Chapter 20
Mapping Platform Transformations

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Abstract Technology insertion provides the means to proactively sustain and enhance the functionality and associated performance levels of legacy product platforms. It aims to deliver in-service technological innovations in response to the need for new capabilities that address emerging threats, obsolescence concerns and affordability issues. Platform modernisation via technology insertion is an interaction between the three principal stakeholders of end-user, acquisition authority and product-service system provider. To bring these three groups together for the vision setting and planning activities, a transformation mapping approach has been developed. It requires the participants to populate three visual templates that respectively map the future strategic context, the portfolio/fleet of complex product platforms and the key functional systems that generate utility. The adoption of this approach provides the ability to outline future capability requirements, determine product development options, and align these with the associated technology upgrade paths against the time dimension. To illustrate the implementation of the method, a case study from the defence industry is employed to depict the typical outputs that can be generated.

20.1 Introduction

Military product platforms have exceptionally long lifecycles, in the order of decades, and given the state of defence budgets there is the general trend of sustaining the operational capability of those legacy platforms for much greater

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periods than their original design intent. In the context of through-life management for complex product-service systems, one of the key challenges is how to direct and co-ordinate the flow of technology for platform modernisation during the in-service phase of the product lifecycle. With a platform in active use by the end-user, inserting the latest technological innovations is achieved principally through technology insertion mechanisms. They provide the means to upgrade and update the capability of a platform in terms of its functional enhancement and associated performance attributes. The requirements for such enhancements is driven by the likely changes in future military operations, the pace of change in technology and the increasing pressures on lifecycle cost reduction.

To guide practitioners, from both the military and industrial communities, a mapping approach has been developed to support the front-end strategic dialogue in respect of the vision setting and planning activities. This approach allows these different stakeholders to visually represent and examine the most appropriate paths to support the operational sustainment of a product platform's capability. To demonstrate the application of the mapping approach a case study on the Royal Australian Navy's Surface Combatant Fleet will be used. This illustration can act as a key reference case. From the position of complex engineering systems, examples from the defence industry provide very rich real-world content and context for exploration. In terms of the defence industry itself, maritime platforms are "inherently technology sensitive and capital intensive. This creates an imperative—an imperative to manage change" (Smith 2001). Thus, they lend themselves to being applicable for exchanging learning outcomes across to the air and land domains. Additionally, in the maritime environment the emphasis on the surface combatant fleet as the main focal point is very pertinent as it represents the Navy's largest investment (Davies 2008). Finally, bounding the discussion and illustration of this case example to the combat system perspective ensures relevance to the current and future issues faced by the Navy and naval industrial-base as it represents the heart of a maritime product platform (SPC 2009).

20.2 Transforming Platforms Through Technology Insertion

Technology insertion is defined as "the utilisation of a new or improved technology in an existing product" (Kerr et al. 2008a). It is concerned with how to manage the flow of technology from the research and development stages into the fielded arena where the recipient platforms are actively on operational service with the end-users (Kerr et al. 2008b). However, it is critical to first address the issue of modernisation viability, i.e., is it actually worth considering the avenue of technology insertion to enhance the capabilities of a given platform? [Note: the use of the term 'capabilities' in relation to a platform signifies its functionality and associated performance levels].

In terms of managing the defence capital stock, there are the two fundamental choices (Dowling et al. 2007; Kosiak 2004) of either (i) continuing with the legacy platform or (ii) replacing the current platform with a new generation. Modernisation viability is a consideration of a legacy platform's capacity to still have a role to play in future military tasks weighed against the level of investment that would be needed to satisfy these operational needs. "In general, upgrading is less costly in the near term, but is only reasonable if the system that is being upgraded can perform well enough and last long enough" (Balaban and Greer 1999). "And even with upgrades, if the lifecycle period under consideration is long enough, eventually the upgraded system will need replacement, so acquisition is deferred, not avoided" (Balaban and Greer 1999). From underneath this legacy versus replacement decision, technology insertion can be described as the best method to utilise "limited resources to sustain weapon systems and grow fielded capability" (Milas and Vanderbok 2006). In that regard, technology insertion considers: (i) the use of better technology, and (ii) a product in need of improvement (Kerr et al. 2008a). Thus, technology insertion provides a mechanism to "enable faster and cheaper capability upgrade" with a "focus on the pull-through of new technology" (MoD 2005); in essence transforming a platform's capabilities, and even role, through selective enhancement packages.

The product platform dimension is obviously the mainstay for technology insertion activities. Recognising that "much of a platform's capability is delivered through its subsystems" (MoD 2005), the primary consideration is thus on product-centric (i.e., systems, equipment and component) changes as opposed to either process orientated improvements or the betterment of associated platform support arrangements. Therefore, in this chapter, the unit of analysis will be the platform (product). Product-centric changes are in response to only three fundamental reasons, as outlined in Kerr et al.'s (2008a) rationale model. They are:

- The threat of obsolescence
- The requirement for additional or new capability
- The challenge of affordability

Additionally in the paradigm of technology insertion (Kerr et al. 2008a), there are four classes of changes (Kerr et al. 2008b) that feed product-centric modifications, namely:

- Changes from the external environment
- Changes from user evaluation
- Changes from technology developments
- Changes from funding availability

Therefore, the promise of technology insertion is the repeated introduction of the latest technology into an in-service platform as both the threats and the technologies, themselves, evolve.

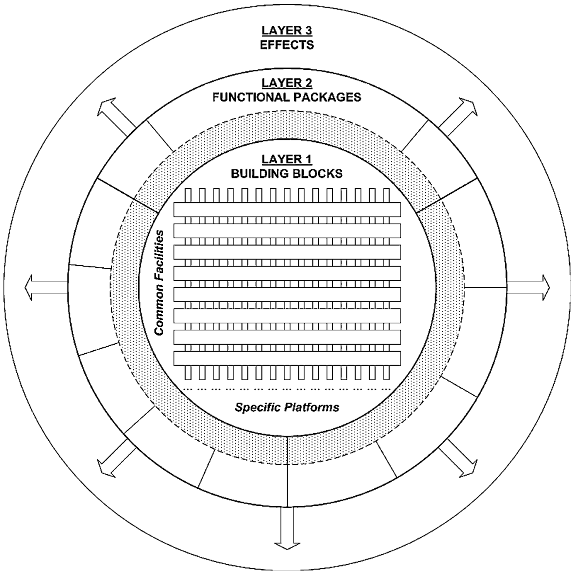

Fig. 20.1 Template for the military capability framework

20.3 A Mapping Approach for Visualising Platform Transformations

This chapter describes the mapping approach developed by the University of Cambridge's Centre for Technology Management. The approach is based on highly visual methods that can be used to clearly articulate and present the capability transformation of product platforms. It is based on the integration of Kerr et al.'s (2006, 2008c) visual framework for military capability and the visually-orientated roadmapping scheme (Phaal et al. 2007; Kerr et al. 2009). There are three steps in the general approach, namely:

- Map the strategic context
- Map the fleet
- Map the functional systems

First, there is the need to vision and articulate the future force for the specific service branch of the military. This is a top-down holistic view that provides the strategic context in which a platform will operate and from where the critical drivers for product-centric changes are derived. It is framed according to the layered structure of the military capability representation developed by Kerr et al. (2006, 2008c). The approach requires the stakeholders to populate the end-state template with their view of the future warfighting effects, functional force packages and building blocks. The template is depicted in Fig. 20.1. The building blocks represent the inner layer of capability consisting of the lines of common facilities, i.e., the support system, interwoven with the spectrum of strategic platform types. Bonded onto the capability building blocks are the functional

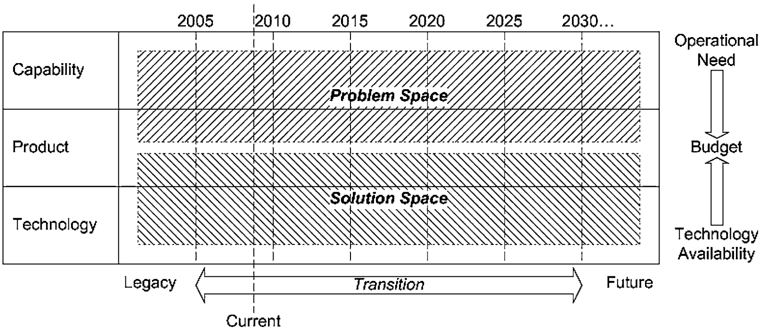

Fig. 20.2 Template for the roadmap

packages which represent the warfighting force functions. The final layer integrates the effects-based approach.

The second and third steps in the approach utilise the roadmapping method. Figure 20.2 shows the template used to structure the architecture of a roadmap. Although it is a tailored configuration for the issue of platforms transformations, the template's layout has been constructed from and conforms to the basic form and principles outlined by Phaal et al. (2004). The vertical axis of the template is composed of three principal layers, i.e., capability/product/technology that reflects the problem-structure for technology insertion. These three layers are broad categories that are to be unpacked to reveal higher levels of granularity. The horizontal axis in Fig. 20.2 consists of a chronological timeline. This axis represents the temporal shifts that take place as legacy capabilities/products/technologies are transitioned to future states. These future embodiments may be evolutions of the current generation, resulting in an incremental change, or a next generation that results in a step/disruptive change. Through the roadmap template the transition paths from the current to end-states can be plotted at both the fleet and functional systems levels. Since capabilities are path dependent (Birchall and Tovstiga 2005), the visual mechanism of roadmapping allows these paths to be clearly plotted that is, mapping "the timeline of product needs and requirements against technology advancement and obsolescence" (Milas and Vanderbok 2006). The power of roadmapping comes from having a recognition that there exists windows of opportunity for inserting technologies into future upgrade blocks, driven from the four classes of change that feed product-centric modifications (as outlined in the previous section), and matching these with the windows of availability from the technology development activities (Kerr et al. 2008b).

Taking a psychosocial stance on the work of Phaal et al. (2007), the adoption and practice of roadmaps provide a mechanism/vehicle to cogitate, articulate and communicate (Kerr et al. 2009). The generated roadmaps are effectively boundary objects because as entities they forge the links between the differing stakeholders and communicate their shared viewpoints (Kerr et al. 2009). They provide a locus for communication and co-ordination (Yakura 2002). Additionally, the resultant roadmaps "should be reviewed and shared on a regular interval to ensure that

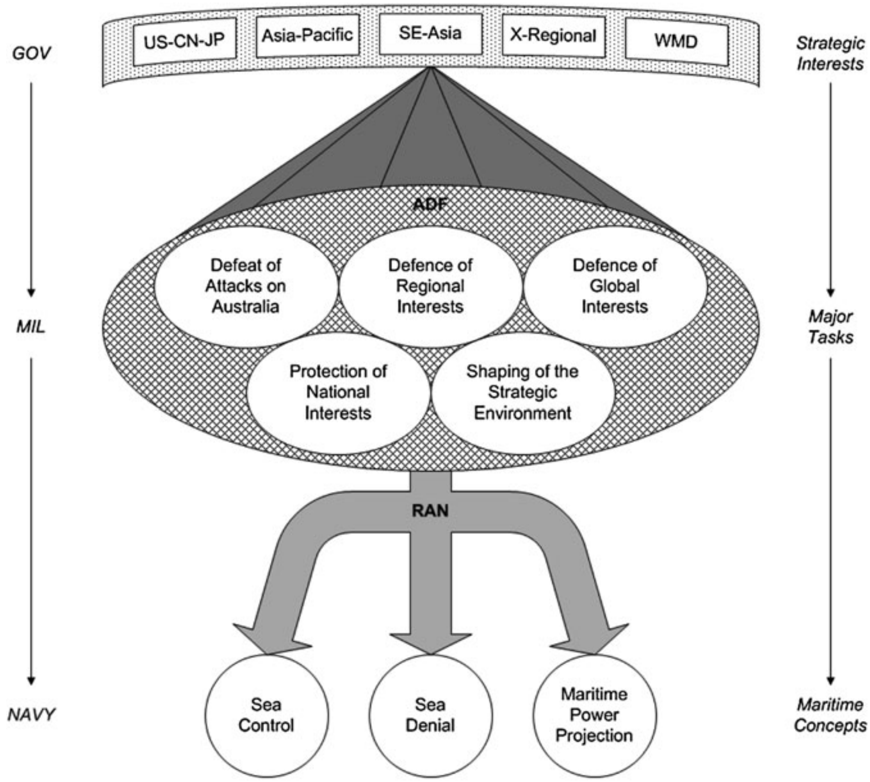

Fig. 20.3 Mapping national and maritime strategy

discontinuances, developments, requirements and changes are known and monitored" (Milas and Vanderbok 2006). It must be noted that the Australian Government's Department of Defence (DoD 2006) highlight the power of roadmapping in terms of its contribution in improving the quality of decision-making and improving the subsequent implementation of those decisions.

20.3.1 Mapping the Strategic Context

The mapping of the strategic context starts with a top-down analysis beginning at a country's strategic and national interests, moving down through its defence priorities to the concepts of operations for the relevant service branches of the military. For each service branch, in turn, the future warfighting elements and effects are determined. Finally, the complex product-service systems are surrounded by this high-level definition of the future strategic context in which they will operate. Figures 20.3 and 20.4 present the case of Australia from the viewpoint of the Royal Australian Navy.

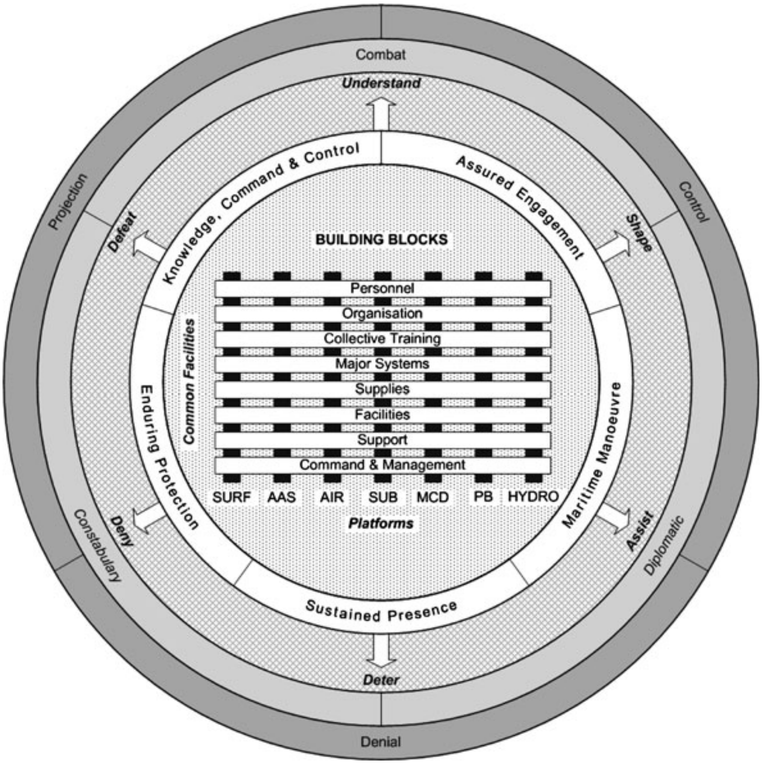

Fig. 20.4 Mapping maritime capability

The Australian Government has identified five enduring strategic interests (RAN 2000):

- "Avoidance of destabilising strategic competition developing between the United States, China and Japan as the power relationships between the three evolve and change.
- Prevention of the emergence within the Asia–Pacific region of a dominant power, or group of powers, whose strategic interests are hostile to those of Australia.
- Maintenance of a benign environment in South East Asia, particularly maritime South East Asia, which respects the territorial integrity of all states.
- Prevention of the positioning of extra-regional military forces in neighbouring countries which might be used contrary to Australia's strategic interests.
- Prevention of the proliferation of weapons of mass destruction."

Below these, in Fig. 20.3, are the associated five major tasks expected of the Australian Defence Force in order to fulfil the nation's security requirements, namely:

- Defeat of attacks on Australia
- Defence of regional interests
- Defence of global interests
- Protection of national interests
- Shaping of the strategic environment

From the major tasks, the Navy's contribution is composed of three maritime concepts namely those of control, denial and power projection. Sea control is defined as "that condition which exists when one has freedom of action to use an area for one's own purposes for a period of time" (JFADT 2004). This condition "includes the air space above and the water mass and seabed below as well as the electro-magnetic spectrum" (RAN 2000). On the other hand, sea denial aims to prevent the use of the sea by another force which implies a more passive posture where the emphasis is on defence (JFADT 2004). For instance, the maintenance of a blockade of enemy forces through the operation of exclusion zones or specific campaigns against an adversary's trade or logistic systems (RAN 2000). The concept of maritime power projection is the delivery of force from the sea. For instance, "the landing of amphibious or Special Forces or the delivery of seaborne land forces, or bombardment by guided or unguided weapons from seaborne platforms" (RAN 2000). These three elements encapsulate Australia's maritime strategy.

Figure 20.4 depicts how the complex product-service systems operated by Royal Australian Navy map into its maritime strategy. The outer ring illustrates the three concepts of sea control, denial and power projection providing the surrounding strategic context in which the product platforms must provide end-users with utility. Aligned to these concepts is the maritime mission space (Crane 2007) that reflects the span of maritime operations (Booth 1977). There are three broad categories:

- Combat
- Constabulary
- Diplomatic

Combat can be classified from two standpoints, i.e., operations at sea versus operations from the sea. Operations at sea include such functions as strike, interdiction, cover and containment (RAN 2000); whereas operations from the sea include the functions of amphibious assault and support to operations on land. Of course, the primary goal of Australia's maritime strategy is to control the air and sea approaches to its continent. Thus, the key requirement is to "maintain an assured capability to detect and attack any major surface ships, and to impose substantial constraints on hostile submarine operations, in the extended maritime approaches" (DoD 2000). The constabulary category reflects the range of policing duties. It includes such operations as anti-piracy, fisheries protection, embargos and sanction enforcement (RAN 2000; Crane 2007). Diplomatic operations embody "the use of maritime forces in support of foreign policy" (RAN 2000). These are either as: (i) a demonstration of capability used to reassure, impress and

Table 20.1 Maritime capability enablers (RAN 2006)

Package	Definition
Assured engagement	The capability of maritime forces to decisively engage target sets across the battlespace using networked systems to provide the required responsiveness, weight of fire, precision and assure success by employing lethal and non-lethal weapons
Maritime manoeuvre	The capability of maritime forces to move freely between the open ocean and the littoral environments and to project force through exerting local sea control to facilitate the delivery of support to the joint or combined mission
Sustained presence	The ability for a joint maritime force of significant combat weight to operate for an extended period at potentially long distances from Australia
Enduring protection	The ability of each maritime force element to successfully achieve designated missions and tasks through the combined capability of defensive, staying and fighting power
Knowledge, command and control	The exploitation of superior battlespace awareness and, through people, innovatively applying operational art and adaptive command to gain decision superiority over an adversary

warn, or (ii) a demonstration of readiness to deploy a degree of combat power (RAN 2000).

The next layer towards the centre of Fig. 20.4 is the effects layer. The Australian Defence Force describes it as the capacity or ability of the force to achieve a particular operational effect (DoD 2006). The Navy has five strategic capability-based effects to deliver, namely:

- “Understand the geopolitical and operational context and maintain appropriate situational awareness.
- Shape (and deter) the choices of potential adversaries seeking to directly attack Australia or its interests.
- Defeat any potential adversary seeking to launch attacks on Australia.
- Deny operational freedom to any potential adversary or security threat within the immediate neighbourhood.
- Quickly and decisively assist the civil authorities of Australia by providing military assistance” (Houston 2007).

Capability must also be considered from the perspective of combat functions (Kerr et al. 2008c). Therefore the functional packages layer, underneath the effects (Fig. 20.4), encapsulates the warfighting force structures of a future force. The template of military capability illustrated in Fig. 20.1 has been populated with the Royal Australian Navy’s Future Maritime Operating Concept Year 2025. The definitions of the functional packages are given in Table 20.1.

Finally, the centre of Fig. 20.4 presents the key building blocks of military capability, i.e., the product-service system space. The supporting infrastructure consists of eight key lines of development (DoD 2006):

- Personnel
- Organisation
- Collective training
- Major systems
- Supplies
- Facilities
- Support
- Command and management

These lines are interwoven in a matrix fashion with the spectrum of strategic platform types. The Royal Australian Navy has seven product area groups (ANAO 2003):

- Surface combatants (SURF)
- Amphibious and afloat support (AAS)
- Aviation (AIR)
- Submarine (SUB)
- Mine clearance diving (MCD)
- Patrol boat (PB)
- Hydrographic, meteorological and oceanographic (HYDRO)

As a visual summary Fig. 20.4 represents Australian maritime capability for 2025. It is a high-level mapping of the future strategic context and presents the future end-state for the Navy to work towards. An analysis of this future military capability poses three challenges (DoD 2000):

- The adequacy of ships' defences against the more capable anti-ship missiles that are proliferating in the region.
- The requirement for a long-range air-defence capacity in the fleet.
- The future provision of support ships to increase the maritime capability by keeping ships at sea longer and at greater ranges from port.

The next step is to then map the future shape of the fleet given these priorities.

20.3.2 Mapping the Fleet

Roadmapping provides a canvas upon which to map the maritime fleet as it transitions from its current form to the future state required to fulfil the Navy's contribution and commitments to national strategy as outlined in Figs. 20.3 and 20.4. A fleet roadmap can be generated for each of the Navy's product area groups. The Surface Combatant (SURF) fleet is used to demonstrate the output that can be achieved by adopting the methods developed by Phaal et al. (2007). This is presented in Fig. 20.5. The architecture of the roadmap is based on a grid layout. The columns are formed from the timescale, in this case 2000–2025 and beyond, with the rows splitting the map between product platforms via classes and technology

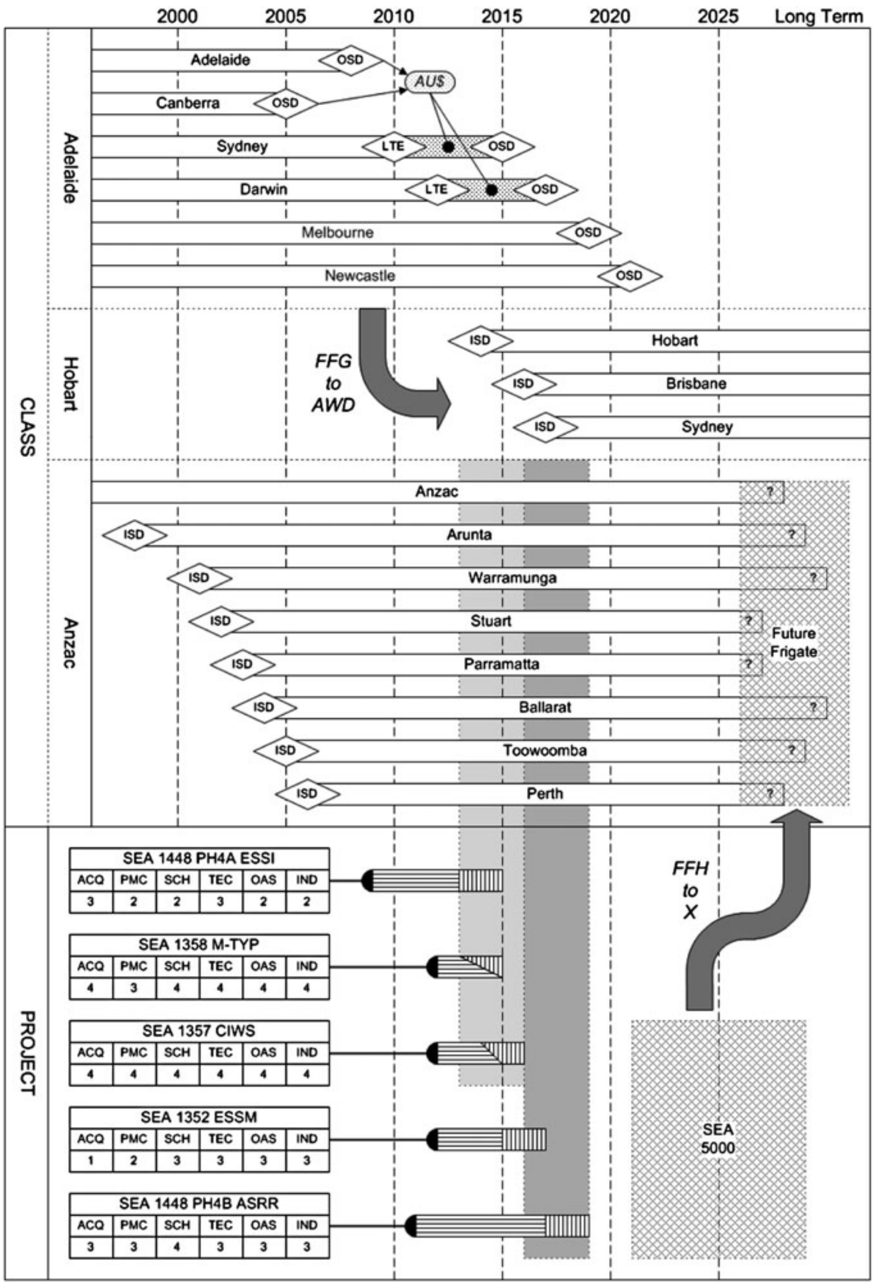

Fig. 20.5 Mapping the surface combatant fleet

insertion projects. In the top half of the fleet roadmap the in-service dates (ISD), out-of-service dates (OSD) and life-of-type extensions (LTE) of the various ships are plotted against the considered timeframe. The bottom half is populated with the key update and upgrade projects.

As can be seen from Fig. 20.5, the current surface fleet consists of two classes of frigate, i.e., Adelaide and Anzac. The Adelaide ships entered service between 1980 and 1993 (DoD 2000). They were based on the US Navy Oliver Hazard Perry design. The first four of the class were built in the United Sates, with specific modifications undertaken in Australia, whereas the last two ships (HMAS Melbourne and HMAS Newcastle) were wholly constructed in Australia. The Anzac's entered service in the early 2000s. They are based on the German MEKO 200 design, with all eight ships constructed in Australia. These two classes, Adelaide and Anzac, are the mainstay of the Royal Australian Navy's fighting ships currently in-service (Thomson 2008).

However, Fig. 20.5 also highlights that the surface combatant fleet is a force in transition (Davies 2008). The Adelaide class frigates will be replaced by a new Hobart class of air warfare destroyer (DoD 2000). This transition is mapped in Fig. 20.5 as the arrow labelled 'FFG to AWD'. The Hobart ships will cost nearly AU$8 billion (DoD 2007) and the first-in-class will enter service in 2014 (SPC 2009). The Hobart class is using the Spanish F100 for its baseline platform design. The three ships will be equipped with an Australianised version of the Aegis combat system. This will then be coupled with the SM-6 surface long-range anti-aircraft missile (Davies 2009; DoD 2009a). The other transition, labelled 'FFH to X', is the likely candidate that will replace the Anzac class in the long-term. The associated new product development programme is being budgeted under 'Project SEA 5000' (Davies 2008). It will potentially see the production of a fleet of eight new 'Future Frigates' (Davies 2009; DoD 2009a) to enter service sometime post-2025.

In the period preceding the two transitions in class replacements, more than AU$3 billion has been committed towards the upgrade of both the Anzac and Adelaide class frigates in order to ensure that they remain at the forefront of regional naval capability (DoD 2007). In respect of the Adelaide class, four of the original six ships will receive an upgrade. As can be seen in Fig. 20.5, the fleet was reduced from six to four vessels. HMAS Canberra was retired in 2005 and HMAS Adelaide was withdrawn from service in 2008 (DMO 2008). These two ships were decommissioned in order to offset the cost of upgrading the remaining four ships. It is worth noting that AU$3 million was allocated for gifting HMAS Adelaide to the New South Wales Government to prepare the ship for sinking as a dive wreck (Thomson 2008). Additionally, HMAS Sydney and HMAS Darwin are to receive life-of-type extensions (ANAO 2007) so that their service on active duty is prolonged by an addition 5 years as illustrated in Fig. 20.5. The details of the technology insertion programme for the Adelaide class will be outlined in Sect. 20.3.3 when the mapping of the upgrade paths for the functional systems is described.

For the Anzac class, the bottom half of the roadmap (Fig. 20.5) depicts the technology insertion projects that will be conducted in the future so as to ensure that these vessels embody operationally relevant functionality and performance. The aim of the upgrades is to enhance the air warfare capabilities and level of anti-ship missile defences against the threats of the next decade (DoD 2008). There are five key projects arranged into two phases. The upgrade paths are the shaded boxed areas in Fig. 20.5 that link the projects with the ships in the Anzac class. In the first bundle of upgrades, three technologies will be inserted into the fleet namely:

- SEA 1448 Phase 4A Electronic Support System Improvements—This reflects an improvement of the CENTAUR electronic system in order to maintain regional capability parity and ensure the sensors align with future threats (DoD 2009b).
- SEA 1358 Mini Typhoon—This is to provide short-range surface defence against asymmetric threats (DoD 2009b).
- SEA 1357 Close-In Weapons System—This is a block upgrade for the Phalanx weapon for improved ship self-defence against anti-ship missiles, helicopters and small craft (DoD 2009b).

Upon successful insertion of these technologies, a subsequent two further upgrades will be incorporated onto the vessels during the second phase between 2016 and 2019. These are:

- SEA 1352 Evolved Sea Sparrow Missile—This is the addition of the named missile system to defend against the evolving anti-ship cruise missile threats (DoD 2009b).
- SEA 1448 Phase 4B Air Search Radar Replacement—This is a replacement of the ageing AN/SPS-49 radar with a modern digital version which will complement the phased array radar system recently installed (DoD 2009b).

On the roadmap, each of the five upgrades has specific metadata contained underneath their named project title captions. The metadata consists of six attributes and associated scores. This representation is based on the ACAT (acquisition categorisation) method (DoD 2009b) as advocated in the Australian Department of Defence's AIS (acceptance into service) framework (DoD 2006). Table 20.2 describes the six attributes used to provide a measure of complexity for the different elements of the technology acquisition process and management activities. Each of the attributes is scored on the basis of a 1–4 rating with 1 representing the very high end and 4 being low.

From inspection of the insertion projects' metadata, it can be seen that there are two upgrades that stand out as being the riskiest. The Evolved Sea Sparrow Missile (SEA 1352) upgrade presents the greatest contributor to cost; it equates to over AU$1,500 million. Whereas, in terms of scoring across all of the attributes, the Electronic Support System Improvements (SEA 1448 PH4A) rates as high. The other three remaining upgrades rate as moderate (SEA 1448 PH4B) and low (SEA 1358 and SEA 1357).

To summarise, the fleet roadmap is a visual tool for visioning the future class transitions and also the key technology enhancements for the current in-service vessels. It provides a high-level depiction for use by planners and contains

Table 20.2 Project attributes (DoD 2009b)

Element	Definition
ACQ (acquisition cost)	This includes the cost of the materiel system (i.e., mission system plus support system), plus facilities costs. This does not include ongoing sustainment budgets
PMC (project management complexity)	This highlights complexity beyond that associated with traditional project management knowledge areas, which are characterised by a project execution environment which is novel and uncertain with very high-level political interactions
SCH (schedule)	This recognises the complexity brought about by schedule pressures on the project requiring the application of varying levels of sophistication in schedule management.
TEC (technical difficulty)	This reflects the inherent complexities which are associated with technical undertakings of design and development, assembly, integration, test and acceptance
OAS (operation and support)	This embodies the readiness of the organisation and environment into which the system will be operated and supported
IND (commercial)	This recognises the capability of industry to deliver and support the required system/equipment, the complexity of the commercial arrangements being managed including the number and level of interdependency of commercial arrangements

metadata orientated for programme managers. The next level down in granularity, which provides the detailed content that describes the actual technology insertion projects is contained in the mapping of a ship's functional systems, i.e., the ship roadmap.

20.3.3 Mapping the Functional Systems

The third and final step in the mapping approach is at the ship level. This is focused on the functional systems and mapping the contents of the bundles of technology upgrades. To illustrate the mapping of the functional systems for a ship, the historic example of the Adelaide class is used. The resultant roadmap is given in Fig. 20.6, in which the focus is limited to the combat system. This map visually outlines the upgrades to the four frigates that are to improve both their self-defence and offensive capabilities until the delivery of the new Hobart destroyers. The most significant enhancement was to address the threat from anti-ship missiles (DoD 2008); this was listed as one of the top priorities for the surface combatants in the Navy's maritime strategy as stated at the end of Sect. 20.3.1. In terms of threat, proliferated anti-ship cruise missiles are the principal access-denial weapon against surface ships (Barber and Gilmore 2001) and the availability of such weapons is increasing (Brooks et al. 2005). Due to the "proliferation of high-capability anti-ship missiles such as Harpoon, Exocet and their Russian equivalents" (DoD 2000). "Such weapons are relatively inexpensive to build or buy.

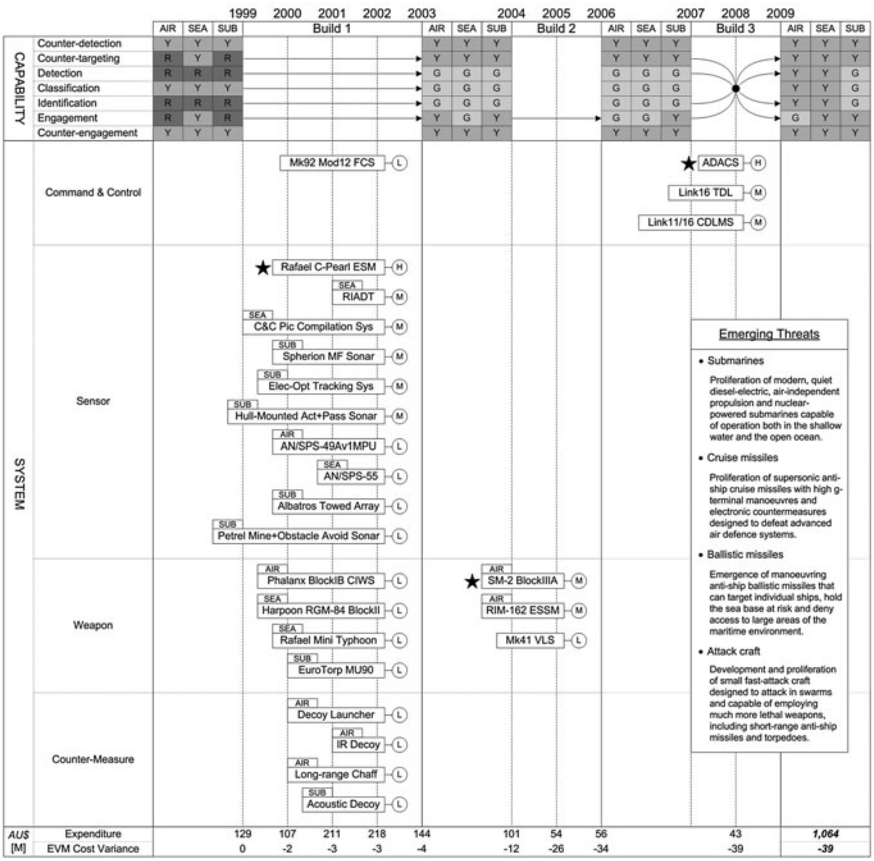

Fig. 20.6 Mapping the Adelaide class' functional systems

New technologies—global positioning receivers, compact gas turbine engines, composite aerostructures—are available to virtually any state or non-state actor wishing to fashion a precise and lethal cruise missile" (Thompson 2004). The roadmap also provides an overview summary of all of the emerging threats facing maritime forces (Mahon 2009); this is contained in the enclosed bullet list on the right-hand side.

At the top of the roadmap (Fig. 20.6) there is the provision of a capability assessment matrix using a traffic light grading scheme where red (R) signifies major deficiencies, yellow (Y) for minor deficiencies and green (G) for sufficient capability. The capability of the ship-level combat system is graded for each three battlespace domains (air, sea surface and sub-sea/underwater) against the key kill-chain functions. The functions are those of counter-detection, counter-targeting, detection, classification, identification, engagement and counter-engagement (RAN 2006). The matrix requires the combat capability to be reassessed after each phase of the technology insertion activities. For example, in Fig. 20.6 the matrix is completed for each of the three builds.

The main body of the ship roadmap outlines the individual upgrades that take place. They are categorised into vertical layers based on the classification of command and control, sensors, weapons and countermeasures systems (RAN 2006). The horizontal time dimension also ties the main columns to the respective builds. In this case there are three phases to the Adelaide's enhancement. The first build is orientated to upgraded fire control, early warning radars and underwater warfare systems (DMO 2008). Build 2 is a focused weapons upgrade which inserts both the Evolved Sea Sparrow and SM-2 missile systems. The third build is the replacement of the original command and control system with the Australian Distributed Architecture Combat System (ANAO 2007) and a new dedicated Link 16 Joint Tactical Information System (DMO 2008). Each of the three build phases has been populated with the relevant technology upgrades. Each project is tagged with their operational battlespace domain (air, sea surface and sub-sea/underwater) to which they contribute to and also a consolidated risk metric (high, medium and low). For instance, the EuroTorp MU90 upgrade, in Build 1 under the weapons layer, is for the underwater domain and has been assessed as a low risk project. The EuroTorp MU90 is an off-the-shelf anti-submarine torpedo. The area of anti-submarine warfare was shown to exhibit a capability shortfall (Davies 2008) and this is reflected in the 1999 capability assessment matrix. The EuroTorp MU90 is the replacement for the older Mk46 lightweight torpedo already installed on the Adelaide class (DID 2009). "The MU90 has greater performance and lethality than the Mk46 and requires less logistic support. It is 3 m long, weighs 300 kg, has a range of more than 10 km and is designed to track and attack quiet-running submarines at depths ranging from 25 m to more than 1,000 m" (Thomson 2008). Finally, at the bottom of the roadmap there is a row of financial data corresponding to the expenditure for each year and the associated cost variance. As can be seen from Fig. 20.6 the upgrades for the four Adelaide ships totalled AU$1,064 million, which is AU$ 39 million over its budgeted cost (ANAO 2007). In summary the ship-level roadmap, which is populated with the functional systems upgrades, provides a visually concise overview of the technology insertion projects that are to be implemented for a given class of product platform. Although the examples used in this chapter are those from the maritime sector, the approach can be applied across to the product platforms in the air and land environments.

20.4 Summary

This chapter introduced an approach for visually mapping the future transitions in complex product platforms. Using the case example of the Royal Australian Navy's Surface Combatant Fleet 2025, the steps in the approach were both described and illustrated. This essentially provides a guide through the method for practitioners and additionally acts as a key reference case that depicts the outputs which can be achieved by utilising the approach. The approach, itself, uses a visual framework for visioning military capability together with a dynamic systems orientated roadmapping template. Using a top-down process, the strategic context in which a product-service system will operate is first determined. This effectively provides a view of the future force for the respective service branch of the military. The defence priorities, concepts of operations, operational-based effects and warfighting elements are all determined. These then provide the surrounding context to the product platforms and the supporting service infrastructure. In order to satisfy this future end-state, the next step is to map the transitions between the current-future portfolio of platforms. It involves plotting the life-of-type extensions and out-of-service dates of the active fleet along with the in-service dates of the next generation replacements. Aligned to the timeframe are the key update and upgrade projects that must be conducted to resolve any capability gaps during fleet transitions. Measures for acquisition cost, complexity of project management, schedule constraints, technical difficulty, operation and support readiness, and commercial arrangements are provided for each technology insertion project. Finally, the phased introduction of the specific technologies within work packages is mapped to the functional systems of the platform together with a capability assessment of their utility with the end-user.

20.5 Chapter Summary Questions

- How do you maintain the technological edge in products that will remain on active service for decades?
- How do you facilitate the engagement of all stakeholders in determining future capability?
- How do you balance operational need, budget constraints and technology availability?
- How do you manage the flow of technology for platform modernisation?

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