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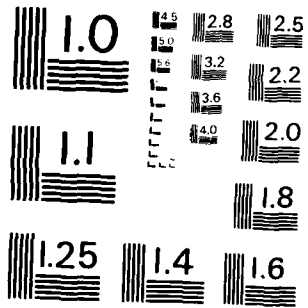
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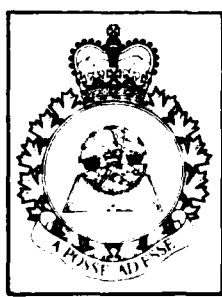
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CURRENT TRENDS IN LIFE CYCLE COST ANALYSIS

by

I. Taylor
K. R. Kavanagh



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CURRENT TRENDS IN
LIFE CYCLE COST ANALYSIS

by

I.W. TAYLOR AND K.R. KAVANAGH

Directorate of Logistics Analysis

Paper presented by K.R. Kavanagh
at the Commonwealth Defence Science Organization
1982 Conference, Australia

General Defence Science Symposium
at Canberra, 24-28 May 1982

Keynote Paper for Session on "Planning to the
End of the Life Cycle", 28 May 1982



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OTTAWA, CANADA

JULY, 1982

ABSTRACT

Life Cycle Costing (LCC) or more appropriately Life Cycle Cost-Effectiveness Analysis (LCCEA) has become established in the defence departments of many countries as a necessary part of equipment procurement procedures. LCC refers to the total cost of ownership; from research and development, through acquisition, operations and maintenance, to final disposal. However, it is often difficult to carry out convincing analyses which will impact on the final decision.

Hundreds of LCC models have been developed in the USA and in certain Commonwealth countries. These models vary in complexity and generality; often they require computer assistance to manipulate large amounts of data. Unfortunately, detailed cost information can be difficult to collect and large data bases and computer models can be costly to operate and maintain. With the advent of micro-computers and powerful hand-held programmable calculators, a trend towards a more modest, practical approach has begun.

In the Canadian Department of National Defence, there are examples of computerized LCC models, programmable calculator models and paper and pencil approaches. Some of this work will be reviewed. The advantages and disadvantages of these approaches will be discussed based on experience in the Directorate of Logistics Analysis (D Log A) of the Operational Research and Analysis Establishment (ORAE).

RÉSUMÉ

L'établissement du coût-régie du matériel ou, mieux, l'analyse coût-efficacité-régie du matériel fait désormais partie intégrante des modalités d'acquisition du matériel, au sein des ministères de la défense de nombreux pays. Le coût-régie du matériel se rapporte au coût total de l'appropriation du matériel, depuis la recherche et le développement en passant par les étapes de l'acquisition, des opérations et de l'entretien, jusqu'à la mise au rancard. Cependant, il est souvent difficile de mener à bien des analyses convaincantes susceptibles d'influencer les décisions finales.

Des centaines de modèles pour l'établissement du coût-régie du matériel ont été mis au point aux États-Unis et dans certains pays du Commonwealth. Ces modèles varient en complexité et en polyvalence; souvent, il faut les relier à un ordinateur pour faciliter l'accès aux nombreuses données emmagasinées. Malheureusement, il peut être difficile de rassembler des renseignements détaillés au chapitre du coût et, en outre, les bases de données et les modèles intégrés à un cycle informatique peuvent être coûteux à exploiter et à entretenir, dépendamment de leur taille. Les micro-ordinateurs récemment mis sur le marché offrent d'énormes possibilités à cet égard, grâce à leurs nombreuses applications pratiques et à leur prix relativement modeste.

Au Canada, le ministère de la Défense nationale exploite des modèles informatisés pour l'établissement du coût-régie du matériel et des modèles de calculatrices programmables, mais le travail manuel y a toujours sa place. Nous nous appliquerons à faire l'examen de certaines des méthodes employées et à débattre leurs avantages et leurs désavantages, compte tenu de l'expérience acquise à la Direction de l'analyse logistique (DAL) du Centre d'analyse et de recherche opérationnelle (CAR Op).

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CURRENT TRENDS IN LIFE CYCLE
COST ANALYSIS

I - INTRODUCTION

1. Predicting the future is a very difficult task. J.S. Armstrong discussed the value of expert opinions in forecasting change in psychology, economics, medicine, sports and sociology (Ref. 1). He noted that because of the difficulty of forecasting future events, individuals with minimal expertise produce estimates as accurate as "so-called" experts (see Fig. 1). Furthermore, this minimal expertise can be obtained fairly quickly and easily.

2. The authors of this paper believe that future cost estimation is similar. Life Cycle Cost (LCC), the total cost of ownership, is difficult to predict with accuracy. However, with minimal training on the economic and engineering concepts and a logical structured approach, the accuracy can be improved.

VALUE OF EXPERTISE IN FORECASTING

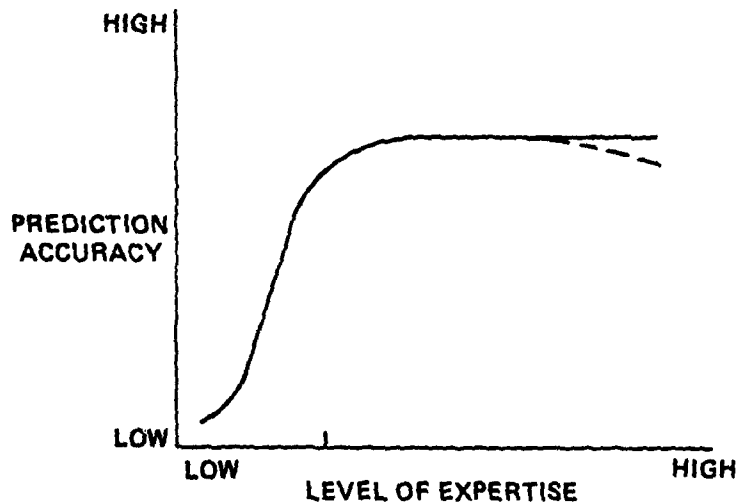


Figure 1: Value of Expertise in Forecasting

3. This keynote paper for the session on "Planning to the End of the Life Cycle" provides an overview of current trends in LCC (Fig. 2). Section II introduces the need for this type of analysis within defence program management; Section III discusses the concept of Life Cycle Cost Effectiveness Analysis (LCCEA); Section IV presents some of the important reasons for doing LCC; Section V elaborates on the uses of such analysis; and finally, Section VI completes the paper with a review of some of the problems or issues involved in application within defence departments.

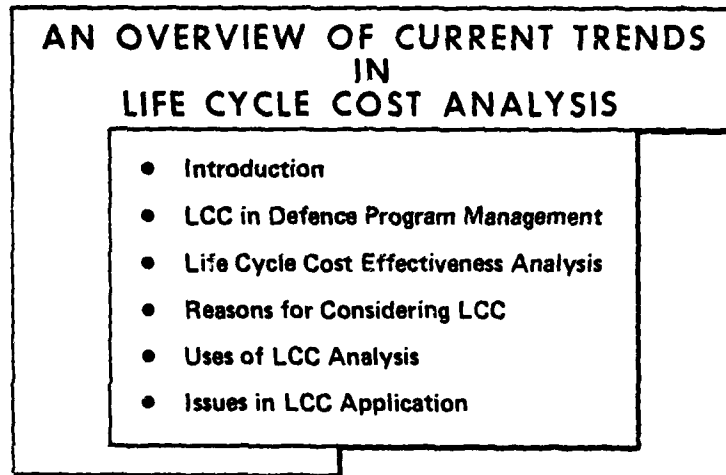


Figure 2: An Overview of Current Trends in LCC Analysis

II - LIFE CYCLE COSTING IN DEFENCE PROGRAM MANAGEMENT

4. Decision-makers at all levels of the Canadian Department of National Defence (DND) are becoming aware that LCC must be considered whenever a decision will affect the future life of an equipment. LCC analysis is being incorporated into the procedures of the two management systems:

- a. the Defence Program Management System (DPMS) which controls the acquisition of new equipment; and
- b. the Life Cycle Management System (LCMS) which monitors the equipment after it comes into service.

Figure 3 shows the stages of the DPMS and LCMS along with the stages of a typical equipment life cycle.

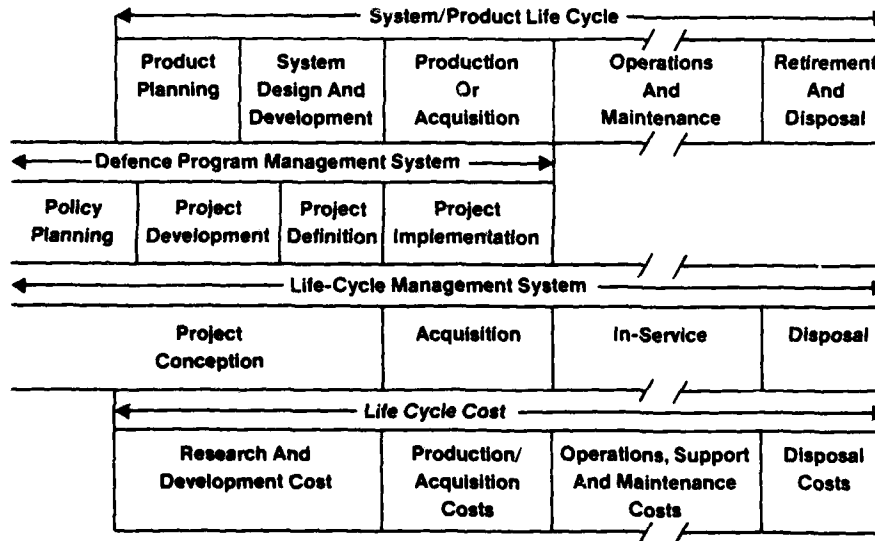


Figure 3: Stages of Equipment Life Cycle in DND

5. Two courses on LCC are offered regularly to DND staff working in these systems: a five-day intensive course intended for people at the working level, and a one-day overview course for senior managers. Working level staffs of these management systems are responsible for carrying out LCC analysis as part of their day-to-day work. They are the most qualified to study the impact of decisions on the future operation of the equipment. Senior management must be involved also because they are the most qualified to interpret how decisions concerning one equipment will impact on other activities.

6. These courses give the students the minimal expertise in LCC analysis necessary to improve their estimation accuracy. However, there is no substitute for common sense, persistence and an intimate knowledge of the equipment when analyzing LCC. Instruction, advice and assistance from analytical agencies in DND can be helpful, especially in the areas of LCC methodology and data sources. However, program and equipment management staffs must be involved in LCC work; the calculation of operating and support cost is too important to leave to cost analysts alone.

III - LIFE CYCLE COST-EFFECTIVENESS

7. LCC is the sum of all relevant costs incurred from the conception of a system until its final disposal. It is often divided into four major cost categories: research and development; acquisition or production; operations and maintenance; and finally, disposal. LCC can be displayed graphically as cash flow versus years in life cycle, i.e. a life cycle profile (see Fig. 4).

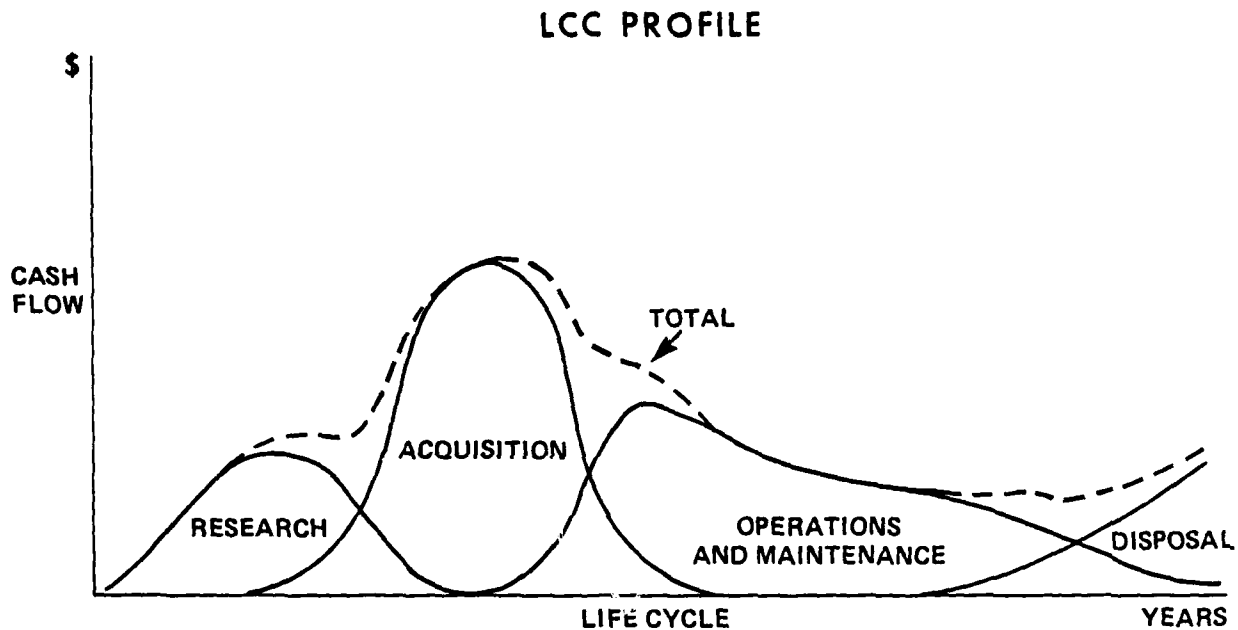


Figure 4: A Life Cycle Cost Profile

8. However, to be realistic, LCC must be tied to some measure of effectiveness. A cheap equipment that does not do the job is worthless. Thus we also need the concept of cost-effectiveness. Simply stated, the goal of cost-effectiveness analysis is to determine the decision with either:

- a. the maximum effectiveness for a given dollar expenditure; or
- b. the minimum cost for a specified level of effectiveness.

Combining these two definitions we obtain an idea called Life Cycle Cost-Effectiveness Analysis (LCCEA).

9. In theory, no one can argue with the value of LCC analysis when purchasing equipment or making decisions affecting its future use. It is being applied increasingly to purchases in the military, government, industry and personal life. The growing popularity of consumer reports and consumer buying guides substantiate this fact. In the DPMS, a full systems analysis approach is outlined: the requirement is determined by analyzing the threat or need compared to our current capabilities; feasible alternatives are developed with an examination of industrial and technological factors; these alternatives are then compared in terms of LCC, effectiveness, risk, human factors, etc. Obviously, if this approach is carried out properly, it will lead to the best decision.

10. In practice, however, this is not straightforward. Requirements analysis is a major stumbling block because neither the threat nor the operational scenario can be defined with certainty. Economic, technological and industrial factors compound the problem. What is cost-effective today may not be tomorrow. Both cost and effectiveness are difficult to measure and often subjective decisions must be relied upon. Many studies relate effectiveness to operational readiness. However, also involved are mission capability, survivability, dependability, human factors and other considerations. Measures of effectiveness can be quite complex and are beyond the scope of this paper.

IV - REASONS FOR CONSIDERING LCC

11. There are many reasons for considering LCC; several important reasons are discussed in the following Section (see Fig. 5).

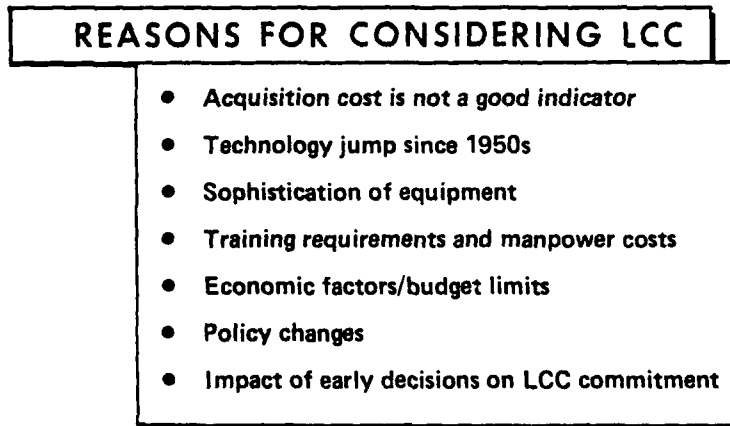


Figure 5: Reasons for Considering LCC

Acquisition Cost Alone is not a Good Indicator of LCC

12. The purchase of a higher cost alternative may result in long term savings because of lower operating and maintenance costs. In other cases, the higher initial cost purchase will also be more costly to operate. The major parts of LCC are not visible at the time of purchase. This is described as the "LCC Iceberg" (taken from Ref. 2). In Figure 6, the "poor management ship" focuses its attention on acquisition cost above the surface but is doomed to crash into the unseen maintenance costs. Carrying the analogy one more step, LCC analysis can be compared to a sonar set which, if working properly, will detect the danger. In the Canadian military, the LCC Iceberg is particularly relevant

because over a 20-year life, the personnel, operations and maintenance costs for a major weapon system will far exceed the acquisition cost.

THE LCC ICEBERG

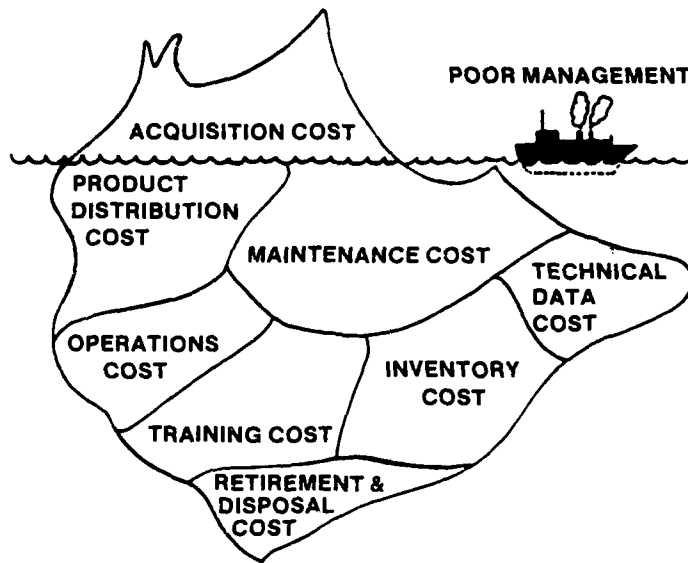


Figure 6: The Life Cycle Cost Iceberg

Technology Jump

13. The long service life of Canadian equipment in the past has created another problem. DND is currently into a replacement program for many of the older systems and is facing a technology jump. Ships, planes, tanks, trucks and communications equipment with 1950's technology are being replaced with new equipment incorporating 1980's technology. This jump will have an impact on personnel, facilities, industrial support and of course LCC. Many other Commonwealth countries face these same problems.

Sophistication of Equipment

14. The inclusion of computer technology in modern weapons systems results in another problem. Micro-chips can be produced inexpensively, yet are powerful, reliable and compact electronic components. Unfortunately, the need for more and more sophisticated equipment has caused the price of weapon systems to rise drastically. In today's throw-away world, maintenance manhours may go down while parts cost skyrocket. Most operators no longer understand how their equipments operate and maintainers no longer understand the internal workings of the components they remove and replace. Yet, training costs are rising.

Training Requirements and Manpower Costs

15. Direct costs now include training aids and simulators as well as student and instructor salaries and facilities costs. The indirect costs are also substantial, such as increases in salaries and higher turnover rates caused by the competition in the labour market for these students with increased skill levels (Ref. 3). This problem has reached epidemic proportions among computer programmers. Computer software is a very sensitive area because methods of developing, testing and maintaining reliable software are being developed slowly, even though computers have been part of our daily lives for three decades. Some engineers believe that software integration will be the highest cost element in new weapon system purchases. Is there new hope with ADA? ADA is a new programming language and system design methodology being "designed with three overriding concerns: a recognition of the importance of program reliability and maintenance, a concern for programming as a human activity, and efficiency". (Ref. 4, p. 11). The US Defense Department is claiming that it will be "the last programming language". Time will tell.

Economic Factors

16. Economic factors compound this cost visibility problem. The spiralling cost of manpower has led the new Canadian Patrol Frigate (CPF) program to consider operation and maintenance policies which will reduce the number of men on board. Similarly, with double-digit inflation and the decline of the Canadian dollar compared to its US counterpart, no wonder the projected cost of the CF New Fighter Aircraft (NFA) program has risen from \$4 billion to \$5.2 billion in the past two years. These huge sums of money create a loss of perspective. Everett Dirkson, commenting on the US situation, remarked: "A billion here, a billion there,...and pretty soon it adds up to real money!" (taken from Ref. 5).

Policy Changes

17. Policy changes also impact on life cycle costs. They can be favourable, such as improvements to procedures, or they can be detrimental, such as delays. The US Navy was sued recently by Litton Industries, who claimed that decision delays and design changes by the US Navy caused them cost overruns. The case was settled out of court for \$447 million (Ref. 6). There have been other cases where projects got underway successfully only to be 'put on hold' because of other priorities or lack of funds. In reality, no project ever holds; it either goes forward, backward, or dies. Even a short delay can change the LCC considerably.

18. The trade-offs between current dollars and future dollars can only be understood from an LCC point of view. Spare parts, for example, are purchased in the first year for future use. If budget limitations force Project Managers to try to save money in the first year by purchasing less spares than required, problems such as

lengthy equipment downtime and urgent demand for spares can cause later-year costs to far exceed the first-year savings. One of the purposes of LCC analysis is to examine the possibility of spending a dollar today to save dollars in the future.

Impact of Early Decisions On LCC Commitment

19. Related to the above idea is the understanding that early decisions have a major impact on LCC commitment. This impact is portrayed in Figure 7 (taken from Ref. 2). In examining our defence requirements, we might ask for example, "Do we need a Navy?". If the answer is yes, a certain minimum amount of money must be put aside today and in the future to follow through with this decision. Next we might ask, "Does this Navy require ships?"¹ The cost impact of this second decision is substantial because even the lowest-price alternative (in the LCC sense) will imply a large life cycle cost commitment. To determine the specific number of ships, their size, on-board equipment and personnel requires a much clearer definition of the requirement and a further clarification of the cost commitment. By the time the ships are in service, significant reductions in LCC may not be possible without reversing previous decisions; for instance to shorten deployment periods and reduce sea days. This patch-work solution can not reverse the impact of the original decisions.

Note:

1. These questions are not as silly as they might seem considering the recent revelations of the UK White Paper on Defence (Ref. 7).

COMMITMENT OF LCC DURING THE SYSTEM LIFE CYCLE

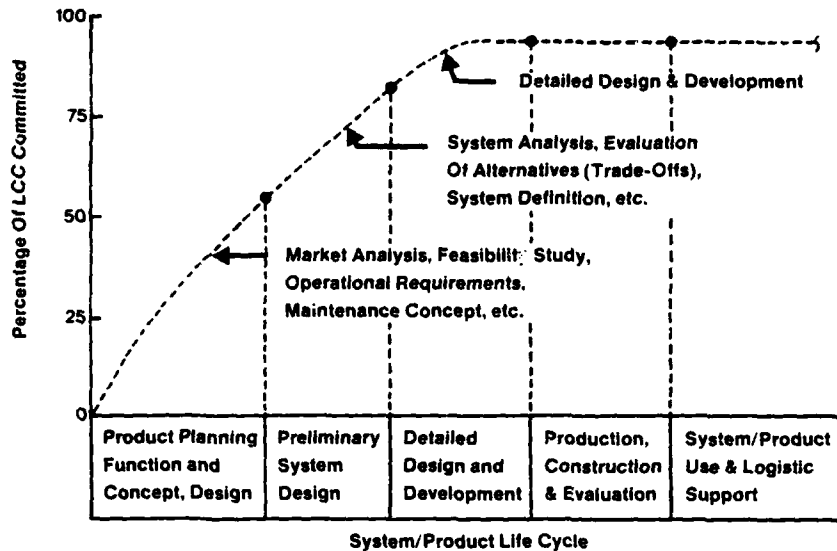


Figure 7: Commitment of LCC During the System Life Cycle

V - THE USES OF LCC ANALYSIS

20. The subtle difference between the iceberg analogy (Fig. 6) and the LCC Commitment graph (Fig. 7) relates to the uses of the LCC analysis. The LCC Iceberg suggests the need to consider LCC in budget decisions, to allocate funds and resources or to determine the total cost of ownership. The LCC Commitment Curve promotes LCC analysis as a tool to aid decision-making concerning requirements, engineering design, operational maintenance and logistic support policies, etc. Within the Canadian Defence Department, there are two main sources of LCC analysis assistance which respond to these two uses. The Directorate of Costing Services (D Cost S) is the official cost estimator for personnel, operations and maintenance (PO&M). This group consists of financial analysts and cost accountants both military and civilian. They prepare and update the DND

Economic Model and the Cost Factors Manual and provide cost-related management information relating to the budgetary side of LCC analysis. The Directorate of Logistics Analysis (D Log A) is interested primarily in LCC analysis from the engineering viewpoint. Our group consists of civilian Defence Scientists and military Engineering Officers, who work on the development, analysis and application of logistics models and information systems. The responsibility for logistics support analysis lies in the program and engineering offices; the techniques available through D Log A are simply tools that may be useful in this work. D Log A is also assisting the instructors in the Materiel Management Training Centre and the Royal Military College to bring the ideas of reliability and maintainability, life cycle management, life cycle cost analysis and logistics support analysis to the working level.

21. A recent trend has been to share the responsibility with the manufacturer, to build these concepts into contracts through reliability improvement warranties and total cost bidding. Contract demands have tasked the potential manufacturer to carry out the complete logistics support analysis and develop detailed LCC estimates. This puts the onus on the manufacturer to do the work and on the project office to evaluate the manufacturer's arguments. The new Canadian Patrol Frigate (CPF) is a good example. The program management office has identified, in its contract with the two competing ship designers, the areas where LCC must be considered:

- a. budget style LCC must be estimated for the total ship; and

- b. the LCC implications must be addressed when the designers choose one system over another during the ship design process.

The competing designers are free to use whatever techniques they wish to carry out these analyses. A great deal of responsibility is placed on the individuals in the CPF Program Office to keep up with the contractors and evaluate the arguments and analysis techniques. Fortunately, the management structure is set up to coordinate this work in the Integrated Logistics Support (ILS) Organization (see Fig.8). This approach has enormous potential but time will tell if LCC analysis can be put into practice on this large a scale.

INTEGRATED LOGISTICS SUPPORT ORGANIZATION FOR THE CANADIAN PATROL FRIGATE PROGRAM

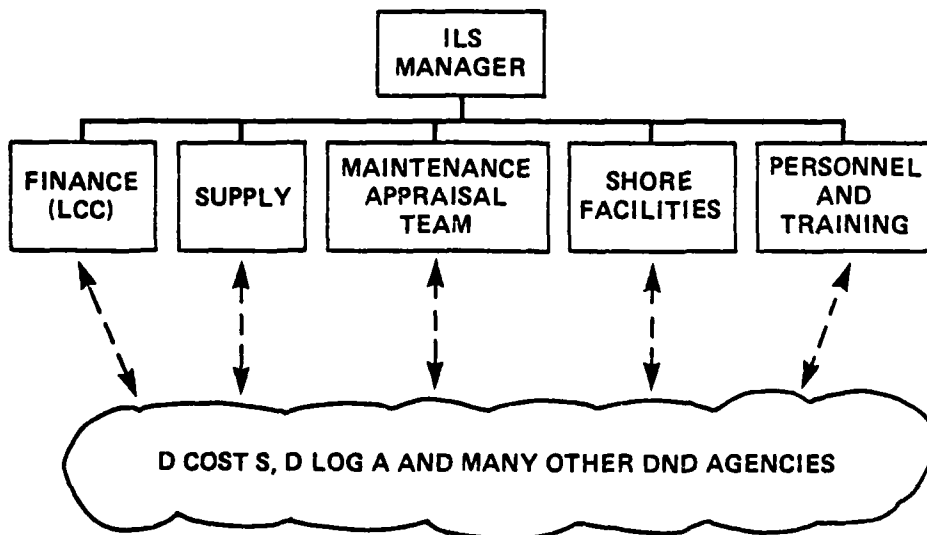


Figure 8: ILS Organization for the CPF Program

22. On a smaller scale, the Canadian Life Cycle Management System combines all of the logistics support tasks into one individual, the Life Cycle Materiel Manager (LCMM). This individual carries a great deal of responsibility because he must ensure that the operational, maintenance, training, documentation and supply organizations are working together to provide integrated logistics support for his particular equipment. In this effort he must cross many organizational boundaries; this leads to another problem affecting the implementation of LCCEA.

23. Working groups and studies, intending to develop integrated logistics support concepts for very large systems, have fallen prey to enormous organizational problems. Jon Reynolds, commenting on the US Defense Department, noted: "LCC requires support from numerous offices throughout the organization; it is difficult to unify the responsibility into a cohesive, effective, implementation program." (Ref. 8, p. 67-68) He found that a number of important questions remain unanswered, e.g. Which organizations should:

- a. conduct formal LCC analyses;
- b. train LCC analysts;
- c. establish and maintain models, data systems and cost factors;
- d. formulate and publish policies;
- e. allocate funds;
- f. validate contractor estimates; and
- g. track LCC forecasts and validate models?

The same situation holds true for the Canadian DND. Currently these tasks are being carried out by several organizations in relative isolation. It is hoped that as more and more individuals become aware of the capabilities and limitations of LCC analysis, these organizational problems will be overcome.

VI - ISSUES IN LCC APPLICATION

24. There are four main difficulties or problem areas, as we see it, in the application of LCC:

- a. improvements to the methodology;
- b. availability of information;
- c. understanding the capabilities and limitations of LCC analyses; and
- d. overcoming the conflicting objectives among participating organizations.

These problems and the approaches to their solution will be discussed.

Improvements to the Methodology

25. The lack of an approved LCC methodology has caused mental anguish to many individuals and organizations in DND. It is clear from the official project management procedures that LCC must be considered, but the manuals do not tell how to do it. There was a search for an "all-singing, all-dancing" computer program or model to solve all our problems. A Royal Navy study in 1978 estimated that over 1200 LCC models are stored in the libraries of the world (Ref. 9). Most are equipment-specific; some apply to a particular operational

environment; some claim to be all-encompassing. This literature is of limited use because of the wide variety of approaches and the lack of surveys or critiques. One thing is certain. There is no all-encompassing LCC model applicable to all equipment in all environments.

26. The trend today is toward a more practical approach. The emphasis is being placed on training and applications. Simpler methods are being examined. Our Directorate, for example, is trying to develop a 'bag of tricks' which may be useful in LCC studies. This collection of models and approaches can apply to various requirements. Some utilize computer programs, or programmable calculators; others are purely manual procedures. The models vary in complexity, data requirements and purpose. The key is in understanding the techniques available and knowing which to apply.

27. The following six-step procedure is recommended as the basis for an LCC methodology.

- a. Develop a cost breakdown ensuring that all relevant costs are counted, but only counted once.
- b. Identify and measure the high cost contributors (drivers).
- c. Use these cost drivers to do trade-offs and determine the most cost-effective decision.
- d. Estimate roughly the remaining cost elements and develop an LCC profile.
- e. Compare the LCC profile against budget constraints; if over budget, re-evaluate system requirements and repeat b. - e. with some new concept.

28. This approach is based on a belief in the Pareto principle, i.e. the 80/20 ratio. That is, for any system, 80% of the LCC will be accounted for by 20% of the cost elements. In turn, 80% of the effort in the study should be placed on the detailed analysis of this 20%. There are thousands of ways to categorize the cost elements. Blanchard gives an excellent breakdown based on the four cost categories of Research and Development, Acquisition, Operations and Maintenance, and Disposal (Ref. 2). Selection of the particular formulae, models, data sources, etc. used in step c. should be based on a detailed knowledge of the equipment, the procedures employed in its operation and support, the cost drivers and the resources available. By emphasizing the large cost elements the analysis is simplified; however, this is not to say the small cost elements are unimportant. One could imagine that for some equipment, documentation costs would be small compared to the cost of purchasing spares or the cost of maintenance manpower. However, if the documentation is poor, this can have a serious impact on other cost elements and on the total LCC. Thus, the primary difference between LCC analysis and logistic support analysis (LSA) is that LCC analysis can concentrate on the cost drivers but LSA must consider all aspects of logistics support.

29. When presenting an LCC argument, there are a lot of "what if" questions that come to mind. A thorough presentation should address as many of these as possible. The study of these "what if" questions is called sensitivity analysis. A particular parameter is systematically varied, so that its effect on the cost elements can be examined. This can involve repeating calculations many times. Therefore, computational aids such as programmable calculators or computer programs are desirable for this work.

30. Because of the difficulty in forecasting, there is safety in numbers (Ref. 1). The US Defense Department requires three estimates for each project: one from the program office, one from the costing office and one from an independent organization. All of these are compared and evaluated before a final decision is made. In DND, cost estimates and the rationale behind them are presented and reviewed by many organizations before a final decision is made. However, in this approach, the reviewers are not independent.

Availability of Information

31. The availability of information is a problem. Many people who have attempted LCC studies claim it is "the" problem (Ref. 10). At the very early stages of the life cycle, there is simply no quantitative information about the system. Inferences can be drawn from similar systems if there are any. However, data on these systems can be difficult and costly to obtain, verify, maintain and analyze. The US Defense Department pays consultant companies to maintain such data bases. At the time of acquisition, the contractor provides information on the equipment and its components. However, these estimates are sometimes questionable. How well do the manufacturer's experimental test results relate to operations in the field? During the in-service stage, information is collected by the various DND management information systems, but studies have found this source difficult to interpret and organize. Errors and omissions in the data often make any analysis questionable. Work is underway in many of these areas to improve the information systems and provide better data for analysis. To provide integrated logistics support analysis, information must be presented "by weapon system". To do this, there must be a direct interface

between the various information systems involved. Jon Reynolds noticed the irony of this situation in the US Defense Department. He concluded, "In LCC we don't even have twenty-twenty hindsight; we cannot determine on a historical basis what it has cost to operate and support a major system. If we don't know how much these systems have cost in the past, how much confidence can we place in estimates of future costs?" (Ref. 9, p. 59).

32. The two areas of methods and information are inseparable. More work is required but for now we must do what we can with what we have.

Understanding of Capabilities and Limitations

33. There has been a lack of understanding of the capabilities and limitations of LCC analysis: estimates cannot be used to allocate funds to the nearest dollar; the early decisions have a major impact on future costs; there are fundamental differences between budgetary LCC and engineering design, logistics support LCC; there is no easy way, no "all-singing, all-dancing" computer program; and, finally, there is no substitute for common sense and persistence. Individuals are learning, through training courses, that good LCC comparisons can be developed at their desks in their day-to-day work. They are no longer afraid of terms such as LCC, LCCEA, cost-effectiveness, design-to-cost, reliability improvement warranties, integrated logistic support, total cost bidding, etc. They understand the need to consider spending a dollar today to save dollars in the future. This 'total cost consciousness' is rising at the working level as well as among senior management.

34. Training is essential but there is more to it. Often one returns from a good course eager to apply new concepts or knowledge only to be side-tracked by the demands of an

'in-basket' of priority items. Perhaps an attempt is made to apply some of the concepts from the course in day-to-day work, but if problems are encountered where can one go for help? Sometimes good intentions are just overtaken by events and the ideas from the course are set aside.

35. By now hundreds of individuals within DND in Ottawa have completed the LCC courses mentioned earlier. However, they must be motivated to apply the newly-learned techniques in their own decision-making. To help in this regard, and to recognize good LCC work in DND, several case studies are being developed to provide examples that might be followed. Analytical groups, such as our Directorate, are prepared to assist in overcoming some of the problems encountered in LCC studies, particularly in the areas of methodology and data sources. Furthermore, independent evaluation of findings is being encouraged. Before LCCEA can be implemented on a departmental basis, practical training and proven applications must be readily available.

Conflicting Objectives

36. Finally, there is the problem of conflicting objectives. Consider the objectives of manufacturers vying for defence contracts. Their motivation is sales or profit. On the other hand, a Defence Department, with limited resources, must maintain a fighting force capable of defending the country and meeting commitments to allies. To some extent, these objectives can be combined if the Defence Department becomes an informed and intelligent consumer and is able to convince manufacturers that it is in their best interest to provide life cycle cost-effective equipment.

37. Consider next, the Government of Canada controlling the distribution of funds to the departments or ministries. It is affected by broad policy, public opinion,

limited resources, conflicting demands and a need to put public revenue to best use, while DND is trying to obtain needed funding in competition with other departments.

38. Again, DND must be able to present logical arguments in terms of total cost (both present and future), as well as in terms of effectiveness. There must be an understanding of the impact Government decisions will have on DND roles and capabilities. Even within our own department, there are conflicting objectives between people on the financial side where budgets and dollars are all-important, and those on the operational and engineering sides where greater priority is placed on equipment and capability. LCCEA can have a unifying role here, however, we must recognize that these conflicting objectives exist and take steps to resolve them.

VII - ONE FINAL ANALOGY

39. This paper is based on an LCC overview lecture and a subsequent internal report distributed widely within the Canadian DND. It has generated considerable discussion at the working level and among management. Many groups have expressed the opinion that more detailed policy directives and official 'how-to-do-it' procedures are required to better incorporate LCC within DND management. The following analogy may be appropriate.

40. Some parts of Canada have enacted seat-belt legislation, i.e. laws which require all automobile drivers and passengers to wear seat belts for their own protection. Following a familiarization period for the public, these laws were strictly enforced and most people complied. However, enforcement was very expensive. When it slackened, many people went back to their old habits, while others continued to wear their seat belts conscientiously.

It seems that initially people 'buckled up' because they had to; if they continued, it was because they wanted to and were convinced that seat belts were in their own best interest.

41. The same can be said of LCC, i.e. both senior management direction and working level enthusiasm are necessary to ensure general acceptance of the concept of LCC in defence equipment procurement.

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13. ABSTRACT Life Cycle Costing (LCC) or more appropriately Life Cycle Cost-Effectiveness Analysis (LCCEA) has become established in the defence departments of many countries as a necessary part of equipment procurement procedures. LCC refers to the total cost of ownership; from research and development, through acquisition, operations and maintenance, to final disposal. However, it is often difficult to carry out convincing analyses which will impact on the final decision. Hundreds of LCC models have been developed in the USA and in certain Commonwealth Countries. These models vary in complexity and generality. In the Canadian Department of National Defence, there are examples of computerized LCC models, programmable calculator models and paper and pencil approaches. Some of this work will be reviewed. The advantages and disadvantages of these approaches will be discussed based on experience in the Directorate of Logistics Analysis (D Log A) of the Operational Research and Analysis Establishment (ORAE).		

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