TECHNOLOGY SUPPORT FOR MILITARY CAPABILITY BASED ACQUISITION

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ABSTRACT

The evolution of military warfare and its increasing complexity has made planning for future military deployments more difficult. The need to plan for more uncertain military operating environments makes it more complex. There exists a significant gap between capability planning and acquisition of product systems in the SANDF. (Thaba J et al, 2015). The need for decision support tools and technologies to assist capability planners to close this gap and make sound decisions has become more critical. As such, many defence forces have made a conscious decision to move away from threat based planning approach to the capability based planning (CBP). "The concept of CBP recognises the interdependence of systems (including material and people), doctrine, organisation and support in delivering defence capability, and the need to be able to examine options and trade-offs among these capability elements in terms of performance, cost and risk so as to identify optimum force development investments. (Botha et al, 2012)

The implementation of CBP in the South African National Defence Force will also influence the acquisition of military systems and reduce the risk of prioritising military capabilities. In order to achieve high levels of efficiency in implementing Capability-based acquisition, decision support tools would have to be implemented. The implementation of CBP will be defined by the Capability Life Cycle (CLC), which will be the cornerstone of managing capabilities rather than managing product systems. The management of the CLC requires various decision support tools for the capability manager to be effective. These tools are amongst others, architecture and knowledge management, capability engineering support, concept development and experimentation. These tools are discussed in this paper.

Key words: Capability, Systems, Concepts, Military Architecture,

INTRODUCTION

The need for Capability-based acquisition is encouraged by the continuous changing demands of the military operational environments. The rapid change of the military operating environment puts pressure on nations to be innovative in their planning, and ensure that more eventualities are planned for. This paper discusses the support required to enable capability-based implementation in the military.

The implementation of capability-based acquisition begins with the definition of the military capability in terms of System Elements (SE) and the Functional Attributes (FA). The understanding of a military capability is then supported by the definition of the CLC, which is the process used to engineer and manage military capabilities.

The implementation of the CLC requires the use of various decision support and technology tools. The tools discussed in this paper are used in the implementation of the CLC in the South African national Defence Force (SANDF). The Architecture management is important to show the model of the military capability, and the interfaces amongst the various components of the military capability. The decomposition of the military architecture requires capability engineering support to ensure validation of capability requirements. For verification of Capability requirements, concept development and experimentation is used throughout the CLC using the Measures of Merit (MoM).

MILITARY CAPABILITY

The definition of military capability may differ, but the crux remains in the basic definition of capability, as the "ability to do something". For military capability, there are other aspects that come to play and are important in defining this otherwise system of systems.

Military capability is defined by the Australian Defence Force as "the ability to achieve a desired effect in a specific operating environment".[1] It is defined by three interdependent factors: combat readiness, sustainable capability and force structure. The free dictionary defines military capability as "the ability to achieve a specified wartime objective (win a war or battle, destroy a target set). It includes four major components: force structure, modernization, readiness, and sustainability[2]."

Table 1: Functional Attributes

Functional Attributes	Definition
Firepower	the capability of a military force, unit, or weapons system as measured by the amount of gunfire, number of missiles, etc., deliverable to a target (www.dictionary.com/browse/firepower)
Mobility	Mobility in military terms refers to the ability of a weapon system, combat unit or armed force to move toward a military objective. Combat forces with a higher mobility are able to move more quickly, and/or across more hostile terrain, than forces with lower mobility.
Information/ Intelligence	Military intelligence is a military discipline that uses information collection and analysis approaches to provide guidance and direction to commanders in support of their decisions. ... These information requirements are then incorporated into intelligence collection, analysis, and dissemination.
Command and Control	"The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. (The US Department of Defence Dictionary of Military and Associated Terms.)
Protection	Preventive measures taken to mitigate hostile actions against Department of Defence personnel (to include family members), resources, facilities, and critical information. Force protection does not include actions to defeat the enemy or protect against accidents, weather, or disease. (http://www.military-dictionary.org/DOD-Military-Terms/force_protection)
Sustainment	The provision of logistics and personnel services required to maintain and prolong operations until successful mission accomplishment. (www.militaryfactory.com/dictionary/military-terms-defined.asp?term_id=5234)

[1] The Australian Defence Capability Development Handbook 2012
[2] http://www.thefreedictionary.com/

Both the definitions above indicate the ability and the effect required. It is also important to note that within the Australian Defence definition, the specific operating environment is also added to the definition. In the South African context, a military capability is comprised of System Elements (SE) (POSTEDFIT, See Table 2) and provides functionality (effects) described as Functional Attributes (FA) (See Table 1). Figure 1 indicates how the military capability is defined in South African (SA) Context. Capabilities must be designed to co-evolve with their environment and the evolution must be supported over a very long time. (Yue Y et al, 2009)

Military Capability for the purposes of this paper, and perhaps best suited for the SA context is defined as the ability to achieve a predetermined military objective within specified operational conditions.

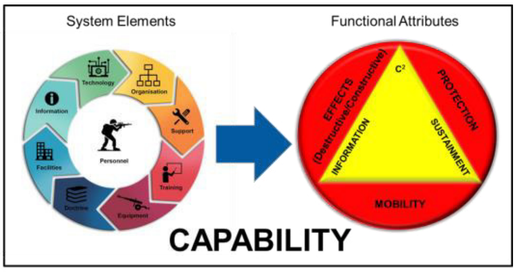

Figure 1: Military Capability

Based on the definition above, and the components of the Military Capability as provided in Figure 1, it clearly indicates that in order to establish a Military Capability, there a various components, including functional attributes that defines it, that requires careful consideration. For the purposes of this paper, the table below shows the definitions for the SE.

Table 2: System Elements

SYSTEM ELEMENTS	DESCRIPTION
P-Personnel	The characteristics of the qualified human resources/required to support the capability, including recruiting, maintaining, staffing levels, career management, development, leadership, morality, ethos and values.
O-Organization	The characteristics of mission task forces, including size, shape, and command and support lines required. This includes actual **organisations** (order of battle and structures), organisational characteristics, responsibilities (command and control), business processes and the allocation of equipment in order to conduct an operation
S- Support	The characteristics of the logistic, financial and information **support** required including resources, support from other Services and agencies, logistic systems and mobilisation planning.
T-Training	The characteristics of the **training** required including individual (single Service), joint and combined training, and training content, methods and resources (curricula, standards, equipment, and simulators, combat supplies funding and time) which enables performance and support of the mission.
E-Equipment	The type, quantity and characteristics of the required defence **equipment** including acquisition, standardisation and compatibility, performance, maintainability, availability, reliability, robustness, flexibility, interoperability and through life support, interpretation of tests and accuracy levels, and any other guarantees that the user requires, are to be stated.
D-Doctrine	The characteristics of **doctrine** (single Service, joint and combined) publications, regulations, operating procedures and other required directives, incorporating concepts, policies, strategy (national and defence), interoperability levels, tactics, techniques and procedures which govern the manner in which operations are conducted.
F-Facilities	The characteristics of the required military support and training **facilities**, (real estate, technical support centres, training areas), Defence infrastructure and national infrastructure, including security.
I-Intelligence	The characteristics of defence **intelligence**, information, data and data processing systems required, including content, timeliness, presentation, format, reliability, compatibility, validity, data correlation and fusion.
T-Technology	The characteristics of the commercial and/or military **technologies** required, including research and development, technology growth paths, cycles and trends, reliability, affordability, cost effectiveness, technical opportunities and risks.

The FA (as depicted as part of Table 1) provides the categories of effects within which Military Capabilities can be classified. These attributes defines the effects required from the military capability. Military capabilities exist at various levels of war, Strategic, Operational and Tactical.

A military capability as described above can be easily understood as a System of Systems (SoS). The complexity involved in measuring the performance/ and or effectiveness of this against set requirements are some of the reasons that prompted this study. The military capability evolves through a Lifecycle as defined in the following section.

CAPABILITY LIFE CYCLE MANAGEMENT

The Capability Life Cycle (CLC) is characterised by four phases (see Figure 2): (1) Capability Definition, (2) Specification, (3) Establishment and (4) Employment. For the success of managing the CLC, it is important to acknowledge the process as an iterative one that emphasises more on process steps hand shaking, rather than hand over.

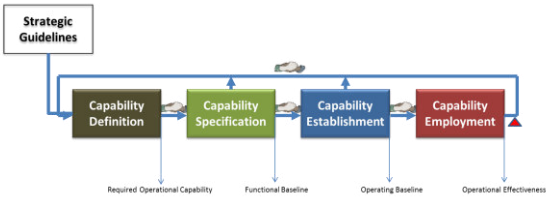

Figure 2: Capability Lifecycle

During the Capability Definition phase, capability gaps are determined, and quantified in terms of effect and envisaged resources required. It is during this phase when the Required Operational Capabilities (ROC) will be determined and validated by J Ops, and categorised to enable dissemination to appropriate services. An Operational Capability Gap as determined in this phase may be broken down into various ROCs' depending on the effects required in this gap, and the ultimate concept determined to be fit to satisfy the Gap. Figure 3 below shows the Military Acquisition process phases. The ROC marks the commencement of the Requirements definition phase. The main question to be asked during this phase is what should the joint force be able to do to achieve its operational objective?

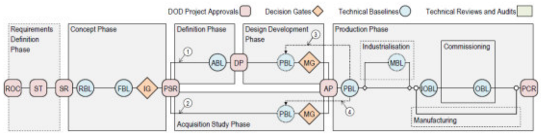

Figure 3: DAP 1000 Acquisition Process

During the Capability Specification phase, the gaps as captured in ROC, are investigated further, for validation, and then translated into functional requirements, ultimately translated into Functional Specifications. The functional baseline will thus be established for the system(s) required to satisfy the operational gap. In Figure 3 above, it can be seen that the Functional Baseline (FBL) is established within the concept phase. The main question to be asked during this phase is what are the typical solutions required to enable the joint force to achieve its operational objective?

The Capability Establishment phase is mainly focused at establishing the capability; this includes establishing all systems elements (see Table 2). This is the phase where the main acquisition projects activities happen. This phase culminates in Operational Test and Evaluation (OT and E) of systems within the operational environment. The Operating Baseline (OBL) is established during the Production phase of the acquisition process, see Figure 3. The main question to be asked during this phase is what are the System Elements required to enable the force to achieve its operational objective?

The Capability Employment phase is more concerned with the Operational Effectiveness of the joint force. . It starts with the employment of the existing capability, and determining how well or not this capability is able to achieve the operational goals. Once the PS has been commission, it is handed over to the operational environment for its employment as part of the Military capability. It is based on this assessment that operational deficiencies will be determined, leading to the Capability Definition phase. The main question to be asked during this phase is how well does the joint force achieve its operational objectives?

Managing military capabilities, instead of product systems (Prime mission equipment) may prove to be more complex. This is because of the complexities of the components of the military capability. Most of these components are complex systems on their own. In order to facilitate the management of the CLC, the following were identified and investigated as necessary to ensure full CLC management:

i. Military Capability Architecture Management
ii. Capability Engineering Support
iii. Concept Development and Experimentation Support

MANAGING MILITARY CAPABILITY ARCHITECTURE

ISO/IEC 42010: 2007 **i** defines ‘’architecture’’ as: ‘’the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.’’ SA Military Capability Architecture is derived from the Systems Hierarchy depicted in Figure 4. This could be further explained by the Capability Architecture Model in Appendix A.

An enterprise architecture role within an organisation is cross-disciplinary, requiring integration of diverse skills, methods and tools, within and beyond the technology community.[3] Holistic EA is pragmatically developed through the ongoing collaboration

[3] https://www.realirm.com/enterprise-architecture

between business role players, the IT executive team, and the EA team.

The Open Group Architecture Framework (TOGAF) defines the purpose of enterprise architecture as to optimize across the enterprise the often fragmented legacy of processes (both manual and automated) into an integrated environment that is responsive to change and supportive of the delivery of the business strategy.[4]

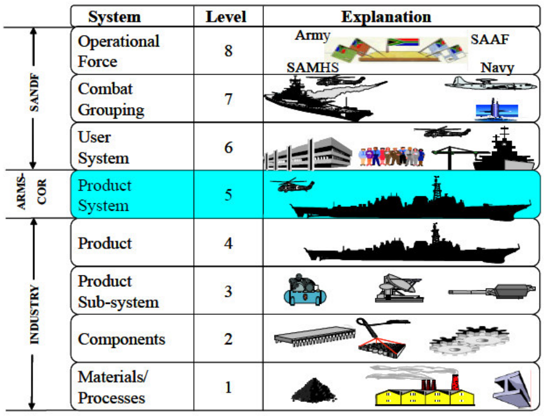

Figure 4: Systems Hierarchy

There are many tools (for e.g. TOGAF, MoDAF, DoDAF etc)[5] already available in the market to model the Military Capability Architecture. The purpose of this paper is to indicate the use architecture modelling as an important tool to managing military capabilities. The use of Architecture to model military capability enables the measuring of operational effectiveness through concept development and experimentation, modelling and simulation and other performance management approaches. This is made possible by Capability engineering support to be discussed hereunder.

CAPABILITY ENGINEERING SUPPORT

Capability engineering is an evolving construct that extends well-established systems engineering principles to a "system-of-systems" perspective.[6] Capability engineering incorporates a holistic blend of people, process, and material, ensuring that capabilities are properly designed, efficiently developed and sustained with a specific focus on interoperability amongst capabilities and other government departments. (Montealegre R, 2002)

Figure 5: The Interoperability Development Environment at the CSIR

The Interoperability Development Environment (IDE) (Figure 5) was established to provide support to the SANDF. The IDE is mainly responsible to define interoperability requirements for military capabilities future and current. Once the capabilities are established, the IDE is also used to test these capabilities against the requirements.

Measuring Capabilities

In order to measure military capabilities, the value-focused metrics, including system–level measures of performance and scenario-based measures of effectiveness must be developed. This will lead to integrated capability metrics

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4 *http://pubs.opengroup.org/architecture/togaf9-doc/arch/chap01.html*

5 Ministry of Defence Architecture Framework (MoDAF), Department of Defense Architecture Framework (DoDAF)

6 *www.cae.com/uploadedFiles/.../Defence_and.../datasheet.capability.engineering.pdf*

suitable to link military strategic guidance to engineered capabilities. *FIGURE 6* below depicts the view of military capability architectures

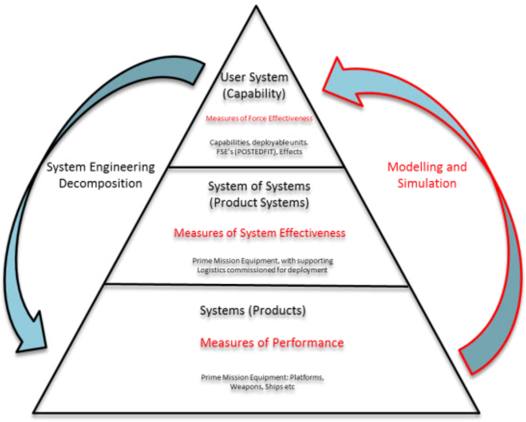

Figure 6: System of Systems, System and Subsystem View of Military Architectures

Through this analytical approach and simulation-based environment the impact of alternative capabilities on variables such as strategic key performance parameters, operational and system performance, lifecycle costing, personnel, and training requirements and methods can be understood.

CONCEPT DEVELOPMENT AND EXPERIMENTATION

A military concept is the description of a method or scheme for employing specified military capabilities in the achievement of a stated objective or aim. This description may range from broad to narrow. It may range from describing the employment of military forces in the broadest terms and at the highest levels to specifying the employment of a particular technology system or the application of a particular training system.

Figure 7: Concept Development and Experimentation Centre at CSIR

Military concepts can be viewed in terms of ends, ways and means, of which the concept corresponds generally to the ways. The means are the military capabilities to be employed in the given situation. They may range from the full arsenal of military forces available at the operational or strategic levels to a particular capability such as a weapon system, vehicle, training system or specific unit at a lower level. The end is the stated objective, ranging from a broad strategic aim to the accomplishment of a particular task (Schmitt JF, 2002).

Figure ***7*** shows the Concept development and experimentation centre established by the CSIR in support of the SANDF and other clients. The decomposition of the Capability as discussed above can be better validated through concept development and experimentation. Appendix A depicts the relationship view of the the Military Capability Architecture with the Concepts and Measures of Merit hierarchy.

Model-Based Systems Engineering

Model-based systems engineering (MBSE) is the formalized application of modelling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases (INCOSE-TP-2004-004-02, Version 2.03, September 2007).

Modelling and simulation has become the computing paradigm of the future. As a paradigm, it is a way of representing problems and thinking about them, as much as a solution method (Vangheluwe H, 2001). The essence of the Capability-based planning is the possibility to plan for an uncertain future with more variable eventualities. To enable this, modelling and simulation has become an important tool. Figure 8 presents modelling and simulation verification and validation activities introduced by Zeigler. (Vangheluwe H, 2001).

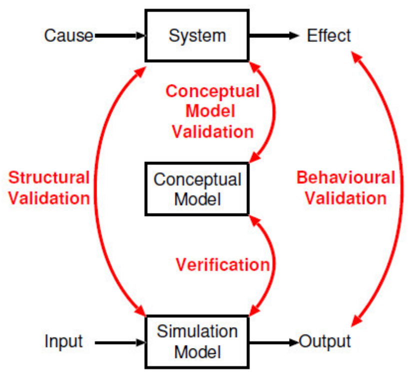

Figure 8: Verification and Validation Activities

Through cost-effective constructive simulation, defence planning teams are able to evaluate the potential effectiveness of military capabilities, and to compare amongst capability alternatives being considered for a particular military objective. Through simulation-based decision support services, decision makers can make informed balance of investment decisions for the military capabilities.

For Capability-based acquisition to be fully realised, requirements definition phase needs to be lead from J Ops, as the overall employer of the capability. This would mean that the Required Operational Capability (ROC) would be an output of the Capability Definition phase (See Figure 2).

CONCLUSION

The implementation of Capability-based planning in the SANDF remains critical to ensure reduction of uncertainty in future planning, but to also ensure that the SANDF is prepared for more eventualities as dictated by the rapid changing operational environment. The decomposition of the military capability and definitions of Measures of Merits at various levels enables the Capability Manager to properly define the capability and set the criteria to measure its effectiveness.

Concept Development and Experimentation once applied correctly will assist in ensuring that the requirements for achieving operational effectiveness required are correctly set, and validated. Once the concepts are developed, simulations models should be used to confirm that the Required Operational effectiveness will be achieved.

For Capability-based acquisition to be implemented and yield required results, all involved stakeholders must understand their roles and buy-in to the process. The establishment of Concept Development and Experimentation Centres is one of the Critical steps towards decision support required for capability-based acquisition. The use of Architecture models allows the capability manager to have a view especially of the gaps to be filled once they become evident.

Implementation of Capability-based acquisition is not an overnight event, and requires a complete mind shift from the threat-based type planning. The language of capability-based planning may be spoken amongst stakeholders; however implementation thereof has not really taken place. The techniques and tools discussed above provide a good stepping stone to implementing capability-based acquisition, in the SANDF.

ABBREVIATIONS

Table 3: Abbreviations

Abbreviations	Description
CBP	Capability-based Planning
CLC	Capability Life Cycle
DAP	Defence Acquisition Policy
DOD	Department of Defence
FA	Functional Attributes
FBL	Functional Baseline
ROC	Required Operational Capability
J Ops	Joint Operations Division
JAD	Joint Air Defence
JCD	Joint Cyber Defence
JC2I	Joint Command, Control and Intelligence
JLD	Joint Landwards Defence
JMD	Joint Maritime Defence
JOSS	Joint Operational Supply and Support
MC	Military Council
PS	Product System(s)
OT and E	Operational Test and Evaluation
OBL	Operating Baseline
SANDF	South African National Defence Force
SE	System Elements
SR	Staff Requirement
ST	Staff Target
SA	South Africa (n)
URS	User Requirement Statement

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APPENDIX A: MILITARY CAPABILITY ARCHITECTURE