the projects being delivered by people who are able to deliver, and aware of their responsibilities and are coherent with the linked projects. In contrast, poor trading results in parts of the project being handed off to organisations who are either not able to deliver, are not aware that they are supposed to deliver, or have inconsistent timescales for delivery that are not cohere with the original project.

<u>What does success look like?</u>

In the UK military context, there are eight recognised factors required to achieve a successful capability that are collectively known as DLODs. A military capability can be achieved using various combinations of these DLODs, although in any solution, there must be a level of representation of all eight (as shown in Figure 1). The eight DLOD are: Training, Equipment, Personnel, Information, Concepts and Doctrine, Organisation, Infrastructure, Logistics.

In addition to the eight basic DLODs, Interoperability is proposed as an overarching theme that must be considered when any individual DLOD is being addressed. Interoperability also covers interaction between Services, UK Defence capabilities, Other Government Departments (OGDs) and the civil aspects of interoperability, including compatibility with Civil Regulations. Interoperability is used in the literal sense and is not a compromise lying somewhere between integration and de-confliction (Ministry of Defence, 2007). The definition of each DLOD is included in Annex A of this paper.

Figure 1 UK Defence Lines of Development (DLOD)

The UK MoD have defined capability as '*an operational outcome or effect that users of equipment need to achieve*' (Ministry of Defence, 2005, p.6), or in systems

engineering terminology, '*the operational need which is satisfied by the deployment of an operational system integrated with other co-operating systems*' (Ministry of Defence, 2005, p.8). Capability can be viewed as a mesh of links that must all be in place to achieve the aim.

The latter definition is a derivation of the former, and recognises the requirement that capability can be delivered without the provision of equipment. The latter point is a key change in approach, as it has been recognised that capability may be achieved as a result of personnel training or in a change of proposed use (or doctrine) rather than additional equipment or upgrades. An example of this is the operation to re-establish democracy in an area. This can be achieved in a number of ways. For example:

1) by invasion by force (equipment DLOD);
2) by educating the population (training DLOD);
3) by developing a self sustaining economy that is not dependent on local militia (logistics DLOD, personnel DLOD);
4) by a combination of all of these.

It can be seen that the use of a capability involves a wide range of military organisations, interacting effectively to deliver a single outcome. The extent of the contribution of each of the organisations will vary across the options outlined in the example, and so there is an optimum solution that ideally should be defined. It is the process of planning for the delivery of such examples, and the trading of components that will support the aforementioned options in the most efficient manner that comprises the area of interest here.

The Capability Trading Environment

In the UK hierarchy of defence acquisition, there are a number of organisations who are responsible and accountable for delivery. At the strategic level of operations, the organisations and roles are well defined, that is, the DE&S organisation (Defence Equipment and Support) deliver equipment and logistics support; the DCDC organisation (Defence Concept and Doctrine Capability) provide the guidelines for operational use. However, at the operational level of delivery, the roles are less well defined and are sometimes down to the discretionary appointments of Integrated Project Teams Leaders (IPTLs) and the Director of Equipment Capability (DEC) of the respective capability groups.

Trading is not a new concept, and is achieved at a number of operational levels within the MoD. Large capabilities are traded in the Defence Budget on an annual basis, for example, the reduction of the number of naval platforms in exchange for an increase in the costs of the future fighter aircraft programme (National Audit Office, 2004). These headline trades are authorised at Government level and made between the respective Chief of Staffs (Army, Air Force and Navy). One example of this is the increasing cost of the UK Typhoon programme which has taken up an increasing portion of the UK Defence Budget, and resulted in the decommissioning of a number of Royal Navy vessels that can no longer be maintained (National Audit Office, 2004). The longer term effect of this trade is that the reduction in ships removes the UK ability to support geographically remote operations, so other provisions need to be made.

In the current acquisition methodology, Integrated Project Teams (IPTs) and DECs are set up and appointed to deliver a bounded capability. These groups could be

bounded to deliver a specifically defined project, or programmes of projects that combine to produce a military capability. These teams could be far reaching such as the Directorate of Underwater Effects (DEC UWE) or platform specific, such as the Future Mine Counter Measures Capability Integrated Project Team (FMCMC IPT). The role and responsibilities of the groups are defined with delivery boundaries, but the groups are inherently interrelated. One interviewee commented *"it was only when the capability of the vessel was broken down in terms of kit that people realised that the whole boat was dependent on the support of nearly fifty different groups, most of which were completely unaware of the boat programme"* (A07-2007-11-26).

In the area of combined operations, are the scenarios that affect a number of IPTs who work in the same capability domain area. One interviewee who had previously been in the role of Requirements Manager in one IPT described an experience, "*in one of my trading meeting, we put forward the preferred solution of an increase to the provision of … (equipment)…., which was agreed at the meeting. Several months later we realised that that equipment was maintained by OMs (Operator Maintainers) who were no longer on the manning profile for that vessel due to previous cuts*" (A10-2007-12-06). This example illustrates that ripple effect of change within one group, having a profound and often undesired effect on the ability of another group to deliver.

The drive to change one requirement to optimise one position can change the whole nature of a delivered capability. For example, on a military aircraft, the desire to maximise the defensive aids suite would require an increase in on-board power, which would increase the fuel load requirements, which would increase the weight of the aircraft. This drive for better aids would enhance the aircraft's reach capability in an operational scenario, but would reduce its range in all of its other operational roles. In non-equipment terms, the change in aircraft may also result in an increase in maintenance, and the ability to support other land operations. It is therefore very difficult for individuals to envisage and effectively plan for all the aspects of a trade, and to identify the common need. In essence, this is the core problem of trading.

In these illustrations, it is crucial to the overall outcome for decisions to be made in full appreciation of the facts and impacts, and the mechanism for exploring the decision options is an integral part of trading. Trading is the mechanism of ensuring delivery of the required effect in the most efficient way. Good trading, for example, will result in the ship being aware of its interactions with other groups, and will ensure that funding is secured to the projects that will support geographical remote operations before the decision is made to decommission the ships.

For any decision, there are a number of solutions and outcomes. Trading is the mechanism of exploring these options with a view to selecting the most efficient solution route that provides long term effectiveness, without compromise to other capability effects. Once a preferred solution is identified, the responsibility for the outcome can then be traded to the group that is most appropriate for delivery, which could be the host IPT, or a neighbouring IPT, or a supporting body.

Ideally, trading requires the ability to:

1) identify dependencies;
2) identify responsible parties;
3) transfer ownership (including budget transfers) to the most appropriate person;
4) deliver the common need.

Trading is a social activity that is achieved by the interaction of individuals who have complementary skills and experiences. Ideally, trading should be achieved between individuals who are part of an accountable group that contains a spectrum of skills and experiences to cover the whole area of capabilities affected by the trading decision.

In reality, the trading process is achieved between Integrated Project Teams Leaders or their respective staff. The most visible trading mechanism is between the respective individuals who are operating in the role of Requirement Manager of two IPT organisations. These individuals are generally serving military representatives who are on short to medium term assignments, that is, in post for between 18 and 30 months on average (National Audit Office, 2004). The skills inherent in operational personnel do not naturally include long term planning and long term decision making. The combination of staff rotation and skill set increases the long term risk of the output of the acquisition decision maker.

To mitigate the risk involved in trading, traceability of requirements trading is essential, and at a team level is generally achieved using complementary databases and requirement structures. This method captures the reasoning behind the trade and illustrates the links and implications on other teams. However, the requirements database and its contents are only as good as the staff who populate and maintain it.

Initial Stage Data Gathering and Analysis

During the period, September 2007 to March 2008, a series of structured interviews were held with various representatives of the defence acquisition community. These people are the first sample of a larger test population who will be interviewed over the course of the year, with the view to building a representation of the trading environment. The overall aim is to develop an enhanced trading model applicable to all stages of the acquisition life cycle and across the various defence domains (land, sea, air, joint, combined etc.). This research is planned to continue for several years and so it is envisaged that the research will develop in time and depth.

The participants have been self selecting at this stage, and include staff within Dstl who are, or have been, involved in acquisition decision making or the provision of advice that has involved aspects of management of requirements and trading. Many of the initial group of interviewees had experience of holding an acquisition decision-making role. It is intended to broaden the population using recommendation and snowball techniques, but it is recognized that this can introduce bias, so nominations will also be sought from other MoD lead organisations. At present, a network of contacts has been established within Dstl across the land, sea and air domains, and this network will be developed to include various levels of operation. Third party population assessment will be achieved using social scientists who are expert in this field within Dstl.

One of the questions asked of the respondents concerned their confidence relating to their trading decisions they made as a contribution to the achievement of the desired outcome. This question clearly made use of the benefit of hindsight, and asked the individuals to reflect on their own performance. This type of questioning was problematic as any individual will be unlikely to grade themselves as failing, so there was an inherent bias in their contributions. For this reason, the questioning was phrased impartially, to focus attention on the confidence in their trading decision taken, with the benefit of knowing the subsequent outcome.

This questioning construct was aimed to explore the personal confidence rating as a whole, with the knowledge that the rating was subjective and affected by a large number of factors that were related to the individual involved. The aim of the data gathering was to examine a representative population in order to develop a hypothesis trend, and to examine the point at which individual feel that they made high confidence trading decisions that resulted in desired outcomes.

An exact definition of confidence was not given to participants, but was considered to be "*the level of confidence that the individual had in the trading decision that they made at the time, based on information available, but now with the benefit of hindsight*" a qualifying question to validate the rating was "*how many times out of 100 would you make the same trading decision again, based on the data available at the time*".

Confidence was selected as a metric, as it is a qualitative concept that had a definition that each individual could recognise and relate to based on a combination of factors including experience, intellectual input, practical learning for past events. A number of other metrics were considered that would provide the ability to input personal experience in a qualitative way that could then be abstracted into a quantative measure by multiple validations by an increasing population of respondents.

Establishing a Confidence Template

In the data-gathering phase, the aim was to examine the confidence of decisions made by the decision making individual on their trading experiences. In the interviews, respondents were asked to review projects that were familiar to them and the data collected was collated against the stage of the UK acquisition lifecycle. This lifecycle is commonly known by the acronym CADMID, which represents the stages of Concept, Assessment, Demonstration, Manufacture, In-Service and Disposal (shown in Figure 2). The data collated to two stages, the concept stage (stage 1) and the in-service stage (stage 5), which emerged as the main sources of the evidential experiences.

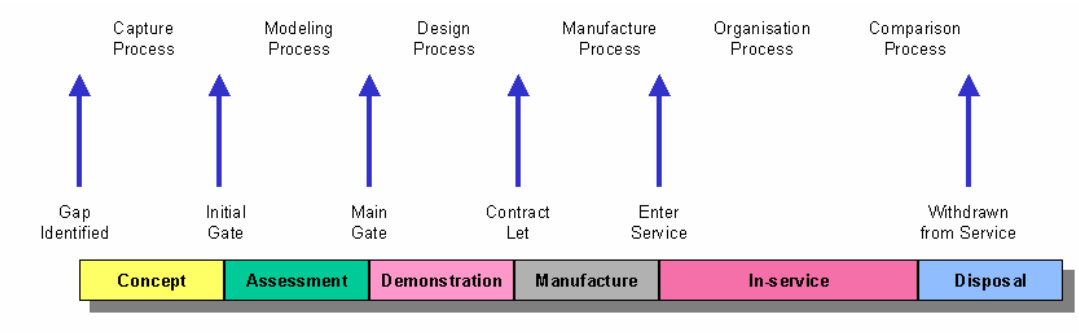


Figure 2 The CADMID Life Cycle

The findings (as shown in Figure 3) were interesting, as with linear extrapolation, people perceived that they could have complete confidence (100%) with their trading decisions after the achievement of a set time on the project. Using the data set, it is also just as valid to extrapolate the results into a standard S-curve with the complete confidence point reaching to infinity. These findings need to be taken within the context that they represented a view that included bias, and lacked impartiality.

However, they were an important step in getting the individual to make the link between their personal confidence level and their social input to the success outcome.

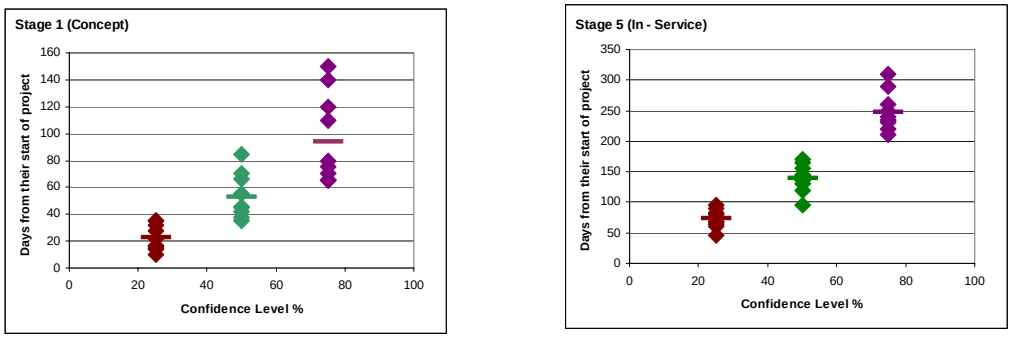


Figure 3 Stage 1 (Concept) and Stage 5 (In-Service) Confidence/Time plot

Leading on from their confidence representations, respondents were then asked about how their confidence rating was constructed in terms of the relevant DLODs. The question asked was "*given your confidence rating on a given trading decision you made, can you decompose the rating into the confidence you felt in consideration of each of the DLODs e.g. how much of your rating was composed from a consideration of …. logistics* etc.". The two stages examined in detail were concept stage (stage 1) and implementation stage (stage 5) as before. The respondents were asked to decompose their confidence rating in consideration of the eight DLODs. The aim of this decomposition was to establish the breadth of consideration given during the trading process, and whether there was any generic bias to the trade. The findings are presented in Tables 1 and 2.

In the majority of cases, the definition of the DLODs had to be stated at the interview as the respondents were unfamiliar with the boundaries and limitations of the individual DLODs as defined. This response in itself was illuminating as these definitions have not changed for a number of years and should be familiar to all who work in the acquisition organisations. In restating the definition of the equipment DLOD, it also became apparent that the definition covered less than the respondent's expectation.

Stage 1 (Concept)								
Respondent	Training	Equipment	Personnel	Infrastructure	Doctrine and Policy	Organisation	Information	Logistics
A01-2007-12-06	20	35	20	5	5	5	5	5
A02-2007-11-25	15	40	15	5	5	5	5	10
A03-2007-11-26	20	25	20	10	5	5	5	10
A04-2007-12-05	15	20	10	5	5	15	15	15
A05-2007-12-03	15	15	10	5	5	15	15	20
A06-2007-12-08	20	25	20	10	5	5	5	10
A07-2007-12-02	12.5	17.5	15	5	5	10	20	15
A08-2007-12-04	20	25	20	10	5	5	5	10
A09-2007-12-04	20	25	20	10	5	5	5	10
A10-2007-12-06	10	25	20	10	10	10	5	10
Standard Deviation	3.74	7.50	4.22	2.64	1.58	4.22	5.80	4.12
Mean	16.75	25.25	17	7.5	5.5	8	8.5	11.5

Table 1 – Stage 1 (Concept) DLOD decomposition of confidence

Stage 5 (In Service)								
Respondent	Training	Equipment	Personnel	Infrastructure	Doctrine and Policy	Organisation	Information	Logistics
A01-2007-12-06	20	10	15	10	10	10	5	20
A02-2007-11-25	25	15	15	10	10	5	5	15
A03-2007-11-26	30	15	10	5	5	10	5	20
A04-2007-12-05	25	10	15	10	5	10	5	20
A05-2007-12-03	30	10	15	5	5	5	5	25
A06-2007-12-08	25	15	15	5	5	5	5	25
A07-2007-12-02	25	20	10	5	5	5	5	25
A08-2007-12-04	25	20	20	5	10	5	5	10
A09-2007-12-04	20	15	20	10	5	5	5	20
A10-2007-12-06	25	15	15	10	10	5	5	15
Standard Deviation	3.33	3.69	3.33	2.64	2.58	2.42	0.00	4.97
Mean	25	14.5	15	7.5	7	6.5	5	19.5

Table 2 – Stage 5 (In Service) DLOD decomposition of confidence

In all cases, the Equipment DLOD needed the least explanation, and this reflected the findings that operational staffs naturally tend to construct solutions around the equipment axis. In the sample population, there were no specialists in some of the more marginal DLOD so it was not possible to examine the comparable views of a non-equipment specialist in detail at this stage of the research. The average results of the decomposition have been illustrated as two 'exploded' pie charts (see, Figures 4 and 5).

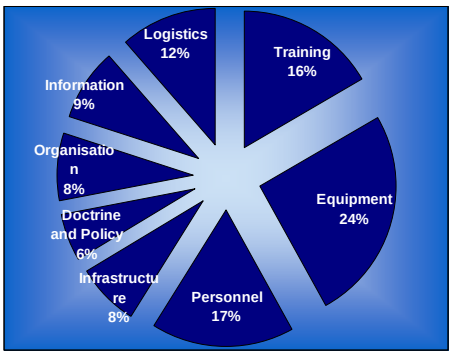


Figure 4 Stage 1 (Concept) Confidence Decomposition

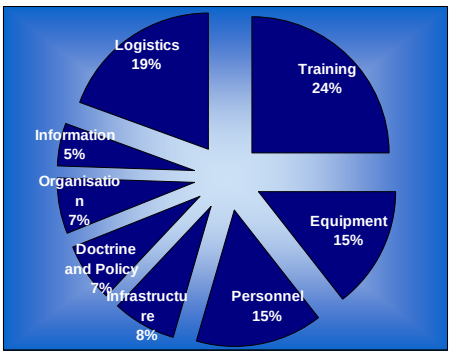


Figure 5 Stage 5 (In Service) Confidence Decomposition

These results showed a bias in the composition of confidence between the DLODs. Four of the DLODs gave a greater contribution to the overall confidence rating, and this was independent of the stage considered. In the initial results, it emerged that for both stages analysed, there are four major DLOD contributors (Logistics, Training, Equipment, Personnel) and four minor DLOD contributors (Information, Organisation, Doctrine and Concepts, Infrastructure). These results are representative of the views of the individual involved in the trading decision; the bias introduced to the composition could be attributed to a number of reasons that are not examined at this point. These reasons will be explored in the progression of hypothesis testing, but could include process bias, appointment bias, experience bias, gate requirement bias.

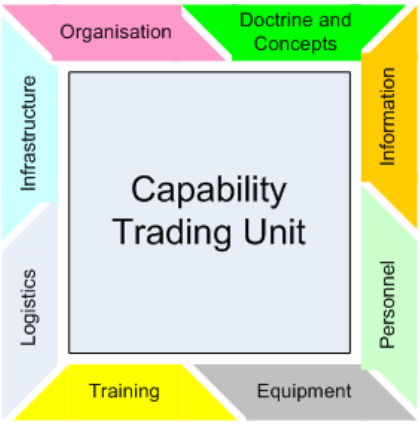
In examining the trading process, the approach was to create a naïve construct that could be proved, or disproved, using an interative approach of experimentation and data collection. This method has value as it can be examined sequentially using action research techniques, whilst delivering benefit during its progression. This

research is a way to disprove some of the myths surrounding the current trading process, using a user's perspective to examine the trading process.

In the defined trading process, it is assumed that all the DLODs are mutually independent and should be considered in equal weighting i.e.

Capability = 12.5% X (Training + Equipment + Personnel + Information + Concepts & Doctrine + Orgsanisation + Infrastructure + Logistics)

So, starting with a simplistic model, the null hypothesis proposed was that all the DLODs are equals, for example, contributing 12.5% to the overall delivery (as shown in Figure 6).



DLOD	Template Ratio
Training	12.5
Equipment	12.5
Personnel	12.5
Information	12.5
Concepts and Doctrine	12.5
Organisation	12.5
Infrastructure	12.5
Logistics	12.5

Figure 6 Null Hypothesis Capability Trading Unit (CTU)

This hypothesis is incompatible with the data collected on confidence, which suggested an imbalance in the consideration taken of various DLODs as a contribution to the overall confidence of the decision-maker. A second hypothesis is therefore proposed using the confidence weightings. This construct is illustrated as Figure 7. This construct has been termed a Capability Trading Unit (CTU).

Capability = 18.75% X (Training + Equipment + Personnel + Logistics) +
6.25% X (Information + Concepts & Doctrine + Orgsanisation + Infrastructure)

DLOD	Template Ratio
Training	18.75
Equipment	18.75
Personnel	18.75
Information	6.25
Concepts and Doctrine	6.25
Organisation	6.25
Infrastructure	6.25
Logistics	18.75

Figure 7 Proposed Capability Trading Unit (CTU)

This Capability Trading Unit (CTU) is proposed as a building block for the trading process that includes a consideration of all the DLODs either as raw data, or as extrapolated data, and provides a more rounded and complete unit of trade.

There is historical evidence that raw data is more available in the equipment, logistics, trading and personnel areas. Whether this data is appropriate or accurate is outside the remit of this paper, but taking the availability of data as a positive event it can be used to provide an assessment of the less data rich areas. In very crude terms, if the equipment cost for a particular capability is £150m, the equivalent ratio extrapolation for the 'cost of doctrine' should be £50m. The trading model will be developed later in this paper, but is built from the basic building blocks of the CTU. The exact ratios of the CTU will be refined as the research continues, and could develop into a family of ratios depended on lifecycle stage and trading level.

Metrics of Military Success

An assessment of defence quality was constructed by Middleton *et. al.* (2006) who concluded that the BOI decision had a direct correlation to the capability output 10-25 years later. Using open source data, the military equipment quality of 10 nations was evaluated from 1971 to 2005 and time-dependent correlation with investment back to 1951 analysed. In summary, the nations studied 'got what they paid for', with their expenditure positively correlated with equipment capability. However, this paper only examines the equipment axis and is limited to the quality assessment or in service capability, and does not examine the full costs through to disposal.

In a recent Government white paper on innovation in Defence Acquisition (Ministry of Defence Innovation Strategy, 2007), Baroness Taylor, the Minister for Defence Equipment and Support (DE&S) stated that "*there is a tendency to opt for low-risk solutions, low-margin players and mature technology – long term planning is not routinely welcomed or rewarded*", and goes on to express that "*we need to ensure organisations….will be fairly rewarded for their contribution through life*". The paper goes on to propose the future is in the form of "*alliances*" with partners.

These long term relationships will mean a strategic move away from short term fiscal measures of capability and will open the opportunity for more holistic metrics of success. This provides the opportunity to explore non-fiscal metrics that can represent the quality of capability at a given time, which in turn could be decomposed into DLOD metric values.

The aim of establishing metrics fits comfortably with the trading concept. By establishing an acceptable baseline for comparison, all trading solutions can be represented in equivalent terms, which is a key enabler in efficient trading.

Establishing holistic metrics will support a fair appraisal of the whole life, capability delivery that supports not only the requirements that were defined at the start of the project, but also can comply with the emergent properties as it is put into service and operated in developing environments.

In the current defence trading (short term) process, the common baseline of assessment is financial, with all factors being converted into fiscal components. For some of the DLODs, this conversion is valid and accurate, but for some it can be inappropriate and misleading. The equipment DLOD is easy to establish in fiscal terms from supplier's contractual data, but this finite definition is itself flawed, as it is reliant on the other DLOD inputs to deliver the contracted capability; and the fiscal

values of that support are considerably harder to define or validate. In the media age that we live in, the metrics of political success that are applied to defence are often in terms of casualty numbers or lives (see Figure 8).

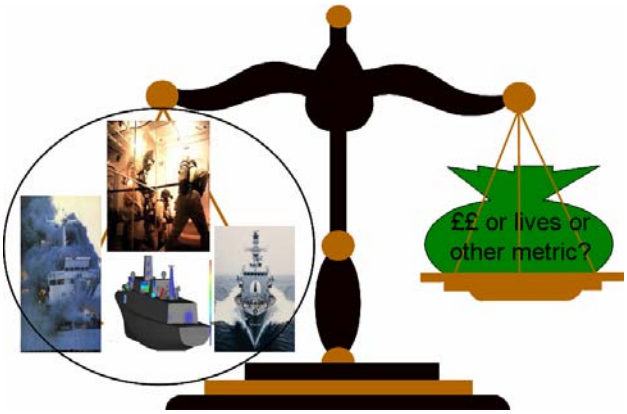


Figure 8 Representation of alternative UK trading metrics

Kaplan and Norton's (1992) concept of the balanced scorecard has received wide acceptance from both academics and practitioners. The design and construction of balanced scorecards in practical applications has not, however, been well documented. Butler, Letza, and Neale (1997) examined the development of integrated performance measures and the domain tailoring techniques used to develop practical models. One of the difficulties they found was in establishing acceptable metric assessments in fast changing environments and concluded that the introduction of non-fiscal metrics introduced bias in the decision making process that did not benefit the outcome. Their findings are not directly applicable to the defence domain, but do highlight difficulties of acceptance of type of metrics in changing organisational structures, accountability boundaries and time boundaries that is very typical of the defence environment.

Johnston, Brignall, and Fitzgerald, (2002) proposed that performance measurement systems along the lines of the balanced scorecard concept have developed rapidly. However there is limited evidence that its use has led to a desired performance improvement. Johnston *et. al.* (2002) adopted a grounded theory approach based on interviews. They concluded that, in all levels of the organisations, it was clear that the intent was consistent and focused on the 'good enough' rather than the detail. This gave managers in these organisations the time and space to concentrate on the use of performance measures on forward looking relevance, understanding and action, rather than retrospective and detailed control. This approach was promoted by senior managers and was based on their ability to see the business in simple terms and their understanding of the key drivers of business performance.

Recent studies (Wong-On-Wing *et. al.* 2007, building on the work of Ittner and Larcker 2003) have provided evidence of commercial companies' tendency to overlook the validity of the causal links between measures of the balanced scorecard and to ignore the underlying strategically-linked causal business models. This research examines the bias that is introduced by metrics that are constructed at strategic levels but implemented at operational (tactical) levels and proposes that lower levels of manager automatically consider the quality of strategy without being prompted to do so. This view will be examined by asking the operational (tactical) level decision maker to assess the metric model.

This latter point is one of the drivers behind the proposed approach of developing theory from practitioners' interviews, as this will enable direct correlation between personal involvement and outcome of success.

A non-fiscal examination of trading was achieved by Vantienderen (1995) who examined trading or covariance at various stages of biological lifecycles and the success of the outcome. His work based on a series of experiments and observations established that outcomes could be foreseen based on trading decision made at an early stage in the lifecycle. This work suggests that a finite set of metrics could be used through any life cycle with a variation on the quantity of factors used at the appropriate stage. Although a very different domain, the inclusion of lapsed time (or lifecycle progress) as a factor to trading is significant, and will be explored more as the evidential data develops.

Trading Model Proposition

This research is aimed at examining trading from a viewpoint that has not been traditionally examined, and to add practical value to the process of trading, at all levels across all defence domains. The research is in its infancy and so the development of a model is immature, however, now that the Capability Trading Units (CTUs) have been proposed as a construct, it is worth exploring their routes of exploitation.

This trading model proposition does not represent a validated approach, but an evolving construct developed using the grounded theory approach.

Trading takes place within the UK defence environment in compliance with a defined process, but in a variable timeframe and scope of accountability. The CTU construct is proposed to provide boundaries that enable trading to be achieved using "like for like" packets.

The proposal is that any CTU can be constructed around a capability solution, and can be built from data from any of the DLODs. Ideally, a unit would contain data from all eight DLODs, or at least from the four major DLOD contributors, but in the absence of hard metrics, it may be possible to extrapolate and construct the whole Capability Trading Unit (CTU) based on metrics from one DLOD. However, the important concept is that a trade can only be achieved of the whole Capability Unit, inclusive of all the DLOD factors associated with a capability solution.

Using the example from earlier, assuming that the only reliable data was available from the equipment DLOD, a CTU could be constructed with appreciation of all the DLOD inputs. Using the earlier example, if the equipment cost for a particular capability is £150m, the three other major DLOD contributors would also be £150m. The equivalent ratio extrapolation for the 'cost of doctrine' would be £50m, and the other three minor DLOD contributors would also be £50m. Therefore to trade the capability between groups, the CTU value would represent £800m (Figure 9)

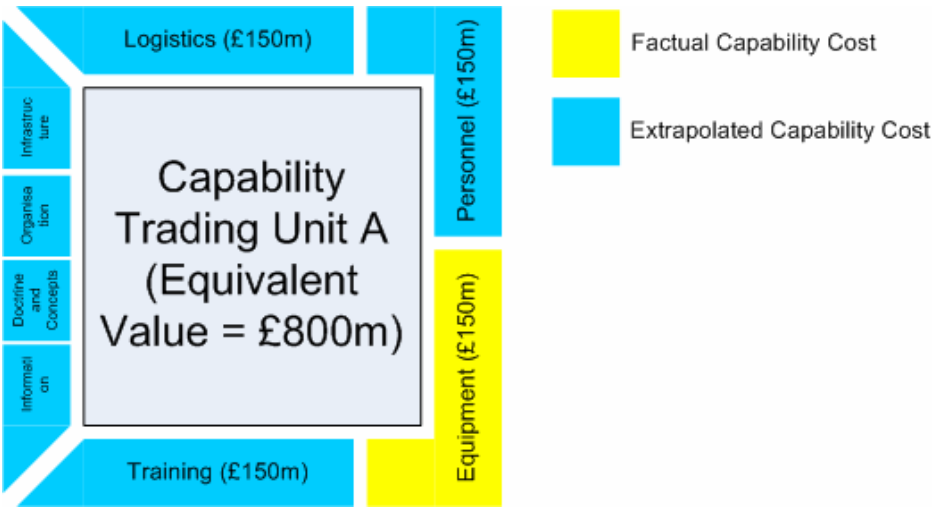


Figure 9 CTU construction from extrapolated factual Equipment cost

Once a CTU has been defined and bounded, the process for trading can be achieved on a representative basis, fulfilling the requirement for DLOD representation using extrapolated data coverage.

The CTU can then be traded in terms of capability. The model proposed in Figure 10 is an illustrative view of the capability trade space and how the model could operate.

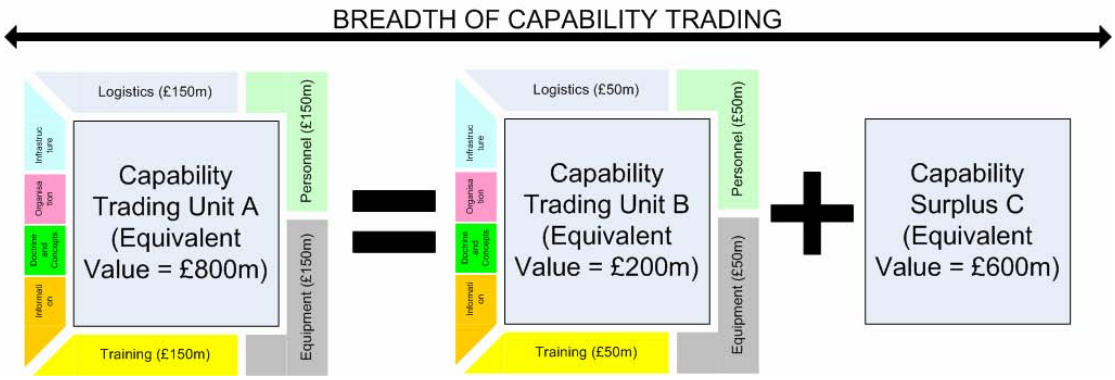


Figure 10 Capability Trading Model

Figure 10 does not include a time element, but this aspect could be developed in collaboration with technical road mapping techniques to enable trading of emerging capabilities. For example, to model the trade between domains that could include a capability that is currently unavailable but is planned to emerge in a different domain at a later date (Figure 11).

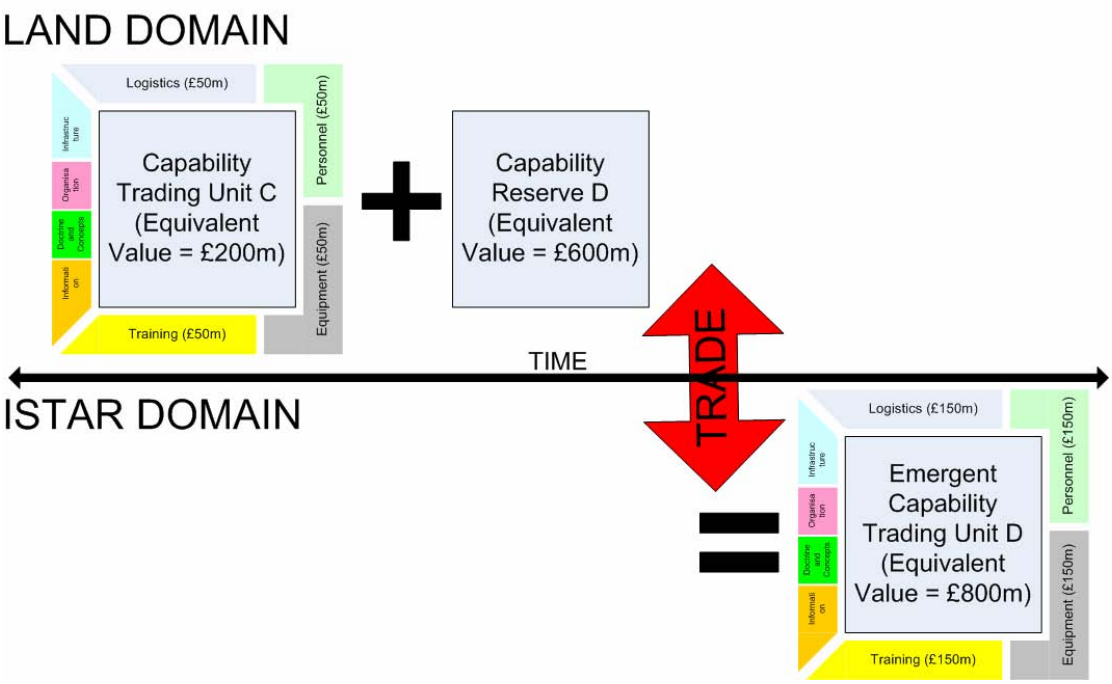


Figure 11 UK Capability Trading Model

Conclusions

This paper has reviewed the capability domain and some of the applicable research to date, and then constructed a Capability Trading Unit (CTU) based on evidential data that has been built on to produce a model construct for trading. This model will continue to evolve and develop by practical use and by application to real projects, with the aim of this research to be able to propose a practical process that will enhance the UK defence capability, now and in years to come.

It is envisaged that the data gathering will continue at a steady rate throughout 2008, and will lead to incremental validation of the CTU construct in terms of lifecycle analysis, transference of confidence template ratios and in the benefits that can be gained by practical use.

Later research will expand the examination of other stages of the CADMID lifecycles, and may also advance onto consideration of the evidential experiences of the trading success of incremental, spiral or evolutionary lifecycles. The research will also examine the 'metrics of success' and who these can be introduced alongside the CTU.

Glossary

Through Life Capability Management (TLCM) TLCM is an approach to the acquisition and in-service management of military capability in which every aspect of new and existing military capability is planned and managed coherently across all Defence Lines of Development (DLOD) from cradle to grave. Since capabilities endure all capability management is in perpetuity, so the use of the 'through life' terminology is redundant. However, in the cultural environment it is still useful to retain the term as it provides a reminder that decision making needs to take a long-term perspective (The Stationary Office, 2005, Pg 17 Section A1:23).

CADMID The acquisition cycle (often referred to as 'CADMID' from the initial letters of its six phases). The cycle contains phases of Concept, Assessment, Demonstration, Manufacture, In-Service and Disposal with discrete entry and exit review points. The CADMID cycle is characterised by approval points generally at either end of the Assessment phase known as Gate Reviews. (Acquisition Handbook Edition 6, October 2005).

Abbreviations

BOI	Balance of Investment
CAA	Civil Aviation Authority
CADMID	Life Cycle – Concept, Assessment, Demonstration, Manufacture, In-Service, Disposal
[dstl]	Defence Science and Technology Laboratory
DACP	Defence Acquisition Change Programme
DCDC	Defence Concept and Doctrine Capability
DE&S	Defence Equipment and Support
DEC	Director of Equipment Capability
DEC	Directorate of Equipment Capability
DEC UWE	Directorate of Underwater Effects
DIS	Defence Industrial Strategy
DLOD	Defence Lines of Development
EAC	Enabling Acquisition Change report (McKane, 2006).
EngD	Doctorate in Engineering, Industrial PhD
FMCMC IPT	Future Mine Counter Measures Capability Integrated Project Team
IPT	Integrated Project Team
IPTL	Integrated Project Teams Leader
MAR	Military Aircraft Release
MoD	Ministry of Defence
OGDS	Other Government Departments
TLCM	Through Life Capability Management (TLCM)
UK	United Kingdom (England, Scotland, Wales and Northern Ireland)

Annex A

Defence Lines of Development (DLOD) The Defence Lines of Development (DLODs) are eight facets of a capability that need to be considered in order to deliver the full potential of a project or service delivery.

- Training. The provision of the means to practice, develop and validate, within constraints, the practical application of a common military doctrine to deliver a military capability.
- Equipment. The provision of military platforms, systems and weapons, (expendable and non-expendable, including updates to legacy systems) needed to outfit/equip an individual, group or organisation.
- Personnel. The timely provision of sufficient, capable and motivated personnel to deliver Defence outputs, now and in the future.
- Information. The provision of a coherent development of data, information and knowledge requirements for capabilities and all processes designed to gather and handle data, information and knowledge. Data is defined as raw facts, without inherent meaning, used by humans and systems. Information is defined as data placed in context. Knowledge is Information applied to a particular situation.
- Doctrine and Concepts. Doctrine is an expression of the principles by which military forces guide their actions and is a codification of how activity is conducted today. It is authoritative, but requires judgment in application. A Concept is an expression of the capabilities that are likely to be used to accomplish an activity in the future.
- Organisation. Relates to the operational and non-operational organisational relationships of people. It typically includes military force structures, MOD civilian organisational structures and Defence contractors providing support.
- Infrastructure. The acquisition, development, management and disposal of all fixed, permanent buildings and structures, land, utilities and facility management services (both Hard & Soft facility management (FM)) in support of Defence capabilities. It includes estate development and structures that support military and civilian personnel.
- Logistics. The science of planning and carrying out the operational movement and maintenance of forces. In its most comprehensive sense, it relates to the aspects of military operations which deal with; the design and development, acquisition, storage, transport, distribution, maintenance, evacuation and disposition of materiel; the transport of personnel; the acquisition, construction, maintenance, operation, and disposition of facilities; the acquisition or furnishing of services, medical and health service support.

In addition to the DLODs, Interoperability is included as an overarching theme that must be considered when any DLOD is being addressed.

- Interoperability. The ability of UK Forces and, when appropriate, forces of partner and other nations to train, exercise and operate effectively together in the execution of assigned missions and tasks.

In the context of DLODs, Interoperability also covers interaction between Services, UK Defence capabilities, Other Government Departments and the civil aspects of interoperability, including compatibility with Civil Regulations. Interoperability is used in the literal sense and is not a compromise lying somewhere between integration and de-confliction. (Ministry of Defence, 2007).

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