"ON THE USE OF INFORMATION MANAGEMENT IN THE CONTEXT OF THROUGH LIFE CAPABILITY MANAGEMENT (TLCM)"

BY

GRAEME SYMES.
DSTL, PORTON DOWN, SALISBURY, UK

ANDREW J. DAW
BAE SYSTEMS, INSYTE, CAMBERLEY, UK

ABSTRACT

This paper presents the first focused evidence considering Through Life Capability Management as an Information Management problem, rather than one of simply equipment, performance and technology management over time.

The paper describes the activities and outputs of a recently conducted Capability Investigation (into the Future UK Mine Counter Measure Capability FMCMC) which was implemented jointly between the UK Ministry of Defence and Industry, supported by Information Management techniques and utilising the Decision Support environment TRAiDE^{TM}. Whilst providing a high level description of TRAiDE^{TM}, the paper concentrates upon the outputs and visualisations produced that enabled a broad picture of all the components that contribute to the capability to be developed and visualised over time with respect to military, industrial, research and commercial perspectives.

With this information centric approach, the paper identifies and highlights the concept of a generic underpinning building block, the development and benefits of an Integrated Management Plan and finally a 'Capability Dashboard', which offers the whole acquisition community (including Industry) a common view and language of Capability Management. This common view is presented in risk terms that are directly pertinent to and understandable by all the various multiple stakeholder perspectives. Each of these elements is contained and managed within a single information repository thus supporting consistency and coherence of information across the bounded problem.

Introduction

Continued downward financial pressure on UK Government is driving the planning and delivery of military capability to be as efficient as possible, maximising the benefits to front-line forces from a finite budget. Expansion of acquisition thinking away from "kit, kit and more kit" to consider instead (or in addition) beneficial interventions in other Defence Lines of Development

(DLoDs)[1] is now a necessity, reinforced by the aspiration of Through Life Capability Management (TLCM):

"Through-Life Capability Management translates the requirements of Defence policy into an approved programme that delivers the required capabilities, through life, across all Defence Lines of Development (DLoDs)" Acquisition Operating Framework (AOF)[Ref. I].

In addressing TLCM, the UK Ministry of Defence (MoD) considers a number of additional facets, such as the Defence Industrial Strategy (DIS)[Ref. II], Defence Technology Strategy (DTS)[Ref. III] and Defence Acquisition Change Programme (DACP)[Ref. IV]. Together these have introduced the concept of the "five perspectives": Capability, Industrial, Commercial, Financial and Research which contributes to a framework for Capability Management and pay particular attention to the way in which programmes are constructed and how decisions are made.

Capability is the enduring ability to generate a desired operational outcome or effect and is relative to the threat, physical environment and the contribution of coalition partners. Capability is not a particular system or equipment - it is delivered by Force Elements (Ships, Aircraft, Army formations, other Military Units and Force Enablers) combined into packages by Joint Force Commanders, tailored for particular operations or missions. Each Force Element is delivered by either a single service, or by joint organisations, and requires the integration of the 8 DLoDs. For any capability, understanding the interactions across these components, the interdependencies with related programmes and implications for each of the five perspectives is complex but essential. Effective Capability Management demands the ability to make informed judgements about a particular course of action in context. This in turn implies the ability to balance a complex picture in the face of external influences, whether they are fiscal constraint, policy changes, evolution of the threat and associated technologies or emerging obsolescence.

The key to good decision-making has always been (and remains) access to robust underpinning information from which to draw the evidence to support the case being made. However, with the constant pressure "to do more with less", it is the ability to identify emergent properties and relationships both within and across capability areas that is most likely to bring about the beneficial changes to acquisition being expected of TLCM and this implies access to information of suitable quality, integrity and relevance, presented logically and intuitively.

Decision Making

Effective decision making requires a broad understanding of both the "problem-space" in all its aspects and the "solution-space", representing the art of the achievable. To achieve delivery within the constraints set imposed, Capability Managers (CMs) seek "trades" across the whole spectrum of opportunities which may occur in any of the five perspectives noted above. Capability trading essentially means making choices (i.e. decisions) about particular courses of action which will have impact and implication across a wide range of contributing areas.

[1] DLoDs = Training, Equipment, Personnel, Information, Doctrine & Concepts, Organisation, Infrastructure, Logistics

Within an integral acquisition approach such as TLCM, it is essential that the extent and detail of the impacts and implications is understood across the whole trading environment.

Opportunities for capability-based decision making exist at a number of levels within the MoD organisation illustrated by the Capability Value Chain[Ref. 1] (4-Blob) model (Figure 1). This model highlights that capability must be managed across the breadth of the MoD organisation and indeed wider government, ensuring that decisions are not made in isolation to a broader set of considerations.

Figure 1 expresses a series of relationships and interfaces that provide the context for Defence Acquisition and the trading that should occur across all components of the environment and community in establishing what (product and or service) should be procured. Each 'blob' provides a context for the subsequent 'blob' and the feedback loops represent a formal set of communication mechanisms that enable opportunities, challenges and corrections from one 'blob' to another in a series of informed decision making activities. Reading from left to right therefore, develops, informs and translates the national (political) aspiration into the military capability contribution to the specific solution concepts and thence to the implementation and delivery mechanisms of the Project teams within the Defence Equipment and Support (DE&S) organisation. The embracing context of this 'left to right' view of the acquisition space is the underpinning budget and aspiration. Reading in the reverse direction however come the mitigating issues and boundaries (expressed as costs and reality) and these act as the constraints of the system context, defining what is and is not achievable. Thus, the system can be closed loop and stable, with informed decision making and an appropriate understanding of the impact and implications of decisions.

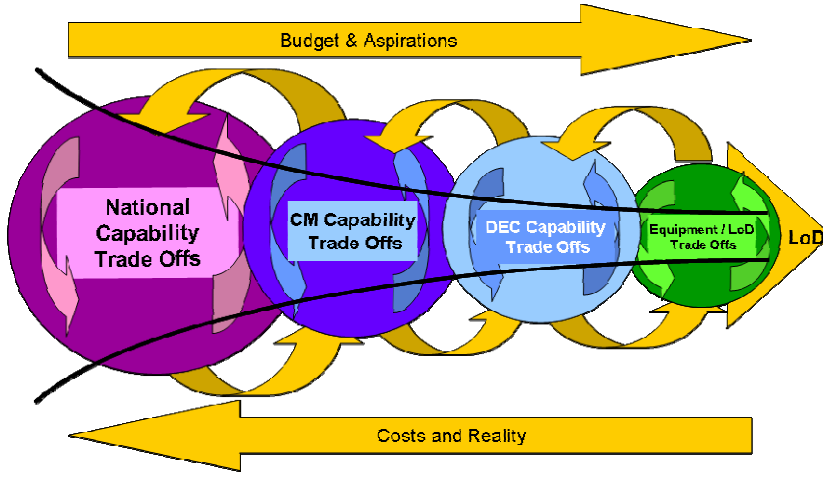

FIG.1 – THE CAPABILITY VALUE CHAIN AND ASSOCIATED DECISION MAKING ENVIRONMENT

The Capability Value Chain represents a view of the overall defence acquisition community, which includes interfaces to industry and academia. Decision-making in this environment is enhanced through coherent and consistent information – indeed information may form the common language for the community as a whole, enabling significantly more wide ranging debate and understanding than

currently achieved or supported. Within this overall decision-making structure, the management of information and its consistent interpretation through effective presentation is essential.

The concepts, techniques and processes described in this paper are most appropriate for the capability planning and capability development activities of the acquisition community. The developed evidence base and the visualisations produced provide clarity over time of:

- Capability aspiration and management;
- DLoD development including industrial and R&T inputs;
- Points of decision-making over commercial, financial, cost and risk issues.

What is Information Management?

ACP 200(B)[Ref. V] suggests that "Effective information management provides relevant information to the right person at the right time in a suitable form, to facilitate situational awareness and decision making. [Indeed the UK MoD has adopted much of this approach in its definition of Network Enabled Capability (NEC) and hence has an understanding of the basic import and impact of coherent information.] Data is the representation of facts, concepts, or instructions in a formalised manner suitable for communications, interpretation, or processing by humans or by automatic means. It is however, only as important as the context within which it is used and the expertise of the individuals using it. Information results from the processing of data via the application of procedures, standards, policies, and training and may be expressed as 'data in context'. When information is studies within a specific context it leads to knowledge. When knowledge is combined with experience and good judgement, it leads to an informed understanding of the situation, i.e. situational awareness. Enhanced situational awareness subsequently results in an improved decision-making capability. This hierarchy is illustrated in Figure 2.

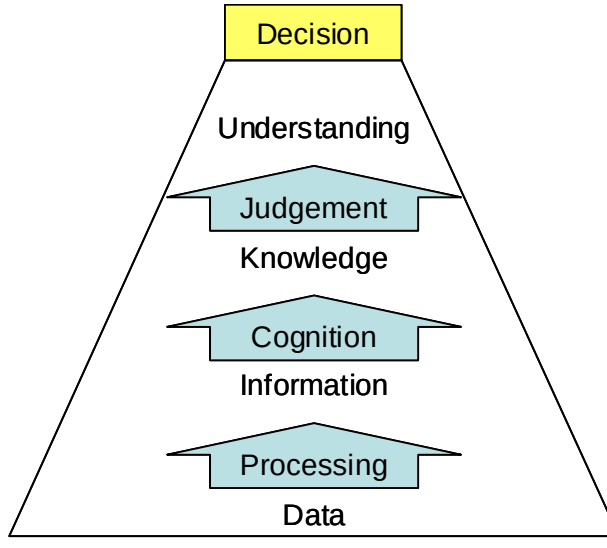

FIG.2 – INFORMATION HIERARCHY

It must be recognised that decision-making can be and is made at any and every level within this hierarchy. The implication is that decisions are often made with incomplete information, in the face of uncertainty and under time constraints.

Principles

Information Management is a set of integrated processes and services that enable or allow information producers and consumers to store, locate, retrieve, and transfer the right information, in the right form and of adequate quality, by the most timely, effective, and efficient means in an appropriate, consistent manner.

The following principles guide best practice in this respect:

a) Relevance – The information should be of sufficient value that it influences the plan or mission (i.e. the information should address the real needs of the user);

b) Accessibility – Information had multiple, even simultaneous uses. Therefore, information should be available to all people that have a legitimate need to know;

c) Integrity and accuracy – Information must be accurate and complete, and requires protection from unauthorised, unanticipated or unintentional modifications;

d) Clarity – Information should be presented to users in a way that they can understand, properly use, and analyse;

e) Timeliness – Information is inexhaustible, but its value may perish with time. Rarely is information of value if it is out-of-date or reaches the decision maker late. Timeliness is typically involved in a trade-off against accuracy. The timeliness of information will also influence its relevance;

f) Consistency – Values and definitions of data must be maintained consistently to ensure that information is understood in the same way when shared e.g. distance should be consistently stated in miles, nautical miles, or kilometres, dependent upon the information domain. To remain consistent users must use it with a common understanding.

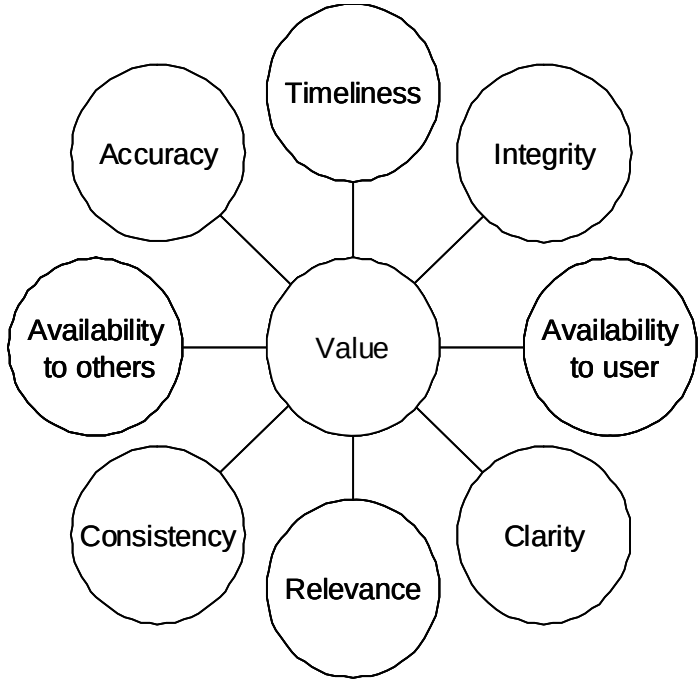

FIG.3 – DETERMINANTS OF INFORMATION VALUE

Users require different degrees of integrity of information, relevance, and accuracy of information. Unfortunately, there is often a trade off between these elements. A highly specific enquiry may require a high degree of accuracy, while a general enquiry may require a high level of relevance. Therefore, in order to maximise effectiveness for any given situation or mission, it is unlikely that there exists a single solution, but rather a broad structured approach is required that can be tailored to the need and individual problem.

To achieve this, information must be well organised and presented so that the recipient can use it effectively. Unlike computers, human beings do not simply manipulate numbers according to predefined mathematical rules. They are more adept at recognising patterns of information and comparing them with past experience or training; consequently, the manner by which information is presented should focus on displaying those patterns simply and intuitively.

However, it must be recognised and accepted that the third Information Management principle noted above is aspirational and idealistic; in the non-trivial

case, information is rarely complete and wholly accurate and decision making is undertaken using and making do with incomplete and ambiguous information and detail. This then has a direct impact upon the behaviours, skills and competencies of those engaged in the endeavour who must be comfortable with uncertainty and ambiguity. The underpinning need therefore is to have the right processes and an appreciation of those processes to make a decision, confident that it is in the 'fight / same ball park' of the solution space as that which would be possible with complete information and infinite time.

The application of these information Management principles and recognising the issues of completeness and sufficiency, suggests a number of key attributes of the decision-support environment, including:

a) Information should only be captured once and updated as necessary. Redundant, duplicate, or irrelevant information should be eliminated. Out-of date data should be highlighted as such and archived as soon as practicable;

b) Information should be tailored;

c) Data definitions must be consistent within a single information domain;

d) Where information is considered to form part of an official record, additional steps must be taken to ensure all changes are tracked (for example, a document could be backed-up before changes so that copies of all previous versions are available). Appropriate configuration management and version control processes should be applied to all official documentation;

e) Ownership of information will not change throughout its life cycle. Hence, ownership, or the authority under which information is published, must be clear and unambiguous at all times.

In summary, it is not sufficient to simply collect data and store it in a repository without giving thought to the purpose of its collection in the first place, the control that will be placed on its management and its dissemination / usage in appropriate forms of output that support the community of interest.

An Example Capability Challenge

One of the current mechanisms adopted by the UK MoD to support its TLCM initiative is to undertake a Capability Investigation (CI) which:

a) Focuses on a particular aspect of the capability programme;

b) Explores opportunities and develop better strategies (e.g. moving toward an incremental acquisition approach);

c) Responds to specific policy direction[Ref. I].

These investigations are completed as part of the ongoing review and planning processes of the MoD and are considered at the ‘early’ stages of the acquisition lifecycle, although the output from such an investigation has the potential to influence In Service contracts and update programmes as well as establishing sound requirements and system solution characteristics for new acquisitions. The outputs from such an investigation may be viewed (as examples) in planning terms, recommendations for expenditure or deferment of options or the commissioning of research. In each case there is the need for a body of evidence

to support a position or case and to support the decision making process. As a fundamental component of TLCM, the information and its management that supports the definition and management of this body of evidence is crucial to understanding the overall impact and implication of the decision making.

The example Capability Investigation considered within this paper is that of Future Mine Countermeasures (FMCM), which seeks ways of achieving improved reach, tempo and flexibility to meet future demands [2].

In TLCM terms the management of this capability, to achieve these characteristics, is not simply an "equipment problem", instead it requires consideration of all the DLoDs, the ability of industry to deliver, the pull-through of Research and Technology, and the information management necessary to enable consistent decision-making. The problem can be addressed through:

a) The ability to articulate and define the capability required in measurable terms;

b) The ability to identify key drivers and constraints (funding, other programme decisions, etc.);

c) The ability to identify where beneficial interventions (opportunities for change) could be made across all the DLoDs;

d) Visibility and understanding of the industrial landscape that would provide products, services, facilities and people (Defence Industrial Strategy);

e) Visibility and understanding of technology development needs to inform investment decisions within MoD and industry research programmes;

f) Recognition that capability is enduring and therefore management of it will include existing systems, people, facilities and organisations as well as future ones.

The joint MoD and Industry enterprise is already aware of the wider remit of managing capability in today's environment and methods exist for tackling some of these issues. However, it is increasingly apparent that it is the ability to integrate data across all these areas that enables effective capability management and the benefits of TLCM to be achieved. The analysis, understanding and ultimately integration of these disparate perspectives, each of which represents a 'dimension' of a multi-dimensional space applicable in both the problem and solution space, offers numerous opportunities for trading and balance across the domain. Each of these trades will have positive and negative effects for one or more perspectives (the 'pros and cons' of a particular course of action) and it is the understanding and acceptance of the impacts and implications of these positives and negatives that underpins sound decision making.

As an example, clearly the financial issues (in both budget and cost terms) are a significant perspective on the development of the solution space and its relationship to the problem being set. The defence budget as a whole is finite and hence programme changes (as a result of decisions) in one particular capability

[2] The existing fleet of MCM vessels and supporting elements were procured to meet the demands of the Cold War era; e.g. assuring access through strategic routes around the UK and North Atlantic operating areas out to the 200m contour. Future capability will need to meet the demands of expeditionary warfare where reach and tempo are key attributes.

area can have potentially significant and often unforeseen implications elsewhere in the MoD and industry enterprise. The means to identify, manage, and ideally predict, these implications is therefore fundamental.

These 'trades' are synonymous with decisions, i.e. decisions are the final output from a trading process and are derived from having considered the pertinent aspects of the issue and resolved or accepted the impact and implications of the decision being made. However, given the multi-faceted, multi-dimensional perspectives and interests, decision-making is difficult and the current TLCM initiative contains an extremely wide range of perspectives to be considered even for a relatively well-bounded problem such as FMCMC.

It is proposed that for complex decision making and TLCM in particular, information management (IM) is an essential component of achieving the required consistency and insight within the trading processes and decision making outputs and it is supported by appropriate tools to bring understanding to the potentially complex "decision-space" (or "trade-space"). The details below record the experience of using the BAE Systems – Salamander TRAiDE™ Environment during the Capability Investigation activity for Future Mine Countermeasures (FMCM) [3].

What is TRAiDE™?

To provide an information management environment in which decision-making can be supported (across the whole acquisition community), BAE Systems in collaboration with The Salamander Organisation have developed a support environment known as TRAiDE™ (TLCM Robust Acquisition inclusive Decision Environment). At the most basic level, TRAiDE™ is the collective name given, by BAE Systems, to a set of systems engineering processes and visualisations implemented and supported through the MooD® Enterprise Architecting software product. Included in this definition is the underpinning repository meta-model and the visualisations available to support trade space definition, system concept option representation and the outputs from the associated modelling and simulation (analysis) necessary to provide and support coherent, consistent decision making.

TRAiDE™ has been developed in response to a belief that TLCM can be viewed as an information management problem rather than simply (or purely) a technical issue. To that end, TRAiDE™ is explicitly concerned with supporting decision making at all levels of organisations, programmes and projects.

The underpinning repository and repository manager, MooD®, enables the basic tenets of database usage and management and provides the engine to which data are captured once and used many times. It acts as the single point of information control from which reports can be produced. Importantly, these reports are visual and graphical in nature, based on a range of artefacts (graphics panels) that exist within MooD®. This allows information to be viewed and easily manipulated from differing perspectives – for example; cost, timeframe, capability, industrial capacity, DLoDs, priority, benefit, risk – to aid understanding. Importantly these

[3] However, it should be noted that this report is not an extensive or thorough examination of TRAiDE™.

visualisations are not specific to any particular business type or problem being investigated; they are simply intuitive diagramming styles.

Figure 4 represents schematically the underpinning TRAiDE™ design. At the core is the MooD® repository which contains / enables interfaces to other software products, data modelling techniques and visualisations – represented by the 'bubbles' in the intersecting areas below. This core has been supplemented with several new interfaces and visualisations – as represented by the annulus around the MooD® core.

The environment has been developed with "openness" in mind and is able to accept a variety of input and information types through open interfaces allowing the data from external sources to be integrated, managed, manipulated and represented in a consistent manner; for example, it supports interfaces to IBM/Telelogic DOORS® (for formal requirements management), Simul8 (a simulation / performance analysis tool), riskHive (for risk and opportunity management and 3-point estimating) and Microsoft Office® products. It can incorporate outputs from external models to enable as comprehensive a picture as possible. This provides a flexible environment for structuring, exploring and visualising numerous perspectives suitable for a broad range of customers.

Using TRAiDE™ as the single source of information, stakeholders can share a common view and draw upon agreed data for analysis with a coherent set of assumptions (same baseline used by all, configuration control, etc.). Population of the repository with prior work from all parts of the stakeholder community provides the programme context and maximises re-use of historical data. Once established, maintaining the repository throughout the life of a programme improves continuity regardless of changes in the project team (a feature which is inevitable over time and highly prevalent in the MoD organisation). Essentially, such an environment provides continuity to an organisational resource and the repository assures a mechanism exists to support, continuously, the decision-making process at various stages and levels of abstraction.

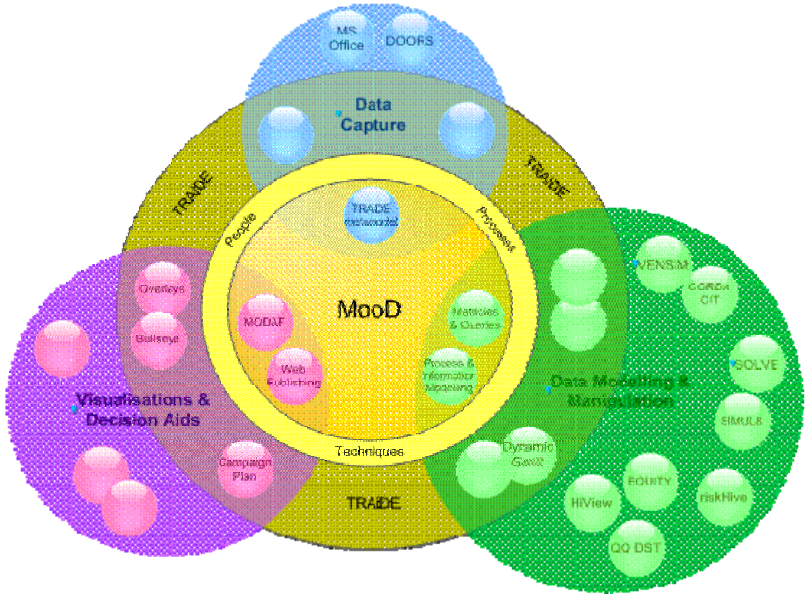

FIG.4 – SIMPLE REPRESENTATION OF MOOD® AND TRAID™

Bringing information into a single repository maximises opportunities to reveal understanding and enables identification of areas to consider from the point of capability trading and for the purpose of further investigation.

This overall environment is not constrained by a set of hard-wired views; instead the user can choose the artefacts that best suit the problem being tackled or question being asked and develop visualisations that are intuitive and enlightening to the decision-makers, which evolve through the life of the project.

It must be emphasised that whilst there are a growing number of formal interfaces between MooD® and external 3rd party software products, there are no tools explicitly within TRAiDE™ – it does not substitute for performance models, for the detailed knowledge of an analyst, and importantly it does not make decisions – it provides evidenced information to support decision-making. Referring back to Figure 2, it provides the first two levels of the information hierarchy.

Operation of TRAiDE™ Within the FMCM Capability Investigation

TRAiDE™ supports decision makers in the challenging TLCM environment by coupling a data repository with the ability to quickly represent that data intuitively and assess the effects of choices. It has been deployed on various programmes for some time as part of its ongoing support to the UK MoD Capability Sponsor, e.g.: Jt Medium Weight Capability (Land), Future Combat Air (Air), capability planning for Head of Capability (Air & Littoral Manoeuvre).

Throughout the FMCM CI, the primary repository was developed in TRAiDE™, capturing data generated through the CI activity, consolidating and structuring the

data for ease of reference, and acting as the medium to represent that data back to the CI community. Typically this implies:

a) Capture background information (key documents, baseline information, presentation material);

b) Record assumptions (technical, acquisition);

c) Capture specific data sets (either from external tools, models, applications or outputs from facilitated workshop sessions);

d) Build an interactive data environment to enable exploration and visualisation of the data;

e) Build interactive visualisations and present these (live) to the CI community for comment, discussion and review;

f) Determine data gaps and any incoherency issues;

g) Disseminate the information base.

The Capability Investigation utilised a workshop-based approach over a six month period. Figure 5 is a pictorial representation of the activity timeline; the diamond shape indicating that the problem was explored in the first half of the period and then refined in the second half.

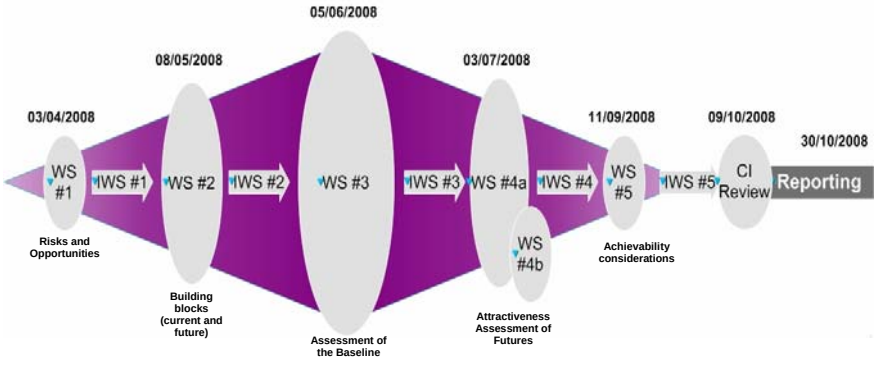

FIG.5 – FMCM CI WORKSHOP DEVELOPMENT

Each workshop developed a particular theme of the problem. This commenced with problem articulation; the aim of which being to explore risks and opportunities presented by a number of acquisition scenarios such as accelerated procurement, life-extension, incremental transformation. Current and planned building blocks were then identified (system components) which were used to define the existing capability configuration and postulate future ones. These capability configurations were then assessed for their likelihood at meeting strategic goals to illustrate the expected benefits, or attractiveness, from anticipated acquisition investment. Determining achievability across the DLoDs and TLCM perspectives allowed the community to arrive at a considered view of the future with due regard for the varying stakeholder perspectives (financial, industrial, research, etc.) and an understanding of both the challenges and risks of that future.

Information was captured in a range of formats – spreadsheet files (Excel®), textual descriptions (Word® documents and direct input), pictorial descriptions (PowerPoint® presentations, pictures, diagrams), graphs and tables – and covered aspects such as:

a) Capability descriptions;

b) Acquisition scenarios;

c) Military scenario information (in generic and declassified form);

d) Military / stakeholder judgement (opinion and voting outcomes);

e) Results from performance / effectiveness modelling (input via spreadsheet and diagrams);

f) Cost data;

g) Risk and opportunities (as a set of observations captured in text);

h) Roadmaps, plans, timelines and decision points.

Building Block Schema

The CI developed the concept of a "Building Block" as a mechanism to describe, in information terms, the physical artefacts that contribute to the generation and delivery of the required military capability. As a physical entity, each building block has an agreed formal definition, is owned by an organisation and is bounded by the dependencies and constraints of the environment. Its contribution to the required capability will be defined by its own performance, its cost and its timely availability, balanced with all other contributions to the overall system of interest. Its development will be informed via research and technology / development activities and the subsequent integration of such improvements within the overall system. It is the population of these attributes and an understanding of the interaction of one building block with another that enables trading and balancing of solution options to be achieved against the requirements of the military and business need.

In only the most trivial case will an individual building block 'deliver' capability on its own. In general terms it will be necessary to combine building blocks into viable sets of blocks – a solution option – in which all necessary and essential attributes are aligned and 'co-operating' and the generation of a comprehensive set of building blocks, with standardised attributes to describe them, enables the effective definition and comparison of solution concepts. It is the data and information underpinning these definitions that enables informed decision making across a wide range of questions - everything from technical aspects, to costs, to DLoDs dependencies and issues. Figure 6, offers a high level view of the schema associated with a building block and its attributes.

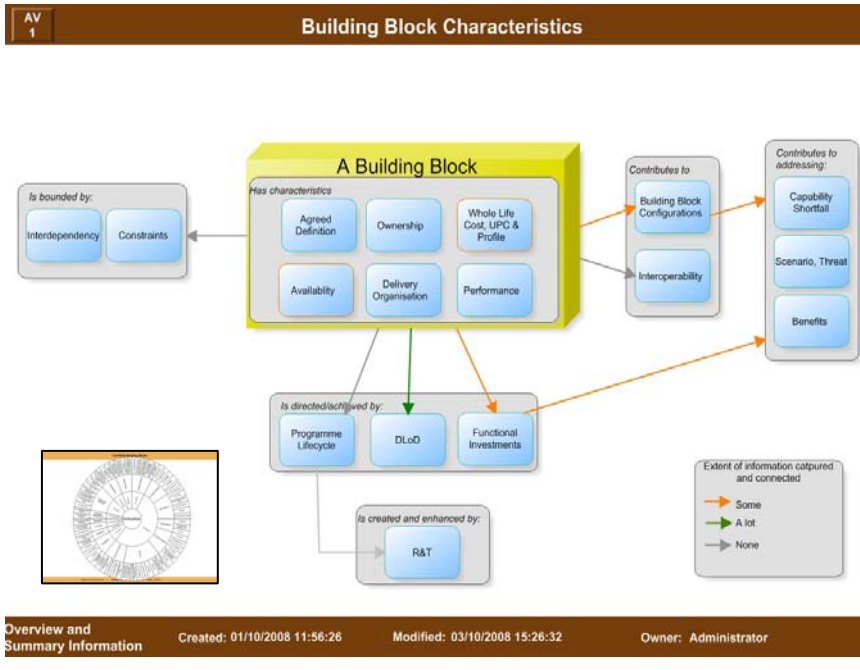

FIG.6 - BUILDING BLOCKS ATTRIBUTE SCHEMA

The population of the characteristics of each building block generates a common information centric style description of the system. This enables consistent and coherent visualisations of the data to be developed for different user needs quickly and reliably, with the differing views likely to reveal emergent issues – impact on Training, changes in Personnel and Organisation, etc. Further, it supports a consistent approach to the measurement and evaluation of these options, thus allowing informed trading and decision making against the valued attributes and problem constraints.

It should be noted that it is not necessary for all attributes and building block descriptors to be populated before useful work can be undertaken (and the FMCM CI operated using this principle). Whatever information is available can legitimately contribute to decision making in those domains, with assumptions recorded for other perspectives. As new data / information become available, the building block attributes can be populated and the assumptions originally made tested and evaluated against the increased knowledge set in a consistent fashion. This leads to an increased maturity in the overall understanding. Thus, an incremental approach can be adopted which recognises and supports the management of uncertainty in (any) decision making process.

Integrated Management Plan

The Integrated Management Plan (also known as a Dynamic Gantt Chart[Ref. VI]) is the key artefact of the overall Information Management development and represents one of the improved planning outputs expected from a CI (as noted above). It forms the key environment and programme representation for bringing

stakeholders together and enables a detailed understanding of all the components that contribute to the required capability, as well as providing clear views of the dependencies between these components (Figure 7).

This plan is developed entirely from the building blocks – i.e. it is built directly and solely from the contributing components to the capability – and incorporates perspectives from Military Capability (TEPID OIL), Industrial Capability (People Process Products Technology and Facilities – P3TF), Research and Technology and finally the Commercial and Financial domains. However, although the Plan when 'read' from left to right may be considered as a standard Gantt Chart, the representations are not activities but lifecycles and decision points. Thus, a Training component is considered in lifecycle terms – course development, execution, candidate assessment – in just the same way as an equipment lifecycle of Concept, Design, Development, Manufacture, In-Service etc. represents the development of a product. The advantage of this lifecycle view is that it enables clear insight into the periods over time when all the essential components are in alignment and hence able to provide / deliver the required capability output.

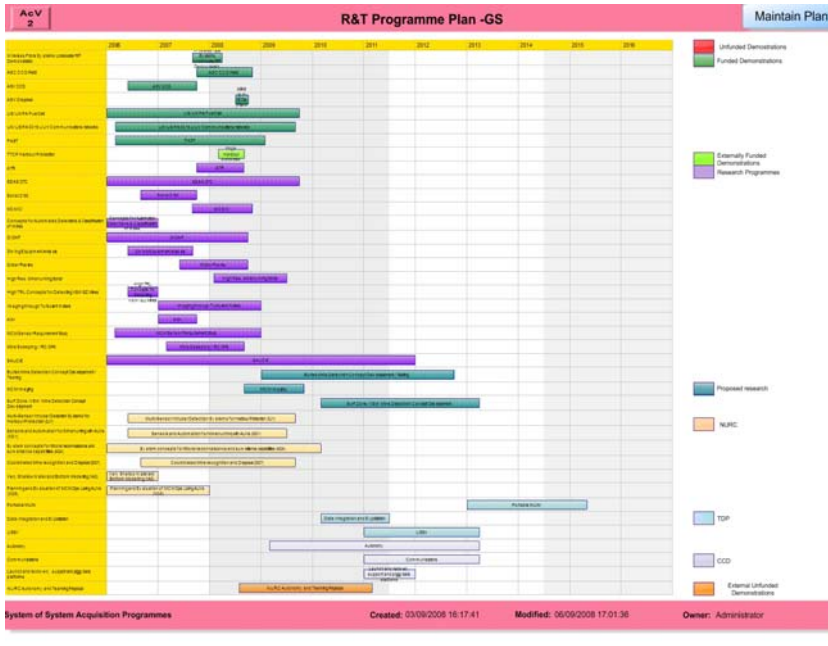

FIG.7 – INTEGRATED MANAGEMENT PLAN (IMP)

Clearly, for the Equipment DLoD, there may be numerous contributing components at all stages of the (acquisition / development) lifecycle, ranging from In-service components (where all other aspects being available) they are making a positive contribution to the capability measure of interest, to those programmes where the acquisition cycle is less advanced (Concept and Assessment, or Demonstration and Manufacture) and the immediate contribution is zero and the In-service activity represents an expected contribution; and yet others that are coming to the end of the In service phase and are ready for disposal or life extension etc. Here the contribution to the measure of interest is positive,

decreasing to zero or transitioning to a different contribution level. Each of these views can be aligned and correlated within this Plan.

As the Plan explicitly represents the lifecycles of the contributing components, it is possible to develop views associated with the trends of the capability over time. Each vertical perspective of the Plan can offer a view of the capability at that snapshot point in time and clearly a sequence of these snapshots can visualise the trend. Commencing on the left hand side of the Plan, where the current extant situation is represented and then developing the planned or aspirational snapshots as one moves to the right, enables a clear insight into the issues of transition between one state (and grouping) of the contributing components and another.

The development and presentation of all these views in a single perspective enables clear visibility of the interdependencies between the components, of the timing of decisions (as milestone points in the Plan), of the future expectations of input and contribution from new components or research outputs etc. It is the broad perspectives that this visualisation enables that inform all other aspects of the Capability Management activity.

Capability Dashboard – Impact of Change

The Capability Dashboard utilises the Integrated Management Plan as the centre piece of an over-arching view of the Capability. From this view can be drawn a series of coherent and consistent views of the capability over time with respect to a range of perspectives. In the case of the FMCM the underpinning views required were ones of performance in the military tasks to which FMCM is itself a contributing factor; the costs and financial profiles associated with the current and proposed artefacts that would deliver the capability; the risks associated with the programmes in terms of confidence in delivery schedules and actual performance contribution from that component to the capability; and finally a view of the commercial and contractual elements that would enable an integrated procurement of the artefacts – recognising that these procurements reflected all DLoDs, not just the equipment element. This overarching dashboard - or a singular Plan on a Page – is presented at Figure 8. For this application the outputs have been highlighted into three distinct areas of the graphic, but the overall perspective, the common language for the community involved in the acquisition, is based throughout on an appropriate interpretation of risk.

Risk to the Military Capability (the Users view)

The upper area of the dashboard provides visualisations and information primarily for the military capability planning community, the MoD desk officers and JCB (if necessary), i.e. of the customer who is setting the requirement for the capability and the solution components in the first place. It is developed through the use of modelling and evaluation with representations of the current and expected products and services available for the delivery of the capability drawn from the central plan and schedule.

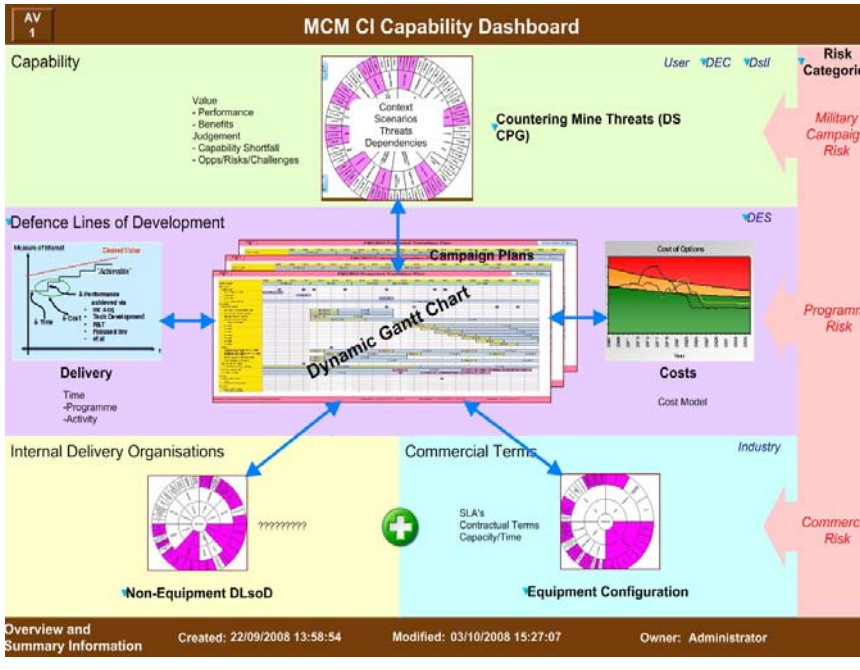

FIG.8 – CAPABILITY DASHBOARD

The bulls-eye visualisation presented here provides a contextual view of the military output and activity required. It is not based on any specific taxonomy; the innermost ring depicts the military tasks and scenarios of operation (in the FMCM case this represents Home Commitments, Chokepoint clearance, port entry etc.); the middle ring is a view detailing the characteristics of the environment in which the task is executed (for FMCM this represents the deep water, shallow, very shallow and surf zones of operation); the outermost ring represents the functions that occur in each of these environments (Sense Manage and Effect).

With this contextual and functional perspective, overlays can be developed that represent (and then visualise) the risk to the achievement of the required task, or the relevant environment, or overall military operation through scenario modelling, operational analysis, effectiveness modelling etc. The elements that are represented in these models are taken directly from those building blocks that are aligned within the Integrated Management Plan i.e. the in-service products and services that are available (or are expected to be available) at a given point in time for the achievement of that particular task.

These bulls-eye representations and the overlays applied can be used to express trends in task achievement, identification of functional shortfalls (which might then inform the R&T community or highlight the need for particular functional procurement) and other elements of interest that inform the understanding of the risk to the achievement of the military capability.

Risk to the Programme of Acquisition (the Acquirers view)

The middle area of the dashboard provides information and visualisations to the whole acquisition community and represents the key elements of the dashboard. The Integrated Management Plan contains all the necessary building blocks that contribute (when aligned in viable combinations and groupings) to the required capability. It includes therefore detail across all the DLoDs, across the Industrial capability / capacity (as expressed by P3TF), across the relevant R&T programme and includes information about the decision points and timings necessary to enable commercial and financial developments. This area of the dashboard also highlights the dependencies across the programmes thus enabling programme management across the whole acquisition space including the DLoDs and highlights mismatches in expectation, planning, timings etc. It is from this plan that all details of the current and expected acquisition activities and their products are taken and used in the associated analysis techniques.

The two visualisations directly associated with this plan in this area of the dashboard represent the risk to time and performance in the staircase diagram on the left and the risk to the financial profile of the acquisition on the right. Together therefore they enable a single view of the risks to the acquisition programme – risks that can be directly related through pertinent analysis to the risk to the achievement of the military objective as represented in the bulls-eye of element 1.

As each of the lines in this Integrated Management Plan presents the lifecycle of an artefact, it is possible to provide a 'dynamic' component to this representation. If when considering any or all of these risk representations there are elements that are unsatisfactory i.e. they register an unacceptable risk in military output terms, or distort the financial profile beyond acceptable limits, it is possible to 'adjust' the lifecycle of the components contributing to that risk – by accelerating an acquisition or extending an in-service artefact contribution etc. Once a more balanced and acceptable combination of artefacts has been identified the information manager can then 'freeze' that combination and initiate a more detailed study of the effects of the changes suggested to confirm the benefits and importantly understand the impact and implications of making the proposed changes upon extant contracts, proposed research plans, training plans, infrastructure support issues (as examples). This 'dynamic' part of this plan and its associated analysis offers pro-active management and understanding, through the coherent and consistent information base, of the overall management of the capability (from all perspectives) through time.

Risk to the Delivery Elements (the Providers view)

The final element, across the bottom, of the dashboard represents the risk to the delivery of the individual products and services of the capability and their integration. On the right is a visualisation which represents the equipment line of development as this is the primary delivery element from Industry. The overlay here can be used to represent which element of Industry is delivering which component, or the status of a particular contract etc. The left hand bulls-eye represents the other necessary non-Equipment DLoDs that have to be aligned to ensure the achievability of the required capability at the point of delivery. This is referred to as the 'internal' delivery element as these would represent other MoD

agencies for example involved in the delivery / achievement of capability. Again the overlays highlight the status of contracts, the definition of service level agreements etc. displayed in a simple Red Amber Green structure.

The combination of these two views therefore may offer some insight into integration issues, including aspects of timeliness, availability, which may be 'summed' through concepts such as System Readiness Levels (as opposed to simply TRLs).

Study Results

The deliberate and focused capture and management of information throughout the FMCM CI has developed a wide range of benefits that are particularly pertinent to the MoD's TLCM initiative. The visualisations of the captured information represent windows onto the domain and environment of interest and are, to a great extent in this example, the primary outputs from the overall investigation. The benefits of these visualisations and the ongoing outputs from the study can be expressed as follows:

- The ability to develop a comprehensive view of the capability requirements through presentations of the strategic intent and operational context, the current contributing components and the gaps that are perceived both in today's environment and looking forward, has provided a mechanism for informed coherent dialogue and communication between all the stakeholders involved in planning, developing and generating the capability. This has developed an improved unity of understanding between MoD and Industry;

- The information captured included the aspirations of and vision for MCM looking forward and prompted the debate about the set of contributing artefacts that were in-plan or anticipated for the delivery of those performance and effectiveness levels. The consistent presentation of that information and its review through operational analysis and performance modelling techniques, as well as through Subject Matter Expert / Military judgement panels, has enabled the development of improved management plans for both the overall delivery of the new artefacts and the necessary mechanisms, critical paths, intervention points and contractual decisions associated with the transition and migration from today's MCM solution to the proposed future solution set. These planning aids and associated visualisations highlight how comprehensive programme level plans sit at the core of the capability management process, providing the desired visibility of decision points, technology opportunities and a clear system boundary, identifying the programmes and activities necessary to achieve successful capability transition with a summary version of these plans contributing to high-level documentation such as the Capability Management Plan (CMP);

- Within the Capability Dashboard, the bulls-eye style visualisation offers a contextual view of military tasks and operations and has, together with the development of a range of plans that show cross-capability opportunities, highlighted a series of touch-points within the capability sponsor

organisation where the activity and decision making within one (military) perspective can have considerable influence and impact on another. The visualisations developed have shown graphically that the areas of MCM, Hydrography & Meteorology and Patrol have a number of key issues and opportunities in common and have provided supporting evidence to what was previously simple belief or hypothesis, i.e. that there is a strong case both militarily and commercially to consider these areas within a single construct. This clarity has given the capability sponsor and the community in general, the necessary confidence to question the 'status quo' and embark on a challenging transformation programme that will actively seek opportunities for common technology pull through, personnel and organisational structures, training and logistical benefits across three traditionally separate warfare enablers. In due course this capability management approach and information interdependence that is implied can be extended to include the Future Surface Combatant programme (and beyond);

- Recognising that the Capability Dashboard represents views of both the problem and solution spaces and utilises the building block concept as a fundamental element of the representation, it is essential that the underpinning information is maintained and developed. This activity has been initially undertaken within a new Ministry – Industry construct MINE (MoD Industry Naval Endeavour) which is taking forward the initial outcomes of the Capability Investigation, building upon the initial plans, developing the 'missing' requirements and identifying and understanding programme risks in the delivery space and any emerging opportunities;

- The investigation clearly demonstrated that solution concept / option generation based upon the building block construct – representing each contributing component to the capability across all DLoDs, Industrial Commercial and Research perspectives – offers a significant advance in both the understanding of the overall capability requirement and its mapping to the appropriate and necessary solution components. The basic primitive set of building blocks identified so far needs to be expanded and populated fully. Aspects of this population activity are underway within MINE as part of the solution concept generation process, which includes the necessary Industry perspective and participation;

- The process of information collection itself has highlighted issues with access to data, trust in and provenance of the information and, at the most basic level, an understanding that the information required did not exist (i.e. information gaps or previously unknown unknowns). These collection issues have also highlighted the need to address the types of commercial arrangements that are necessary to ensure that the required and appropriate information is available to the community through time to achieve the necessary long term management activities (so establishing an 'openness' in the acquisition system to support an enduring capability and community);

- The MoD's MCM Research Plan has been restructured on the basis of the visualisations developed where increased understanding, through the Integrated Management Plan, of the risks and uncertainty associated with the timing of key decisions and exploitation paths for the research has improved the coherency and timeliness of research plans, enabling limited resources to be targeted appropriately. From this insight, the research plan has been rescoped to address imbalances in terms of the priority and urgency of the original programme;

- Capability Management using an information centric approach offers the ability to balance (military) output and delivery across a range of component elements (e.g. across TEPID OIL, inclusive of commercial and financial models and research developments) and the ability to use effectively the richness of information captured, developed and visualised requires a range of analysis techniques and 'mindsets'. Through the use of the building block concept, the Capability Dashboard aligns stakeholders with an inclusive Capability Management view, displaying different perspectives of the same information in support of an Integrated Decision Support process. The current mindset towards analysis for Capability Management and the techniques employed do not exploit fully these opportunities and the opportunity to enhance this type of activity through analysis was constrained during the investigation by the inability to use the full detail of the captured information within existing analysis models. Additionally, there is a need to execute analysis more quickly and based more directly upon specific contributing elements. This leads to a recognition that different styles of analysis are required that make better use of the information captured within the repository; that allow opportunities for trading between the capability contributing components through the use of the common currency of the building block; that allows for sensitivity analysis as a key mechanism to highlight opportunities to manage uncertainty and imprecision. Taken together this suggests that currently analysis is not a fully connected part of the integrated decision making process.

To gain the fullest benefit of the investigation, building constructively on the relationships developed and the insights gained through the use of information and its consistent management, it is necessary to maintain and extend the perspectives developed to date. Whilst there is much being done to achieve this, the impetus generated by any activities can easily dissipate and momentum lost – whilst the information captured remains available, its currency and pertinence reduces over time, the interdependencies and relationships change and the ability to achieve coherent acquisition and management of capability over time diminishes.

Conclusions

Within the overall Defence Acquisition community, TLCM remains an evolving concept, the understanding and interpretation of which remains patchy and inconsistent across large areas of the Defence Community. However there is a growing body of evidence and belief that TLCM can be viewed as an Information

Management problem rather than simply a technical / technology issue addressed by the management of equipment, performance and technology over time.

The use of Information Management techniques during the FMCM Capability Investigation, supported by the use of the decision support environment TRAiDE™, has contributed to the overall debate and understanding of TLCM, through both problem (FMCM) specific insights and observations and more generic, domain independent perspectives and benefits. These are summarised as:

a) The investigation activity demonstrated that the generic techniques and applications of Information Management are essential to any overarching view of Capability Management, supporting the broad hypothesis that TLCM can be viewed as an information management problem;

b) The development of a repository of information provides an enduring single point of reference and support for the overall programme:

- As a consequence, the development of a common language about and understanding of the issues can be reached quickly; this may also help overcome resource limitations;

- The maintenance of this repository and its contained information is crucial to the overall consistency and coherence of the capability management activity.

c) The adoption of an Information Management approach brings greater understanding in a shorter time:

- The immediacy of insight gained contributes to an improvement in working efficiency and success, to the more rapid identification of gaps / omissions / contradictions; the straightforward development of output products to achieve successful outcomes and overall progress;

- The overall development of appropriate visualisations of the gathered information is significantly enhanced through the choice of information manager with easy accessibility to 3rd party tools (such as Excel®, Word® and PowerPoint®) and proprietary applications (such as simulation models).

d) The concept of “Building Blocks” - the basic contributing components of the capability and described through a comprehensive set with standardised attributes and consistent ‘rules of combination’ - enables viable ‘solution’ configurations of contributing elements to be generated quickly, cognisant of the overall output (capability) characteristics being sought. This allows the development of continuous and effective comparison of potential solution options across a wide range of scenarios and perspectives (both military and industrial) in areas such as technical aspects, costs, DLoDs dependencies and issues, from the extant situation (today’s capability) to tomorrows expected / aspirational circumstances:

- From these evaluated comparisons, roadmaps and plans at varying degrees of detail can be developed to facilitate the planning, management, delivery and assurance of the transition (from now to then) providing support for

all stakeholders involved with all data drawn from a consistent source with known levels of confidence over time.

e) The Integrated Management Plan is the key information visualisation and enabler of TLCM. It is developed from the contributing components of capability drawn from the military perspective of TEPID OIL, the Industrial contribution of P3TF, the input and forward view from Research and Development / Technology and finally the decision points and constraints of the commercial and financial environment. The ability to consider each contributing component as a building block enables clear visibility of the data / information flows necessary to populate the appropriate models and tools pertinent to whatever stakeholder view is required, be it cost modelling, risk analysis to schedule and performance contribution on delivery, operational analysis for performance / effectiveness calculations in context;

f) The development of a Capability Dashboard which is built around an Integrated Management Plan enables a wide range of stakeholder perspectives to be presented coherently in a single output visualisation. The interdependencies of the plan can be clearly identified and the impact and implications of decisions addressed. This dashboard, built upon an Integrated Management Plan, forms a key element of the common language of TLCM. However:

- Issues associated with the analysis techniques necessary to support these forms of presentation have indicated shortfalls in the modelling and simulation techniques and availability of models;

- Issues of commercial and financial openness and visibility are essential to enable a fully rounded view of the dependencies and interactions between components of the capability;

- Knowledge and visibility of ownership of the contributing components is not always clear – particularly in the non-Equipment DLoDs.

g) Clarity and understanding of the decision making environment is achieved through a small consistent set of visualisations:

- The bulls-eye visualisation style of presentation is seen as a core component to understanding the issues. The underpinning framework of the bulls-eye represents a contextual structure for presentation and comparison and the multiple overlays adopted on that single framework represent the parameters of interest and value to a particular stakeholder or community;

- The use of standard graphical elements e.g. silt charts, histograms, X-Y plots from standard 3rd party products provides a familiar environment for the user and stakeholder enabling an emphasis on the data and information presented rather than the visualisation techniques itself;

- The ability to develop composite views using multiple individual visualisations enables the broader more complex picture of the problem / solution space to be presented incrementally, thus improving opportunities

for understanding, debate and the identification of critical features. This also enables the timely development of the most appropriate visualisation for the individual communities (considering issues such as the 'appearance' of the data, the identification of the emerging threads of investigation) and addresses the interpretation issues associated with multiple viewpoints, thus enabling stakeholder A to see / understand the perspective of stakeholder B, through the presentation of the most appropriate / relevant data to each party from a common repository, single point of reference with consistent interpretation of the common language.

h) The issues associated with the identification, communication, ranking, measurement and evaluation of the key values, parameters and components of the community are crucial. The Capability Investigation highlighted particularly the need for an endorsed set of capability statements (or characteristics) with sufficient functional decomposition to enable the generation of an appropriately detailed MCM context. Importantly, these characteristics need to be defined and valued such that concepts can be assessed in terms of the perceived benefit (or otherwise) that they deliver when compared with alternative options. This is essential to support informed decision making.

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