UNIT COST ESCALATION:

IMPLICATIONS FOR POLICY

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INTRODUCTION

1. The attention of operational analysts is focused generally upon the next step - be it better use of existing equipment or, else, the specification of whatever is to succeed that. This paper takes a longer view. It highlights the phenomenon of unit cost escalation which, working persistently decade by decade, comes to influence profoundly procurement programmes and, through these, the size, composition and effectiveness of armed forces.

2. It is argued that the progress of unit cost escalation has now reached a stage at which - for even the largest nations - it presents acute problems for solution by defence planners. If operational analysis (OA) is to assist in the resolution of these then it is urgently necessary to advance the methodology of OA both as regards better solutions for some old problems and in tackling problems of a new kind.

DEFINITION

3. As used here, the term "unit cost escalation" refers to the persistent tendency for new equipment to cost more unit-for-unit than that which it replaces (even after due allowances have been made for inflation, changing production quantities and the like). It is manifest as exponential growth of Unit production cost (Upc) with In-Service Date (ISD) such as is shown in Fig. 1 for strike aircraft over the period from 1940 to the present.

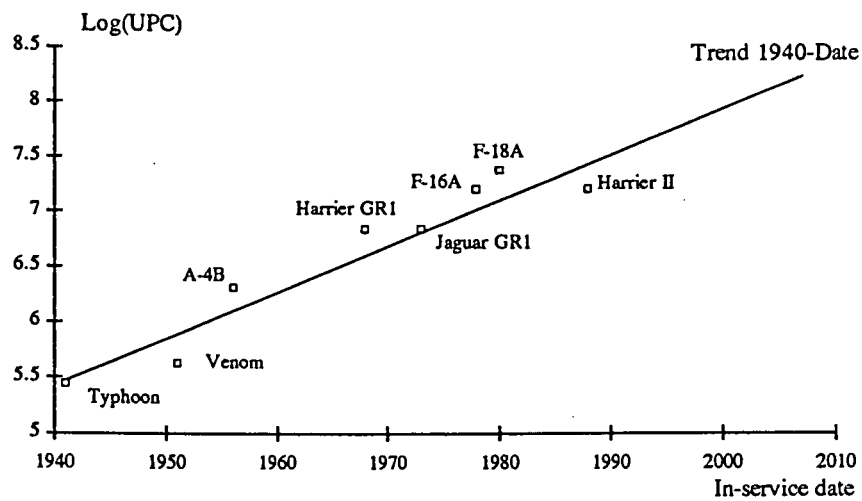

Fig 1: Unit costs of Strike Aircraft (Upc in £ at 1995 prices)

CHRONICITY AND UBIQUITY

4. Unit cost escalation is neither a new nor a rare phenomenon. On the contrary, chronicity and ubiquity are its hallmarks.

5. Historical research has found unit cost escalation, at rates much as now, in the costs of oared warships of the Hellenistic era, of warhorses of Norman times and of castles of the Plantagenet period. As for the present era, over at least the last half century Upc has approximately doubled every decade for all of the multifarious types of weapon system listed in Fig. 2 .

Over at least the last half century,
Upc has approximately doubled each decade for:

Sea warfare	Land Warfare	Air Warfare
Battleships	Anti-tank GW	Strategic bombers
Battle/heavy cruisers	Area air defence GW	Interdictor aircraft
Fleet aircraft carriers	Main battle tanks	Strike aircraft
Light cruisers	S.P. artillery	Fighter aircraft
Escort carriers	Attack helicopters	Medium range AA GW
Submarines	Transport helicopters	Stand-off weapons
Destroyers	Tactical air transport	
Frigates	Strategic air transport	
Corvettes		
Fast patrol boats		
Mine warfare vessels		
ASW helicopters		
ASW aircraft		

Fig. 2: Unit cost escalation is now virtually ubiquitous

6. Hence, while the remainder of this paper employs naval examples by way of illustration, the same theme can be expounded equally well via the histories of land or air forces.

7. Unit cost escalation defies even major geopolitical and technical changes. As Fig. 3 illustrates, the rate of unit cost escalation remains sensibly constant through peace and war and is unaffected by technical advances even as major as the change from gun to aircraft as armament of capital ships. When threats recede procurement may lapse (as during the "battleship holiday" following the Washington Naval Arms Limitation Treaty); but when threats return and construction resumes it is at unit costs which continue the former trend as if nothing had happened in the interim.

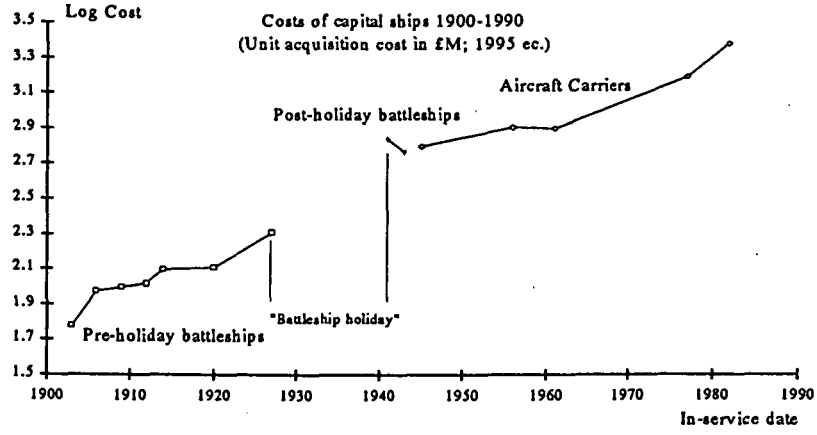

Fig. 3: The Continuity of Unit Cost Escalation

CAUSE AND CONSEQUENCE

8. The chronicity and ubiquity of unit cost escalation arise from it being intrinsic to military competition.

9. Cost relates to performance. Spending more will, ceteris paribus, obtain equipment of higher performance. But, effectiveness flows not from performance per se but from performance advantage over a rival. To procure equipment of higher performance and, so, enhance one's own security is inevitably to diminish the rival's security by reducing the effectiveness of his forces vis a vis one's own. One's security and his insecurity (and vice versa) are but two sides of the same coin.

10. Thereby, as Fig. 4 demonstrates, there is set up a positive feedback loop leading to continual exponential growth in unit costs.

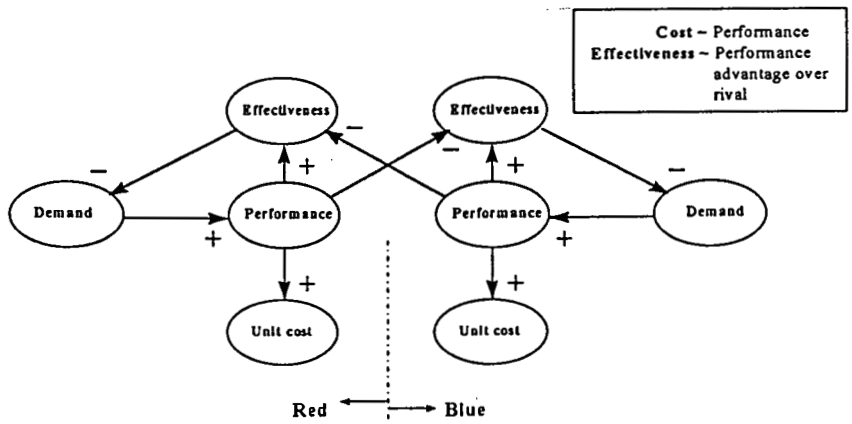

Fig. 4: The chronicity and ubiquity of unit cost escalation arise from it being intrinsic to military competition

11. The effect of this unit cost escalation is to diminish continually the effective purchasing power of defence budgets. By way of example, Figs. 5a & 5b show the variation over the period 1972-95 of the UK defence and equipment budgets with these expressed in alternative economic terms. Fig. 5a provides the conventional presentation of (more-or-less) level spending in terms of "constant (UK, 1996) purchasing power" (i.e. the additional quantity of retail goods which taxpayers might have bought in the High Street had they not been taxed for their defence). In contrast Fig. 5b demonstrates the rapid fall of budgets in terms of their ability to buy the latest and best of contemporary military equipment.

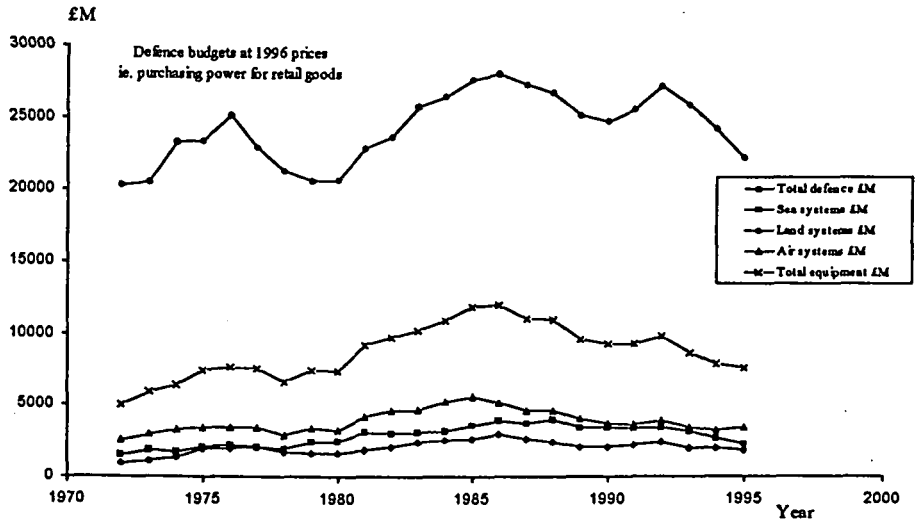

Fig. 5a: Retail purchasing power of UK defence and equipment budgets

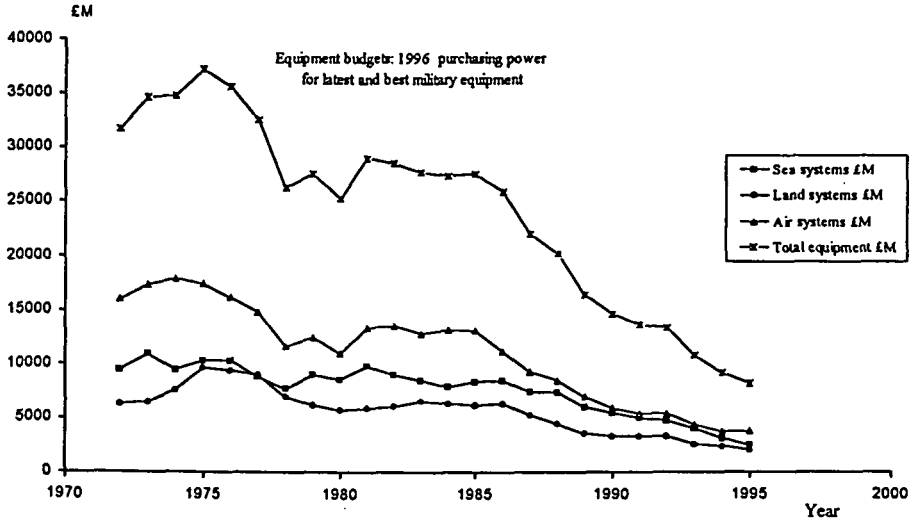

Fig. 5b: Purchasing power of UK defence and equipment budgets in terms of units of the contemporary latest and best military equipment

12. Thereby arises the paradox that taxpayers perceive themselves to be paying much as before while defence planners experience increasing pressure of costs upon budgets.

SMALLER AND OLDER FLEETS

13. As unit costs rise so lesser quantities can be procured generation on generation - as demonstrated, for example, by Fig. 6 showing the decline of UK warship production decade by decade save following the exceptional, immediately post-war, period of 1946-55.

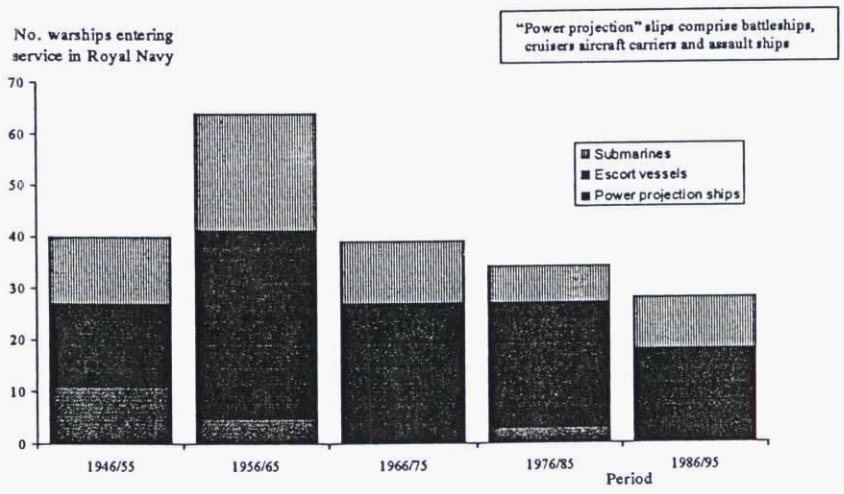

Fig. 6: Rates of UK warship construction 1946 to 1995

14. Since new matériel arrives at a diminishing rate, the active fleet must either decrease in size or grow older (or both).

15. This process is illustrated in Fig. 7 which plots the histories of the number of "power projection" ships (battleships, cruisers, aircraft carriers, assault ships and monitors) in service with the Royal Navy and of the average age of that fleet. At times the fleet was briefly rejuvenated with the retirement of its oldest members, in other periods numbers declined and average age remained steady and in others numbers were steady while the fleet grew older. However, overall long-term trends were firmly towards marked reductions in size and increases in average age.

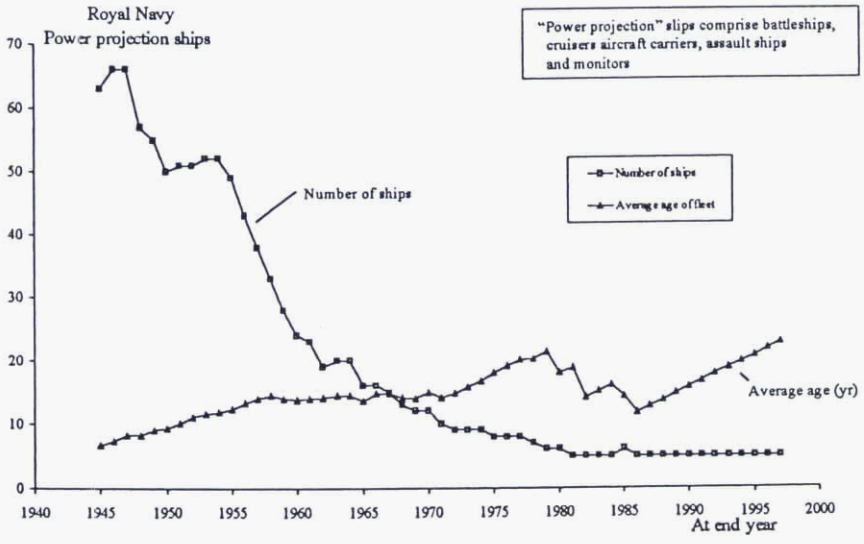

Fig. 7: Numbers and age of UK "power projection" warships

A similar analysis of the USN carrier fleet exhibits differences in detail but the same trends predominate (see Fig. 8).

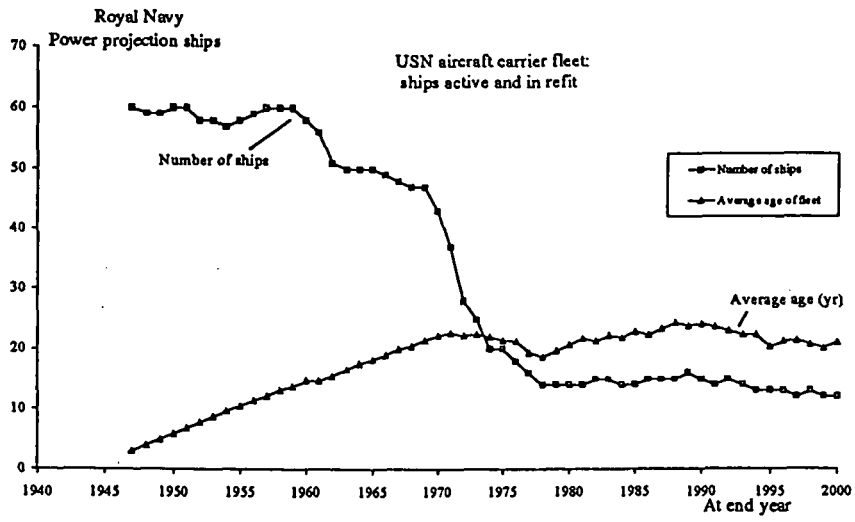

Fig. 8: Numerical strength and average age of USN carrier fleet

MORE EGGS, FEWER BASKETS

16. Since age cannot be allowed to increase indefinitely, forces have to adapt, over the longer term, to much reduced numbers of units. Just how far that process has gone already is illustrated in Fig. 9 for the two fleets just examined.

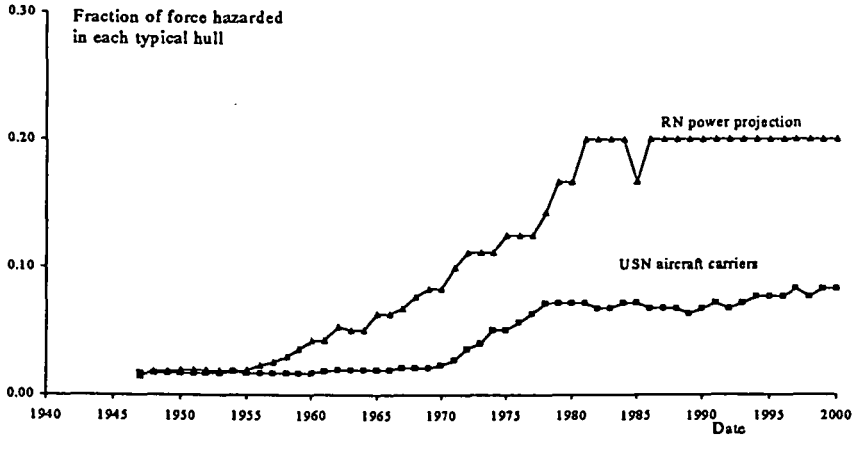

Fig. 9: Fraction of force hazarded in a single typical hull

17. As each major warship represents now 10% or 20% of its kind within a navy then, allowing for ships in refit or transit, if a force is to be deployed into distant waters some third or half of its power may well be embodied within a single hull. The success of a major operation can, therefore, turn upon the loss or preservation of that single vessel. One lucky hit could transform the balance of naval power within a region and/or doom an expedition to failure.

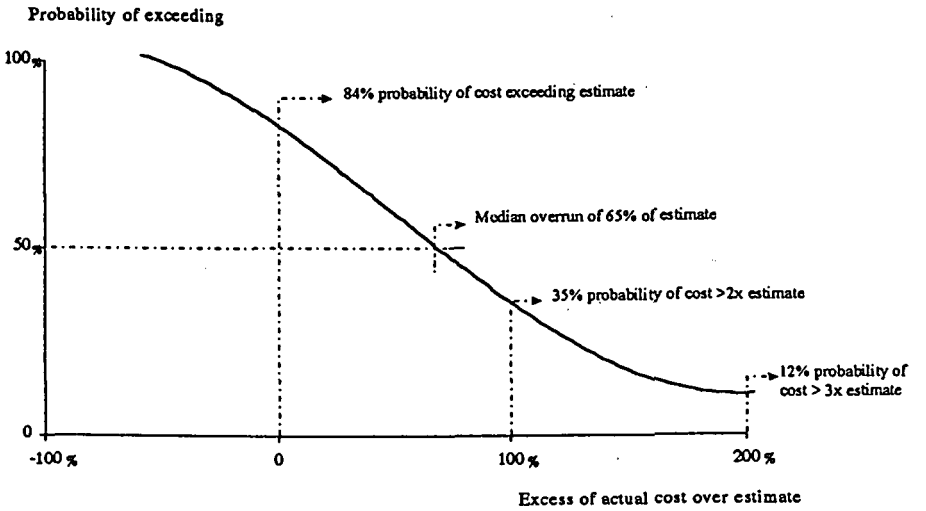

Fig. 11: Accuracy of cost estimates made by current methods at the start of major projects

23. Under-estimating future costs can lead to the (erroneous) belief that "the mould has been broken" and that technological and/or management fixes have been found for previous problems of cost escalation. Such hopes are raised often and disappointed invariably.

BETTER COST-ESTIMATING

24. Yet, cost-estimates need not be so much in error -even very early in a project. The accuracy of early cost-estimates is much improved by the use of newly-emerging "performance-based" techniques of "concept costing".

25. Whereas traditional methods relate cost to design details subject to doubt until much development work is complete, these new methods relate costs to performance requirements -known with some certainty from the earliest stages. The new methods benefit, therefore, from building their early estimates upon firmer foundations. Thereby, as Fig. 12 shows, they can use only information available at the start of a project to generate immediately forecasts towards which the outputs of traditional methods incline only as work proceeds.

MANAGING CHANGE

18. Nevertheless, as has been shown, if the impotence of obsolescence is to be avoided then, over the long term, continued reductions in numerical strength are inevitable.

19. This is not the unalloyed bad news that it might appear. After all, friend and foe suffer alike in that both experience unit cost escalation and, hence, both must undergo continual change. Advantage lies, therefore, with whomever manages change best.

20. But, to manage change requires foresight and forecasts are rarely correct.

21. Examples of erroneous forecasts are legion and it is to be emphasised that that shown in Fig. 10 was chosen only for it being to hand. In common with many others which might have been cited in its stead, this exemplifies how expectations are continually disappointed - largely through the effects of unit cost escalation.

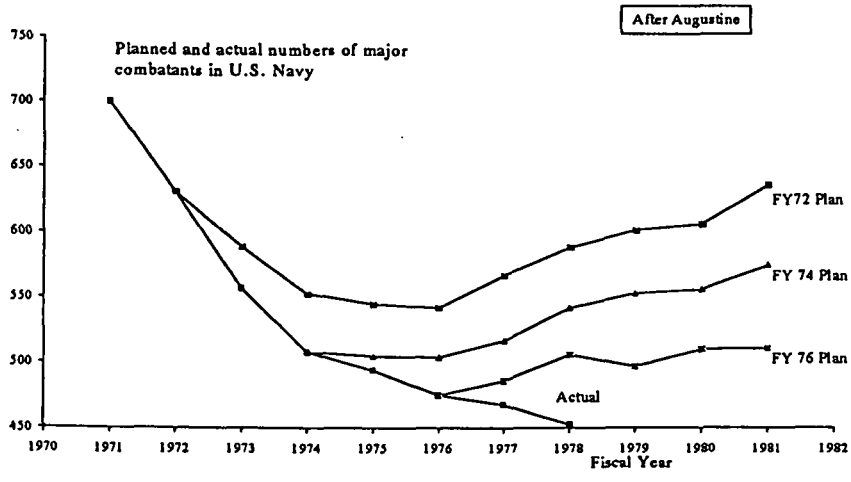

Fig. 10: Plans and reality - U.S. Navy in the 1970s

BREAKING THE MOULD?

22. A major reason why plans are so often in error is that future escalation in unit costs is obscured by chronic under-estimating of the costs of equipment yet to be developed. Recent research suggests that, at the start of major defence projects, errors in cost estimates have a probability distribution much as shown in Fig. 11. There is a high probability of eventual (outturn actual) costs exceeding estimates made early in the life of a project and significant probabilities of actual costs being several times those then estimated.

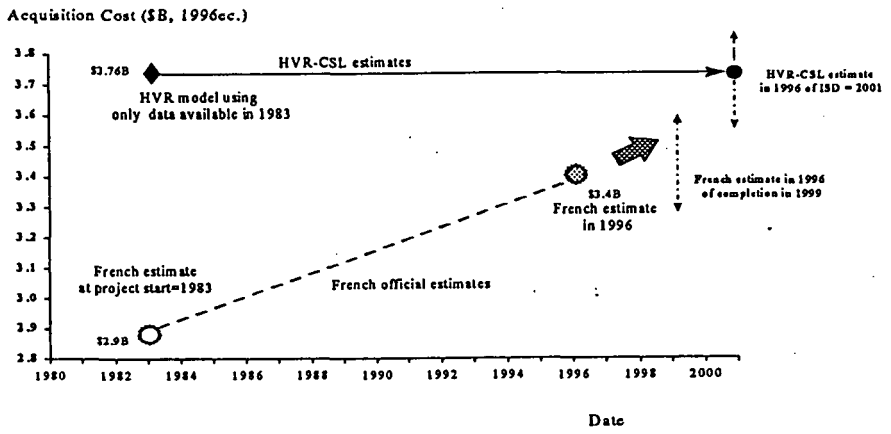

Fig. 12: "Charles de Gaulle" : estimates of acquisition cost.

26. The problems presented by chronic under-estimation of costs are, hence, soluble via newly emerging techniques.

CONCLUSIONS

Significant conclusions flow from this study of unit cost escalation and its implications. They may be summarised conveniently, as below, under two heads according as to whether they concern simply technical matters for the operational analyst or, else, they raise wider policy issues towards whose resolution new approaches may be required within OA.

a) Technical

Over the long term, the pressure exerted upon budgets by escalating unit costs becomes the primary determinant of force sizes and structures. It follows that:

i) one-for-one replacement of old equipment by new is an implausible assumption in OA studies

ii) quality versus quantity trade-offs and comparisons at constant (total) cost should be of the essence in studies to define requirements for new equipment.

b) Moreover, if plans are to be realistic then accurate cost estimates have to be available from the very earliest stages of projects. That requires widespread adoption of the newly emerging means of "concept costing" shown already to be practicable and effective.

c) Policy

The geopolitical future appears to be one in which Operations Other Than War (OOTW) are likely and general war a remote contingency. However, the latter cannot be ruled out entirely since although its probability is small its consequences, should it come to pass, would be huge. There is, therefore, a problem of reconciling the manpower-intensive demands of most OOTW with the further decline in numbers (of men as well as equipment) that is inevitable if forces are to continue to be equipped with the "latest and best" - as is essential if they are to remain effective in war. Hence, it would seem necessary for operational analysts to study how one might formulate measures of effectiveness which comprehend both probable but elective and also improbable but vital contingencies.

d) Increasingly, major units involved in operations will be few in number but very valuable individually. There is a need, therefore, to address issues arising from the risks and constraints associated with exposure of such units to hazard. In addition to increased uncertainty as to outcome, there are questions of how to represent both perception and reality within the calculus of risks on either side within, say, wargames.

THE WAY AHEAD

27. Unit cost escalation will pose increasingly difficult problems in the formulation of defence policy. If operational analysts are to contribute as they should to the resolution of these then there is particular need for:

a) improvements in the accuracy of cost estimates such as could be effected via widespread adoption of newly emerging means of "concept costing" shown already to be practicable and effective.

b) the devising of methodology for handling operational issues arising from the exposure to hazard of major units that are few in number but very valuable individually and the construction of measures of effectiveness which comprehend both probable but elective and improbable but vital contingencies.

ACKNOWLEDGEMENTS

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