The Auditor-General

Life-cycle Costing in the Department of Defence

Department of Defence

Australian National Audit Office

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Canberra ACT
12 May 1998

Dear Madam President
Dear Mr Speaker

The Australian National Audit Office has undertaken a performance audit of Department of Defence in accordance with the authority contained in the *Auditor-General Act 1997*. I present this report of this audit, and the accompanying brochure, to the Parliament. The report is titled *Life-cycle Costing in the Department of Defence*.

Yours sincerely

P. J. Barrett
Auditor-General

The Honourable the President of the Senate
The Honourable the Speaker of the House of Representatives
Parliament House
Canberra ACT

AUDITING FOR AUSTRALIA

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Abbreviations

ABM	activity-based management
ADF	Australian Defence Force
ADFA	Australian Defence Force Academy
AFRAM	Air Force Resource Attribution Model
AMPS	Type of maintenance management system used for surface ships
ANAO	Australian National Audit Office
ANZAC	Class of Australian Navy frigate
AUTOQ	Automated Q-Store system (Army logistic information system)
ATC, ATCR	Air traffic control, Air traffic control radar
C^3IS	Command, Control, Communications, Intelligence and Surveillance
CAIG	(US Department of Defence) Cost Analysis Improvement Group
CAMM	Computer-Assisted Maintenance Management
CASA	Cost Analysis Strategy Assessment (LCC model)
CBS	Cost Breakdown Structure
CDF	Chief of the Defence Force
CEI	Chief Executive Instructions
CEPMAN	Capital Equipment Procurement Manual
CLO	Class Logistics Office (of Support Command - Navy)
DAS	Department of Administrative Services (now part of the Department of Finance and Administration)
DCC	Defence Capability Committee
DCOST	Directorate of Costing
DER	Defence Efficiency Review
DICVAS	Divisional Inventory Control Visibility and Accounting System (Army logistic information system)
DMC	Defence Management Committee
DPUBS	Directorate of Publications
DSDC	Defence Source Definition Committee
DSTO	Defence Science and Technology Organisation
FDB	Functional Design Brief
FELCCA	Front-End Life-Cycle Cost Analysis
EAS	Equipment Acquisition Strategy
EDCAS	Equipment Designer's Cost Analysis System (LCC model)
EMEMIC	Electrical and Mechanical Engineers Management Information Computer
FFG	Guided Missile Frigate

FMA	Financial Management and Administration (Act)
FSPPC	Force Structure Policy and Programming Committee (now abolished)
FYDP	Five-Year Defence Program
GAO	General Accounting Office (of the USA)
GMLS	Guided Missile Launcher System
ILS	Integrated Logistic Support
IT	Information technology
JCPAA	Joint Committee of Public Accounts and Audit (of the Parliament)
JCSE	Joint Communications Support Environment (a major project)
JISE	Joint Intelligence Support Environment (a major project)
JORN	Jindalee Operational Radar Network
LCC	Life-Cycle Costing
LRNAC	Long-Run Net Avoidable Costs
LOTMIS	Life-of-Type Management Information System
NAO	National Audit Office (of the UK)
NPOC	Net Personnel and Operating Costs
O&S	Operating and Support
P-3C	Type of long-range maritime patrol aircraft
R&D	Research and Development
R&M	reliability and maintainability
RAAF	Royal Australian Air Force
RFP	Request for Proposal
RFQ	Request for Quote
RFT	Request for Tender
SC-A	Support Command - Army
SC-AF	Support Command - Air Force
SC-N	Support Command - Navy
SDSS	Standard Defence Supply System
SIMS/SIS	Ships information management system
TLCC	Through-life-cycle costing
TYDP	Ten-Year Development Plan
USAF	United States Air Force
VAMOSC	Visibility and Management of Operating and Support Costs
WBS	Work Breakdown Structure

Part One

Summary and Recommendations

Audit Summary

Summary

1. Life-cycle costing (LCC) is a technique for estimating the total cost of ownership of an asset over its lifetime. Its purpose is to assist decision-makers in making more-informed decisions concerning management of assets. These decisions can occur at any stage throughout the management of an asset - from initial planning, through budgeting to source selection, in-service management and, finally, at disposal. Resources tend to be determined by early decisions. Consequently, the first application of LCC should be made as part of early planning for purchase of an asset. Desirably, LCC analysis should commence at the concept development stage and continue through the acquisition and in-service stages and finally to disposal.

2. Within the Department of Defence, LCC analysis is used in the areas of major capital equipment and facilities as well as in minor capital and administrative acquisitions. Expenditure on major capital equipment and facilities is budgeted at $2.8b in 1997-98. Since life-cycle costs are generally two to three times capital costs, they clearly account for the majority of the defence budget. The audit placed most emphasis on major capital equipment as it is more material to financial outcomes and more risky due to the complexity of these acquisitions.

Audit objective and criteria

3. The objective of the audit was to report on whether Defence applies LCC appropriately in support of decisions throughout the acquisition and management of its capital assets, and to make recommendations for any improvement.

4. Criteria were established against each of the issues considered by the audit, namely LCC policy and coordination, use of LCC in investment decisions, use of LCC to support budgeting, data to support LCC and LCC training and education.

Overall conclusions

5. LCC is a technique widely recognised in other nations' defence forces, and in some commercial organisations, as a valuable aid to making more-informed decisions on the management of assets. Based on such experience, Defence should promote extended use of LCC to ensure major financial decisions are cost-effective.

6. There are many cases where Defence uses LCC to support decisions, mostly in relation to tender selection. However, LCC is not generally used at other stages in the acquisition life cycle, such as the early concept development stages, and the in-service and disposal stages. Defence policy has been set for LCC for some time, but there appears to be little top-level enforcement or encouragement at present for the use of LCC throughout the acquisition life-cycle. There are also few incentives for middle managers to adopt life-cycle costing principles by making investments now to save operating costs later. At the present time, there are some limitations to the conduct of LCC due to the lack of available data. However, these difficulties can be addressed by concerted efforts to extract suitable information from available data bases and ensuring that any redevelopment of data bases addresses the need for specific data to support LCC.

7. The conclusions of this audit draw on advice from consultants, commercial organisations in Australia and from overseas Defence forces. The ANAO has also prepared a better practice guide to life-cycle costing, which is attached as an appendix to this report.

Key Findings

8. The major issues detailed in the audit report are summarised below.

Chapter 2 - Implementation of LCC in the Department of Defence

9. Defence policy on LCC is stated in a 1992 departmental instruction and in Defence's purchasing manual and costing manual. There is scope for simplification of the policy by issuing a brief overall policy statement with supporting guidance material. Such a policy should confirm that LCC, tailored according to the significance of the life-cycle cost, is required for all assets with an ongoing cost of ownership.

Chapter 3 - LCC in the capability proposal stage

10. There is a high potential pay-off from improved decision-making during concept development for a proposed acquisition. In Defence this is carried out through the preparation of capability proposals seeking to acquire major Defence equipment. Indeed, Defence policy calls for the use of LCC at all major decision points throughout the materiel cycle, including the capability proposal stage. However, this requirement appears not to be enforced or encouraged by senior management. None of the seven case studies we selected included life-cycle cost analysis at the capability proposal stage, although most considered, in general terms, the costs of support of continued operation. We briefly reviewed some cases where Defence had carried out LCC analysis in the capability proposal stage. These cases showed that the use of LCC is both possible and useful at this stage but could be improved through a more comprehensive approach to the application of the technique.

Chapter 4 - LCC in the acquisition stage

11. The acquisition stage consists of initial planning leading to the preparation of a request for tender or similar document, followed by tender selection and contract negotiation. At the acquisition stage a reasonable estimate of the total cost of ownership of a capability is possible. Most of the projects we studied sought and reviewed life-cycle cost estimates submitted by tenderers. In some cases, however, their analysis was flawed or incomplete. There appeared to be only patchy commitment to the conduct of LCC in support of acquisition, although recent Defence statements on the significance of LCC may lead to some improvement in this respect. In the cases chosen, LCC analysis was found to be incomplete and had not influenced the selection decision. This was despite evidence that LCC can assist decisions within the acquisition process on component options. The

ANAO observed such evidence in several of its case studies and was informed by Defence that, in one case, a saving of $400m was confirmed using LCC.

Chapter 5 - LCC in the in-service stage

12. During the in-service stage LCC can be used to optimise arrangements for logistic support and to identify systems or components that become expensive to support and therefore should be modified or replaced. In our case studies, we observed that the use of LCC for this purpose was limited. This was partly due to lack of incentives for managers to adopt LCC and a lack of readily available relevant data to support its use.

Chapter 6 - Facilities

13. Defence has used LCC to assist in decisions on the acquisition of land, buildings and other facilities for some time. Defence's Estate Organisation has such a policy in place, and has successfully employed LCC to improve facilities decision-making. However, the application of LCC is of varying quality across the agency.

Chapter 7 - Administrative acquisition

14. Defence has also applied the principles of life-cycle costing to the acquisition of administrative equipment such as photocopiers.

Chapter 8 - Data and models

15. The two major requirements for the application of LCC are readily-accessible data in a format that is easy to use, and suitable models, techniques and methodologies to analyse the data. Data and modelling requirements depend on the complexity of the system, the stage being examined in the life cycle and the depth of analysis required.

16. The development of information systems in Defence has generally not been well managed. In addition, operating cost data for current equipment is not readily available. Defence has taken some steps to improve data availability, through either development of information technology solutions to data management, or through implementation of management approaches such as activity-based management, but these endeavours will take time to produce a positive impact on performance.

17. Accurate and dependable cost data for new equipment are also difficult to acquire. This is especially so for new technologies. However, a combination of manufacturers' data, data from other operators and extrapolations from experiences with other equipment can assist in producing a reasonable assessment. Defence takes considerable care in validating manufacturers' estimates; to reduce the risks to Defence, these estimates should be made contractually binding.

Chapter 9 - Budgeting

18. Defence has processes that allow for the incorporation of variations to operating costs in future budgets. However, LCC utilisation is not adequately integrated with budget processes, leading to a lack of incentive to ensure LCC is effective. Forward budgeting has not allowed for increasing support costs arising from the ageing of equipment.

19. Defence has noted that increased funding provisions are required because of the rising costs of in-service support, with increased costs associated with new equipment such as the Lead-in fighter, the C-130J aircraft, the Caribou aircraft replacement and the new hydrographic ships.

Chapter 10 - Organisation and staffing

20. Defence provides project staff with training courses on LCC but expertise is spread thinly. There would be advantages in developing more widespread skills and experience in LCC. Availability of LCC expertise to users would be improved by centralising LCC experts into a unit capable of providing expert advice and assistance as required.

Response to the audit

21. Defence agreed to all but one of the audit recommendations. Defence added, however, that many of the recommendations are not new and do not present fresh approaches to assist in managing life-cycle costing. The report makes clear that the approaches recommended by the ANAO are based in part on actual and proven commercial or overseas experience. The recommendations are intended to prompt a more business-like approach to Defence operations by promoting greater awareness of life-cycle costs across the agency. By doing so, it is likely that the agency itself could generate 'new and fresh approaches' to the technique.

22. Defence also said that in many instances it is already implementing or progressing towards implementation of the recommendations. The ANAO welcomes this as a positive outcome which is strongly supported by the audit.

Recommendations

Set out below are the ANAO's recommendations with report paragraph references and an indication of Defence's response. The ANAO considers that Defence should give priority to Recommendation Nos.2, 3, 4, 6 and 8. Priority recommendations are shown below with an asterisk.

Recommendation No. 1
Para. 2.24

The ANAO *recommends* that Defence:

a) establish and promulgate a brief overall policy statement on the use of life-cycle costing throughout the Department for all stages of the materiel life-cycle;

b) retain the requirement in LCC policy for LCC analysis but with provision for the analysis to be tailored as appropriate to the materiality of the ongoing cost of ownership; and

c) develop and promulgate guidance material to support the implementation of life-cycle costing in the various defence programs responsible for acquisition and support.

Defence response: Agreed.

***Recommendation No. 2**
Para. 3.26

The ANAO *recommends* that Defence:

a) ensure that LCC issues are addressed by capability proposals;

b) as part of the development of guidance on the application of LCC policy, establish consistent definitions of terms, structures for analysis and presentation of life-cycle costs; and

c) ensure that explicit information is provided to relevant Defence committees and other decision makers on the total costs of the capability throughout an asset's life as part of good corporate governance.

Defence response: a) Agreed.
b) Agreed with qualification.
c) Agreed with qualification.

***Recommendation No. 3 Para. 4.18**

The ANAO *recommends* that Defence:

a) ensure that life-cycle cost analyses of tenders are adequate and given due weight in source selection considerations;
b) encourage the submission of tender options which provide low life-cycle costs while meeting project requirements; and
c) seek to have tenderers' assertions relating to reliability and other LCC information translated into contractual arrangements with recourse for lack of achievement and incentives for achieving a lower operating cost than specified.

Defence response: a) Agreed.
b) Agreed.
c) Not agreed.

***Recommendation No. 4 Para. 5.34**

The ANAO *recommends* that Defence:

a) improve data bases of costs of operations where cost-effective to do so to allow tracking of operating costs;
b) monitor operating costs of Defence equipment so as to assist decisions on whether components need replacing or upgrading, and on optimising logistic support arrangements such as spares holdings, maintenance policies and facilities; and
c) institute a means whereby support managers are encouraged to take a longer-term view of supporting their equipment economically. These means might include the ability to commit future maintenance budgets to spend on current investment.

Defence response: Agreed.

Recommendation No. 5 Para. 6.17

The ANAO *recommends* that Defence Estate Organisation:

a) include a representative from its Estate Operations and Planning Branch on design review and tender selection panels;
b) promulgate the benefits of LCC analysis and training; and
c) monitor the implementation of LCC.

Defence response: a) Agreed with qualification.
b) Agreed.
c) Agreed.

***Recommendation No. 6 Para. 8.60**

The ANAO *recommends* that Defence where cost effective to do so:

a) use more than one source of current operating cost data if available data are unreliable;
b) endeavour to make costing information for in service equipment readily available by means such as introduction of activity-based management and redevelopment of logistic information systems; and
c) improve the accuracy and completeness of operating cost data collection, especially for new equipment.

Defence response: Agreed.

Recommendation No. 7 Para. 9.29

The ANAO *recommends* that Defence further refine its processes for estimating the long-term effect of a new equipment on the operating cost budget of the Department and encourage programs to identify operating cost savings through the use of suitable management incentives.

Defence response: Agreed.

***Recommendation No. 8 Para. 10.14**

The ANAO *recommends* that Defence establish some central repository of advice and assistance on LCC matters.

Defence response: Agreed.

Recommendation No. 9 Para. 10.24

The ANAO *recommends* that Defence improve levels of LCC expertise by the encouragement of relevant personal developmental opportunities, and the use of appropriate consultancy assistance.

Defence response: Agreed.

Part Two

Audit Findings and Conclusions

1. Introduction and Background

This chapter provides some background to life-cycle costing including the reasons for its significance. The chapter also gives information on the conduct of the audit including the case studies considered.

Introduction

Definitions

1.1 Life-cycle costing (LCC) is a technique for estimating the total cost of ownership of an asset over its lifetime. As such, it is a key means of assisting resource allocation decisions.

1.2 Life-cycle costs can be defined as the sum of all monies expended, attributed directly and indirectly to a defined system from its conception to its disposal, encompassing the acquisition, ownership and disposal phases of a project.[1] These costs include costs for research and development, production, personnel to operate and maintain the system, ongoing logistic support, facilities and eventual disposal.

Purpose of LCC

1.3 In addition to assisting resource allocation decisions LCC assists with decisions on management of assets. These decisions can occur at any stage throughout the life-cycle of an asset - from initial planning, through budgeting to source selection, and in-service management and finally disposal.

1.4 LCC has many uses. These include:

- to account for resources used by Defence now or in the past (reporting);
- to assess future resource requirements (budgeting);
- to assess costs of acquiring different capabilities (investment appraisal);
- to decide between sources of supply (source selection);
- to improve system design;
- to optimise logistic support; and

[1] National Audit Office (UK), *Ministry of Defence: Planning for Lifecycle costs*, HMSO 174, January 1992.

- to assess when assets reach the end of their economic life and replacement is required (disposal).

The first of the above uses is concerned with past expenditure for reporting purposes, and the remainder with projected costs for economic decision-making. Past expenditure can also be a source of data for economic decisions.

1.5 LCC analysis can be used when equipment or facilities are being designed, in order to optimise the balance of initial cost and cost of upkeep. It can also be applied to other decisions with cost impacts extending over several years, such as changes to organisational arrangements, outsourcing,[2] or changes in level of use.

1.6 The extent of LCC analysis depends on the type of decision to be made. For example, at the concept stage, the decision may be between investing in two quite different military capabilities, and so the full cost of those capabilities should be estimated. When the decision refers to methods to optimise logistic support for specific equipment already purchased, research and development (R&D), capital and acquisition costs are fixed and LCC analysis would focus on the direct and indirect logistic support costs.

Development of LCC

1.7 LCC came to prominence in the US Department of Defense in the early 1960s. By the mid 1970s, the technique was well established for military procurement, and was starting to be employed in industry.[3] Its significance has increased as the in-service lives of major defence equipments have extended to 25 years or more.[4]

1.8 The UK Ministry of Defence adopted some basic guidelines in 1974.[5] Defence procurement initiatives introduced by the Thatcher Government included making more use of sophisticated life-cycle costing techniques, with greater emphasis on reliability, maintainability and the costs of in-service support.[6] A 1992 report indicated that only in the early 1990s were

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2 Ellram, Lisa M. and Maltz, Arnold B., *The Use of Total Cost of Ownership Concepts to Model the Outsourcing Decision*. International Journal Of Logistics Management, Vol. 6, No.2 1995, pp. 55-66.

3 Harvey, Graham, *Life-cycle costing: a review of the technique*, Management Accounting, October 1976.

4 Kinch, M.J., *Life cycle costing in the defence industry* in Life Cycle Costing for Construction, ed. John W. Bull, Blackie Academic and Professional London, 1992.

5 Ministry of Defence, (UK) *Defence Life Cycle Costing: Introduction and Guide* April 1974.

6 Bourn, John (Comptroller and Auditor-General) *Securing Value for Money in Defence Procurement*, RUSI Whitehall Paper Series, 1994, p. 15.

satisfactory procedures for LCC being put in place.[7] The Comptroller and Auditor-General of the UK has stated that, although it is difficult to quantify potential savings from the application of life-cycle costing principles, they are widely regarded as enabling greater value for money to be obtained from both equipment acquisition and in-service support.[8]

1.9 In Germany the armed forces consider life-cycle costs on an equal footing with other parameters such as operational and technical requirements and timeframe for acquisition.[9]

1.10 The Australian Defence Department has conducted some LCC analyses since at least the early 1980s. By 1983 it was recognised that 'whenever a decision to spend money is to be made, through-life cost should rate as a basic parameter and an essential criterion for choice.'[10] The Secretary and Chief of the Defence Force (CDF) directed in 1989 that greater emphasis was to be placed on LCC in procurement processes. The first Defence Instruction on the subject was issued in 1992.

Commitment of resources

1.11 Most of the life-cycle cost of an equipment is committed early in its life when characteristics of the equipment are defined. Ideally, the first application of LCC should be at the early planning stages for purchase of an asset. Some estimates are as follows:

- Decisions made before the end of the concept phase will determine 70 per cent of the eventual life-cycle costs.[11]
- After the design, 66 per cent of costs are fixed, and after construction 95 per cent of total costs are fixed.[12]
- Some 90 per cent of the life-cycle costs may be committed at the time a decision to go ahead with production is made.[13]

These percentages can vary significantly according to the type of system involved.

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7 National Audit Office (UK), *Ministry of Defence: Planning for Lifecycle costs*, HMSO 174, January 1992.

8 Bourn, John, (Comptroller and Auditor-General) *Securing Value for Money in Defence Procurement*, RUSI Whitehall Paper Series 1994, p. 30.

9 Thompson, Doug, *The Australian Defence/Industry Interface*, MTIA Defence Manufacturers' Council, 30 June 1995, p. 50.

10 Department of Defence, *DRB 37: Value Analysis*, March 1983, p. 13-9 (internal document).

11 *Asset Management - The Methodology of Life Cycle Costing*, Life Cycle Costing Papers, Asset Management Group, 1983.

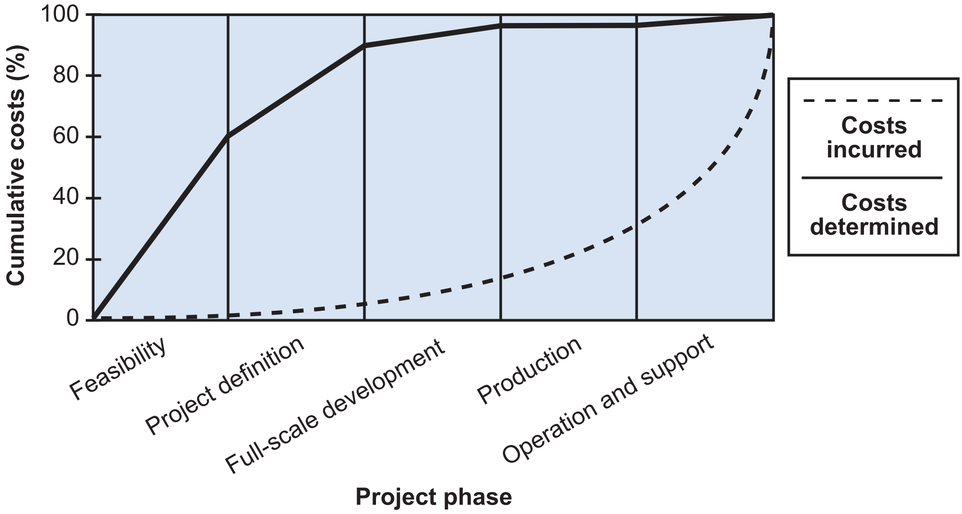
12 *Life Cycle Costs - its Implications on Management* Wubbenhorst, Klaus L., Technische Hochschule Darmstadt, Life Cycle Costing Papers, Asset Management Group, 1983.

13 Bourn, John, (Comptroller and Auditor-General) *Securing Value for Money in Defence Procurement*, RUSI Whitehall Paper Series, 1994, p. 30.

1.12 The UK Ministry of Defence indicated a pattern of expenditure and commitment as in Figure 1. The five phases of the equipment life-cycle are feasibility; project definition; full-scale development; production; and operational support. For example, at the end of the first phase, feasibility, only some 2 per cent of the life-cycle cost will have been spent, but decisions made during that phase (eg choice of design options) have determined 60 per cent of the life-cycle cost.[14]

Figure 1

Life-cycle costs — commitment and expenditure



Source: UK Ministry of Defence, via NAO report

1.13 Nevertheless, LCC remains valuable in all stages of the life-cycle. In the later stages, there are more data available, and therefore a better chance of realising efficiency gains in supporting the equipment.

Conduct of the audit

1.14 The audit considered five topics, which are listed below together with an outline of the criteria considered for the topics:

- LCC policy and coordination: is policy consistent with Government policy, coordinated within Defence, and promulgated satisfactorily?

[14] National Audit Office (UK), *Ministry of Defence: Planning for Lifecycle costs*, HMSO 174, January 1992, p. 8.

- use of LCC in investment decisions: is LCC applied to all relevant decisions, and taken into account by decision-makers?
- use of LCC to support budgeting: is LCC used in short and long-term financial management?
- data to support LCC: are there adequate mechanisms for collecting and disseminating data to support LCC?
- LCC training and education: are there sufficient trained and experienced staff to conduct LCC?

1.15 Audit activities included:

- background review including overseas sources;
- consulting selected companies for views on best practice of LCC;
- consideration of models used for LCC;
- consulting Defence's Support Command on sources of LCC data, models and related issues;
- consulting relevant planning and policy areas in Defence;
- identification of a sample of projects and investigation of the LCC issues related to the sample; and
- discussion of issues with the selected consultants.

1.16 The consultants who advised the ANAO during the audit were:

- Prof. Benjamin S. Blanchard, Professor Emeritus, Virginia Tech, USA;
- Mr Peter King, Computer Power Group; and
- Dr Stefan Markowski, The University of New South Wales (ADFA).

1.17 Interviews were conducted with representatives of the following organisations, whose assistance was greatly appreciated:

- Qantas Airways Ltd;
- BHP Co Ltd;
- NSW State Rail Authority;
- US Army Cost and Economic Analysis Centre;
- (US) Navy Center for Cost Analysis;
- The (US) Air Force Cost Analysis Agency;
- U.K. Ministry of Defence - Director of Defence Support Policy;
- Lend Lease Property Investment Services;
- General Property Trust; and
- Roberts Weaver, Design and Technology Consultants.

1.18 Written comments were received from ADI Limited and Tenix Defence Systems Pty Limited.

Audit coverage

1.19 Our review of projects and other material has not included the period before the current Defence policy on LCC was introduced in 1992.

1.20 Within the Department of Defence, LCC analysis could be utilised in the areas of major capital equipment, facilities, minor capital equipment and administrative acquisitions. Defence spends a significant amount on acquisition. The 1997-98 budget provided $2.4b for acquiring major capital equipment and $408m for facilities acquisition. Life-cycle costs are approximately two to three times the acquisition amount and therefore potentially have a significant impact on annual budget outlays.

1.21 We placed more emphasis on Major Capital Equipment, as it is highly material in financial terms and considered more risky - the Joint Committee of Public Accounts and Audit has indicated its strong interest in Defence's management of major acquisition projects. Investment in facilities is also substantial and has had little prior ANAO audit coverage. The third priority is minor capital and administrative acquisitions.

1.22 For the purposes of the audit a selection was made of a sample of seven projects of varied types and sizes over a variety of projects, at differing stages of the major capital acquisition cycle and spread across all Services. In addition, two major facilities projects were selected. The nine projects were:

- Project Parakeet - a trunk communications system for use by Army and Air Force;
- Joint Intelligence Support Environment (JISE) - a secure network facility for dissemination and analysis of intelligence;
- Air Traffic Control Radar;
- Project Overlander - a project to replace the fleet of field vehicles (these include semi-trailers, trucks large and small together with four-wheel drive vehicles);
- Amphibious Watercraft;
- P-3C aircraft upgrade;
- FFG frigates upgrade;
- RAAF Base Scherger (bare air base); and
- DSTO Laboratory Complex Salisbury.

1.23 The following table identifies the case study projects and the phases that the projects have covered. For each phase listed, the ANAO considered whether and to what extent LCC was used.

Table 1
Audit Case Studies

Project	Service(s)	Type	Phases covered		
			Capability proposal	Acquisition	In service
Parakeet	Army (mostly)	Communications	X	X	
JISE	Joint	Software	X	X	
ATC	Air Force	Radar	X	X	
Overlander	Army	Vehicles	X	X	
Amphibious Watercraft	Army, Navy	Vessel	X		
P-3C Upgrade	Air Force	Aircraft	X	X	X
FFG Upgrade	Navy	Ship	X	X	X
Scherger	Air Force	Air base	X	X	
DSTO Laboratory	DSTO	Laboratory complex	X	X	X

1.24 The audit began as a preliminary study in June 1997. Audit issues papers were distributed to Defence between December 1997 and February 1998. Following receipt of comments on these papers, the proposed report of the audit was put to Defence in March 1998. The report was completed having regard to Defence's comments provided in April 1998. The audit was conducted in conformance with ANAO Auditing Standards and cost $315 000.

2. Implementation of LCC in the Department of Defence

This chapter discusses Defence policy on life-cycle costing and the manner in which that policy and supporting guidance is promulgated.

Government policy

2.1 The *Financial Management and Administration Act 1997* (FMA Act) contains a provision that 'A Chief Executive must manage the affairs of the Agency in a way that promotes proper use of the Commonwealth resources for which the Chief Executive is responsible'. This is supported by regulation 9 of the FMA Regulations which states 'an approver … will make efficient and effective use of the public money'. This regulation replaces Finance Regulations 44A and 44B, which expressed the need to make efficient and effective use of public moneys and obtain the best value for the Commonwealth.

2.2 Commonwealth Procurement Guidelines, which are given force by a regulation under the FMA Act, state that 'Procurement practices and procedures are directed to achieving the best available value for money in the acquisition of goods and services for government programs. The test of the best available value for money is a comparison of relevant benefits and costs on a whole-of-life basis.' Purchasing Australia has issued a guide to 'whole-of-life' costing, which provides helpful advice for straightforward cases and a useful checklist of cost categories.[15] Advice is also contained in the booklet *Introduction to Cost-Benefit Analysis for Program Managers* issued by the then Department of Finance in 1992.

Defence policy

2.3 Defence policy on life-cycle costing for major capital equipment is contained in a 1992 Defence Instruction, DI(G)LOG 03-4. It states that LCC is to be undertaken at decision points throughout the life-cycle of an equipment or weapon system. It does not refer to LCC application in other areas, such as administrative or facilities acquisitions.

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15 Purchasing Australia. *Whole-of-Life Costing in the Assessment of Value for Money* AGPS 1996. A similar checklist is in *Commonwealth Procurement Guidelines*, p. 178.

2.4 The policy calls for the use of LCC at all major decision points throughout the materiel cycle. The decision points can be considered as falling into three broad categories:

- capability development;
- acquisition; and
- in-service management.

2.5 The major decision points in the capability development stage are:

- consideration of the capability proposal by the Defence Capability Committee (for higher level projects) and the Capability Forum for less significant proposals;
- consideration by the Defence Management Committee for inclusion in the overall budget; and
- approval by the Government, usually in the context of its annual Budget.

Prior to July 1997 a more complex process and committee structure were in place.

2.6 The major decision points in the acquisition stage are:

- consideration of the equipment acquisition strategy (EAS) by the Defence Source Selection Board;
- preparation of tender documentation, including Requests for Proposal, Quote or Tender (RFP/RFQ/RFT);
- tender evaluation;
- drafting and negotiation of contracts; and
- major trade-off decision analysis during the in-contract design of the equipment and its logistic support.

2.7 Decision-making in the in-service management stage tends to be a continual process involving decisions concerning modifications, life-of-type extensions or disposal.

2.8 There has been recognition at Commonwealth Ministerial level of the significance of LCC. For example, the Minister of Defence stated that, in the past, Defence has found to its cost that there is much more to buying equipment than simply the up-front purchase price, and that the real cost of equipment included long-term maintenance and support, training the people who use it and the opportunity costs of other projects forgone.

2.9 The Defence Efficiency Review of 1997 recommended (R24)[16] that the through-life cost of ownership of equipment should be competed rather than accepting the cheapest initial acquisition cost. Defence responded in October 1997 that this recommendation was agreed in principle, and that action was complete, with part of government procurement policy being to evaluate tenders on a whole-of-life basis.

2.10 LCC is also referred to in some Service-specific documents, in particular those on integrated logistic support (ILS). The Air Force ILS instruction states that the objective of an ILS program is to achieve weapon system preparedness requirements at minimum life-cycle cost. In its Fleet Management Handbook, Support Command - Army states that LCC is a financial analysis tool which is used throughout the materiel management process.

2.11 Commonwealth Procurement Guidelines refer to the desirability of evaluating the value for money (reflecting whole-of-life program benefits and costs) achieved by a procurement project with a view to improving procedures and processes. However, there is no Defence policy requiring validation of previous LCC estimates once the equipment is in service.

Promulgation of policy

2.12 The Defence Logistics Manual reiterates the Defence Instruction. It describes in detail the requirements for life-cycle cost models, and proposes tender and contract clauses relating to the provision of LCC data. LCC policy is also stated in Defence's purchasing manual and costing manual, in slightly different terms.

2.13 Defence's Chief Executive Instructions (CEI) directs purchasing officers to the Defence Procurement Policy Guide (DPPG). Part 6 of the DPPG, Value for Money, states 'evaluating what suppliers offer in a comprehensive and fully professional manner by taking account of the benefits and costs involved on a whole-of-life basis' is part of the determination of best value for money.

2.14 The Directorate of Contracting Policy has issued brief guidelines for whole-of-life costing. These are applicable to all purchasing, not just major capital equipment. The Defence Costing Manual issued by the Directorate of Costing (DCOST) includes a chapter outlining the conduct of life-cycle costing, and providing a checklist of cost categories to be included. Most policy development is occurring in Capital Equipment

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16 *Future Directions for the Management of Australia's Defence*, Report of the Defence Efficiency Review, Department of Defence, 10 March 1997, page E-5.

Program Division, but there is no single area responsible for either policy or operations.

2.15 Defence policy on LCC accords with the Commonwealth procurement guidelines that purchasing be efficient and effective. However, the policy is expressed in at least three different documents. Although these are consistent, there remains the scope for simplification by issuing a brief <u>overall</u> policy statement with supporting guidance material. Supporting guidance could be in documents such as the Defence Logistics Manual and the Capital Equipment Procurement manual.

Defence policy review

2.16 A 1995 Defence Five-Year Defence Program (FYDP) review report stated that Service Programs, Development Division (now Capability Division) and Acquisition and Logistics Program would need to place greater emphasis on, and accuracy in, life-cycle costing, and the then Force Development and Analysis Division would need to ensure impacts were recorded and assessed. The report went on to state that 'it is important that LCC be considered more fully in the early phases of the materiel cycle, particularly during the concept, options and equipment solution phases'. The review team also considered that the Defence policy instruction on life-cycle costing (DI(G) LOG 03-4) required expansion to provide guidance on the application of LCC at the critical milestones, especially on how the key cost drivers might be identified.

2.17 In 1995 Defence established a working party to review LCC. It recommended the establishment of database for LCC, the acquisition of a standard suite of LCC models, provision of LCC training and the review of LCC policy.

2.18 In 1997 Defence established a working group to revise DI(G) LOG 03-4. Given changes to the Defence structure due to the Defence Reform Program announced in April 1997, development of the revised policy was postponed.

2.19 Neither the original instruction nor the proposed revision includes reference to the need to consider LCC in all procurement, not just for major capital acquisitions. The proposed revision also does not specifically state that LCC should be used where applicable for source selection, and does not specify a requirement to collect data for future LCC estimates.

Conclusions

2.20 The ANAO view is that Defence policy on life-cycle costing could be expressed very simply in one document for easy reference. It should reflect the notion that life-cycle costing is an aid to decision-making and should therefore be tailored to reflect the requirements of the relevant decision-makers. Life-cycle costing policy could be extended to include:

- description of basic concepts of life-cycle costing - possibly as currently expressed in the Costing Manual or Purchasing Guidelines. These would include the requirement to define the asset's life, provide assessments of capital costs, through-life support costs and disposal costs for each year of that life, express total cost in net present value terms, and perform sensitivity analysis on relevant factors;
- clear instructions as to the application of LCC to all relevant decisions where it would advance efficiency and effectiveness of decision-making; eg significant administrative, capital and facilities investment decisions where there are ongoing commitments of expenditure for more than a year;
- acknowledgment of the need for consistency with the principles of efficient and effective asset acquisition and through-life management at all stages of an asset's life; and
- tailoring of LCC to the materiality of the purchase, the availability of data and the nature of decision being taken (eg in relation to budgeting, tender selection, disposal).

2.21 With such a top-level document being related more to overall prudence in financial decision-making than simply to any one area such as capital equipment, facilities or logistics, the appropriate area for carriage of this policy might be a central area such as Resources and Financial Programs Division.

2.22 Specific guidance on 'tailoring' of the top-level policy - which could be very extensive - could be left to those areas within Defence that conduct LCC analyses.[17] These include the Acquisition Organisation, Support Command and Estate Organisation. For example, Defence Estate Organisation issued the document 'Project Director's Handbook' in 1992 designed to assist project directors by providing both policy and detailed guidance. The emphasis here is that, although life-cycle costing can be complex, the principles are reasonably straightforward.

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17 An early document by the Ministry of Defence in the UK, *Defence Life Cycle Costing: Introduction and Guide* April 1974, noted at p. 6 that 'the nature of costings and the degree of detail into which it is sensible to go in any particular exercise should be considered in the light of the circumstances of each case. It will depend on the precise purpose of the exercise and the degree of precision desirable, the size and importance of the project, and the quality and degree of uncertainty of the data that can be made available.' These considerations remain valid.

2.23 This guidance could be based on the principle that all costs which influence the decision under consideration should be included. Guidance should also reflect the need for a level of analysis appropriate to the materiality of the on-going cost of ownership. It could include the model developed by the Directorate of Acquisition Management Systems (Systems Engineering) and other guidance based on that already issued by authorities such as DCOST and Director Contracting Policy. The promulgation of policy and guidance should also be backed up by training on life-cycle cost principles to maintain skills and experience.

Recommendation No.1

2.24 The ANAO *recommends* that Defence:

a) establish and promulgate a brief overall policy statement on the use of life-cycle costing throughout the Department for all stages of the materiel life-cycle;

b) retain the requirement in LCC policy for LCC analysis but with provision for the analysis to be tailored as appropriate to the materiality of the ongoing cost of ownership; and

c) develop and promulgate guidance material to support the implementation of life-cycle costing in the various defence programs responsible for acquisition and support.

Defence response

2.25 **Agreed.**

3. The Use of LCC in the Capability Proposal Stage

Using examples from case studies as well as other sources, this chapter discusses how Defence implements life-cycle costing in the early or conceptual stages of acquiring major capital equipment. It considers the extent to which LCC is employed, and the nature of the LCC analyses.

Introduction

3.1 The capability proposal stage entails the development and submission of formal documents called Capability Proposals to the Defence Capability Committee (DCC), which considers high-level projects, or the Capability Forum, which considers less significant proposals. Prior to June 1997 there was a more complex system of submissions and their consideration by committees.

3.2 The capability proposal or conceptual stage is the first and possibly most significant stage in the materiel life-cycle. Within Defence, it refers to the development of capability proposals prior to approval by Government. Activities in this stage are carried out primarily by the Capability Development and the Capability Program and Resources Planning Divisions in Defence Headquarters, and the Acquisition Organisation. Initial proposals for new capabilities, such as improved communications equipment, are put forward, and the outlines of performance, cost and timing are decided. Decisions must be taken on which sets of capabilities are the most cost-effective, with comparisons made across the spectrum of potential Defence investments. Life-cycle cost is therefore one of the major factors, along with others such as capability and timing, which should be considered at the conceptual stage. A further indication of the high potential pay-off to provision of life-cycle costing information at this stage is the effective commitment of a large proportion of the life-cycle costs by decisions taken at this early stage.

3.3 Chapter 2 discussed developing policy together with supporting guidance for LCC. At the capability proposal stage, Defence policy states that life-cycle costing of the options is essential for all options to be adequately considered. The policy accepts that much of the data will be based on estimates and calls for the conduct of sensitivity analysis to show the effect of the more critical cost drivers.

3.4 The significance of LCC at the conceptual stage was recognised by the Defence Efficiency Review report in March 1997. DER[18] Secretariat papers noted, among other things, that a critical ingredient was a thorough through-life costing assessment during the definition phase. The DER was also concerned about identifying total costs of activities, a concern also shown by the Chief of the Defence Force in evidence to the then Joint Committee of Public Accounts (JCPA) and by the JCPA itself.[19]

Organisational arrangements

3.5 The Capability Development Division is organised by 'environment' - ie Land, Sea, Aerospace and C^3I.[20] There is no centre of expertise on resource matters. The conduct of such work depends on officers seeking precedents set by other projects, liaising with those they believe to have some knowledge of LCC and through personal research. Staff consulted are not confident that they have sufficient information and training to perform life-cycle costing appropriately.

3.6 The Capability Program and Resource Planning Division includes a section which deals with cost analysis, among other things, but this section has only been in operation since October 1996. The intention is that the section would offer consultancy services to Capability Development. Together with Aerospace Development branch, the section conducted a study on navigation training which considered life-cycle costs for options such as upgrading the current fleet of HS748 aircraft or replacing them with new smaller aircraft.

3.7 Another occasion, where assistance from outside the Division was used for life-cycle costing, was the Surface Combatant Force Study, which investigated various options for the development of the surface combatant force beyond the year 2010. This study was completed by the Analytical Studies Unit (now part of Capability Analysis Branch within the Strategic Policy and Plans Division) in 1996 and overseen by Maritime Development Branch.

3.8 Air Force established a requirement for 'Front-End Life-Cycle Costing Analysis' (FELCCA) to provide order of magnitude LCC analysis to support its acquisition decision processes. Advice on FELCCA is provided by the Joint Logistics Systems Agency at Support Command.

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18 Defence Efficiency Review.

19 Parliament of the Commonwealth of Australia, Joint Committee of Public Accounts *Report 352, Review of Auditor-General's Reports 1996-97 Second Quarter*.

20 Command, Control, Communications and Intelligence.

3.9 The audit concluded it would be beneficial if Defence formed a group to offer impartial and consistent advice on costing issues. This is discussed in Chapter 10.

Observations from case studies

3.10 None of the case studies undertaken by the ANAO included life-cycle cost analysis of the proposed investment at the capability development stage, although most discussed in general terms the costs of support. The two upgrade projects - for the FFG frigates and P-3C aircraft - both referred to the possibility of saving operating costs but, with the exception of an analysis of one component of the P-3C upgrade, there was no analysis at the capability development stage. See the 'P-3C upgrade case study' box below. In the case studies considered, senior committees did not promote the use of life-cycle costing; there was no indication of ramifications where life-cycle costing was not undertaken or was incomplete.

3.11 One case study used the evolutionary acquisition concept. A draft chapter of the Capital Equipment Procurement Manual (CEPMAN) states that for each requirement for an evolutionary acquisition project, there should be an understanding of the likely cost in life-cycle terms. This chapter also states that the iterative process should expose any logistic support problems early, allowing for reduced in-service support costs. However, no reviews planned by the project indicated any evaluation of LCC factors.

P-3C Upgrade - Case study

For the P-3C aircraft refurbishment project, a major consideration was life of type and the extent to which this could be extended by reducing weight, acquiring austere aircraft for flying training and other means. However, there was no consideration of life-cycle costs as such in consideration of the project by the Force Structure Policy and Programming Committee (FSPPC) in 1992 and 1993, other than confirmation that Air Force could operate within the provision for current operating costs. There was some analysis of fuel savings due to fewer flying hours being needed to calibrate a replacement sensor, but there was no further analysis of variations to running costs nor was there any overall comparison of the stream of expenditure, with and without the measures taken to extend the life of type. After the conceptual stage, analysis of tenders was undertaken on an LCC basis.

3.12 For two of the cases, project staff stated that LCC analysis was not appropriate until after tender selection.

Other observations

3.13 There were some examples reported to us of the use of life-cycle costing at the concept development stage. One related to support of the Leopard tank fleet, where an analysis showed that the cost of replacing current Leopard tanks would be similar on a life-cycle cost basis to retaining the current tanks. However, the ANAO was advised that LCC estimates were not the basis for the decision to retain the current tanks.

3.14 Another example reported to us related to an analysis of options for recovery of practice torpedoes and related items. This analysis, which was done by an eight-week consultancy, considered acquisition and operating costs for several different types of vessels and several different ownership and support options. The ANAO concluded that the analysis was of an appropriate level of detail to support a conceptual-stage decision.

3.15 In the case of the Joint Communications Support Environment (JCSE) the Capability Development staff developed an outline of costs, including some support costs, at the concept development stage.

3.16 Where such work was carried out, however, the ANAO observed, in some cases, that the analysis was incomplete. This indicates that LCC analysis may provide more reliable advice to decision-makers if assisted by better guidance and a centre of LCC advice and specialised assistance.

Availability of data for conceptual-stage decisions

3.17 We asked about the use of cost data derived from current equipment as a guide to operating costs for future equipment. Apart from some informal consultation to obtain approximate figures, this practice did not seem to be occurring.

3.18 The Surface Combatant Force Study observed that Defence had not addressed LCC well, and was not good at collecting current costs, or estimating future costs. It further observed that the conduct of LCC analysis during the concept phase was frustrated by, among other things, the lack of specific training and guidance for undertaking the task. Difficulties included attribution of different overheads, different collection methods, different rates of effort and missing costs. The study also noted that neither Navy nor Air Force were able to provide accurate life-cycle cost data. Nevertheless, by consulting a range of sources of data, the study was able to derive LCC information of sufficient validity for the purposes of the study.

3.19 Some operating cost data can be obtained from suppliers of potential equipment, from other defence forces and through market research or consultants.

3.20 The ANAO accepts that complete and accurate data will not always be available to assist decisions at the conceptual stage, especially when the capabilities themselves may not be well defined. Nevertheless, we observed that, where efforts had been made to collect available data, it was possible to make LCC estimates which, although approximate, greatly assisted in the decision-making process. Where the costs of a new capability are unknown an estimate can be made by dividing the project into components and seeking cost parallels for each of these components.

3.21 Further discussion on data for LCC is in Chapter 8.

Conclusions

3.22 Life-cycle costing has the potential for providing significant relevant information to assist decision-making at the conceptual stage. Stated policy requires life-cycle costing. However, Defence has not taken full advantage of the opportunity to employ life-cycle costing analysis at the conceptual stage.

3.23 Proposals do consider at least some aspects of operating costs at the conceptual stage. They also usually contain general discussion about logistic concepts to be employed to support the capability. However, the Surface Combatant Force Study was the only example found where the costs were assembled into formal or informal life-cycle cost estimates. Although current policy calls for presentation of LCC information, this was not, for the case studies considered, enforced or encouraged by the senior committees involved.

3.24 There is no consistent or comprehensive guidance on how to prepare life-cycle costs for conceptual planning. LCC planning activities could be more efficient and effective if there were better guidelines and a specified contact point for LCC advice. Such measures could also help to produce more consistent LCC estimates. The ANAO has already recommended (Recommendation No.1) that guidance material be developed and promulgated to support LCC policy.

3.25 The ANAO recognises that data on current operating systems are held in a variety of locations and are not easy to access. Nevertheless, these potential sources of information have not been exploited as thoroughly as they could have been.

Recommendation No.2

3.26 The ANAO *recommends* that Defence:

a) ensure that LCC issues are addressed in capability proposals;

b) as part of the development of guidance on the application of LCC policy, establish consistent definitions of terms, structures for analysis and presentation of life-cycle costs; and

c) ensure that explicit information is provided to relevant Defence committees and other decision-makers on the total costs of the capability throughout an asset's life as part of good corporate governance.

Defence response

3.27

a) Agreed.

b) Agreed with qualification. Any definitions, structures and presentations of life-cycle costs will need to be flexible enough to encompass a very broad range of capability proposals, and as such cannot be too prescriptive.

c) Agreed with qualification. The amount and type of LCC information presented to committees will vary according to the issues being considered and only pertinent information should be included.

4. The Use of LCC in the Acquisition Stage

This chapter discusses the use of life-cycle costing in the acquisition stage, which primarily relates to tender evaluation. It considers, using the case studies referred to earlier, the impact of LCC on tender selection, the availability of relevant and accurate data, and the methods used in the LCC analysis.

Introduction

4.1 A major use of life-cycle costing is to assist appropriate value-for-money decisions in the acquisition phase, focusing on tender evaluation. The acquisition phase is frequently conducted over a period of years, commencing with the original project approval.

4.2 At the start of the acquisition phase, a project office usually commissions a Project Definition Study (PDS) to collect further relevant information. A Request for Tender document will then be prepared requesting information, including LCC data, to permit the Commonwealth to make an evaluation of tender responses. A tender evaluation board will be tasked with assessing all aspects of the tenders on the basis of agreed evaluation criteria and value-for-money considerations including life-cycle costs. Once a tenderer is chosen negotiations commence culminating in the signing of contracts.

4.3 At the start of the acquisition phase, it is not generally feasible to undertake an accurate LCC analysis but a reasonable estimate of the total cost of ownership of a capability is possible as discussed in the previous chapter. As a project develops, more accurate LCC analysis can and should be undertaken particularly at the Request for Tender and Tender Evaluation phases. Each LCC analysis should meet minimum standards such as those discussed in this report in the appendix on good practice; however, there is scope for the tailoring of LCC analysis to meet the requirements of individual projects and of specific decisions required within those projects.

Case studies

4.4 Of the seven major capital equipment case studies in the audit, two had not reached the acquisition phase and one did not conduct any LCC analysis during the acquisition phase. The FFG (frigates) Upgrade project had only recently gone to tender and the RFT had requested LCC data.

The remaining three have utilised LCC analysis to varying degrees of adequacy and success. In each case LCC provided information in support of the decision, in that the preferred tenderer was also considered to provide the best value for money on the basis of whole-of-life costs. However, in no case did LCC by itself change the preferred tenderer. LCC did, however, assist by quantifying in monetary terms the impact of factors such as reliability or simplicity of maintenance.

4.5 None of the case studies included total Commonwealth costs, resulting in through-life costs being low as a percentage of acquisition costs. A more complete inclusion of costs would enable better identification of the impact of tendered proposals on these costs, and enable better forecasting of support requirements.

4.6 A Defence LCC working group reviewed the LCC activities of two projects. The group found that, in the first project, LCC was not identified as a significant discriminator between tenderers. Data provided were incomplete and difficult to validate. Nevertheless the exercise was useful as the data confirmed the areas of risk and showed up variations in the quality and type of information provided by tenderers. LCC data also led to confirmation of the selection of a major sub-assembly, which had life-cycle costs some $400 million lower than the alternative. The Defence LCC working group commented that there was a need to use experienced and well-trained personnel. (ANAO was informed that this was the case for this project.)

4.7 For the second project, the LCC working group found that staff were inexperienced; LCC responses provided by tenderers were poor; and the project was unable to develop sound cost estimates. Data validation was difficult. The result was poorly received by senior committees. As well there was little confidence in the in-service budget forecast.

Parakeet - Case Study

Project Parakeet is to provide Army and Air Force with a mobile, integrated, secure tactical trunk communications system.

LCC was used in Phases 4.1 and 4.2 of the Project, both in the interim and final source selection. An LCC working group report assessed the data provided by the tenderers and adjusted it where necessary. Subsequently the Defence Source Definition Committee (DSDC) explicitly referred to LCC considerations in its value-for-money assessments.

For Phase 4.3, LCC information was sought from tenderers and examined by a LCC working group. Adjustments were made to proposed models to ensure compatibility between models and to reflect additional information received from tenderers. Through-life costs were very small, less than 5 per cent of the contract price, and the differential did not provide any discrimination between tenderers.

The DSDC Agendum for Phase 4.3 listed LCC costings for six of the tenderers. These varied by a factor of over 10, although the absolute figures were small in relation to the acquisition cost. DSDC discussion noted that life-cycle-cost estimates seemed unrealistic and that poor information from tenderers had detracted from the quality of these estimates. Price, but not LCC, had been mentioned in the negotiating directive for Phase 4.3.

Observations

4.8 We found no evidence, in our case studies or elsewhere, that LCC analysis swayed a decision on source selection. The capital cost, by contrast, has been a significant influence. One tender assessment (outside our sample) applied a weighting of 1.2 per cent to life-cycle cost - in such a case it was not surprising that life-cycle cost was of little influence. The Acquisitions Organisation maintains a 'lessons learnt' data base but the only lesson referring to life-cycle costing stated: 'LCC information sought in the RFTs continues to provide little meaningful information in the context of source selection'. The DSDC did consider LCC information provided but, where the information was limited, did not, for our case studies, seek more complete analyses.

4.9 The ANAO concludes that LCC has had little impact on selection decisions. However, LCC can confirm tender selection decisions made on other grounds, thereby reducing risk.

4.10 Part of the reason for low impact is that LCC information provided by companies is uncertain and hence is either adjusted so that tenderers' estimates are brought closer to each other, or given less weight. One approach to increasing the validity of companies' data is to include contractual provisions designed to provide assurance of the accuracy of the tenderers' statements. This approach, though acknowledged to have its difficulties, has been pursued by some companies and overseas forces. The difficulties are eased when the prime equipment contractor is also responsible, through the main contract or a parallel support contract, for part or all of support costs. Payment against such a support contract can be made dependent on factors such as availability and reliability.

4.11 A further potential use of LCC is for the calculation of liquidated damages (or incentive payments) that may be payable under a contract if performance is less (or more) than agreed in the contract. This assessment could be conducted a reasonable time (3-5 years) after acceptance into service. The US Air Force uses a LCC model in source selections that helps in deciding on any award fees and hence in motivating contractors.

4.12 LCC data can be improved during the conduct of a test and evaluation program by collecting performance data such as reliability and maintainability. LCC analysis can also be used to assist in project strategy decisions, such as whether to purchase source code, and in intellectual property decisions generally.

4.13 The ANAO observed that in some cases companies were supplied with a life-cycle model and asked to fill in the details. In other cases, companies were asked to provide data so that the Department could perform the actual costing. In either case, it is important to specify the correct level of detail of data - sufficient to inform the decision, but not impracticable to provide or analyse. It is also important, as recommended in Chapter 3, to maintain a consistent structure for analysis and presentation of life-cycle costs. Development of the basic structure would vary from case to case.

4.14 If tenderers were encouraged to submit alternative solutions together with corresponding LCC analyses, a lower life-cycle cost option may be offered. In one case study in the audit a tenderer commented that the omission of data on many parameters such as training meant that the benefits of any alternative or optional maintenance arrangements cannot be shown in the LCC analysis.

Conclusions

4.15 LCC at the acquisition stage was undertaken in three of the projects studied in the audit, but was generally conducted in an incomplete or inconsistent manner. There may be advantages in forming a unit which can offer advice and assistance to project offices with the aim of improving the quality of LCC advice to decision-makers. Performance may also be improved through increased LCC expertise. These issues are discussed further in Chapter 10.

4.16 In principle, LCC has the potential to provide a clear indication of the whole-of-life costs of a capability, which would assist in budgeting for operating and support costs. It could further provide the Department with information relating to the total cost of ownership of a capability, and provide inputs to decisions such as whether to take up options offered by contractors. This requires that source selection authorities should seek the best practicable information on life-cycle costs to inform decisions. Effective use of LCC also requires that people tasked with project definition studies, preparing RFTs and evaluating tenders have the technical and costing knowledge to seek the right information, specify appropriate LCC requirements and analyse and validate results.

4.17 The fact that tenderers' statements relating to LCC parameters such as reliability are not currently enforceable reduces the likelihood that life-cycle costs will influence tender selection. Contractual provisions regarding life-cycle costs would help to reduce the risk for the Commonwealth of future costs.

Recommendation No.3

4.18 The ANAO *recommends* that Defence:

a) ensure that life-cycle cost analyses of tenders are adequate and given due weight in source selection considerations;

b) encourage the submission of tender options which provide low life-cycle costs while meeting project requirements; and

c) seek to have tenderers' assertions relating to reliability and other LCC information translated into contractual arrangements with recourse for lack of achievement and incentives for achieving a lower operating cost than specified.

Defence response

4.19

a) Agreed.

b) Agreed.

c) Not agreed. Defence already considers whole-of-life costs and value for money during tender evaluation and source selection. In line with Government policy the Defence Acquisition Organisation is continually looking at ways of reducing the high cost of tendering for Defence business. Making life-cycle costing assumptions contractually binding will not only add to an already onerous load on tenderers but costs would increase to militate against the risk of getting it wrong, particularly for new technologies. The cost of making tenderers' life-cycle costing assumptions contractually binding would far outweigh any potential benefit and it would be very difficult, if not impossible, to implement in practice.

ANAO comment

4.20 The ANAO notes Defence's response to recommendation (c) but remains of the view that the recommendation has merit. It would encourage tenderers to minimise expected life-cycle costs and improve their estimates of such costs. It seems reasonable to expect tenderers, as part of their contract performance, to make a firm commitment at the contract stage regarding significant assertions made at the tender stage on life-cycle costs that they are able to influence. This would help to reduce some of the risks to the Commonwealth of unexpected future costs. To omit reference to life-cycle costs in acquisition contracts leaves the contracts silent on what could be a major area of risk to the Commonwealth.

5. The Use of LCC in the In-service Stage

Life-cycle costing remains relevant to the management of an equipment after it has been introduced into service. This chapter discusses the initial management of new equipment as it enters service and the extent to which Defence has used LCC in the management of equipment which has been in service for some time.

5.1 Life-cycle costing can be used to optimise support after equipment is introduced into service. It can assist decisions on the logistic solution for new acquisitions, decisions on adjustments to the support provided for equipment which has been in service for some time, and decisions on whether and when to replace equipment. Each individual decision on in-service management may be inexpensive, but cumulatively such decisions can affect markedly the cost-effectiveness of the capability.

New equipment

5.2 The estimation of in-service costs as part of LCC prior to contract signature was covered in Chapter 4. This section covers the work done after contract signature to use LCC to plan for the initial in-service stage of a capability.

Introduction

5.3 The significant amount of data provided by contractors, both before and especially after contract signature, can be used to design logistic support arrangements for the capability. These include decisions made on the level of repair, the location of repair facilities and the positioning, and number, of spare parts. In the Parakeet project, for example, it was demonstrated that having two levels of repair was cheaper than having three. Such decisions are a part of the discipline known as integrated logistic support (ILS), a key element of each project. Air Force policy on ILS states that 'the objective of an ILS program is to achieve weapon system preparedness requirements at minimum [life-cycle cost]'.

5.4 We were informed that the details of logistic support planning requires an amount of data available only after contract signature. Before then, the prime contractor often does not have access to detailed information held by prospective sub-contractors.

Passing information from the project office to Support Command

5.5 In-service management is assisted by a proper transition of information and management models from the acquisition project office to Support Command. The mechanism for this is an ILS instruction first prepared by the project office and subsequently passed to Support Command.

5.6 The DER Secretariat papers noted that:

> *critical ingredients in the transition of equipment to the running system are integrated logistic support (ILS) and a thorough through-life-cycle costing (TLCC) assessment during the definition and tender evaluation phases. For the transfer of assets into service to occur seamlessly, ILS and TLCC assessments must accurately identify all resource issues to ensure that the receiving Service has adequate funding to support the new equipment from its desired operational date.*

Contractual arrangement

5.7 Increasingly, in-service support is being provided by a contract arranged at the same time as the prime equipment contract. This seems an effective way of proceeding in many cases and has been given ministerial encouragement.[21] For example, the Parakeet project has set up a system support facility operated by British Aerospace Australia and employing some Defence staff, reporting to Support Command. In the case of the Air Traffic Control radars, a contract was let to the successful tenderer to provide ongoing support of the systems.

Overseas and commercial arrangements

5.8 UK military requirements now lay down as a contractual requirement the equipment's required level of reliability and maintainability (R&M). The UK also recognises that contracts should stipulate the method of demonstrating that the required level of R&M has been achieved.

5.9 Some major Australian companies consulted laid down life-cycle cost parameters such as reliability and maintainability as part of contractual obligations. These are enforced using the results of an established information management system.

5.10 US Defense policy states that the adequate funding of Operating and Support (O&S) costs is a key component of preparedness, with O&S costs frequently exceeding acquisition costs, and total life-cycle costs

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[21] McLachlan, Ian, Minister for Defence, *Australian industry must be involved in through-life support of defence equipment*, Press Release MIN 111/97 of 27 August 1997.

increasing as weapon systems become more complex. US policy requires the explicit consideration of O&S costs from the beginning of the acquisition process throughout the operational life of a program to manage and control these costs. Their Visibility and Management of Operating and Support Costs (VAMOSC) Program has been established as a means of responding to this requirement. VAMOSC involves the establishment of an historical data collection system together with a well-defined, standard presentation of O&S costs. VAMOSC produces costs by user command, by type of cost - depot maintenance, spares etc - and by major subassembly. US Defense requires that VAMOSC data be used as a basis for decisions concerning affordability, budget development, support concepts, cost trade-offs, modifications, and retention of current systems. Furthermore, the use of VAMOSC data in deriving O&S cost estimates for future defence programs is encouraged.

5.11 US Defense also has a practice of reviewing operating costs shortly after the equipment enters service to help overcome initial problems and to refine logistic solutions. A US Defense executive considered LCC to be equally as important at the capability management phase of the life-cycle as at the acquisition phase. He noted that 70 per cent of the equipment which will be in the field in 2020 is in the field now. LCC is an important tool in identifying cost drivers during the life of a capability, and there is a great opportunity for the use of LCC for modernisation decisions.

Existing equipment

Introduction

5.12 In-service management of existing equipment often has little inherent flexibility. The requirement for prime equipment, the locations, available repair facilities and the modes of operation are usually fixed. The issue is then to support the equipment as well as possible within the annual budget provided, and to determine when it has reached the end of its economic life.

5.13 LCC can be useful in the support of existing equipment if problems lead to the need to consider changes. For example, data analysis may lead to the conclusion that a major component is failing too frequently, leading to poor availability of the prime equipment. Options then need to be considered such as replacing this component with a more reliable one in all prime equipments, purchasing more spares or changing the maintenance policy. LCC can assist in making the decision between such options.

5.14 The US Air Force recorded in its lessons learned database that complete LCC data should be presented with each engineering change proposal. This was in the context of their current use of an incomplete LCC model. The recommended action was to ensure there was an LCC focal point to ensure correct application of LCC.

Army

5.15 Support Command - Army (SC-A) noted that LCC should be conducted whenever:

- activity levels or usage rates change;
- modifications are being considered to either the prime equipment or any of its components;
- a life-of-type extension is proposed;
- changes are made to logistic support policy; or
- disposal options are considered.

5.16 SC-A does not monitor operating costs as such, but the reporting of defects can lead to a judgement that the operating costs are too high and therefore one of the options above needs to be considered. Decisions are taken after discussion between parties involved; SC-A staff stated that these decisions considered LCC principles, but were not formal LCC analyses. Lack of data on cost savings can impede acceptance of proposed changes, but some Defence officers stated that the primary reason for not considering potential improvements is lack of investment funds. The availability of such funds is not related to potential savings which might be gained.

5.17 In the case of cranes fitted to Mack trucks, unwarranted failures had been noted since 1987. A review of options was requested in October 1997 when it was noted that funding constraints will determine the timing of any modification. If there had been a simple LCC analysis of the costs and benefits modifying the equipment, there may have been earlier action with consequent improvements to cost-effectiveness.

FFG case study

5.18 As part of the FFG frigates upgrade project, Support Command - Navy (SC-N) proposed several configuration changes relating to reliability and habitability. Configuration changes are processed by a working group which includes relevant areas from SC-N and the FFG frigates upgrade project. At any one time, some 300 changes are listed, but only about half of these are considered to be of high priority. Priorities are driven more by user requirements and issues such as safety, habitability and capability than by cost savings. Many of these changes have been under consideration for some time. The ANAO inspected the files for three of these proposed changes. Summary results are shown in Table 2.

Table 2

Analysis of three proposed configuration changes

Configuration change	Maintenance-free batteries	GMLS sprinkler system	Stern flaps
Date proposed	July 1989	September 1989	October 1994
Purpose	Reduce maintenance; reduce weight	Improve reliability	Reduce fuel usage
Initial cost estimate	TBA	$ 40 320	$200 000
Revised costs	$84 000	$198 000	$100 000
Number of ships	4	4	4

5.19 In no case was the future reduction in operating costs analysed using LCC. In the case of the stern flaps, reference was made to an article in Marine Technology which stated a pay-back period of 10 months. Each of the proposals originated in the US. They are decided on by Maritime Headquarters or by the minor capital equipment section, which then passes the modification to the class logistics offices (CLO) for implementation. Navy personnel stated that better information would be generated after the CLOs had been in operation for some time; for example, the FFG CLO is now considering ways of costing the support of particular sub-systems, which enable identification of cost trends and hence identification of candidates for modification or replacement.

5.20 Funds for configuration changes are limited, and are allocated by measures such as the configuration control working group to allocate the highest priority items. They are not related to any potential savings which might be achieved. Some of the ship availability proposals considered as part of the project have the ability to reduce costs, but life-cycle costing in itself was not used in deriving those proposals reviewed by the ANAO.

Case study - small ships' navigation radars

5.21 Small ships' navigation radars have proved to be expensive to maintain, and hence the Navy has been considering alternatives. The problems of unreliability were well understood, but very little statistical data on the patrol boat radar were held. One Navy comment was that the approach of retaining the radars as long as they were technically supportable, despite problems with cost and reliability, should be revised. It was later stated that the annual in-service support costs for the radars approximated the capital cost of a replacement, and that replacement would yield savings within two years. The replacement radars were funded through a combination of minor capital and maintenance funding.

P-3C Case Study

5.22 In-service logistics management of the P-3C fleet is carried out by the Maritime Patrol Logistics Management (MPLM) Squadron. Part of this task is configuration management, for which MPLM Squadron has established procedures that explicitly call for life-cycle costing information to be presented. Approved configuration changes are first considered for funding at MPLM Squadron level. If funds are not available, a funding request is then submitted to Support Command for consideration.

5.23 The ANAO reviewed a sample of three proposed configuration changes. One case concerned replacement of the crash position indicator. MPLM Squadron had identified in early 1994 that there were economic benefits over the life of the aircraft in replacing the indicator, due to high maintenance costs for the current equipment. Nevertheless, funding was not approved for over two years. Alternative funding arrangements through use of minor capital funds, on the grounds of operational requirement, were not accepted. The equipment was ordered late in 1996.

5.24 The second case concerned an ignition exciter (an engine component). A sudden increase in failures in 1993 and 1994 led to an investigation of options. A solid state alternative to the previous mechanical exciter was identified, with higher reliability, with a life-cycle cost analysis indicating break-even in four years and a predicted life-of-type savings of $3.1 million. Approval for funding, at first rejected, was approved six months later.

5.25 The third case concerned a fuel float vent valve. This proposed configuration change dated from 1992 and economic evaluation had been omitted, leading to considerable work (135 hours recorded) towards redesign of a failing component. The issue was then reviewed in 1997, leading to a decision to replace the valve, which was of relatively low cost, with a new one whenever its condition deteriorated.

5.26 MPLM Squadron also sets and reviews maintenance policies. In the case of brake assemblies, increasing failures led to cases of aircraft being grounded and hence the need to find an improved way of supporting the aircraft. Subsequent analysis by MPLM Squadron found that the current maintenance policy of partial repair by the maintenance squadron and full repair by contractors could be replaced by a policy of replacing defective parts with new, with a saving on a life-cycle cost basis of some $14 million.

5.27 MPLM Squadron has put together a cost model which presents the majority of direct costs required to support the P-3C fleet, whether expended by MPLM Squadron or other authorities. However, this model does not consider all costs, and does not consider increasing costs with age. It is being developed so that it can show costs by system (eg navigation system), and show the influence of rate of effort on overall costs.

5.28 Data bases such as the Maintenance Analysis and Reporting System (MARS), the Aircraft Information Management System - Breakdown Spares (AIMS-BDS) and the Standard Defence Supply System (SDSS) can provide data for LCC modelling. However, MARS data is sometimes unreliable, requiring checking against paper records, and can be hard to extract. An automated way of extracting information from MARS, SDSS, and AIMS-BDS is now being constructed by MPLM Squadron.

Disposal

5.29 Disposal is the last of the events in the life-cycle of an equipment, but should nevertheless be considered in the LCC analysis. One view is that disposal costs should include any additional costs necessary for retraining or redundancy for the staff connected with that capability.

5.30 Most replacement decisions in Defence are made on the grounds of capability, eg current equipment not meeting requirements due to functionality or reliability, rather than on the grounds of cost. If LCC were used to analyse when equipment had reached the end of its economic life, there would be scope for overall savings through avoidance of high support costs.

Conclusion

5.31 Life-cycle costing can contribute to decision-making during the in-service phase. The major potential use is the tracking of the life-cycle cost of components and sub-systems, leading to the identification of the need for action such as replacement or modification. However, the use of LCC so far has been limited and inconsistent.

5.32 The ability to make such use of LCC is limited by the lack of consistent data on the past costs of operation. Measures to improve these databases would assist future LCC estimates. The ability to use LCC to justify investment to save future support expenses is also limited by constraints on budgets for investment, which can produce a short-term perspective.

5.33 An approach which uses a simple LCC technique, such as estimating the ratio of investment to savings in operating costs over the remaining life of the equipment, could assist in ranking changes to configuration or to support arrangements.

Recommendation No.4

5.34 The ANAO *recommends* that Defence:

a) improve data bases of costs of operations where cost-effective to do so to allow tracking of operating costs;

b) monitor operating costs of Defence equipment so as to assist decisions on whether components need replacing or upgrading, and on optimising logistic support arrangements such as spares holdings, maintenance policies and facilities; and

c) institute a means whereby support managers are encouraged to take a longer-term view of supporting their equipment economically. These means might include the ability to commit future maintenance budgets to spend on current investment.

Defence response

5.35 Agreed.

6. Facilities

Life-cycle costing can be applied to facilities projects as well as major capital equipment. This chapter discusses Defence policy on facilities LCC and goes on to discuss its implementation using two case studies.

Introduction

6.1 Facilities proposals may emanate from a number of sources including the Minister of Defence, users, functional authorities, major equipment proposals and Defence Headquarters.

6.2 A facilities proposal accepted by Defence is included in the Capital Facilities Sub-Program (Green Book). A project team is established and the proposal is developed before being forwarded to the appropriate committee for approval. All projects over $6 million (either for new projects, refurbishment or repairs and maintenance) are referred to the Parliamentary Public Works Committee for scrutiny and subsequent approval by Parliament.

Life-cycle costing in facilities

6.3 LCC has been utilised by the property industry for many years during both the design and construction phase and the ongoing maintenance of a facility. In the design phase it can be used to identify the optimal design to minimise life-cycle costs, and in the maintenance phase to maximise the performance of the building; for example, by adjusting air-conditioning to meet user requirements. In the property industry LCC analysis is widely used by investors and owner occupiers but property developers who intend to sell a building after construction are unlikely to have much interest in LCC.

Policy

6.4 Defence Estate Organisation issued the 'Project Director's Handbook' in 1992. The Handbook was designed to assist project directors and provides not only policy but also guidance to project officers. It states:

> *It is crucial that there is early high-level agreement on objectives and the level of investment … In preparing and validating the proposal, search for alternatives, carry out life cycle costings, analyse the risks and determine your acquisition strategy.*

6.5 There is no current policy that relates to the use by DEO of LCC analysis during the life of a facility. As a result of the Defence Reform Program announced in April 1997 DEO has taken over from the other Defence Programs the responsibility for the delivery of Facilities Operations. The Business Practices section is drafting policy that will cover all areas of responsibility of DEO and it is expected that it will take some twelve months for this new policy to be put in place.

Project initiation

6.6 The design phase seeks a balance between capital costs and the through-life costs of the facility to achieve a functional building that can be maintained at minimal costs throughout its economic life.

6.7 Two facilities projects were included in the case studies for this audit - Defence Science and Technology Organisation (DSTO) Laboratory Complex, Salisbury, and RAAF Base Scherger. The Scherger project commenced in 1991 and there was no attempt at LCC analysis during the project initiation phase. DSTO Salisbury was initiated in 1993-94 and two studies utilised LCC analysis to assist in the determination of the best option for this project.

6.8 The studies undertaken at the conceptual phase of the DSTO project provided decision-makers with support for the decision to proceed with a consolidation into a new building.

Project implementation

6.9 LCC analysis is able to assist in the decision-making process during project implementation - the design development stage of the construction phase - by providing details on through-life costs of particular systems or sub-systems. It can aid the Project Director to adopt the most cost effective solutions at each stage of development.

6.10 During the course of the Scherger project some twenty Functional Design Briefs (FDBs) were prepared and the contracts for the design and constructions of these elements were let progressively between 1992 and 1997. Four of the FDBs were updated from the original drafts (prepared in 1992). One of the four FDB, No 8, Explosive Ordnance Storage, required a building life of thirty years but made no reference to through-life costs or LCC analysis. Defence used a mature building design but the lack of LCC analysis in the FDB meant there was no assurance that it was still cost effective from the LCC perspective in the Scherger location. Two of the revised FDBs had no requirement for the designer to consider LCC analysis. The brief for the 'Fuel Farm' had a requirement for LCC analysis to be undertaken in relation to the fuel storage tanks, stating that 'A detailed through-life costing analysis will be required as part of the Preliminary Design Report (PDR).' Although this requirement was in the FDB, Defence did not seek the LCC analysis from the contractor until recently. When it was received it was not in fact a detailed through-life costing analysis but a table of through-life costs for the various options.

6.11 The Facilities Operations (FACOPS) section of Estate Operations & Planning Branch was formed in September 1997 and is now responsible for operating costs. These costs were previously managed by the other Defence Programs. Their inclusion in the Design Review or LCC processes could help ensure that future maintenance costs of a facility are minimised by appropriate use of LCC analysis.

6.12 The Functional Design Brief for DSTO Salisbury had as one of the Project Objectives a requirement for 'optimisation of facility life-cycle costs.' The Engineering Parameters required the following features to be considered:

> *evaluation of alternative concepts or designs shall include consideration of life cycle costs. Selection should be made on the basis of least total cost over the life of the facility (with appropriate moderate energy consumption). Selection should also give appropriate consideration to non-quantifiable benefits, such as aesthetics, ease of maintenance and availability of equipment where applicable.*
>
> *plant design and selection shall minimise maintenance costs consistent with life cycle costing of the installation.*

6.13 A major design alteration to the building was subjected to life-cycle costing analysis prior to approval. A number of systems were also subjected to LCC analysis.

6.14 The LCC undertaken during the design and construction of the DSTO project has assisted decision-makers in achieving a balance between capital input and through-life costs. Although the primary driving factors in the Scherger project were strategic and operational this same level of assistance was not provided to decision makers.

Conclusions

6.15 The DEO has LCC policy in place for the project initiation, design and construction phases, but application of the policy would appear to be uneven. Policy relating to the through-life maintenance of facilities is only now being prepared.

6.16 Although LCC analysis is required under the policy and is stated as a requirement under the current generic FDB, this information is not always sought by Defence.

Recommendation No.5

6.17 The ANAO therefore *recommends* that Defence Estate Organisation:

a) include a representative from its Estate Operations and Planning Branch on design review and tender selection panels;

b) promulgate the benefits of LCC analysis and training; and

c) monitor the implementation of LCC.

Defence response

6.18

a) Agreed with qualification. The Defence Estate Organisation will include a representative from the Estate Operations and Planning Branch on design review and tender selection panels where possible.

b) Agreed.

c) Agreed.

7. Administrative Acquisitions

Life-cycle costing can also be applied to office equipment, and this chapter discusses Defence's approach to LCC in this area.

7.1 This chapter refers to the use of life-cycle costing for such items as photocopiers and fax machines which require ongoing support after purchase. A 1996 ANAO audit report of asset management observed that whole-of-life-cycle costing methodologies needed to be introduced in public sector agencies, and recommended that agencies review asset policy and procedure manuals to ensure that they addressed all aspects of the asset life-cycle.[22] The ANAO also produced an Asset Management Handbook which stated that:

> *The use of life cycle costing techniques allows a full evaluation of the total cost of owning and maintaining an asset prior to acquisition. This creates the opportunity to determine the most cost-effective program delivery solution (this may be a non-asset solution). Estimating life cycle costs prior to acquisition also establishes a standard which is the basis for monitoring and controlling costs after acquisition.*

7.2 In Defence, administrative acquisitions represent a much smaller investment than major capital equipment, but still account for significant expenditure. For example, Defence Canberra spends some $2 million per year on photocopier supply and maintenance. For administrative acquisitions, coverage of LCC in purchasing training material is scant and the relevant policy-setting officer was unsure of practices.

Business machines

7.3 At the time of audit, Purchasing Australia (part of the then Department of Administrative Services) established common-use contracts for equipment such as photocopiers, facsimile machines and printers for use by Commonwealth agencies. Photocopiers were divided into about 13 categories by volume, and in each category the cost per copy was calculated for potential purchasers. These costs included the machine itself and all consumables, but excluded power and air-conditioning. The 10 to 15 offers in each category were ranked and distributed to Commonwealth

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[22] Audit Report No.27 1995-96, *Asset Management*.

agencies. End users then decided which copier they wanted. Costs were predictable, as they were based on preset maintenance contracts and on preset offers of repurchasing machines at the end of a stated period. The main user risk was that the actual usage of the machines differed from that estimated; if this occurred, another machine in a different usage category would probably have been a better buy. Similar considerations applied to other equipment such as fax machines.

7.4 In Defence Canberra, business machines are managed centrally by the Directorate of Publishing (DPUBS). In 1995 DPUBS recommended replacement of slow photocopiers on the basis of an analysis that included a review of the operating costs of photocopiers. This analysis led to the selection of machines for general Defence office use from the DAS common-use contract, but with Defence negotiating different conditions. The analysis showed good appreciation of LCC principles, such as including the cost of operator time. Even further improvement to the spreadsheet to enhance its accuracy would be beneficial.

7.5 Costs of operation are reduced by measures such as having a single brand-name in each building. This allows the relevant contractor to provide more efficient service by having a stock of parts held in the building. Usage of photocopiers is monitored monthly to determine whether they should be exchanged with another of a more suitable capacity, and whether users are performing 'publishing' tasks that should be done centrally.

7.6 It is more difficult to estimate and manage the life-cycle costs of other business machines, such as printers and facsimile machines, where costs are harder to control and usage harder to predict.

7.7 Networked printers need to be assessed and managed as corporate assets. The application of LCC is essential to improving the management of networked printers in general and to reduce capital investment. LCC considerations associated with the installation of devices combining photocopying and printing functions in a single machine have a further potential to reduce Defence resources expended on administrative support functions.

Other Items

7.8 Army reported that although minor acquisitions made up the majority of the inventory, LCC was not applied to these purchases.

7.9 There are significant costs of computer ownership in the form of costs of upgrading software and hardware. Some organisations in Defence are contemplating lease arrangements instead of purchase because of the convenience of a more regular flow of expenditure. However, a LCC analysis, with the time cost of money taken into account, should also be applied to such decisions. In the case of computers in the field, LCC could assist with decisions on whether to sustain losses due to occasional breakages or to acquire more rugged computers.

Conclusion

7.10 As for other purchases, there are risks of poor LCC decisions on administrative purchases when there is limited knowledge or experience of purchasing. The risks are reduced if management is in the hands of a knowledgeable group of people, and if external advice or checking of LCC analyses is used.

7.11 The ANAO has recommended (Recommendation No.1) that LCC should be applied to all assets with an ongoing cost of ownership and that supporting guidance material be developed. This also applies to the purchase of administrative equipment. The ANAO has also recommended the formation of a cell which can offer LCC advice and assistance; this advice and assistance should be available to assist decisions on administrative purchases.

8. Data and Models

Keynes: *It is better to be almost correct than precisely wrong.*

The impact of LCC data and models has been discussed above where relevant. Here, some general observations are discussed. The chapter focuses on the need for accurate data to support life-cycle costing, current difficulties in acquiring and accessing data and some possible approaches to addressing these issues. Different approaches are relevant with respect to data for prospective and current equipment. With respect to the latter, activity-based costing is discussed as a possible approach.

8.1 Two requirements for the success of LCC are readily accessible data in a format that is easy to use, and the availability of practical models, techniques and methods to analyse the data. Data can be held in a variety of formats from computerised data bases to records held in hard copy format and dispersed across numerous areas within the Services. Models for analysing data can be simple (a spreadsheet) or complex dedicated programs.

Data

Introduction

8.2 Accessible data is important to the success of LCC. This was recognised by Harvey, who wrote in the early 1970s as follows: 'Without some form of data bank of historical information, an LCC study will be very difficult to carry out.'[23]

8.3 The requirement for data will change during the acquisition life-cycle of equipment. When the proposal for acquisition is first raised, outline data is required to consider whether the proposal is potentially cost-effective. At the tender selection stage, there needs to be sufficient information to make a fair and reasonable selection of the tender which offers the best value for money. When the equipment enters service, there may need to be large volumes of data on the details of its operation in order to implement effective logistic support.

8.4 A sound knowledge of the support costs of current equipment is necessary to determine savings if the equipment is retired. Where

[23] Harvey, Graham, *Life-cycle costing: a review of the technique*, Management Accounting, October 1976.

technology is similar, current costs provide a basis on which to estimate the total costs of the replacement equipment. Potential sources of such current costs include Support Command and operating units in each of the Services.

8.5 Where technology represents an advance on current equipment, data is more difficult to acquire. Possible sources include foreign defence forces operating similar equipment, data based on extrapolations from current equipment or components of current equipment, and estimates based on initial work by research and development establishments.

Data collection and storage for current equipment

8.6 In this subsection we first consider some of the general issues of data management, followed by some specific problems. Good approaches to data management are then discussed.

8.7 For current equipment, it is often difficult to identify a continuous record. Data may have been collected by many users over the years, using a variety of data collection and storage methods.

8.8 This is partly the consequence of the state of information systems in Defence, which have not been well managed. This has been reported in the ANAO's report on Defence inventory management, which noted a lack of reliable information on stock levels and prices and a the lack of system connectivity. An internal Defence report noted that 'Information is … difficult and time-consuming to obtain, and generally of poor quality.'[24] We were informed on several occasions that there was a multiplicity of data bases created in Defence and that relevant information is usually held somewhere in the logistic system and, given the will, can be extracted.

8.9 Recorded cost data may also be influenced by expenditure constraints, leading to an artificially low cost of operation. This would only show up as loss of capability, or the need for catch-up expenditure, both of which may take some years to manifest themselves.

8.10 Data uncertainties can vary by Service. Navy's operating and support costs include costs for overseas repair and refuelling, which can vary considerably from local costs. In the case of Army, there are a large number of units which collect relevant data, and the collection of consistent data is not as straightforward during deployments (eg maintainability data from forward repair units).

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[24] *Defence's Life Cycle Cost Policy: The Way Ahead*, internal Defence paper, September 1995.

Army

8.11 In Army there is little visibility of data. With respect to spares accounting, for example, it is not possible to monitor centrally first line spares usage through the automated Q-Store system (AUTOQ) or second line usage through the Divisional Inventory Control Visibility and Accounting System (DICVAS). Third and fourth line spares usage is visible through the Standard Defence Supply System (SDSS). The Electrical and Mechanical Engineers Management Information Computer (EMEMIC) is used to gather maintenance information from Land Command units that maintain B (and A) vehicles as well as Support Command units. One exercise carried out by Support Command - Army took two weeks to identify assets. In addition, current systems cannot tell whether reliability varies with location.

8.12 Currently, Army can produce such data as average maintenance costs of vehicles to a degree of accuracy adequate for forecasting budget requirements. However, Army stated that such analyses could take considerable time and effort. There were also limitations such as trailers of all types being lumped together.

8.13 Army's Project Overlander has a requirement for visibility of data for the Life of Type Management of the B vehicles (field vehicles and trailers). The Project Overlander Life of Type Management Information System (LOTMIS) will comprise a combination of existing information system assets and new hardware and software. Army is intending to use data warehousing; it is estimated that the cost to Support Command for the data warehouse is in the vicinity of $1 million and that specific data extraction and manipulation tools could cost $300 000 with annual maintenance costs of approximately 40 per cent of capital costs. This investment has the potential to yield savings since the replacement cost of the B vehicle fleet is in excess of $1 billion, there are thousands of items to track, and difficulties mentioned above indicate that there is scope for better data to allow for improvements to the management of the fleet.

Air Force

8.14 Air Force uses its Computer-Assisted Maintenance Management (CAMM) system to acquire cost data, together with the spares requirements identified by the Weapons Systems Logistics Management Squadrons. An Air Force paper noted that there had been difficulties with the mechanics of collecting costing information to support its Cost of Capability process.

8.15 Maritime Patrol Logistics Management (MPLM) Squadron was able to determine raw expenditure figures in support of the P-3C upgrade project for selected items of avionics for the P-3C aircraft. The figures refer to purchase of spares rather than usage, did not correlate with flying hours or other measures of usage, and did not distinguish between increased need for spare parts and increasing prices. Nevertheless, they were sufficient to show a trend of increasing costs.

Navy

8.16 For Navy, operating cost information is collected by the Ship Logistics branch of Support Command. Navy's data collection systems include SIMS/SIS for corrective and preventative maintenance for submarines, and AMPS for preventative maintenance only for the Anzac frigates. SIMS/SIS has on-line configuration management, but cost capture is not complete, although costs can be extracted for major sub-systems. Information is then distributed to projects as requested and annually to DCOST for the generation of steaming hour rates.

8.17 Navy conducted an FFG frigate supportability study between 1992 and 1994 to help decide whether the frigates were supportable to the end of their life in 2010. The study involved collection of data on reliability and cost of support of the various sub-systems of the FFG. Considerable difficulty was experienced with extraction of data to support the cost estimates, with numerous data bases being examined, many of which were incomplete or had incorrect data. Nevertheless, the study managed to produce information on the estimated cost of support of the major FFG sub-systems, including supply support and scheduled and unscheduled maintenance.

8.18 The supportability study was also tasked with developing a defect reporting system for the FFG. This system records some 2000 defects per year, collected on a monthly basis. No costs or repair times are recorded in this data base, but it can be used to detect trends in reliability by ship and by equipment. Once an unsatisfactory trend is detected, cost data can then be extracted with a view to considering how best to address the problem. Another example of a small data base is one constructed by Navy to assist in the management of calibration and test equipment. This data base enables cost to be recorded against an individual instrument, an instrument model, a ship or a calibration centre, enabling identification of unreliable equipment.

8.19 Navy is also taking steps through its new class logistics offices to establish information systems to assist in providing in-service support.

Approaches to data management

8.20 The ANAO report on defence inventory management suggested data warehousing and executive information system (EIS) technologies offered considerable potential to fuse data from heterogeneous sources, thereby providing more meaningful information to logistic managers. Data warehousing has been recognised as a complex undertaking, which requires high-quality data if the integration of that data is to produce effective business solutions.

8.21 An issue for consideration is whether comprehensive information technology solutions are required, or whether LCC data should be sought from existing sources when required. Development of an overall LCC data base was considered by Defence, but has not proceeded. The alternative approach involves deciding precisely what data is required to make a decision, and then seeking that data in existing systems. Alternatives to full historical cost data collection include sampling, focusing on high-cost items, and generating costs from other known data, eg personnel costs based on crew numbers. Establishing systems for the collection of information can be expensive. In 1975 the United States Armed Forces initiated a system at a capital cost (to 1990) of some US$30 million for monitoring actual in-service costs for each equipment.[25]

8.22 One issue, as noted by a 1974 US report, is that there is little incentive for operators and maintenance personnel, usually the original recorders of the data, to collect accurate data. One approach to addressing this problem is to ensure that any new information system should, in addition to its normal operational function, provide an historical record of operating costs by weapon system. The decision on the appropriate means of data management will depend on the cost and number of equipments, the life of type, the nature of the support arrangements and the reliability and maintainability.

Cost recovery rates

8.23 Cost recovery rates are calculated and distributed widely in Defence. Several cost recovery rates are calculated, eg direct cost, indirect cost and program cost. These rates are used by Defence for charging external bodies or estimating the cost of such activities as rescues and exercises. Not all costs are allocated to the relevant equipment; this is indicated by the fact that in 1996-97 the full costs of RAAF aircraft covered only 55 per cent of the RAAF budget. Navy identified several classes of costs which are not attributed to steaming-day cost recovery rates, such as training, facilities, simulators, some ship upgrades, hydrographic support and communications and intelligence support. The cost recovery rates therefore provide some information towards life-cycle costs, but Defence explicitly states cost recovery rates are not life-cycle costs.

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[25] National Audit Office (UK), *Ministry of Defence: Planning for Lifecycle costs*, HMSO 174, January 1992. p. 3, 30.

8.24 When we asked those bodies responsible for issuing cost recovery rates whether projects had sought LCC information, Navy and Army responded that they had not; Air Force referred such requests to Support Command.

8.25 Navy stated that the Activity-based Management (ABM) project (see below) will include some of the cost elements currently not attributed. In addition, Navy's cost recovery rates will improve in accuracy when direct costs for fuel, rations and the like are available through ABM by about March 1998.

8.26 Further useful costing information is provided by the Defence *Ready Reckoner of Personnel Costs and Related Overheads*, which provides cost data on various categories of civilian and defence personnel in a range of locations.

Activity-based costing and related issues

8.27 Activity-based costing (ABC) is an approach to costing which emphasises activities - the resources they use and the outputs they produce. ABC costs activities and their outputs, usually by allocating total expenditure on a range of different inputs (labour, utilities, materials, facilities etc) to activities. It is distinguished from the 'overhead' method of costing, whereby costs were calculated on the basis of labour costs, with all other costs considered overhead and distributed in proportion to labor costs. ABM goes further and considers performance measures of activities as well as their costs. A limitation of ABC and ABM is that they can only consider and cost current activities, whereas Defence is required to invest now in capabilities to provide for future contingent activities which are difficult to predict.

8.28 The Management Advisory Board, in its 1997 publication *Beyond Bean Counting: Effective Financial Management in the APS - 1998 & Beyond* described ABC as a best practice model, that could add value to resource management in an agency. An exposure draft by the Department of Finance and Administration, *The Performance Information Cycle: A Guide for Managers* recommends that the preferable costing method is Long Run Net Avoidable Costs (LRNAC). It states that activity-based costing is often a cost effective proxy for LRNAC.

8.29 Navy is implementing ABM. The ANAO has recommended in the context of supply management that Defence develop and implement ABM, having regard to Navy's work. The ANAO also has supported recommendations by the DER directed at establishing a resource management system that focuses on the real costs of delivering Defence outputs; ABM would assist Defence to achieve this. The ABM approach may allow the better collection of data to support LCC decisions. However, time is required before ABM accumulates an adequate history of data on which to base estimates.

8.30 Air Force has developed an Air Force Resource Attribution Model (AFRAM) which has many similarities to an activity-based costing approach. This model includes costs of Air Force support such as air traffic control and facilities, but not costs from the remainder of the Defence portfolio. Three years' data are now available. The model, started in 1992-93 and completed in 1994, contains about 4000 attribution rules and accumulates 400 000 records of data per year.

8.31 Because of the simplicity of some of the rules (eg maintenance allocated according to flying hours) the process is not suitable for determining accurate operating costs of aircraft. For example, it cannot currently distinguish between the various aircraft types in the tactical fighter group (F-18, Macchi, PC-9). In addition, allocation of all of a support organisation's costs overstates the marginal cost of providing additional support to an operational unit. Costs are also allocated on a cash rather than accrual basis.

Data collection - new capabilities

Data from Tenderers

8.32 Data supplied by tenderers needs to be checked. One review suggested that over reliance on prices from tenderers should be avoided, and an appreciation of direct and through-life project costs should be acquired from within the project team or from consultants.[26] For example, Black Hawk helicopter actual maintenance man-hours per flying hour greatly exceeded the manufacturer's estimate; it was later found that the latter figure referred to unscheduled maintenance only. Other users can be consulted about actual operating costs and engineering data can be compared with marketing information. One concern is the validation of data which may be based on laboratory, rather than field, conditions. Sometimes suppliers are not aware of the harsh environment in which military equipment will be operating.

8.33 Of the seven case studies examined by the ANAO, four had reached the stage of examining contractor data. In three of the cases, the data provided was of doubtful quality, and in all cases project staff reviewed the manufacturers' data and made adjustments to it. In no case was there

[26] Hinge, Alan, and Markowski, Stefan, *Defence Project Management: Pitfalls and Pointers Volume II*, Australian Defence Studies Centre, 1997, pp. 165-167.

any contractual guarantee on LCC parameters. In most cases, manufacturers were asked not only for data but also for the source of the data and any assumptions behind it.

8.34 One issue is whether companies are able to produce LCC data at the tender stage. If they are merely viewed as suppliers of hardware, with no responsibility for in-service maintenance, then it may be difficult to provide LCC data. It may also be that not all sub-contractors have been defined at the time of tender, making LCC estimates difficult; and sometimes sub-contractors may be unwilling to provide details. An alternative view is that responsible companies would take an interest in knowing the reliability and support costs of their equipment. A good design process should produce both reliable equipment and good LCC data.

8.35 Companies can find it expensive to produce LCC data - perhaps $100 000 to $1m for a significant tender. A 1974 US report referred to costs of preparing LCC estimates by contractors in the region of US$300 000.[27] Defence tenderers consulted by the ANAO, though supporting LCC, were concerned at the cost of providing detailed data together with the difficulty of providing data to a consistent level of detail and accuracy. Consultants to the ANAO commented that not all data provided by tenderers was used.

8.36 Ideally, life-cycle costs would be validated by comparing actual costs incurred after equipment has entered service with those proposed by contractors in their tenders. This would enable any contractual provisions relating to operating cost performance to be implemented. Validation exercises would also show how effective life-cycle cost estimates were at capturing all costs, thus leading to the potential for improving data collection and LCC models with consequent improvement in future LCC estimates.

8.37 Validation is difficult because the planned mode of operating equipment may vary, operating costs may take some time after introduction to service to settle down to a steady state and there may be unexpected changes in prices. None of the case studies examined by the ANAO had a specific process established for validation, although for one case there was a parallel contract for support which put some incentive on the supplier to achieve a low operating cost. In another case, operating costs have been higher than forecast, leading to a service bid for budget supplementation.

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[27] Report to the Congress by the Comptroller General of the United States, *Life Cycle Cost Estimating - Its status and Potential Use in Major Weapon System Acquisitions*, PSAD-75-23, December 1974.

8.38 One issue is whether to supply companies with a life-cycle model and ask them to fill in the details, or request companies to provide data with the Department performing the actual costing. Of the five cases where the project had reached the stage of collecting operating cost information from tenderers, three explicitly requested information in the form of inputs to the Cost Analysis Strategy assessment (CASA) model. The UK has now developed a generic LCC questionnaire to put to tenderers which seeks both numerical and qualitative information. The specification of a LCC model for use by tenderers was supported by one ANAO consultant, who noted that this would enable tenderers to conduct their own LCC analyses with the possibility of generating a cheaper overall option, but disputed by another, who felt that tenderers could artificially adjust their data to produce an attractive tender.

Data by comparison with existing systems

8.39 The US Armed Forces require that, within their acquisition process, the part of their life-cycle cost estimates dealing with in-service support should be compared with the actual costs of one or more similar equipments already operational, as well as with data from technology demonstration prototypes. One US official stated that although every weapon system is planned to be cheaper to operate than its predecessor, it never is. Costs due to capability improvements tend to outweigh savings due to increased reliability and maintainability.

8.40 The UK National Audit Office reported that: 'The formalised comparison of estimated in-service support costs with those incurred for similar, already operational equipments, reinforced with data from technology demonstration, would significantly increase confidence in the accuracy of the estimates.'

8.41 This approach was not followed by Defence here, where none of the case studies used comparative life-cycle costing as such. Defence stated it was not practicable to do so, because of significant technological differences between current and proposed equipment. In the upgrade projects examined by the ANAO, operating costs were required to be estimated before and after the upgrade; and in one project operating cost trends in the current equipment were used to establish information on its remaining life.

8.42 It is sometimes possible to use existing projects and capabilities to make estimates for future capabilities. For example, current C-model Chinook data was used, with an improvement factor, to estimate costs for the new D-model. Critical components of the estimated costs were then subjected to sensitivity analysis. The Surface Force Combatant Study used a variety of data sources to assess life-cycle costs. In this way it added to the reliability of its estimates while pointing out the difficulty of deriving appropriate and consistent cost estimates.

8.43 Data based on existing systems can also be used, with greater uncertainty, to make predictions on costs for new technology equipment. Few technologies are totally new; many components are similar to those already in use and so data on these components can be used to assemble an estimate of the new technology cost. Trends can be established, such as those relating to the trend in costs for information technology equipment. Parametric models (see below) can be used to estimate the cost of new equipment based on its outline characteristics.

Models

Introduction

8.44 LCC models are methods of combining data and assumptions to answer specific costing questions. Examples of such questions are 'What is the overall resource cost of this capability over the next ten years?' 'Which is the cheapest of these two alternatives over their lifetimes?' and 'How long must this equipment remain in service for this maintenance-saving investment to be worthwhile?'

8.45 Different modelling approaches are needed at various stages of project development. In the early phases, only simple models are required. But later in the materiel acquisition cycle, the quantity of the data available and the precision with which costs are required increase, so more comprehensive modeling approaches are required. However, it is also important not to discard early simpler models, as they remain useful for producing quick estimates and can show in a consistent way the impact of later data on early cost estimates.

8.46 Inconsistency between competing projects as to which cost elements should be included or excluded is a significant problem. In particular, there needs to be more certainty with respect to the inclusion of indirect costs. For example, one contractor's estimate of operating costs noted that the Defence estimate excluded the cost of activities such as configuration management, design development and information systems support. In another case, full personnel costs were provided when only variable costs were called for; and in another, vehicles required as part of the capability were omitted from the life-cycle costs.

8.47 One possible solution is to develop a simple Work Breakdown Structure (WBS) as a guide to developing data elements and forming initial LCC estimates on a consistent basis. The current Defence Capital Equipment Procurement Manual provides an example of a WBS for the elements of a project; this concept could be extended to cover the components making up the life-cycle cost. Existing formats such as the data sheets used for the Air Force Cost of Capability or the life-cycle cost breakdown issued as part of a Defence ILS training course could be used as a basis for such a WBS. The WBS should be as generic as possible, and capable of being tailored to generate more detailed estimates. The GAO in 1974 recommended that the Secretary of Defense define and standardise the ownership cost elements that should be included in life-cycle cost estimates to make them consistent and comparable.

Types of model

8.48 LCC models can vary from simple models such as analogies to complex proprietary models which build up costs from a description of all the costs related to the sub-assemblies and components of the equipment, sometimes descending to many levels of detail.

8.49 Defence established a working group to consider the desirable characteristics of a LCC model to acquire for Australia. The working group concluded that Defence requires a suite of models of various types with simple models at the start of the materiel cycle being expanded as the acquisition process develops.

8.50 The main models in use by Defence are the proprietary models CASA and EDCAS. Defence is currently considering the best model to procure for future use in the acquisition process.

8.51 Defence has developed a spreadsheet model of LCC which has been used by several projects to estimate LCC, and is being developed further. Spreadsheets can be effective, but need sound documentation and validation.

8.52 In the case studies examined, there were three projects where the CASA model was used to collect and assess LCC data. In each case, there were no problems with using the model itself but there were some problems with poor data entered into the model. Two examples of spreadsheets being used were observed. These can be effective, the potential difficulty being in the completeness of the cost components included in the spreadsheet, and the need to check the correct operation of the more complex spreadsheets.

8.53 Parametric models estimate the cost of an equipment, or a component of a subsystem, by applying an equation to significant parameters of that equipment, such as size, speed, reliability, and complexity. Defence appears to have generally discounted the value of parametric models, although they are widely used in the US. One argument is that the US models generate information specific to them, and Defence's data base of past costs is inadequate to construct parametric models. However, a combination of adjusting the US models for local factors, and giving more weight to what Australian experience there is, may yield a reasonable parametric approach. Parametric models may be of particular use where there is little firm cost information on an equipment but its major characteristics (parameters describing its performance, dimensions etc.) are known.

Overseas experience

8.54 The US Department of Defense uses many different life-cycle cost models. Defence has stated that they have considered some of these models but found them to be inappropriate as they do not reflect our business processes.

8.55 Development of life-cycle costing models can be expensive to construct and maintain. For example, UK reported that models for naval equipment and armaments cost over $20 million with further costs of almost $2 million per year. Army and RAF proposals to acquire comprehensive logistics information technology (only part of which would refer to LCC) were estimated to cost about $1300 million in total. The UK noted that the collection of equipment-based data is the most significant obstacle to life-cycle costing. Strategies to address information needs may take almost ten years to implement, and even then may be incomplete because of funding constraints.

Conclusions

8.56 Good data is important to achieving sufficiently accurate life-cycle cost estimates. Currently, there are significant limitations to data availability. There are however, many sources of data on operating costs of current equipment, even if some of these sources are of doubtful validity or completeness. In these circumstances, a reasonable approach is to try to find at least two sources of data, which will then indicate both a more reliable estimate and a measure of the accuracy of that estimate.

8.57 In the medium term, the development of activity-based costing approaches will help to generate a data base of more reliable operating cost information. In the long term, there may be redevelopment of logistics management information systems which may yield better life-cycle cost information. However, development of such systems is expensive, and is unlikely to be justified purely for developing better LCC data. If such systems are developed, Defence should ensure that there is an ability to store historical cost information.

8.58 In the case of new equipment, data provided by tenderers is often perceived as unreliable, and always requires checking. As discussed earlier in this report, (Recommendation 3 (c)) stronger contractual requirements on achieving stated logistics performance may assist. Comparison with current equipment should also be used more, perhaps on a sub-system level where there is no reasonable system analogue currently in service.

8.59 Models are ways of answering specific management questions, and should be related to those questions and to the availability of data. In the early stages of the materiel cycle, simple models such as spreadsheets are likely to be sufficient, but they do require to be checked for completeness. They should also use consistent definitions to ensure that results are comparable, as recommended previously (Recommendation 2 (b)). In later stages such as tender assessment and logistic support analysis, larger volumes of data are available and consequently more robust models are required to handle the data and produce reliable results. Defence should acquire and use an LCC model or models which are as simple as practicable, having regard to the data they must process and the nature of the decision which the model is designed to assist.

Recommendation No.6

8.60 The ANAO *recommends* that Defence where cost effective to do so:

a) use more than one source of current operating cost data if available data are unreliable;

b) endeavour to make costing information for in-service equipment readily available by means such as introduction of activity-based management and redevelopment of logistic information systems; and

c) improve the accuracy and completeness of operating cost data collection, especially for new equipment.

Defence response

8.61 Agreed.

9. Budgeting

This chapter discusses LCC and budgeting - the connection between identifying cost estimates for life-cycle costing purposes and providing funds for the future support of the equipment under consideration.

Introduction

9.1 As noted at para 5.6 above, the DER Secretariat drew attention to the use of LCC to support funding for new equipment. The two examples that follow indicate that operating and support costs of new equipment are difficult to fund and that better life-cycle costing in the past might have better informed decisions on how to provide for these costs.

9.2 An ANAO report on Army Presence in the North[28] recommended that Army consider introducing simulators to achieve savings. Army noted that expenditure on simulation will be difficult to achieve because of high initial costs.

9.3 A Defence submission to the Joint Standing Committee on Foreign Affairs, Defence and Trade noted that no funding provision has yet been made for the substantial personnel and operating costs of yet to be approved projects such as the Airborne Early Warning and Control capability, and helicopters for the ANZACs and Offshore Patrol Combatants. Air Force stated that it was unable to adequately implement new capabilities such as the lead-in fighter, C130J and AEW&C aircraft without detriment to the existing funding base.

Overseas experience

9.4 The UK has recognised that a potential difficulty with the concept of life-cycle costing is that there can be a significant divergence between the cash budgeting system and the whole-of-life projections of LCC. In the US system there is little connection between LCC and budgeting, although total ownership cost is the major theme for the US Defense Department for the second Clinton Administration. Under the National Performance Review led by Vice-President Gore, Defense is establishing a new accounting system to enhance visibility of costs. This is being achieved through implementation of Activity Based Costing (ABC).

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[28] Audit Report No.27 1996-97, *Army Presence in the North*.

Budgeting for in-service equipment

9.5 Defence's budgeting for support funding starts with submissions from organisations such as Support Command, which prepare impact statements supporting their budget bids. These bids if approved become 'single line' funding, with impact statements then no longer taken into account in the disbursement of those funds. Army staff therefore felt there was a need for better definition of account codes to define which area is using resources. This need would be more pressing when tri-Service management was instituted. Some staff working in projects and Support Command have commented that estimates of operating costs do not translate to budgets for support.

9.6 A study carried out by Defence on the surface combatant force found that through-life management of assets was not possible because Defence policy does not address ways of minimising life-cycle costs.

Budgeting for new acquisitions

9.7 When committees consider the early stages of major acquisition projects, there is only brief consideration of ongoing support costs.[29] Programs are often asked to absorb operating cost increments. Otherwise, they can apply for supplementation under the Net Personnel and Operating Cost (NPOC) process. LCC has the potential to give information to decision-makers on the extent of cost savings or supplementation required.

Net Personnel and Operating Costs process

9.8 The NPOC is designed to identify the variations in operating costs over the Five-year Defence Program (FYDP) caused by the introduction of new major capital equipment.

9.9 NPOC funding has grown markedly since the first estimate in May 1994 that $60 million per year was required in the long term. The current estimate for 2007-8 is $550 million. Increases are required because of the rising costs of in-service support, with increased costs associated with the Lead-in fighter, the C-130J aircraft, the Caribou aircraft replacement and new hydrographic ships. Navy stated it had previously under-estimated its operating costs for new capabilities by not including non-project costs for developing a new capability to acceptance into naval service. For some platforms, there will be a cost for assuming parent navy responsibility.

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[29] In its response to the proposed audit report Defence advised that a separate considerations paper is being developed for the Defence Capability Committee on through-life aspects.

9.10 Defence guidelines on NPOC stated that bids should be consistent with advice previously provided to committees. However, projects can be released from previous undertakings if circumstances change.

9.11 NPOC bids are normally derived from information provided by projects on estimated future costs. They can also be submitted by establishments which expect increased operating costs due to a change in capability, although these costs need to be distinguished from those relating to new major capital projects. Some bids are forecast years in advance. Others are identified only after contract signature.

9.12 A 1995 Defence review of the first round of the NPOC process found, among other things, that monitoring the impact of major capital equipment should be a feature of the Ten-year Development Plan (TYDP) and a consistent methodology be used when developing personnel and operating costs estimates. However, the ANAO was informed that the TYDP, which is to be recast as a future directions paper, considered the financial issues only in a very broad sense.

9.13 A 1997 Defence review of the NPOC process stated that assessment of through-life costs and savings is becoming more critical and that NPOC issues should be exposed to the DCC. A better process is needed to make an initial assessment of NPOC, to track projects to determine when they should be assessed for costs or savings reviews, and to apply lessons learned to initial estimates of through-life costs. Navy, however, stated that it was unrealistic to expect programs to determine total NPOC costs or savings of projects which have just received budget approval.

9.14 Service bids for NPOC are not necessarily linked to project estimates, as project staff sometimes minimised costs. The project does not bear responsibility for these costs, which are the responsibility of Support Command.

9.15 Possible weaknesses of NPOC are the lack of reliable cost data early in the life of an equipment and lack of incentive for Programs to offer operating cost savings. Projects are generally subject to the NPOC process only if they are submitted by the Services for consideration.

9.16 The NPOC process does not allow for increasing support costs arising from ageing of equipment. For example, Air Force estimates that for aircraft, support costs should be increased by 3-5 per cent a year because of ageing. Defence stated that Programs can seek supplementation for such purposes through other budget processes. The 1997 NPOC review also noted that there were logistics funding shortfalls associated with current equipment, and there were difficulties in assessing the relative priority of NPOC bids and the bids for logistic support for current equipment.

9.17 Life-cycle cost estimates should be linked to the budget process. In this way, there would be an incentive for proponents of the system to provide a fair estimate of the LCC as, if approved, the LCC informs the determination of the operating budget.

Cost of Capability process

9.18 Air Force introduced a process similar to NPOC called Cost of Capability (C of C) in 1995. It is defined as the incremental resource variations associated with the introduction of a new capability or non-capital equipment initiative. This process applies to major equipment, minor equipment and facilities. It requires sub-programs - logistics, combat forces, training and executive - to acknowledge the expected incremental resources required by a new capability. Much of the detailed information required comes from Support Command. Whereas NPOC is an overall budgeting tool, C of C assists in gaining agreement on each organisation's responsibility for funding the new capability.

9.19 An Air Force paper noted that difficulties associated with C of C included:

- costs changing because of changes to operational concepts;
- optimistic contractor estimates;
- split accountability for estimating costs;
- inadequate systems;
- lack of a feedback loop; and
- lack of experience and training.

9.20 Other weaknesses observed in the C of C process were a lack of confidence in data available on costs of currently operating aircraft and weapon systems, and that a full appreciation of the logistics component of LCC is not clear at the time of acquisition.

9.21 An Air Force paper commented that the rigour in providing cost of capability information to senior committees could be improved, and that it was important not to accept absorption of operating costs of a new equipment without proper analysis. It further noted that there had been difficulties with the mechanics of collecting costing information to support the C of C process.

9.22 Air Force, through its Air Force Development Committee, requires estimates of five years' operating and support costs. In addition, a 'Front-End Life-Cycle Costing Analysis' (FELCCA), which identifies major cost drivers and areas of cost risk, is required as part of the C of C process. C of C applies to both major and minor projects, but is not carried out for all projects.

Minor equipment

9.23 Handling of minor equipment proposals has been within the individual Services. Navy noted that there had been a general lack of information regarding life-cycle costings of new or replacement equipment. The information was necessary to ensure that funds were available within the logistics sub-program. Navy has also proposed that life-cycle costs should be estimated for minor equipment.

Conclusion

9.24 When committees consider the early stages of major acquisition projects, there is only brief consideration of the ongoing support costs. However, the NPOC and C of C processes offer some prospect for the proper inclusion of future operating costs in budget formulation. However, the NPOC process sometimes starts late - ie when the operating costs are about to be incurred - and is not adequately linked to LCC estimates.

9.25 Neither of the processes discussed attempts to measure the entire cost of operating a current capability. At present, it is not possible to determine either what this cost is, or how it would vary with rates of effort. The use of activity-based costing approaches may assist with producing this information.

9.26 The current processes such as NPOC and C of C represent a significant advance on previous practice and on what is known about overseas approaches to integrating operating cost estimates into the budget process.

9.27 There is scope for further improvement in areas such as linking initial LCC estimates in to the NPOC and C of C processes, recognising that these initial estimates can change as the project develops.

9.28 There is also scope for devising management incentives to encourage the various programs to identify operating cost savings.

Recommendation No.7

9.29 The ANAO *recommends* that Defence further refine its processes for estimating the long-term effect of a new equipment on the operating cost budget of the Department and encourage programs to identify operating cost savings through the use of suitable management incentives.

Defence response

9.30 Agreed.

10. Organisation and Staffing

This chapter considers whether Defence has sufficient trained or experienced staff to undertake LCC analysis for all phases and types of acquisition, and whether they are deployed in the appropriate manner.

Organisational issues

10.1 In Chapter 2, we commented that policy-setting and conduct of LCC were carried out in a large number of areas of Defence. These include, for example, the Finance and Inspector-General program (Director of Costing) and various parts of Acquisition Organisation, components of the Support Command, Defence Estate Organisation, DSTO and Corporate Support program.

10.2 In Defence the management of the life-cycle of an equipment is divided between several agencies - from Capability Development Division for initiation, through the Acquisitions Organisation for acquisition, the Services for operation and Support Command for support and eventual disposal. Other nations, such as Switzerland, have a more integrated approach. Since 1996 the Swiss Defence Procurement Agency has been responsible for the whole system life-cycle, from early definition studies to final decommissioning of equipment. LCC is expected to be performed periodically throughout the system's life to assess its cost effectiveness.

10.3 Support Command staff should contribute to the work of the tender assessment team through identifying ongoing support costs, both for life-cycle costing purposes and for future budget planning by Support Command. We were advised that, when a project has advanced to tender selection, Support Command staff are normally represented at tender negotiations to provide input on supportability, but not specifically LCC.

10.4 The ANAO concluded that Defence should encourage a greater level of liaison between the team members in capability development, project office and Support Command.

Location of LCC expertise

10.5 The UK has dedicated life-cycle costing cells in each of the 'Systems Controllerates' for Sea, Land and Air within the Procurement Executive. Consideration could also be given to the UK use of 'reliability panels', which provide advice on potential trade-offs to minimise overall costs. The United

States and Canadian Armed Forces have dedicated organisations for testing and developing models and databases, located outside the Project Management Offices which used them. The US has a centralised Cost Analysis Improvement Group (CAIG) under the Office of the Secretary of Defense. The CAIG reviews the cost estimates prepared by the sponsor and by an independent cost-estimating team to ensure that an independent projection of system costs is available to the Defense Acquisition Board. These cost estimates are prepared for each milestone review, starting with Milestone 1, concept demonstration approval. (Costs are not required for Milestone 0, concept studies approval.)[30]

10.6 The UK NAO view is that 'sound modelling requires a dedicated life-cycle costing cell responsible to top management for data capture and the provision of effective modelling capability to support all projects.'[31] The US GAO stated there were advantages in a cost estimating cell independent of the project office, in order to create a more realistic estimate, not one that is artificially low in order to meet proposed budgets.[32]

10.7 Defence feels one of the better sources of LCC expertise is the Air Force Project Support Logistics cell within the Joint Logistic Systems Agency in Support Command. This is a small group, not readily available to all projects. There is also a small (1-2 people) group in the Acquisition Organisation in Canberra, and a few other individuals working in specific projects who are knowledgeable in LCC. Since October 1996, the Capability Program and Resource Planning Division has had a section which deals with cost analysis among other things. The intention is that the section would offer consultancy services to Capability Development Division. In addition, there is some initial work being done towards developing life-cycle costing in the DSTO. Defence is also considering whether LCC expertise should be outsourced: a panel of contractors may be established.

10.8 Defence's LCC expertise is limited and fragmented. There may be advantages in taking steps, along the lines adopted overseas, to centralise the provision of costing advice. This should ensure advice and assistance are more readily accessible to those who need to use LCC. A central cell could also help to make LCC activities more consistent across the Department, and pass on good practice in LCC.

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30 (US) Cost Analysis Improvement Group, *Operating and Support Cost-Estimating Guide*, May 1992.

31 National Audit Office (UK), *Ministry of Defence: Planning for Lifecycle costs*. HMSO 174, January 1992. p.16.

32 Report to the Congress by the Comptroller General of the United States, *DoD Needs to Provide More Credible Weapons Systems Cost Estimates to the Congress*. GAO/NSIAD 84-70, May 24 1984.

10.9 Advice could be offered on issues such as the level of detail of costs appropriate to the conceptual stage, technical and modelling issues and availability of data. The advisory group may include elements from the areas mentioned above. Ideally, there would be a central full-time cell, assisted by other authorities on a part-time basis. If necessary, outside consultants could also be used.

10.10 Should a centre for advice and assistance be formed, there is the question of its organisational and physical location. In the US there are centres of costing expertise established for each of the Services, and under the Office of the Secretary of Defence, all located in the Washington area. In the UK there is a policy body located with the central Defence organisation in London, but with the specific experts in costing located with the Procurement Executive in Bristol. Therefore one possible locus for an Australian centre for advice and assistance is with the Acquisition Organisation in Canberra.

10.11 Other possibilities are with the Defence Headquarters, or with Support Command, specifically the Joint Logistic Systems Agency. The former would allow a greater emphasis on the concept development stage of life-cycle costing, whereas the latter would allow more emphasis on in-service support. An arrangement involving two physical locations to serve Support Command and Canberra elements may be appropriate.

10.12 An alternative or supplementary approach to forming a central group is to out-source the provision of LCC analysis. There may be parallels with the former financial cost investigation group, which was established to provide advice on financial aspects of contract administration. The group was apparently used little by major project teams, and will be abolished in July 1998, with its tasks to be carried out under contract. However, much of the work in the case of LCC is specific to Defence, requiring familiarity with and access to Defence data bases and procedures.

10.13 The key issue, however, is not so much the extent of technical expertise but the adoption of the principles of LCC to support asset management by those charged with the responsibility of managing those assets.

Recommendation No.8

10.14 The ANAO *recommends* that Defence establish some central repository of advice and assistance on LCC matters.

Defence response

10.15 Agreed.

Organisation of project teams

10.16 Each project team consulted included LCC as part of the duties of the ILS section, although one project reported that in an earlier phase LCC had been part of the finance section responsibilities. One Defence officer commented that the finance section was the better place for LCC. One ANAO consultant felt strongly that responsibility for LCC lies with systems and design engineering; the ILS section must approve the design and the LCC estimate; and close liaison must be maintained throughout with the finance section. Another consultant commented that LCC is a costing and budgeting function, but only users, logistic staff and contractors can identify the costs. The ANAO concludes that either systems engineering, ILS or finance can be a reasonable location for LCC analysis but that in any case there should be close liaison between all areas, with LCC issues specifically referred to in all relevant sections of the tender assessment.

Staffing and training

10.17 The cost of performing LCC analyses at the tender selection stage is not formally recorded, but some project offices were able to make estimates. In most cases the time required for preparation of the RFT and analysis of tenders was about 0.5 person-years.

10.18 In the majority of the case studies considered by the ANAO, relevant staff had undertaken some LCC training. However, an internal Defence minute noted that Defence's application of LCC principles is impeded by varying levels of LCC capability in project staff, other Defence agencies, and defence industry.

10.19 Computer Power Pty Ltd runs two courses for the Department. One is of two days' duration and is titled Life Cycle Costing: Modelling for Concept. It looks at cost estimating and spreadsheet LCC analysis for the early phases of the acquisition process. The other course is of five days' duration and is titled Life Cycle Costing: Applications for Tendering and During Contract Administration. This course focuses on the use of the Equipment Designer's Cost Analysis System and spreadsheet modelling techniques to assist in source selection. This LCC training was developed and trialed in 1996 and three each of these courses were run in 1997. Training has so far focused on Acquisition Executive staff, but should be extended to others. The courses addressed principles of LCC as well as training on running specific LCC models.

10.20 In addition to specifically LCC Courses, Defence offers short courses on the capital acquisition process and integrated logistic support which include some reference to LCC. Defence also offers a series of courses in procurement training. Of these, there is only a brief mention of LCC in one of the non-compulsory modules of the Certificate IV (complex level) in public sector procurement.

10.21 At tertiary level, courses are offered by institutions including ADFA, the University of Southern Queensland and Royal Melbourne Institute of Technology. Selected Australian staff used to gain LCC training as part of an ILS course run by the United States Air Force Institute of Technology, but attendance has now ceased.

10.22 In addition to training on LCC model use, there needs to be an appreciation of the financial and economic aspects of LCC decision-making. This could be achieved by relevant staff undergoing developmental opportunities such as experience in the centre of LCC advice and expertise referred to above, and relevant tertiary courses.

10.23 A consultant to the ANAO stated that what was really required was an overall appreciation of but these issues were not included in course notes for either of the current two LCC courses.

Recommendation No.9

10.24 The ANAO *recommends* that Defence improve levels of LCC expertise by the encouragement of relevant personal developmental opportunities, and the use of appropriate consultancy assistance.

Defence response

10.25 Agreed.

Canberra ACT
12 May 1998

P.J. Barrett
Auditor-General

Part Three

Appendices

Appendix 1

Better practice in life-cycle costing

This appendix includes comments from other agencies, consultants and texts. It is an attempt to combine views on how life-cycle costing should be practised to achieve good outcomes.

Purpose of life-cycle costing (LCC)

1. Life-cycle cost can be defined as the total cost of a system or product over its full life, including design and development, production, operation, maintenance and support, retirement and disposal. This should always be interpreted as including operator costs as well as the personnel costs associated with system maintenance and support. All costs should be considered, regardless of funding source or management control. For example, armaments or missiles should be considered when looking at the cost of a weapons platform.

2. LCC has many uses. These include:

- to account for resources used now or in the past (reporting);
- to assess future resource requirements (budgeting);
- to assess comparative costs of potential acquisitions (investment appraisal);
- to decide between sources of supply (source selection);
- to improve system design;
- to optimise logistic support; and
- to assess when assets reach the end of their economic life and replacement is required (disposal).

3. The first of the above uses is concerned with past expenditure for reporting purposes, and the remainder with projected costs for economic decision-making. Past expenditure can also be a source of data for economic decisions.

4. Life-cycle costing should be applied to all investment decisions where there will be an ongoing cost of ownership. This includes business machines, minor capital equipment, facilities, software and major capital equipment. However, the extent and scope of the life-cycle cost analysis will vary according to the size and complexity of the decision. For example, some methodological differences would be expected between LCC for equipment, facilities and IT acquisition. In particular, LCC for software acquisition requires careful assessment. For simplicity, the rest of this appendix uses the term 'equipment', which should be read as including all items mentioned in this paragraph.

5. Life-cycle costing should also be applied to systems already in being. In this case, the objectives are to identify areas with unduly high resource consumption, and assist decisions on selecting alternative approaches with better cost-effectiveness.

6. The lack of a robust cost accounting system is a significant impediment to managing and controlling life-cycle costs.

Translation of LCC estimates into budgets

7. Life-cycle cost estimates should be linked to the budget process. In this way, there is an incentive for proponents of the system to provide a fair estimate of life-cycle costs as if approved. LCC becomes the basis of the operating budget. Support of this approach requires top management commitment to providing reasonably accurate estimates of operating costs at an early stage, together with reasonable mechanisms for adjusting operating budgets as better information on operating costs is received.

8. Budgets are often segmented between acquisitions and support. Mechanisms are needed to allow efficient transfers of resources between these two categories, eg higher investment to save future operations costs.

Promulgation of policy on LCC

9. The main factors in making LCC successful are promotion of the concept by senior management and implementation by middle management. A combination of incentives and top-level monitoring of the use of LCC is required to ensure that it is used in practice.

10. Policy on LCC is best stated as a brief summary of fundamental issues. This can be achieved in 1 or 2 pages. The policy should be consistent with any overall economic appraisal rules set out by the organisation.

11. This policy can then be amplified, if necessary, by more comprehensive guidance for particular types of acquisitions. This may be complemented with access to sources of expertise who can best advise on putting the principles into practice.

Allocation of responsibilities

12. Organisational responsibilities for life-cycle costing should be identified. They will normally fall primarily on the responsible project or acquisition manager. However, project managers may need to consult other authorities to gain essential information on support costs, such as for personnel and training. They also need advice from the future operators on operational factors such as the extent of usage. It is advisable to have specific personnel from the relevant organisations nominated (possibly on a part-time basis) as responsible for providing costing information.

13. An integrated approach to developing cost estimates - involving each of the authorities required to approve those estimates - can assist in developing a thorough and defendable cost estimates. Many serial iterations and formal review points are simplified, and there are improvements to quality. This approach has the potential to compromise independence, but the risk of lack of independence may be reduced if the team member providing costing advice retains organisational responsibility to the independent costing organisation.

14. An LCC estimate for a complex project is best done by the project management team in conjunction with independent advice from costing experts, either within the organisation or by consultants. The independent costing group should have direct access to senior levels to ensure its independence, and also have good access to data. Life-cycle cost projections should be reviewed along with other major project factors during periodic program management reviews.

15. The level of organisational review of LCC should be appropriate to the organisational level which approves the purchase itself. For a simple purchase of business machines there is no need for independent LCC analysis; purchasers need only assure themselves that the purchase offers good value for money. For a major capital acquisition proposal that is reviewed at a senior level, life-cycle cost estimates should also be reviewed at a senior level.

16. In order to gain acceptance of LCC as a discipline, it is important that analysis be presented to senior decision-makers clearly and concisely, emphasising the relevance of the data to the decision at hand.

17. There is value in having a repository of costing expertise. This area could also provide a training program in areas such as resource accounting and costing techniques.

Application of life-cycle costing

18. There are broadly three stages at which LCC should be applied. These are:

- the conceptual stage, when initial proposals for investment are being considered;
- the acquisition stage, when tenders for the supply of equipment, facilities or software are being assessed; and

- the in-service stage, when decisions are being continually made on whether to maintain, improve or dispose of the equipment.

Different applications of LCC may be appropriate to each of these stages.

Conceptual stage

19. At the first or conceptual stage there is probably the greatest leverage to be achieved by LCC. The emphasis here should be on getting at least initial estimates for all the key components of LCC, organised in a consistent manner so as to ensure a fair comparison between alternatives. Consistency of organisation also enables replication of the life-cycle cost estimate by a third party, if required. Also, starting out with a well-structured initial cost estimate enables easier refinement of that cost estimate in later stages of the project, with continued visibility of the cost changes and the reasons for the changes.

20. A major purpose of LCC at this stage is to predict the pattern of future expenditure over the life of the equipment, enabling provision to be made in future budgets for the cost of acquisition, operation, refit and support. The LCC information can also be used to make cost-performance trade-offs before an acquisition approach is finalised.

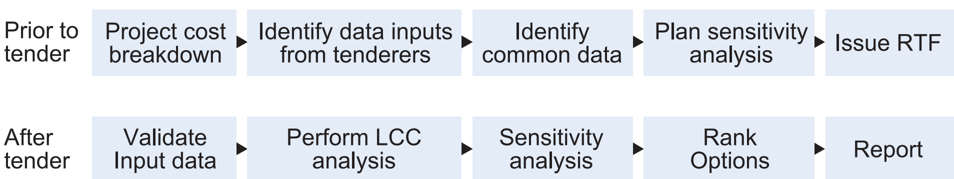
Acquisition stage

21. The emphasis here is on using LCC to help select the tender that offers the best cost-effectiveness.

22. One effective sequence of project office activities is shown in Figure 2.

Figure 2

Using LCC in tender selection



(*) Common data refers to data common between sections of the project office such as finance, systems engineering and logistics.

23. Before issuing the Request For Tender (RFT), the project office should establish a baseline model of the equipment and its environment. It should also identify the potential acquisition cost and major influences on support cost and consider means of constraining these costs. If these activities, summarised in the top row of the diagram above, are performed well, the post-tender activities (depicted in the bottom row) could be rapid and straightforward. As part of contract negotiations, the project office should seek to fix support costs, possibly by contracting for support with the prime contractor. Parallel contracts for through-life support have been planned or negotiated in several cases.

24. Where the purchase is for equipment of new design, there should be a contractual provision enabling the purchaser to be assured that the designer has taken into account key LCC parameters such as reliability, maintainability and availability in the design of the equipment. There should be similar provisions relating to the use of LCC in the design of logistic support infrastructure.

25. The inclusion of LCC parameters in the contract must be matched with a willingness to enforce these requirements routinely, ie to withhold payment or collect compensatory payments when specified factors such as reliability or maintainability are not as agreed in the contract. These contractual requirements may also be supplemented by incentives offering bonus payments if the contractor reduces life-cycle costs below a specified level. These approaches require a validated model that relates logistic parameters to measurable and predictable operating and support costs. Such a model should recognise that the factors influencing LCC will vary from one system to another. One approach is to use a specific Design-to-Cost[33] figure of merit, along with a definition of the cost components to be included in the life-cycle cost.

26. Where there is a multi-stage acquisition process, eg project definition followed by purchase, or staged purchase of various batches of equipment, there should be an explicit mechanism for feeding back the results of life-cycle costing conducted in the earlier phases to influence specifications for the later ones.

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[33] "Design-to-cost" is a concept that establishes cost elements as management goals to achieve the best balance between life-cycle cost, acceptable performance, and schedule. Under this concept, cost is a design constraint during the design and development phases and a management discipline throughout the acquisition and operation of the system or equipment (from US Federal Acquisition Regulations).

In-service stage

27. For this stage, the provision of a comprehensive and accessible data base of life-cycle costs is advantageous. This enables decisions on configuration changes and revisions to maintenance policy to be made with the assurance that the cost implications of these changes are well founded. The ability to calculate rapidly the LCC impact of a configuration change is facilitated by the establishment of cost relationships which indicate the cost variations contingent upon such factors as weight, power consumption, reliability and time to remove failed components. These cost relationships are not necessarily straightforward, eg the weight of an aircraft component may affect operating cost through fuel consumption, available payload and fatigue life. Further, the ability to identify those components and features generating high costs in systems currently in use could help in deriving improvements leading to cost reductions, and enable better budgeting for future expenditures.

28. Good knowledge about the actual operating costs of in-service equipment is important not only for improving the cost-effectiveness of the equipment in question, but also for learning lessons which can be applied to specifications for future equipment.

29. A comprehensive database will also allow tracking of costs as they vary (normally increase) with system age. This will provide information to assist decisions on whether to continue as is, initiate the necessary steps for the modification of the system to avoid increasing costs, or retire the system and recycle or dispose of its elements.

Components of LCC

30. In principle, LCC should be based on long-run net avoidable costs. This implies that all costs which are attributable to the decision to buy the equipment in question should be included. In particular, attempts should be made to trace all indirect costs to the organisational element or segment of the system that is the cause of the cost being expended. In practice, it is difficult to allocate all indirect costs. Attribution of indirect costs also has diminishing returns, in that these costs are usually less than direct costs. The important point is that the costs are consistent and are used for appropriate means; for example, if all indirect costs are not included then the LCC cannot be used to determine full impacts of a purchase on an indirect support unit such as a training school or a supply depot.

Provision of data for new equipment

31. Good data are essential to provide good results. Feasibility studies, project definition studies and the like conducted by potential suppliers may provide useful LCC data. However, LCC analysis must specify what data are needed and how accurate they should be.

32. Government purchasers often attempt to extract proprietary data from companies, either as part of the tendered information or as a contract deliverable. However, the quality of data supplied depends on the ability of the project to manage the relationship with the contractor, in particular in being able to specify what data are needed and why.

33. One approach to collecting consistent data is to include a tailored LCC questionnaire that helps to discern how the bidder has arrived at the tender price. Another approach is to establish a standard 'Cost Breakdown Structure' (CBS) applicable to life-cycle costing, and base all estimates on it. The CBS could also be used to put structure into the call for LCC estimates provided by tenderers. Similarly, it would be useful to define carefully, through a common Data Item Description (DID), all the LCC terminology relevant to tenderers.

34. Tendered data can be validated by independent checks; for example, testing whether the claimed reliability figures are consistent with those achieved elsewhere. Where there are contractual guarantees relating to support costs, such testing by the purchaser is simpler.

35. There needs to be an adequate mechanism for collecting and disseminating data on current operating and support costs. It needs to define the source of data, the format in which it should be stored, the frequency with which it should be collected, information on the accuracy or reliability of the data and the method for distribution of the data. Costs for data collection and processing should be identified.

Provision of data for existing equipment

36. Collection of indirect costs, enabling greater capture of total costs, is facilitated by the adoption of activity-based costing and management. Activity-based costing and activity-based management (ABC/ABM) have the potential not only to provide costs for LCC purposes but also to assist management by providing comprehensive resource and performance information. However, ABC and ABM do require significant management commitment for successful implementation.

37. Usage data assists in forming predictions of operating costs, and in forming estimates of the relative impact on total operating cost of usage-related cost drivers such as distance travelled or rounds fired.

Data storage and retrieval

38. Automated cost databases are very useful for the analysis of life-cycle costs. When establishing new information systems, the need for good data to support LCC should be borne in mind. A top-level specification of the range of data which should be stored for LCC purposes would be useful.

39. When storing data, it is also necessary to store 'meta-data', ie data about the data. This meta-data should include such things as source of the data, the nature of any assumptions, estimated accuracy and whether the data is private or classified. Commercially-supplied data is proprietary and provision of this data to other related contractors may be subject to caveats and to secrecy agreements. Data bases need to be able to handle these restrictions.

40. There may be a multiplicity of different databases used for different purposes, all of which contain some information relevant to LCC. The assembly of this information in the appropriate format is not straightforward, but can be solved by approaches such as data warehousing. One alternative to a comprehensive database is to decide on a case-by-case basis what data is required, and then extract that data from existing systems. Other alternatives to full historical cost data collection include sampling, focusing on high cost items, and generating costs from other known data, eg personnel costs based on staff numbers.

41. It would also be of assistance to assemble cost data collected by previous projects in a single location, or employ other means by which this information can be made readily available to later projects or other users.

42. Checking a sample of actual life-cycle costs against earlier estimates will help to show whether there is any systematic bias in LCC estimates. It would also point the way to improving the validity of LCC models and overall LCC estimates. It is not necessary to validate every estimate.

Models and techniques for life-cycle costing

43. Techniques for LCC vary from simple calculations through spreadsheets - some of considerable complexity - to complex commercial LCC software packages and large-scale special-purpose models.

44. A minimum requirement is that models used to compare competing alternatives are consistent. They should address the same range of cost categories and use the same assumptions. One way of achieving this is through a Master Data and Assumptions List for each project; this is a repository of debate and information on the acquisition process. It includes input from users, project officers, ILS managers, the support authority and finance authority and helps to sort out conflicts quickly.

45. The best model to use will depend on the nature of the decision to be made and the range and extent of data available. Where the project is high value or costs are uncertain, there are advantages in using two types of model for cross-checking purposes, eg checking an engineering model cost estimate with a parametric cost estimate. More complex models require significant training to understand how to operate them; misunderstood features can cause incorrect results. It is therefore better, when in doubt, to use a simple model, at least to begin with.

46. Models should be reliable in terms of repeatability of results. They should adequately represent the impact of key parameters on cost. They should be simple enough to allow for timely implementation, and capable of being modified to allow for additional capabilities.

47. Models should always use discounted cash-flow techniques, and employ a range of discount rates to test sensitivity of results. Typically, analyses will use the base case discount rate and discount rates both 2 -3 per cent higher and lower than the base case to determine whether there is any effect on the preferred decision. Models should also be used to consider sensitivity of the results to other key assumptions. The results of such sensitivity analyses should be linked to the risk management plan for the project.

48. Proprietary models are fundamentally of two forms. One type is the 'engineering' model in which the life-cycle cost is built up from estimates for the various components of a cost breakdown structure. Such models often incorporate features such as calculations of spares required to fill supply pipelines, and level of repair analysis. The other main type of model is the parametric model, whereby key parameters or 'cost drivers' for an equipment are identified. The dependence of the life-cycle cost on these parameters is inferred from analysis of the actual costs of a number of similar equipments.

49. Special purpose models can also be of the engineering or parametric type, often tailored to specific types of equipment or application. In addition, systems dynamics modelling has been used to make detailed predictions of the way system activities (eg intensity of use of equipment) affect costs of operations.

50. There is a very large range of parametric models, mostly of US origin. Such models need to be selected on a case by case basis. This requires a very good knowledge of the available models. Analysis is at the sub-system level such as for ship hulls and propulsion.

51. Purchasers vary on whether they require their suppliers to use a particular LCC model in submitting bids. Commercial firms, both as suppliers and as purchasers, prefer simpler analytic tools such as spreadsheets. Requests for tender should tailor the LCC data requirements to those which will be used in tender assessment.

Training and education for LCC

52. There needs to be a combination of thorough training in life-cycle costing principles and application for a relatively small number of people who can act as advisers on LCC. This needs to be supported with a wider program of brief training for project management personnel and others involved in procurement on the fundamental principles of LCC. These training programs should be accomplished through the normal training principles of defining competencies, creating tailored training courses and allocating sufficient resources.

Appendix 2

Performance audits in the Department of Defence

Set out below are the titles of the ANAO's performance audit reports in the Department of Defence tabled in the Parliament in recent years.

Audit Report No.22 1992-93
New Submarine Project

Audit Report No.5 1993-94
Explosive Ordnance

Audit Report No.11 1993-94
ANZAC Ship Project -Monitoring and Contracting

Audit Report No.19 1993-94
Defence Computer Environment Supply Systems Redevelopment Project

Audit Report No.27 1993-94
US Foreign Military Sales Program (follow-up audit)
Explosives Factory Maribyrnong

Audit Report No.2 1994-95
Management of Army Training Areas (follow-up audit)
Acquisition of Additional F-111 Aircraft

Audit Report No.13 1994-95
ADF Housing Assistance

Audit Report No.25 1994-95
ADF Living-in Accommodation

Audit Report No.29 1994-95
Energy Management in Defence
ANZAC Ship Project Contract Amendments
Overseas Visits by Defence Officers

Audit Report No.31 1994-95
Defence Contracting

Audit Report No.8 1995-96
Explosive Ordnance (follow-up audit)

Audit Report No.11 1995-96
Management Audit
Defence Quality Assurance

Audit Report No.17 1995-96
Management of ADF Preparedness

Audit Report No.26 1995-96
Defence Export Facilitation and Control

Audit Report No.28 1995-96
Jindalee Operational Radar Network Project (JORN Project)

Audit Report No.15 1996-97
Food Provisioning in the ADF

Audit Report No.17 1996-97
Workforce Planning in the ADF

Audit Report No.27 1996-97
Army Presence in the North

Audit Report No.34 1996-97
ADF Health Services

Audit Report No.5 1997-98
Performance Management of Defence Inventory
Defence Quality Assurance Organisation

Audit Report No.34 1997-98
New Submarine Project

Audit Report No.43 1997-98
Life-cycle Costing in the Department of Defence

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Audit Report No.2 Performance Audit
Government Business Enterprise Monitoring Practices
Selected Agencies

Audit Report No.3 Performance Audit
Program Evaluation in the Australian Public Service

Audit Report No.4 Performance Audit
Service Delivery in Radio and Telecommunications
Australian Telecommunications Authority and Spectrum Management Agency

Audit Report No.5 Performance Audit
Performance Management of Defence Inventory
Defence Quality Assurance (preliminary study)

Audit Report No.6 Performance Audit
Risk Management in Commercial Compliance
Australian Customs Service

Audit Report No.7 Performance Audit
Immigration Compliance Function
Department of Immigration and Multicultural Affairs

Audit Report No.8 Performance Audit
The Management of Occupational Stress in Commonwealth Employment

Audit Report No.9 Performance Audit
Management of Telecommunications Services in Selected Agencies

Audit Report No.10 Performance Audit
Aspects of Corporate Governance
The Australian Tourist Commission

Audit Report No.11 Performance Audit
AUSTUDY
Department of Employment, Education, Training and Youth Affairs

Audit Report No. 12 Performance Audit
The Pharmaceutical Benefits Scheme
Department of Health and Family Services

Audit Report No.13 Performance Audit
Third Tranche Sale of the Commonwealth Bank of Australia

Audit Report No.14 Financial Control and Administration Audit
Official Travel by Public Sector Employees

Audit Report No.15 Financial Control and Administration Audit
Internet Security Management

Audit Report No.16 Performance Audit
Equity in Employment in the Australian Public Service
PSMPC and other agencies

Audit Report No.17 Performance Audit
Sydney Airport Noise Amelioration Program
Department of Transport and Regional Development

Audit Report No.18 Performance Audit
Management of the Implementation of the New Commonwealth Services Delivery Arrangements
Centrelink

Audit Report No.19 Performance Audit
Risk Management in ATO Small Business Income
Australian Taxation Office

Audit Report No.20 Performance Audit
Sales Tax
Australian Taxation Office

Audit Report No.21 Financial Control and Administration Audit
Protective Security

Audit Report No.22 Financial Control and Administration Audit
Audits of the Financial Statements of Commonwealth Entities for 1996-97
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Audit Report No.23 Performance Audit
Ministerial Travel Claims

Audit Report No.24 Performance Audit
Matters Relevant to a Contract with South Pacific Cruise Lines Ltd
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Audit Report No.25 Performance Audit
Gun Buy-Back Scheme
Attorney-General's Department

Audit Report No.26 Performance Audit
Strategic and Operational Management
National Registration Authority for Agricultural and Veterinary Chemicals

Audit Report No.27 Performance Audit
Managing the Year 2000 Problem
Risk Assessment and Management in Commonwealth Agencies

Audit Report No.28 Performance Audit
Contracting Arrangements for Agencies Air Travel

Audit Report No.29 Financial Control and Administration Audit
Management of Accounts Receivable

Audit Report No.30 Performance Audit
Evaluation Processes for the Selection of
– Records Management Systems
– Internet Access Services
for the Commonwealth
Office of Government Information Technology

Audit Report No.31 Financial Statement Audit
Aggregate Financial Statement prepared by the Minister for Finance and Administration
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The Management of Boat People
Department of Immigration and Multicultural Affairs
Australian Protective Service
Australian Customs Service Coastwatch

Audit Report No.33 Performance Audit
Commonwealth Management of the Great Barrier Reef
Great Barrier Reef Marine Park Authority

Audit Report No.34 Performance Audit
New Submarine Project
Department of Defence

Audit Report No.35 Performance Audit
DEETYA International Services
Department of Employment, Education, Training and Youth Affairs

Audit Report No.36 Performance Audit
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Protection of Confidential Client Data from Unauthorised Disclosure
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