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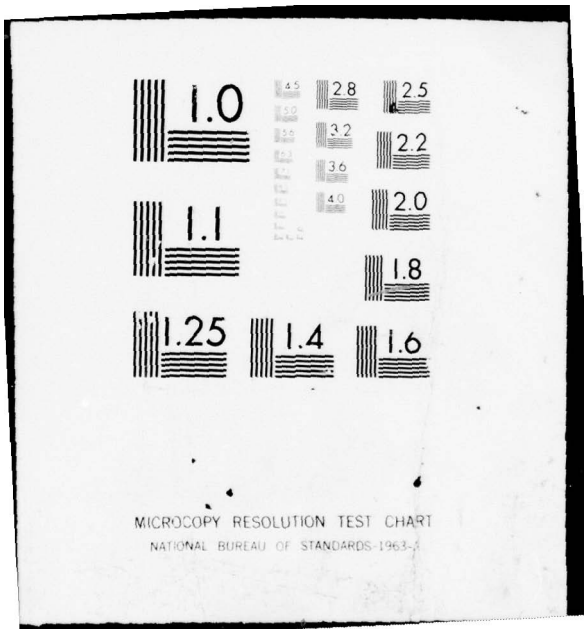
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REPORT

VOLUME II

Methodology to Quantify the Potential Net Economic Consequences of Increased NATO Commonality, Standardization and Specialization

Prepared for:

The International Economic Affairs Directorate
Office of the Assistant Secretary of Defense
International Security Affairs

In response to:

MDA 903-78-C-0166

By:

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Potomac, Maryland 20854

as

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METHODOLOGY TO QUANTIFY THE POTENTIAL NET ECONOMIC CONSEQUENCES OF INCREASED NATO COMMONALITY, STANDARDIZATION AND SPECIALIZATION

Prepared for:

The International Economic Affairs Directorate
Office of the Assistant Secretary of Defense
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This study defines and demonstrates interrelated methodologies for estimating the costs of cooperative NATO weapons systems production programs for (a) individual programs (the MICRO methodology) and (b) NATO Alliance member nations (the MACRO methodology). The MICRO methodology is based on standard cost estimating techniques and requires detailed input data concerning production factors. The MACRO methodology relies on production data from analogous industrial

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(20) Abstract

activities in combination with gross expected major system acquisitions to estimate gross economies available to the Alliance from utilization of least cost production option. Cost estimates derived by both MICRO and MACRO methodologies are for demonstration purposes only.

PREFACE

This Report has been prepared by C & L Associates for the Vertex Corporation, as prime contractor, under Department of Defense study contract MDA 903-78-C-0166. It develops one approach to the problem of formulating a methodology for measuring potential cost saving through NATO weapon system standardisation. The analysis has been conceived and elaborated to complement the 'micro' approach to this same problem adopted in work done, under a parallel sub-contract, by Management Analysis Corporation.

The Report has been written by one of C & L Associates' European Consultants, David GREENWOOD, who is Director of the Centre for Defence Studies at the University of Aberdeen, Scotland and who, with Steven L. CANBY, directed the work undertaken in its preparation. Responsibility for the structure, content and conclusions of the Report - and for infelicities of style and expression - is the author's. However, it should be recorded that the important survey material on empirical evidence about production economies at Appendices I and II was collected in the first instance by Dr. Keith HARTLEY (University of York, England) and Dr. Ben KLOTZ (Temple University, Philadelphia) in their capacities as Project Analysts.

In submitting the Report, the author would like to acknowledge, first, the helpful guidance received in early discussions about the exercise from members of the International Economic Affairs directorate of the Office of the Assistant Secretary of Defense for International Security Affairs; and, secondly, the great kindness shown by members of the United States' Mission to NATO in offering working facilities in Brussels during June 1978. Thanks are also due to the secretaries who laboured on drafts and the final text, both in Scotland and the United States; and especially to Margaret McROBB who bore the brunt of this work.

Potomac, Md.
August 1978

DG

CONTENTS

Chapter 1

INTRODUCTION AND OVERVIEW

This study is concerned with how certain of the benefits from increased standardisation among the members of the North Atlantic Treaty Organisation (NATO) might be measured.

From its inception the Alliance has acknowledged that military and economic advantage would accrue to the promotion of commonality (or at least compatibility) in tactical doctrine, modes of organisation, procedures and equipment. However, achievement has fallen short of aspiration. To be sure the member nations have formally subscribed to an agreed strategy and to more or less harmonious concepts of operations. But under this overarching rubric they have tolerated significant variations of doctrinal emphasis, giving rise to dissimilar mission priorities. Hence force structures and organisational arrangements differ widely among them. Similarly there has been (and remains) considerable diversity in operational procedures and even more in administration and logistics practices. Finally, and in large measure because of these other considerations, NATO has fielded a bewildering variety of equipments over the years for essentially equivalent roles. (To be more precise, individual members have procured richly variegated inventories of weapons and assigned, earmarked or otherwise declared their forces to the Alliance; and NATO's order of battle represents no more, some would say less, than the sum of these parts.)

Thus under the aegis of a joint security arrangement there has been no collective defence effort but a loose affiliation of largely independent national efforts, together with an integrated command apparatus which in normal circumstances plans, exercises and cajoles but does not carry effective authority when it comes to settling the size and shape of national contributions.

The Alliance's history is replete with references to the unsatisfactory nature of this state of affairs. Yet the impulse to order things differently has never been very strong. Rightly or wrongly, member nations have believed it possible to maintain an adequate naval and military balance vis-a-vis the Soviet Union and Warsaw Pact without sacrificing cherished national and Service convictions about the conduct of military operations and the organisation of armed forces, and without compromising national economic and employment objectives or offending industrial interests.

RECENT HISTORY

But attitudes are changing. Observation of the pace and extent of force modernisation in Soviet and Pact formations, and of associated changes in doctrine and organisation, has made the West apprehensive. There has been a quite palpable erosion of confidence in the Alliance's continuing ability to deter, at least to the extent that deterrence rests on a demonstrable capacity to mount a convincing conventional defence of NATO territory against any challenge. The fear is not so much of defeat in a shooting war as of political intimidation and coercion arising from, on the Soviet side, consciousness of the possession of preponderant

power and, on the Western side, submissiveness born of a sense of weakness. Anxiety is none the less real for that.

At the same time, in the aftermath of the 1973 oil crisis, a less sanguine view of general economic prospects has to be taken. Moreover it is impossible to anticipate any moderation in the strength of claims for resource allocations aimed at the alleviation of social ills in Western societies. Nor are electorates prepared to countenance diminution of accustomed living standards. Thus it is unrealistic to expect NATO countries to devote substantially higher shares of their national resources to security purposes; and it is unlikely that economic growth will reach levels which would mean that constant, or even falling, shares could sustain adequate defence provision.

In these circumstances there has been renewed interest over the last few years in the rationalisation of Western defence efforts. Reflecting the felt need to both enhance military effectiveness and make more efficient use of resources allotted to defence, a major thrust has been in the direction of achieving greater commonality in equipment. Standardisation in this limited sense offers the prospect of - but may not necessarily guarantee - greater interoperability among Alliance armed forces. In this respect it is a means to an end (although interoperability in itself, of course, is strictly speaking only a means to the end of more effective 'coalition operations'). It also offers the prospect of - but, again, may not guarantee - less expense on the acquisition of weapons systems, because of scale and other economies; and reduced outgoings over their lifetime in service, because of logistics savings. In this respect standardisation is an end in itself (although to be sure

more economical procurement is not the ultimate purpose of the exercise but rather a way of safeguarding military effectiveness in the face of budgetary constraints or of maximising the military pay-off from given appropriations).

This is not the place for a detailed account of the way in which the standardisation issue has come to prominence recently as part of the broader wave of attention to rationalisation in general. Suffice it to say that currents running in several quarters in the United States - the analytical community, the Executive branch and the Congress - converged in the mid-1970s; that the issue was taken up early in 1977 by President Carter's Administration within the framework of a general exercise in mending Alliance fences, and was invested with major political significance on that account; and that, having evoked some response from NATO's European members and engendered expectations elsewhere, there is now very considerable pressure to translate the policy initiative into practical measures. In short, after decades in which NATO has done very little about standardisation beyond paying lip-service to its worth, in the past three or four years matters have moved through the phase of advocacy (and accompanying rhetoric) to the point where major policy guidelines have been laid down and affirmative action is expected.

PRESENT PROBLEMS

The point of departure for the present study is the two practical problems which the Department of Defense and other agencies face in this connection. These are

- Where should initial effort be applied? Which are the procurement decisions that call for special attention in the interests of promoting standardisation either because adoption of common systems would confer greater military advantage or because the budgetary benefits would be substantial?

- How should the objective be pursued? Which are the acquisition methods that afford the greatest likelihood of promoting standardisation, given that it is only if several (ideally all) allies can be induced to procure a system that major gains are likely to materialise.

Not that these are separate questions in practice. Experience on collaborative ventures has confirmed that to achieve commonality may require acquisition arrangements that actually entail higher budgetary costs for the 'lead' producer if not for all participants. Similarly it is clear that assigning the highest priority to pursuit of maximum budgetary savings may preclude acquisition arrangements capable of attracting high participation among member nations. There is a trade-off problem, in other words; and one which has received insufficient attention in the debate on standardisation policies to date.

It is instructive to ask why, in the advocacy of fresh initiatives on standardisation, the interconnection between budgetary savings and participation in joint procurement undertakings has been neglected. The answer lies in the atmospherics of argument in these affairs. The main protagonists of bold departures have lent weight to their case by citing the waste involved in duplicated R & D effort, parallel production lines and a multiplicity of national logistics systems and by concocting estimates of the substantial budgetary benefits that might result from its elimination. In doing so they have persuaded many people, whether intentionally or not, that the expense

of present practice measured against that of some ideal set of arrangements could serve as a reliable indicator of the actually attainable benefits from a more efficient use of resources. This is not so. In fact, it is irrelevant when the 'ideal' corresponds to a situation which it would be hard to approach even in a highly centralised alliance vested with supra-national authority in setting security and socio-economic policy priorities let alone in a community of independent sovereign nations sharing common security concerns but emphatically not an identity of interest.

The argument is all the more misleading, and culpably so (though the offence may be one of intellectual negligence rather than deliberate intent), because the same protagonists have chosen to register their recognition of realities by acknowledging that attainment of commonality objectives could require 'second best' solutions to the 'mode of acquisition' problem: collaborative schemes - including complex co-production arrangements - offering only limited scope for budgetary cost reductions.

Advocates may have sought to have it both ways. But this is a practice in which decision-makers and policy advisers should not indulge.

How then are the immediate problems to be addressed? Because heavy stress has been placed on 'the standardisation dividend' in terms of budgetary savings the prime need is

- to develop more refined estimates - based on analysis and argument rather than bald assertion - of the potential impact on NATO members' budgets of efforts to yield commonality of equipment;

  and

- to do so with a realistic appreciation of the available margin for budgetary manoeuvre

and with due regard to the alternative acquisition strategies that are feasible.

Only in this way can the true fiscal benefit of standardisation be exposed and set in relation to other costs and benefits.

There are other costs and benefits, of course. From the point of view of socio-economic and industrial/regional policy values the procurement arrangement which, in the interests of standardisation, requires manpower release in some sector or closure of a plant or abandonment of some area of technological endeavour entails real costs. From a military standpoint the introduction of an item of equipment fully interoperable with those of allies and capable of being supported by more than one national logistics train yields real benefits (capable, in principle, of valuation in money terms) which should be entered in any reckoning either in addition to budgetary savings associated with its acquisition or to offset extra budgetary burdens incurred to secure commonality. In fact a full evaluation of any given policy option should encompass these and any other relevant elements. The essence of the cost-benefit calculus is its concern with all economic costs and benefits and not just those which occasion cash outlays or returns.

Notwithstanding these considerations, initially assessment of direct budgetary impact merits priority. The value is of interest in its own right. It must be identified for possible incorporation in yet more broadly-based calculations. Most important from a practical perspective, policy options which offer no (or negligible) budgetary benefit are unlikely to commend themselves for early attention in comparison with those which do. Having said that, the need remains to ensure that budgetary benefit is not seen as the be-all and end-all. This means structuring the computation of savings in such a way that

the results lend themselves to consideration alongside appraisal of other relevant categories of cost and benefit.

The question arises: is it even practicable (or necessary) to attempt evaluation of all possible sources of budgetary benefit, in the first instance? The answer is that it is not. The obligation to do so is relieved, first, by the requirement to frame assessments with regard to available margins for budgetary manoeuvre. This rules out extravagant arithmetic based on tabula rasa assumptions. Secondly, it can be shown that it is only research, development and production outgoings that are amenable to influence, even in principle, over the medium term. It is unrealistic to include potential logistics savings in partial analyses of budgetary cost-reduction opportunities. Pay-offs in this area cannot be expected to arise piecemeal as the number of standardised systems grows. Rather they depend on the fundamental reorganisation of arrangements that might be feasible if and when commonality were to obtain more or less across-the-board, so that 'logistics is a national responsibility' - to use the NATO formula - would become an anachronism.

Can one go yet further in narrowing the scope of a preliminary gauging of budgetary benefit? Practically speaking, are research and development expenditures any more amenable to influence in the medium-term than outlays on operations and maintenance? Sweeping assertions have been made that 'the United States does everything anyway' so that the European R & D effort is superfluous and the bill for it an acceptable proxy measure for the (avoidable) cost of duplication. This is absurd. For one thing it is clear that even if equipment acquisition strategies based on specialisation in production found widespread favour this would not justify exclusive specialisations

at the R & D stage. That would stifle the intellectual competition in pursuit of innovation which is one of the well-springs of technical progress. More to the point, it is simply unimaginable that any country with proven competence in a specific area of military technology could give an irredeemable hostage to fortune by voluntarily abandoning its investment altogether. Those who imagine that national defence R & D efforts are 'negotiable' within broader transnational procurement strategies delude themselves, perhaps by failure to recognise that the pursuit of knowledge is not a 'derived' activity but one invested with significance and value in its own right.

The conclusion is: an analysis aimed at calculation of attainable budgetary benefit with a realistic appreciation of (a) the margin for manoeuvre available and (b) the acquisition policies that are feasible can legitimately focus more or less exclusively on production expenditures.

METHOD OF ASSESSMENT

The central thesis of this study is that to facilitate the setting of policy priorities there should be a three-stage approach to the task of assessing the potential impact on NATO members' defence budgets of the production economies that might arise from efforts to attain greater commonality of equipment.

In the first place, it is necessary to take a view of the salience of equipment expenditures in country budgets. Ascertaining the scale of national resource allocations to procurement of major systems, current and planned, establishes the general benchmark against which cost

reduction opportunities can be measured. The absolute value of savings is not irrelevant of course. But, given the where and how questions already identified as the practical policy problems of the Department of Defense (and other agencies), it is obviously of particular importance to discover whether initiatives to promote standardisation hold out the promise of budgetary benefits which amount to a trivial or a sizeable slice of overall expenditures on defence. At the same time it is the worth of attainable future benefits that is the policy-relevant value. This calls for specific examination of the pattern of planned procurement within the Alliance to isolate those programmes for which acquisition strategy options remain open. Armaments plans that have gone beyond the project definition stage to development work may have slipped out of reach from this standpoint.

Second, from such empirical evidence on production economies as is available, the analysis must indicate how plausible values might be derived for potential cost savings in principal systems areas on alternative assumptions about procurement arrangements. This is a major undertaking in its own right, which may explain why many contributions to the standardisation debate have been short on analysis and long on assertion. Certainly the technical problems are less straightforward than one might surmise from attention to that debate. For example, advocates (or analysts) have not always distinguished sufficiently carefully among the main sources of production economies in this context: concentration on the lowest-cost supplier or shifting to the lowest average cost curve; securing the benefit of larger-scale production or getting as far out as possible along the operative average cost curve so as to obtain economies of scale; and taking advantage of what longer production runs offer in terms of 'learning'.

The protagonists of specialisation in production of materiel for the Alliance typically invoke all three in their case, usually with a dose of 'comparative advantage' reasoning added to the argument. Yet there is an abundance of logical booby traps here:

> What about the situation where one country is lowest-cost supplier at some levels of output but not others?
>
> How does one deal with average cost curves that are flat (constant unit costs) over a broad band of possible output levels, including the interesting ones?
>
> Is 'learning' transferable between plants?
>
> As for international trade theory, is not the notion of a regime of managed transnational procurement arrangements which 'reflect' comparative advantage a monumental contradiction in terms?

Some conceptual clarification is necessary as a prologue to the examination of empirical data on production economies.

Be that as it may, an indication of how plausible values for such economies under alternative acquisition arrangements might be derived is imperative for the third stage in the analysis. The task is to elucidate the budgetary benefit/participation nexus. This is where the policy interest lies. Valuable though they may have been in securing visibility for the rationalisation movement, generalised statements that promotion of standardisation might permit savings of n billions of dollars a year are of little use for illumination of specific programme options, where the need is for 'differentiated' quantification: to indicate what budgetary benefit might accrue if particular equipment requirements were to be met by a specified mode(s) of acquisition. Such calculations would enable the Department of Defense,

first, to appreciate the nature of the crucial trade-off between budgetary savings and participation; and, secondly, to identify those areas where significant budgetary benefits are attainable on feasible acquisition strategies.

This is not a prescription for a full cost-benefit calculus. But it is a formula for the generation of information without which there can be no worthwhile appraisal of budgetary benefit vis-a-vis military advantage and/or the costs of socio-economic and industrial disturbance involved in recasting weapons acquisition processes.

To summarise this progression of argument: it is suggested that to assist decision-making on where initial effort in pursuit of standardisation goals should be applied and on how objectives should be pursued (i.e. by what pattern of procurement arrangements)

- there is a need for more refined estimates of the potential impact of standardisation initiatives on NATO members' budgets;

- these should be developed taking explicit account of (1) the limited margin for budgetary manoeuvre available at any time and (2) the limited number of acquisition strategies that it is feasible to contemplate if that allied participation is to be obtained without which US initiatives are a dead letter;

- in the first instance it is legitimate to concentrate on exposing the budgetary benefits attributable to production economies;

- the method of assessment that commends itself is one which involves three stages of analysis as summarised in Fig. 1 overleaf.

METHOD OF ASSESSMENT	
Stage 1	Construction of total budget and procurement budget profiles to provide benchmarks against which cost reduction opportunities can be measured and to expose where armaments planning has not foreclosed acquisition strategy options.
Stage 2	Derivation of 'cost reduction factors' from empirical evidence on the economies of scale/learning and comparative costs in principal systems areas.
Stage 3	Generation of alternative (or differentiated) estimates of attainable budgetary benefits under feasible procurement arrangements based on the application of 'cost reduction factors' (Stage 2) to benchmark data (Stage 1).

Fig. 1

In the main body of this study the rationale of this approach is elaborated and the procedure is demonstrated, to the extent possible in a limited and time-constrained exercise, using selected budgetary and procurement planning information for the main NATO nations (except France) and the results of two specially-conducted surveys of empirical evidence on scale economies, learning, and comparative costs.

STRUCTURE OF THE STUDY

The material which follows is presented in four parts. The first of these is complementary to this Introduction and Overview. It consists of two Chapters. Clarification of the policy context is offered in Chapter 2, which incorporates a discussion of the historical and circumstantial background to current standardisation policy; presentation of a frame of reference summarising the rationale of recent initiatives, together with an account of the expectations they have engendered; and a fuller statement of the benefit measurement problem, including a short critique of the quantitative evidence that has been adduced in the standardisation debate to date. This is a long Chapter, but the extended treatment is appropriate on two counts. There is a need to compensate for some of the slipshod thinking which has characterised much argument on standardisation issues; it is an inadequate basis for policy implementation. There is a need to establish precisely why more refined estimation of the potential impact of alternative measures is necessary. In a somewhat shorter Chapter 3 there is a full description of the analytical approach to budgetary benefit measurement together with observations on the material required to exercise it.

The budgetary setting is the subject matter of Part B. Data on procurement outlays in selected NATO members' defence budgets are reviewed in Chapter 4. Some relevant features of armaments plans for the 1980s and beyond are noted in Chapter 5. The material on production economies is synthesised in Part C which consists of three Chapters (6-8) dealing respectively with concepts and methods, the empirical evidence and derivation of 'cost reduction factors' (to use the expression coined earlier) as a device for generating

estimates of the budgetary benefit that might be associated with different procurement policy options.

The final part of the work, Part D, contains a preliminary and provisional demonstration of how the approach might be applied (Chapter 9) and a few pages of summary and conclusion (Chapter 10).

PART A CONTEXT AND APPROACH

Chapter 2

THE POLICY CONTEXT

The most succinct statement of the current policy of the United States on NATO standardisation is contained in Department of Defense Directive 2010.6 (March 11, 1977) which records that

> 'A. In accordance with Public Law 94-361, Sec. 802 (reference)... it is the policy of the United States that equipment procured for U.S. forces stationed in Europe under the terms of the North Atlantic Treaty should be standardized or at least interoperable with equipment of other members of the North Atlantic Treaty Organization.
>
> B. The Department of Defense will actively seek standardization and interoperability of weapon systems and equipment within NATO on a priority basis in order to conserve resources and increase the combined combat capability of U.S. and NATO forces.'

Later paragraphs of the document's policy section add glosses to these core propositions. Among other things they lay it down that,

> 'The worldwide orientation of U.S. forces should not be considered a basis for failing to seek, at a minimum, U.S.-European interoperability for U.S. general purpose forces equipment expected to be used in the European area.'
>
> and that,
>
> 'DoD Components will include NATO standardization and interoperability as fundamental considerations in their development and procurement programs....'

The obligations embodied in these statements represent the point of departure for the present work.

The particular problem to which the study is addressed - the measurement of certain economic benefits from increased NATO standardisation - arises in connection with the role allotted to the Assistant Secretary of Defense (International Security Affairs) (ASD(ISA)) in the implementation of policy. Directive 2010.6 assigns to ASD(ISA) responsibility for:

> '1. Coordinating development of overall DoD policy on NATO standardization and interoperability.
>
> 2. Acting as the principal point of contact between the Department of Defense and other governmental and appropriate NATO agencies for standardization and interoperability matters.
>
> 3. Initiating action to change policies, procedures, regulations, or laws that impede the achievement of standardization and interoperability within NATO.
>
> 4. Monitoring the political and economic factors which affect standardization and establishing intermediate goals which are achievable in light of current pressures.
>
> 5. Monitoring implementation of the National Disclosure Policy by DoD Components to ensure such implementation (a) fosters the mutual exchange of R & D information for the development of standardized or interoperable equipment by NATO while protecting U.S. interests, and (b) is consistent among agencies.'

The task set by item 4, and the injunction to establish 'intermediate goals which are achievable in light of current pressures' in particular, is a daunting one on any reckoning. It is in relation to it that the specific benefit measurement problem occurs.

Briefly stated the problem is this. The 'current pressures' include pressures for early evidence of progress towards the stated policy objectives. The setting of priorities is therefore a key issue; and that carries with it a requirement for well-informed policy choices. An important item of relevant information for this purpose is the budgetary impact of alternative courses of action. Yet there is no methodology to hand which is self-evidently 'right' for this sort of calculation (nor is it self-evident what 'right' means here).

The aim of this study is to develop a method which would be appropriate for the policy purpose; and, in a preliminary and provisional way, to demonstrate it.

Appropriateness for the policy purpose is the principal consideration that has been borne in mind throughout the exercise. This being so it is necessary to deal explicitly with the historical and circumstantial background to Directive 2010.6. In particular, some attempt must be made to gauge the strength of current pressures to promote standardisation, and to make clear in exactly what sense it is important that well-informed policy choices should be made in response to them. To this end, it is instructive

- to record certain features of the Alliance's attention to the standardisation issue in NATO's first quarter-century (1949-74) and to note particular circumstances (and personalities) responsible for the revival of interest in the past few years,

  and

- to elucidate the rationale of recent initiatives and comment on the expectations that they have engendered, with special reference to those concerning budgetary benefits and the development of greater reciprocity in Atlantic arms acquisition.

Having sketched that background it will be apparent that, if properly informed choices are to be made, decision-makers will need more refined estimates than have been available hitherto of the potential budgetary impact of the alternative courses of action available to them. Accordingly it is relevant

- to elaborate the argument for such refinement and to indicate how estimates which are both empirically based and explicitly related to possible courses of action might meet the need in question.

In the remainder of this Chapter each of these themes is addressed in turn. The first is treated at length, the other two more succinctly.

THE STANDARDISATION ISSUE

It is somewhat ironical that in promoting standardisation, under the broader rubric of policies to eliminate inefficient resource allocation in NATO, President Carter's Administration has in fact been reaffirming old aspirations.

One of the North Atlantic Council's first acts, at its inaugural meeting in Washington on September 17 and 19, 1949, was to set up

> a Military Production and Supply Board (MPSB) 'to promote co-ordinated production, standardization and technical research in the field of armaments.'
>
> and
>
> a Defence Financial and Economic Committee (DFEC) 'to develop....overall financial and economic guidance for defence programmes and to fix the limits both of those programmes and of military production in relation to the economic and

> financial resources of member countries' and 'to recommend financial arrangements for military plans and, particularly, to make recommendations on the interchange of military equipment among Treaty countries.'[1]

Neither body was to acquire effective, lasting authority. Moreover, the precise interpretation that would have been given to their terms of reference in 1949 is not quite what it would be today. Nevertheless it is worth reflecting on what was envisaged.

It is clear from the roles foreseen for the MPSB and DFEC that NATO's founders understood what mounting a collective defence effort would entail. In particular they appreciated that it meant going beyond adoption of common equipment to comprehensive management of the Alliance's productive capacity. In this respect they may have shown more wisdom than some of their successors. Certainly a difficulty associated with several current policy initiatives is that, although projected as measures to foster standardisation (in principle, a 'good thing'), they amount to proposals for radical refashioning of NATO's defence industrial base. What is more, they are appraised as such, whether their proponents wish it or not.

NATO's First 25 Years : 1949-74

Wisdom at Washington there may have been. But it was not matched by good fortune in fulfilment of the founders' aspirations. The organisation baulked at pursuing their grand design. The institutions for Alliance defence resources management proved ineffectual. Regarding standardisation as such, outside the area where it obtained because of American largesse, no headway could be made.

Not surprisingly, since piecemeal pragmatism was the only policy and exhortation virtually the only instrument.

A major reason for the fitful, even pitiful, progress made in NATO's first 25 years lies in the Allies' failure to follow the founders in recognising that every standardisation question is really a question concerning the structure, organisation and prosperity of defence-related industry. It is true - as has been argued in one invaluable recent study - that there was no compelling military rationale for standardising NATO's forces in the 1950s and 1960s; and that the loss of impetus that the movement to European political integration suffered with the failure of the European Defence Community was a critical setback.[2] Yet neither of these factors can fully account for the lukewarm responses to periodic pleas - from the leading NATO Commanders and others - for elimination of the diversity among NATO's weapons systems. They cannot explain President Eisenhower's failure to revive interest in standardisation in 1957. That came to nothing because 'when the United States talked about standardization the discussion inevitably led to a strong US sales pitch for one of its weapons systems' - to the evident irritation of the Europeans.[3] Likewise, it is to the role of socio-economic and industrial considerations, present in every acquisition decision, that one must look for the reason why no major system has ever been standardised under a formal NATO Standardization Agreement (STANAG) and why no NATO Basic Military Requirement (NBMR) ever resulted in agreement to co-operate in producing equipment to meet it.

In fairness it should be said here that, in these early years and subsequently, the STANAG procedure has facilitated some low level standardisation. There is a STANAG on 'rules for conversion of dimensions on drawings of United States'

origin for countries using the metric system' for instance. And by laying down standards, in this exact engineering sense, it continues to have a part to play. The NBMR system's track record is not so impressive. Although the scheme ran for seven years, 1959-66, it achieved virtually nothing.

By 1966, to cut a long and sorry story short, the Alliance had decided that - for all practical purposes - standardisation was a lost cause. With the interests of their research communities and armaments industries uppermost in their minds, the main nations were unwilling to relinquish any freedom of independent action in procurement choices. Where national advantage might be served by bilateral or trilateral collaboration they saw no reason to eschew some temporary ad hoc arrangement. And NATO clutched at this straw by encouraging such accommodations faute de mieux 'in the hope that one day all countries would agree to develop and produce completely standard items of equipment'.[4] Yet this can only have been wishful thinking. The collaborative projects launched in the later 1960s did enable participants to withstand the pressure of budgetary constraints. They did result in a slight reduction in the diversity of systems in NATO inventories. But they had nothing whatever to do with standardisation.

Indeed, ritual references apart, the issue languished throughout most of the next decade; until, in fact, there occurred that particular conjunction of military, economic, and political circumstances in which the most recent policy developments originated.

Circumstances (and Personalities) 1975-78

What were these circumstances? With whom did they 'register' and with what effect?

First, the circumstances. Among the commentaries already written on the antecedents of recent statements and actions there are numerous differences of emphasis. However a rough-and-ready synthesis would certainly incorporate the following elements.

- Disenchantment with detente set in very quickly from 1973 and prompted attention to new appreciations of the military situation vis-a-vis the Soviet Union and Warsaw Pact. These showed evidence of force modernisation and the recasting of tactical doctrine; and, in particular, there were indications that the adversary might be acquiring the capacity for a short warning attack. The inference was that NATO's conventional force posture should be improved. Concurrently, evaluation of the 1973 Middle East War experience (and other evidence) pointed to the importance of such things as the adequacy of stocks of consumables and the ability of forces to interoperate (not least to facilitate mutual support and the assimilation of reinforcements).[5]

- The five-fold increase in oil prices of 1973-74 meant considerable economic distress for most NATO countries and the expectation was that it would persist. In Western Europe it was recognised that 'the prospect of unilateral defence cuts in some countries and the general economic crisis made it imperative that the best use should be made of existing resources'.[6] Confronting this problem, all the member nations experienced a heightened awareness of 'the magnitude of unnecessary duplication and waste that had resulted from over a decade of weapon system proliferation against a backdrop of sharply rising weapons costs and shifting national priorities'.[7] A new look at standardisation was the logical reaction.

- Neither the military nor the economic impulses to rationalisation of defence efforts would have come to much had the political climate not been right. But from mid-1974 it was.

  (1) At the Alliance-wide level, the Ottawa Declaration on Atlantic Relations of 19 June 1974 expressed determination to avoid repetition of the 'bad and dangerous experience' of the previous year; and new 'objectives for co-operative efforts within the framework of NATO strategy' were set at subsequent Ministerial meetings. Thanks to 'a high-level campaign to this end by the NATO Establishment' standardisation emerged as a major focus in this connection.[8]

  (2) The West European preoccupation with economic difficulty produced fresh interest in co-operation on equipment programmes. Although alluded to in policy pronouncements, standardisation per se was not the dominant theme here however: at the heart of European aspirations lay, and lies, the object of preserving European defence industry. Hence, the political support for rationalisation carried with it the proviso that 'progress on standardization of equipment must involve genuine two-way traffic between the European allies and the United States'.[9]

  (3) What made the atmosphere in the United States conducive to a resurgence of enthusiasm for rationalisation, standardisation and interoperability (RSI) is a more complicated matter. Clearly disengagement from Southeast Asia 'allowed American policymakers to focus attention on security interests in Western Europe' and in both the Nixon and Ford Administrations they chose to examine RSI issues. The choice was not entirely free however. The Congress obliged the Administration to pursue them with 'a succession of standardization related measures' which itself reflected a political phenomenon of some significance: the passing of Congressional leadership on NATO issues to 'those members who were impressed by the necessity of maintaining a conventional capability in Europe which was militarily effective and yet as cost efficient as possible' and for whom the standardisation question presented itself as an opportunity to wield influence.[10]

> There is an important conclusion to be drawn from even this cursory sketch of Alliance politics in the mid-1970s. It is that, while the climate was indeed generally propitious for the pursuit of commonality in NATO equipment, particular constituencies formed among whose interests and expectations it could not be presumed that there would invariably be harmony.

Reflection on the overall conjunction of military, economic and political circumstances prompts a similar observation. True, it yielded an atmosphere conducive to measures for better management of NATO's defence resources. But the main military interest was in interoperability not standardisation, the European economic interest and the American were not self-evidently compatible, and (as noted) political motivations were diverse.

The question 'with whom did the circumstances "register" and with what effect?' is posed because the genesis of current United States' policy positions is significant for subsequent argument. The particular personalities in particular places who were to be influential or instrumental in shaping events fall into three groups.

- The Congressional leaders on NATO issues already mentioned, notably Senators Culver and Nunn, who in successive years obliged the United States Administration:

  (1) to pursue the question of standardisation in NATO (Public Law 93-365)

  (2) to justify instances of failure to procure for U.S. Forces in Europe equipment not standardised or interoperable with that of allies (Public Law 94-106)

  and, at a later stage,

  (3) to ensure that - except in specially extenuating circumstances - only standardised or at least interoperable equipment would be procured (Public Law 94-361 (s.802)).

The main thrust of this group's interest and insistence in the last few years has been in the direction of standardisation, with special reference to the procurement process. The relative lack of attention to other facets of standardisation in its extended definition (See Fig. 2 below) and the 'second best' connotations in references to interoperability testify to this. In addition, there is the evidence of s.803 of Public Law 94-361 which, first, lays it down that weapon systems being developed for the NATO theatre shall conform to a common NATO military requirement; secondly, commends expanded inter-Allied procurement based on licensing and co-production agreements; and, thirdly, recognises the importance of Atlantic reciprocity in arms acquisition and encourages 'European armaments collaboration among all European members of the Alliance' (s.803, a-c).[11]

- The independent analyst Thomas A. Callaghan, who issued in August 1974 a study undertaken for the State Department which proposed a trans-Atlantic common market in defence equipment and the establishment of a European Defence Procurement Agency to facilitate the operation of the European end of this 'two-way street' - a phrase which, incidentally, became part of the regular currency of debate with the appearance of Callaghan's report.[12] The broad vision, imaginative reach, vigorous anecdotal style and bold, colourful prose of Callaghan's piece ensured that it made an impact; and there is an abundance of circumstantial evidence to indicate that it was immensely influential. Nor is it hard to see why, for the study 'not only reflected avowed Congressional concern at the waste of Alliance resources through lack of standardization, but also held obvious appeal for the European allies with its proposals for increased American purchases of European equipment'.[13] On close examination the Callaghan Report turns out to contain a bewildering multiplicity of suggestions. But the central thesis stresses the 'two way street' with specialisation in production (juxtaposed, confusingly in places, with expressions of approval for role specialisation) and, references to 'market forces' notwithstanding, envisages managed trade flows to achieved balanced traffic.

- The group of analysts at the RAND Corporation, among them Robert W. Komer, who during 1973-76 produced for the DoD an influential study dealing with rationalization of NATO's defence posture and the wider-ranging Alliance Defence in the 80s (AD-80) report which, among other things, 'urged that a long-term programme be designed collectively by NATO to provide an integrating framework for meeting increasingly critical needs'.[14] Until 1977 the significance of this work seems to have been limited to the assistance it afforded the Nixon and Ford Administrations in the Alliance fence-mending of 1974 and in responding to various Congressional (and other) pressures for enhancing NATO's efficiency (during 1975 and 1976). It made its distinctive contribution in this period by emphasising rationalisation - in the all-embracing sense of making the best possible use of Alliance resources - as the essential goal for innovative policies to meet the dual challenge of growing Warsaw Pact strength and constraints on allied defence outlays. (Standardisation as such features as a subsidiary objective.) Since 1977, and the advent of a new Administration, Komer et al have played a more decisive role: in setting NATO policy priorities for the United States, and in urging their collective endorsement and adoption of 'coalition-mindedness'. The broad rationalisation theme is dominant in this effort as before. Closer armaments co-operation - with more balanced trans-Atlantic traffic - has been emphasised as the vehicle for more efficient use of resources in the materiel field, together with improvement in 'the compatibility of NATO forces via harmonization of doctrine and tactics, plus interoperability if not standardization of equipment'.[15] Most important Komer as Adviser for NATO Affairs to the Secretary and Deputy Secretary of Defense has seen fulfilment of the ambition to have these and other objectives assimilated in the 'integrating framework' of a Long Term Defence Programme for improvement of the common defence.[16]

There are some obvious inferences from this essay in bureaucratic politics (if that is what it is). General awareness of the need to repair deficiencies in NATO's posture and provision prompted attention to a tangled skein of inter-related matters (for which 'the

standardisation issue' is sometimes used loosely as a portmanteau expression, sometimes used to mean what the standard NATO definition(!) - as in Fig. 2 - would have it mean, and sometimes used with a narrower connotation that relates exclusively to equipment). Common ground could be found on the need for policy responses. But differences emerged on the precise modalities and emphases of required action; and since more than one group has been influential, if not instrumental, in fashioning policy, the effect of those differences is discernible. The relatively clear language of Directive 2010.6 notwithstanding, there are several terms (in the mathematical sense) in the Administration's objective function and judgement on specific measures to implement declared policy is the more complicated on that account.

The most obvious expression of this is the profusion of terms (in the literary sense) that are used in this area. But that is not the end of the story, for these terms are not used in a consistent fashion. It is true that 'agreed' definitions have been promulgated for use within the Department of Defense, and some of these have been 'approved' by NATO as a whole. The more important are set out in Fig. 2. But, valuable though such an exercise may be, it cannot eliminate terminological confusion in the wider community; and it is pointless to claim that it can or to act as though it does. For example, most politicians, journalists, commentators and analysts would probably find the official definition of rationalisation unexceptionable. But they would normally assign to standardisation and interoperability meanings with a closer reference to equipment than those in Fig. 2, in line with the House Committee on Government Operations' view that 'the distinction between

Fig. 2

DEFINITIONS OF TERMS RELATED TO
RATIONALIZATION/STANDARDIZATION

Commonality A quality which applies to materiel or systems possessing like and interchangeable characteristics enabling each to be utilized or operated and maintained by personnel trained on the others without additional specialized training; and/or components; and applying to consumable items interchangeably equivalent without adjustment.

*Compatibility Capability of two or more items or components of equipment or materiel to exist or function in the same system or environment without mutual interference.

Harmonization The process and/or results of adjusting differences or inconsistencies to bring significant features into agreement.

*Interchangeability A condition which exists when two or more items possess such functional and physical characteristics as to be equivalent in performance and durability, and are capable of being exchanged one for the other without alteration of the items themselves or of adjoining items, except for adjustment, and without selection for fit and performance.

*Interoperability The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together.

Rationalization Any action that increases the effectiveness of Allied forces through more efficient or effective use of defense resources committed to the Alliance. Rationalization includes consolidation, reassignment of national priorities to higher Alliance needs, standardization, specialization, mutual support, improved interoperability or greater cooperation. Rationalization applies to both weapons/materiel resources and nonweapons military matters.

*Standardization The process by which member nations achieve the closest practicable cooperation among forces; the most efficient use of research, development, and production resources; and agree to adopt on the broadest possible basis the use of (a) common or compatible operational, administrative, and logistics procedures; (b) common or compatible technical procedures and criteria; (c) common, compatible, or interchangeable supplies, components, weapons, or equipment; and (d) common or compatible tactical doctrine with corresponding organizational compatibility.

* Both NATO and DoD approved. (Others are DoD approved only, but have been recommended to NATO for incorporation in the NATO Glossary of Terms and Definitions for Military Use.)

standardization and interoperability is that where standardization focuses on efforts to make future weapons and equipment similar, interoperability seeks to make dissimilar weapons or equipment compatible'.[17] That cryptic formulation probably reflects everyday usage accurately and, unless otherwise stated, it is the sense the words carry in this study.

Present Priorities

The foregoing account of the 'historical and circumstantial background' establishes that the policy context is more complex than might be inferred from the clear formal commitment in Directive 2010.6 to 'actively seek standardization and interoperability of weapon systems and equipment within NATO on a priority basis' (where the words carry their approved meanings, of course). Specifically,

- Congressional interests (and expectations) centre on the weapons acquisition process and expanded inter-Allied procurement with two-way traffic,

- devotees of 'Callaghanism' - inside government and out, on both sides of the Atlantic - share this preoccupation and see specialisation in production based on comparative advantage as an attainable goal,

- encouragement of armaments co-operation also features prominently in the Administration's overall approach, as articulated by Komer and others, because it is seen as one aspect of correcting the inefficient allocation of resources among the Allies; but the 'greatest deficiency' perceived is 'inability to operate more effectively together in coalition war' (in Ambassador Komer's own words).[18]

Furthermore, to echo the note on which the historical survey opened, it is acknowledged - at least in some quarters - that what are nominally addressed as rationalisation/standardisation issues in fact touch on some of the most sensitive areas where individual nations' economic security, self-esteem and solvency are seen to be at stake. Reporting to Congress in January 1978, Secretary of Defense Brown defined the problem as: 'to find cost-effective means to enhance the defensive capability of NATO which also accommodate the legitimate interests of the members of the Alliance'. Regarding the solution, he observed that: '....the achievement of all the benefits of standardization and common least-cost production will entail far-reaching changes in national practices and extensive rationalization of NATO research and development efforts and Alliance defense industries'.[19]

RECENT INITIATIVES : RATIONALES AND EXPECTATIONS

At this juncture it should be evident that there is a pressing need for some analytical device which, without oversimplifying to the point of trivialising, can express the complexity of the policy context and the relationships among the several elements in the policy-makers' objective function.

Rationales : an analytical device

It is fairly clear that the purpose of all recent activity in the area of interest is to promote increased efficiency

in the employment of Alliance resources. The designation of RATIONALISATION (with special reference to equipment) as an overarching aspiration confirms this.

Efficiency is synonymous with 'cost-effectiveness': that is to say, the efficient solution to any (or the) defence resource allocation problem is one which provides for the attainment of a given level of effectiveness at least cost or, what is logically equivalent, yields maximum effectiveness for given real resource costs. It follows that the aim of any policy innovation must be either increased combat effectiveness or reduced resource costs (or a combination of the two).

Important judgements have been made in the recent evolution of United States' and Alliance policy about what needs doing to achieve these aims. For increased combat effectiveness the emphasis has been on enhancement of NATO's ability to implement the existing concepts of operations for the defence of the North Atlantic and Western Europe, by improving the capacity of forces to perform present-day roles and missions, within the framework of prevailing assumptions about structure, organisation and deployment. Whether this emphasis is right is a question lying beyond the scope of the present exercise. Suffice it to say the matter is disputed and, in particular, the notion that the main thrust of policy should be directed to improving NATO's ability to do what it is currently doing has come under challenge from reputable analysts who favour doctrinal/structural reform rather than remedial measures.[20] Important though that controversy is, however, for present purposes it is beside the point. Remedial measures are the favoured medium for fulfilling the aim; and attention has focused on improving possibilities for interoperation and mutual

support among NATO forces and on eliminating redundancy in communications and support provision.

For reduction in resource costs the emphasis has been on improvement in the military muscle mustered for given outlays: by elimination of duplication in R & D; by exploitation of economies of scale and learning and of least-cost sources in systems acquisition; and by effecting savings in operations and maintenance (O & M) expenditures. This is not so controversial. Clearly these are the loci of cost-reduction opportunities on the equipment side. But note the implied assumption that the scope for manpower economies is either non-existent or less attractive and the failure to acknowledge that much O & M expenditure is relatively insensitive to the exact equipment assigned to units. In addition it must be said that doing things more efficiently is sensible only if one is doing the 'right' things (so that issues in the structural/doctrinal debate are germane here too). There is also a need to check the impulse to settle for the cheapest system, which may also be the least effective in combat.

What are regarded as policy goals actually enter the reckoning at this state. INTEROPERABILITY and COMPATIBILITY are desired ends because of what they contribute to increased effectiveness (and of course STANDARDISATION in its broadest sense is one of the ways of getting them). The importance of armaments co-operation lies in the expectation that it should yield acquisition cost reductions; STANDARDISATION of equipment is a related goal, because of the promise of savings in logistics spending.

It might be thought that to claim that all this amounts to elucidation is stretching a point. But if the essential

argument of the preceding paragraphs is arrayed in tabular form, as has been done in Fig. 3, useful clarification is achieved. Depicted in such a manner, what United States' policy is really about can be appreciated more readily than in most official pronouncements and presentations.[21]

Fig. 3

RECENT INITIATIVES FRAME OF REFERENCE		
PURPOSE	RATIONALISATION Increased Efficiency in the Utilisation of Alliance Resources (with special reference to equipment)	
AIMS	Combat Effectiveness Benefits (Military Gain)	Reduced Resource Costs (Economic Gain)
requiring....	1. Improvement in possibilities for interoperation 2. Improvement in possibilities for mutual support 3. Teeth-Tail Ratio improvements	1. Elimination of wasteful, duplicative R & D 2. Production Economies 2.1 Scale/Learning 2.2 Least-cost sources 3. Support Cost Savings (O & M, especially logistics)
....therefore GOALS	INTEROPERABILITY COMPATIBILITY	Armaments Co-operation (implying common systems)
requiring/ entailing	Interface devices STANDARDISATION (doctrine, procedures, C^3) STANDARDISATION (equipment)	[Alliance Armaments Planning e.g. PAPS, NAPR]* STANDARDISATION (equipment)
* See Ch's 3 and 5 below		

Expectations....

The utility of Fig. 3 as an analytical device goes further than this however: it provides a frame of reference for comment on the expectations that have been engendered by the very process of constructing an outline agenda for policy action along these lines. There are two principal points to be made.

- Having asserted that preservation of a satisfactory naval and military balance vis-a-vis the Soviet Union and Warsaw Pact requires rationalisation of Allied defence efforts, the United States (with other nations) is under pressure to effect it. The endorsement of the Long Term Defence Programme in May 1978 has, or should have, stepped up the pressure. Not only does the rationalisation strand run through the whole fabric of the programme but the Administration has made a substantial investment of political capital in the enterprise, stressing determination not to allow it to go the way of such earlier exercises as AD-70 and the 1973 Basic Issues Report.[22] What this means is that early evidence of progress towards attainment of the set goals is necessary if confidence and credibility are not to be undermined.

- Considerable significance has been attached to

  (1) the achievement of reductions in resource costs, not with budget cuts in mind but to allow force improvements even if appropriations are constrained (and yet more significant gain if 3 per cent real growth in expenditures can be sustained).

  (2) co-operation in armaments planning and production, identifying least-cost sources of supply and exploiting opportunities for scale (and other) economies while at the same time accommodating 'legitimate interests' (including concern for socio-economic and industrial values).

  In setting policy priorities, therefore, attention must be paid to actions which will yield budgetary benefits yet satisfy the participation requirements.

Obviously if these expectations are to be fulfilled courses of action must be identified which meet very stringent demands, promising early evidence of progress, with significant budgetary pay-offs while satisfying tough participation criteria. That is going to call for extremely well-informed policy choices.

....and their Implications

Against this background the central problem for the present study can be brought into sharper focus. One of the responsibilities placed on ASD(ISA) is to identify 'intermediate goals which are achievable in light of current pressures'. To discharge this duty answers are going to be required to a pair of inter-related questions.

The first is: WHERE should initial effort be applied? It is clear that there are some categories of equipment where procurement of common systems would confer great military advantage and/or yield substantial budgetary benefit. There are others where the pay-offs would be more modest. If the reasoning of the preceding paragraph is right it is important that those responsible for implementing action should be able to identify the first category and, within it, measures that promise discernible budgetary benefit. This is where initial effort should be applied.

The second question is: co-operation in armaments planning and production having been given special salience (with standardisation goals particularly in mind), HOW should this objective be pursued? There is a variety of acquisition strategies available, ranging from straight-forward identification of a least-cost source and

consolidated Alliance procurement therefrom, through all manner of licensing and co-production arrangements, to approaches in which extensive independent national development and production is accepted. To the extent that engaging broad participation while acknowledging industrial interests is the desideratum suggested (and this is really only another way of defining 'achievability'), those responsible for implementing action should be able to identify feasible alternative procurement arrangements which satisfy participation requirements. These are the modes of acquisition to be emphasised.

The inter-relationship between the questions obtains because, although they are separable in principle, in practice they become fused. Experience on collaborative ventures has confirmed that obtaining participation has its price in forgone budgetary benefits. The general expectation from the complex F-16 procurement arrangement (for example) is that 'cost increases from co-production in Europe will be no greater than the savings resulting from the larger domestic requirements to meet EPG [European Participating Governments'] aircraft'.[23] Looked at another way, if the highest priority is assigned to getting large and early budgetary pay-offs, that may preclude acquisition strategies capable of attracting high participation among NATO's member nations. In short, there is a trade-off problem; and it is accordingly incumbent on those responsible for policy implementation to generate their information on 'discernible budgetary benefit' with specific reference to 'feasible alternative procurement arrangements'.

From this argument there emerges, then, a clear specification of a crucial, if not the crucial, information requirement for sensible policy choices: more refined estimates than have been available hitherto of the potential budgetary impact of alternative courses of action.

Elaborating on that assertion, the matters to be taken up in the final pages of this Chapter are

> In exactly what sense is there a need for more refinement in benefit estimation than has been available hitherto?
>
> How, in broad terms, should the assessment of the potential budgetary impact of alternative courses of action be approached?

Answering the first question calls for a brief critique of the claims concerning budgetary savings that have featured in the policy debate thus far. Answering the second means stating the essential argument of the present study's approach, which is aimed at the estimation of realistic values of 'discernible budgetary benefit' linked to 'feasible alternative procurement arrangements'.

Claims : A Critique

Dissatisfaction with existing estimates of budgetary savings has been expressed in more than one quarter. For example, Gardiner Tucker has observed that,

> '....there is nowhere a competent and discriminating assessment of the efficiency or inefficiency with which the forces of the Alliance are equipped or with which that

equipment is developed, produced and maintained.'

and, finding this unsatisfactory, Tucker has urged that

'....assertions and examples....need to be replaced with comprehensive data and discriminating analysis.'[24]

Citing this comment among others, the authors of NATO Standardization : Political, Military and Economic Issues for the Congress express the view that 'more rigorous economic analysis' would make it possible to produce 'more specific and realistic estimates of the military and economic benefits and costs of standardization'; and, in so doing, clearly imply that they would like to see it done.[25] In the General Accounting Office's January 1978 Report to the Congress on Standardization in NATO..., after a recital of some familiar claims, there is the caustic comment that

'....cost savings realizable....are, however, speculative. Such estimates as have appeared in print are not based on detailed analyses of empirical data. Studies of this type do not exist either in the United States or in Europe.'[26]

And in a perceptive paper, Arthur Smithies has pin-pointed the implications of the savings/participation linkage in noting that objectives may be 'politically attainable only through allowing the less efficient members of the alliance to participate in the production of at least some systems or components...[which]... can lead to higher costs'. 'The extent to which costs are increased', Smithies continues, 'depends upon the approach taken by the alliance to insure collective participation.'[27]

On investigation it turns out that the financial estimates under fire here appear to be based on data produced by the Department of Defense and incorporated in the Report

to the Congress on The Standardization of Military Equipment in NATO and Other Related Actions (submitted in response to Public Law 93-365 of August 5, 1974 which, among other things, directed the Secretary of Defense to assess the costs and operational penalties attributable to failure to standardize weapon systems, consumables and 'other military impedimenta' in NATO).[28] Some of the benchmark figures in this document bear a striking similarity to those which appeared in the much-publicised Callaghan Report.[29] It is impossible, however, to say whether the Pentagon used the analyst's numbers or vice versa; or indeed whether the correspondence is quite fortuitous. What is clear is that, because the official document was classified whereas the Callaghan study achieved a wide circulation, the 'estimated waste' figures postulated in the latter are the ones which have gained the greatest currency. This is significant because many of the qualifications and reservations to be found in the Report to the Congress are not acknowledged in the Callaghan assessment. Indeed, whereas the DoD's cautious calculation of annual estimated waste is $6.0 billion, Callaghan's is over $11.0 billion! (And this last figure is given with the comments that 'every effort has been made to under-state the estimated annual waste of defense resources' and 'figures of $15.0 billion to $20.0 billion could probably be sustained with better data'.[30])

For interest and information the evaluations made in these two sources are presented in Table 1 overleaf. There is a cryptic statement of the reasoning behind the entries in the respective 'Estimated Waste' columns in the Notes to the Table.

Table 1

SPENDING FOR THE DEVELOPMENT AND PRODUCTION
OF GENERAL PURPOSE FORCES EQUIPMENT FOR NATO

Estimated Annual Outlays in $ billions 1975

Item	US	Europe	Total	Est'd Waste
A. Department of Defense Calculation				
R & D	5.0	2.2	7.2	1.0[a]
Procurement	11.7	7.7	19.4	2.0[b]
Support	-	-	-	3.0[c]
Total	-	-	-	6.0
B. Callaghan Report Calculation				
R & D	5.0	2.6	7.6	2.6[d]
Procurement	12.0	7.0	19.0	2.95[e]
Support	-	-	-	5.65[f]
Total	-	-	-	11.2[g]

SOURCES: See Text

NOTES

a. Derived by reasoning that the European figure 'can be taken as an approximate theoretical measure of duplication' but that in practice a 'sizeable portion' of that figure could represent desirable or necessary duplication, so that 'a very rough estimate is that around half, or around $1 billion of the duplication is excessive'.

b. Derived by reasoning that 'based on the available examples, a reasonable estimate of the potential cost to NATO of producing non-standard equipment would be on the order of 10 per cent of the money spent annually on procurement'.

c. Derived by reasoning that 'support costs over a system's life will be about equal to the weapon's acquisition costs; therefore cutting acquisition costs up to the potential amounts mentioned....would eventually produce an equal annual saving of $3.0 billion in logistics costs'.

d. Estimated at 100 per cent of the European R & D expenditure.

e. Estimated at 10 per cent of the American procurement expenditure ($1.2 billion) plus 25 per cent of European procurement ($1.75 billion)

/Contd. foot of p.42

There is another 'guesstimate' that has been widely repeated in the standardisation debate, principally because of the presumed authority of its originator (or perpetrator). During 1974-75, General Andrew Goodpaster - Supreme Allied Commander Europe (SACEUR), 1969-74 - on several occasions expressed the view that lack of standardization led to a degradation in the effectiveness of NATO forces of 30-50 per cent. For example, writing in Survival (September/October 1975) he suggested that

> 'Lack of standardization, poor resistance to welding air forces into true centralized commands with common systems for their employment, absence of an "area logistics system" to enable ground forces to be used with adequate freedom of action, disinterest (sic) and opposition towards proposals for common procurement programmes - all this takes a toll of effectiveness which I have estimated as at least 30 per cent, and for some forces 50 per cent.'[31]

These figures were taken up, unreservedly and uncritically, in more than one forum. Moreover, they underwent a subtle mutation, turning up as measures of the benefits possible through improved standardization. In a prepared statement to a Congressional Committee Timothy Stanley, for example, observed that

> 'Various people have made different estimates of the savings which more efficient standardization, interoperability and economies of scale could produce. But I would take as reasonable that of former SACEUR General Andrew J. Goodpaster: namely, some 30 per cent.'[32]

NOTES to Table 1 continued from p.41 above.

f. Estimated at 10 per cent of the 'direct American annual NATO cost' ($0.40 billion) plus 15 per cent of European general purpose force expenditures per year ($5.25 billion).

g. Rounded down to 'more than $10.0 billion' throughout the Callaghan Report.

However, not only is this kind of transposition unwarranted the basic numbers themselves are suspect. Pressed for elucidation of their derivation, General Goodpaster informed Congressional researchers (in January 1977) that his estimate was worked out in terms of logistic support and constraints alone, based on exercise data (especially study of the Allied Command Europe (ACE) Mobile Force) which suggested that

> 'maintenance of separate national lines of support reduced by 30-50 per cent the support which could be provided to field forces working against a fixed logistics capability.'[33]

Be that as it may, the figures have been widely used. Indeed they continue to be quoted, seemingly gaining credence with repetition.

What is it about computations of this sort that makes them unhelpful for the policy purpose or purposes currently at issue? In the first place there is the simple fact that they were done for quite different purposes. This is neither a frivolous nor a trivial point. It would be wrong, for instance, to brand the Callaghan calculations as 'incompetent and undiscriminating' (to echo Tucker's comment), given their setting: an essay in persuasion in which the author was more concerned with atmosphere than arithmetic. Similarly, it would be unfair to castigate the Pentagon's work for its lack of rigour when the requirement was for no more than a crude first estimate of how things might be if circumstances were completely different. (As for General Goodpaster, perhaps he is guilty of no more than having tolerated unjustifiable exaggeration in a good cause.)

In the second place for any area of endeavour speculative statements about the expense of present practice measured

against that of some ideal state of affairs are invariably a poor guide to the financial benefits actually attainable from change. You start from where you are; and you do not, in normal circumstances, have complete freedom of manoeuvre. (That the word 'achievable' features in Directive 2010.6 is hardly accidental.)

More specifically, any assessment of budgetary benefit designed to inform policy choice in the circumstances described in this Chapter must acknowledge that

- since NATO members have defence programmes-in-being (with associated budgetary targets) the margin for manoeuvre is severely limited;

- other constraints obtain because, (1) national R & D efforts are only 'negotiable' to a limited extent in the fashioning of transnational procurement arrangements and (2) the scope for logistics savings is strictly limited in any step-by-step approach to acquisition of common weapon systems;

- even in the field of production economies, generalised statements about notionally obtainable benefits of scale economies and least-cost production are misleading for - to repeat Arthur Smithies' words - what is attainable in this respect 'depends upon the approach taken....to insure collective participation'.

The last of these considerations is perhaps the most fundamental. All the critics' remarks about 'comprehensive data', 'discriminating analysis', 'specific and realistic estimates', the need for reference to 'empirical data' and the importance of attention to what is 'politically attainable' are to the point in precisely this connection. What the illumination of policy options requires is empirically-based and 'differentiated' quantification: to indicate what budgetary benefit might accrue if a

particular set of national equipment needs were to be met by a specific mode of acquisition that would make some economies accessible (but might, of course, by its very terms preclude others).

The Essence of the Approach

In summing-up it remains to cast in more positive and definite terms the conclusion to which the foregoing critique has led.

The benefit measurement problem to which this study is addressed is: how to generate policy-relevant estimates of the potential impact on NATO members' budgets of alternative course of actions contemplated or proposed for the fulfilment of the objectives to which the United States (with its allies) has registered commitment? Such estimates are necessary to assist in setting policy priorities and, in particular, for deciding <u>where</u> initial effort should be applied and <u>how</u> the goals might be attained.

As has just been argued that calls for more refined estimates than have hitherto been available. Generalised assertions that at the end of the rainbow labelled 'standardisation' there is a pot of gold worth $6-10 billion afford no guidance whatever when it comes to deciding - in the absence of a yellow brick road - which of a number of feasible routes to take from <u>here</u>.

The refinement required encompasses the following,

- estimation which takes as its benchmark the actual expenditure profiles for member nations over the next several years (on which more in Ch. 3 below).

- estimation which speaks to the 'achievability' problem, first, by gauging the area within which armaments co-operation policy options are not effectively foreclosed (e.g. because planning has gone beyond the project definition/ feasibility study stages of the procurement cycle); and, secondly, by having regard to the unwillingness of nations to countenance acquisition strategies involving irrevocable sacrifice of R & D capabilities and the inability of the Alliance as a whole to achieve sizeable logistics savings by piecemeal progress towards commonality of equipment.

- estimation which, in the production economies area, uses such empirical evidence of scale economies and comparative costs as there is to derive values for economically attainable benefits; and at the same time uses that evidence with discrimination - that is, having due regard to feasible alternative acquisition strategies - in order to derive values for politically attainable benefits.

This does not, to be sure, amount to the full specification of all costs and benefits that rational choice requires. It does not, for example, cover those other areas whose values enter the policy reckoning - the area of socio-economic/industrial concerns and the military-operational domain. But it does permit incorporation in the decision-making process of necessary if not sufficient information for affirmative action in pursuit of standardisation and related goals.

Such is the essence of the approach outlined in this study. The proposed benefit measurement procedure is specified more completely and precisely in the next Chapter.

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Chapter 3

THE ANALYTICAL APPROACH

The purpose of this short Chapter is to develop the points made in the closing paragraphs of the preceding one. An attempt was made there to convey the essence of the approach to budgetary benefit measurement that this study advocates. In what follows the aim is to specify more completely and precisely the method of assessment envisaged and to discuss, briefly, the information required to exercise it.

METHOD OF ASSESSMENT

The procedure suggested comprises three stages dealing in turn with the budgetary setting, the evaluation of possible production economies, and the generation of alternative (or differentiated) estimates of attainable benefits under feasible procurement arrangements.

The Budgetary Setting

Clarification of the budgetary setting is the obvious point of departure for any budget impact assessment. For present purposes this means examination of the expenditure projections associated with NATO member nations' defence programmes-in-being; and, in particular,

identification of intended resource allocations to procurement of major systems. This is not merely a matter of defining the context for impact analysis. More important than that, data on current and planned outlays establish the benchmark(s) against which to measure cost reduction opportunities. It could be argued, of course, that any economy is worth having (other things being equal). Certainly the absolute value of savings is not irrelevant. However, in discussing the policy context the importance of early evidence of progress towards set goals was noted. Without this, the argument ran, credibility and confidence in the United States' (and the Alliance's) seriousness of purpose would be questioned. That puts a premium in policy implementation on measures holding out the promise of budgetary benefits which would amount to a sizeable, rather than trivial, slice of overall expenditures on defence equipment; or at least on measures whose pay-off in reduced costs might be comparatively large in relation to the procurement line to which they apply. Put bluntly, there are unlikely to be glittering prizes for the official who advocates disruptive policy innovation to effect a 5 per cent saving on an item which accounts for 0.001 per cent of aggregate spending.

Equipment expenditure projections prescribe the outer limits of the area within which savings can be sought. But clearly the effective zone of discretion is far less extensive. Attainable savings lie within bounds set by those procurement plans for which acquisition strategy options remain open. In practice, that means among armaments plans which are at the concept study, feasibility study or project definition stages. Where work has proceeded to development, and a fortiori where production is underway, options for change have been effectively foreclosed. There is therefore a second aspect to

portrayal of the budgetary setting: analysis of Alliance armament plans to define the 'effective zone of discretion' - both how extensive it is and precisely where it is.

Summarising, what this first stage of the suggested method involves is:

> Stage 1 Construction of total budget and procurement budget profiles to provide benchmarks against which cost reduction opportunities can be measured and to expose where armaments planning has not foreclosed acquisition strategy options.

Production Economies

As defined in the previous Chapter the benefit measurement problem with which this investigation is concerned does not require comprehensive assessment of all the conceivable impacts on defence budgets of an infinite range of policy possibilities. Direct budgetary benefit is the focus of interest; and it is what is attainable that matters.

Two things follow from this. First, it is admissible to omit speculation about savings on research and development (R & D) expenditures, other than pre-production outlays in the final stages of what may be nominally designated as development. This is a simplification, but a justifiable one. It seems reasonable to assume that no co-operative procurement arrangement will commend itself that irrevocably commits participating purchasers or partial co-producers to that same status for all time. Hence no nation with competence in a specific area of military technology is likely to be induced to abandon its investment altogether. In short, R & D efforts

cannot be considered seriously 'negotiable' in these transnational affairs. Nor is it evident that this would be desirable from the wider NATO viewpoint. Whatever may be the merits of equipment acquisition strategies based on specialisation in production, they emphatically do not apply to R & D where much duplication, far from being wasteful, has its own value. Certainly a stifling of intellectual competition in pursuit of innovation would inhibit technological progress. This is true in general terms; there is also abundant evidence of particular innovations which might have been frustrated if, for example, R & D leadership in the relevant domain had earlier been ceded to the single nation with apparent dominance. The conclusion is: states will continue to spend on R & D in some measure regardless of how production is structured, and this may not be disadvantageous. What rationalisation can be about in this area is the more telling use of funds; it is unlikely to be the justification for significantly lower appropriations.

Secondly, it is unrealistic - and therefore, for the purpose of this methodological exercise, unnecessary - to include potential logistics savings in partial analyses of budget cost reduction opportunities. The reasoning is straightforward. Pay-offs cannot be expected to arise piecemeal with gradual growth in the number of standardised systems. In fact, wherever the single opportunity to create a large-scale multi-national support apparatus for a particular system does arise overall costs are more likely to go up than down, for only exceptionally can national logistics organisations be expected to effect savings sufficient to outweigh the expense of the new joint facility. If ever commonality of equipment came to obtain more or less across-the-board it would be a different matter. To cling to the NATO

precept that 'logistics is a national responsibility' would then be nonsensical and a radical reorganisation of combat support would be a practicable possibility. But that is not going to happen - at least not for a long time - and there is nothing to be gained by doing the sums as if it were. (This may also be the point to enter a reservation about the possibility of logistics savings *pari passu* with acquisition cost savings, based on the rough-and-ready 'rule' that life-cycle support costs equal procurement cost. Regard for this 'rule' has envisaged use of estimated procurement savings as a proxy for achievable logistics savings without addressing the functional relationships determining support expenses. If acquisition costs fall because of production economies, what *is* the basis for presuming that outgoings for logistics - apart from those on parts - can be reduced similarly?)

It is one thing to say that assessment of cost reduction opportunities can legitimately focus on production expenditures; it is quite another to find valid bases for gauging *ex ante* the likely size and character of the production economies. However, a working procedure can be devised. Moreover, it can be based on empirical evidence, a review of which is included in Part C below (Chapter 7). From this material one can derive *cost reduction factors* to indicate the percentage reductions in the inputs bill for a given procurement line (or equipment area) which might reasonably be expected under different acquisition strategies. This is not the place to confront all the technical problems that calculation of such factors raises. Suffice it to say that the conclusion reached in Part C is that it should be possible, especially if the readily available evidence can be augmented by data from defence's internal and industrial sources.

The attempt itself is illuminating anyway, clarifying as it does the sources of production economies. Casual allusions to economies of scale, learning curves, common least-cost production and the like abound. It is instructive to perform some rigorous, even though elementary, economic analysis in order to facilitate clear thinking about exactly what the possibilities are. In the simplest possible case two sources of economies can be distinguished.

- Cost conditions within plants in a given industry in a particular country may be such that at higher levels of output unit costs would be lower. Expansion yields cost savings. This is a straightforward reflection of the familiar assumptions about costs made by economists in drawing L-shaped or U-shaped long-run average cost (LAC) curves. Unit cost reduction occurs because of economies of scale and/or learning. (It is difficult, if not impossible, to separate the two because some cost reductions arising in large-scale operations may derive from learning and some reductions attributed to learning may just be consequences of scale. This does not mean that the terms are interchangeable however. Scale refers to level of output per unit of time. Learning is a phenomenon related to the length of the production run (in output units).)

- In any one country costs may be lower than in another country, for all - or maybe only some - levels of output, in general or perhaps only in specific plants. There are therefore possibilities of cheaper production by switching to the lower-cost source.

These possibilities can be expressed graphically, as has been done in Fig. 4 overleaf.

It should be added that the switching referred to under the second heading here is to a lower-, or least-, cost source as indicated by the relative positions of the countries' respective LAC curves. What these show is

SOURCES OF PRODUCTION ECONOMIES

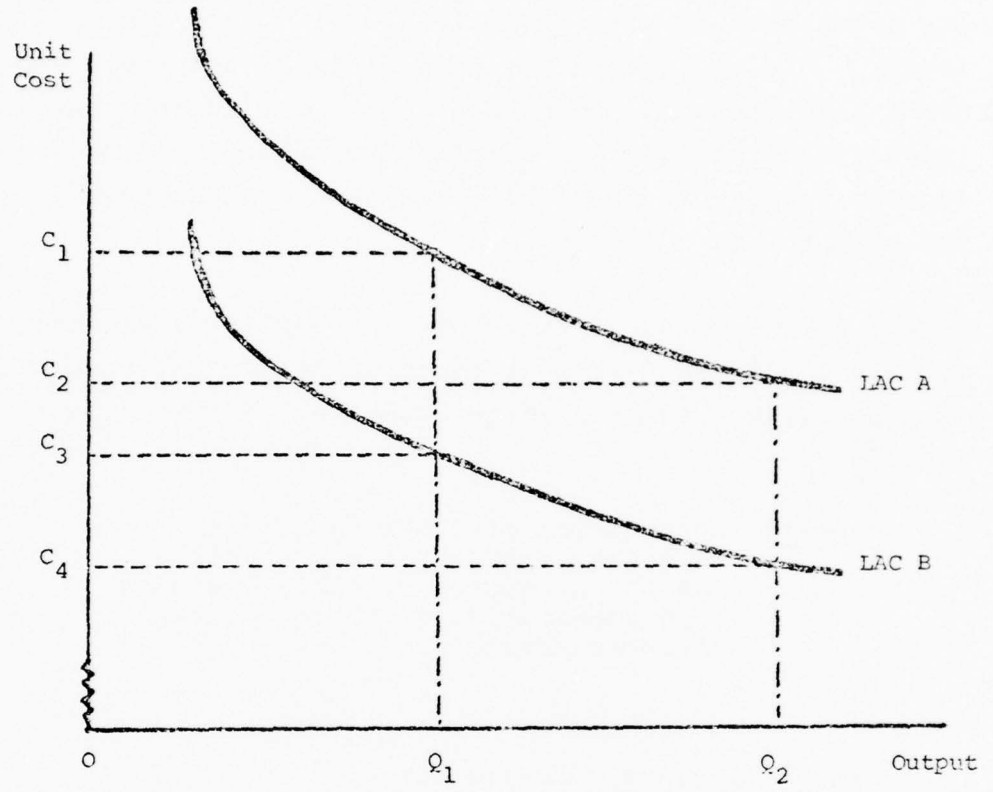

Fig. 4

Expansion of output from OQ_1 to OQ_2 on LAC curve A in Fig. 4 would yield a reduction in unit cost from OC_1 to OC_2. This is the first case (source) distinguished in the text. Switching production from LAC curve A to LAC curve B (another country) would make possible production of the original output, OQ_1, at average cost per unit OC_3. This is the second case.

Perhaps of greatest interest, however, are the possibilities raised by a switch to the lower-cost producer which is associated with (or permits) expansion of that country's output. In the diagram this is illustrated by the indication that on LAC curve B the production of OQ_2 could be achieved at average cost OC_4.

(For a fuller exposition see Chapter 6).

the absolute (cost) advantage of the cheaper producer. Opportunities for trade based on comparative advantage are another thing altogether (and will be dealt with later). It is necessary to stress this, for there has crept into the standardisation debate a slipshod use of 'specialisation based on comparative advantage' and 'common least-cost production' as though these meant the same thing. They do not.

To sum up: the second stage of the benefit assessment procedure envisaged in this study is one which, concentrating on production economies (for reasons given earlier), entails:

> Stage 2 Derivation of 'cost reduction factors' from empirical evidence on the economies of scale/learning and comparative costs in principal systems areas.

Differentiated Benefit Estimation

Setting priorities for policy implementation in armaments co-operation with standardisation in mind may be assisted by the inspection of budgetary data and procurement schedules alone. Certainly the most obviously unpromising areas should be identifiable from such information. Empirical evidence on production economies likewise may have a contribution to make in its own right. In any specific systems area, for instance, absence of significant differences among NATO countries in the positions of relevant cost curves and/or the existence of curves which are horizontal over relevant ranges would constitute strong prima facie evidence that neither specialisation in production nor the institution of elaborate co-production arrangements would be likely to yield substantial budgetary benefits. Nor should there be reluctance to reject policy

options on the strength of such tests. Rather the contrary: for answering the question 'where should initial effort be applied?' they might be invaluable in eliminating unattractive options, thus narrowing down the area within which further analysis is necessary.

Having said that, however, the need for elucidation of more complex cases remains. The third stage in the benefit measurement method addresses this problem, with particular attention to the other policy-relevant issue: that in deciding how objectives might be pursued decision-makers must strike a balance between the obligation to secure participation on the one hand and the desirability of tangible budgetary pay-offs on the other.

The essence of the problem is obvious enough, and familiar. It might be demonstrable that one nation is more efficient than all others in the manufacture of some system (or sub-system) and that were this producer to manufacture the Alliance's total predicted requirement for the equipment over a specified period further economies could be obtained. In such circumstances specialisation - allowing production at this single source - would maximise budgetary benefits. However, that mode of procurement might be politically unattainable because of its implications for purchasers, who would have to acquiesce in the rundown of their own productive potential. What might be politically attainable is some other formula: say, a complex co-production arrangement incorporating an elaborate matrix of single- and multi-source sub-system production elements and - depending on the case - two, three or even more final system assembly facilities (as in the F-16 programme, for instance). But that mode of acquisition would offer a lesser potential for production economies and thus mean forgoing budgetary benefits. So too would any other method; and there is an almost infinite number of possibilities

given the scope for varying the exact configuration of multinational procurement formulae.

This is a simple, even trite, illustration. But it highlights the fundamental policy predicament: the savings/participation trade-off problem. The fact that the range of possible acquisition methods is extensive, including variations on all the principal modes listed - with an indication of their potential for production economies and their attainability 'rating' - in Fig. 5 overleaf, does not affect the nature of this problem.

But what of benefit measurement? Does not elucidation of the savings/participation trade-off necessitate a comprehensive (exhaustive) listing of the budgetary benefits that would accrue to each of the multiplicity of procurement policy possibilities that are imaginable for fulfilment of some shared system requirement? Formally, one might argue, it does; in which case the problem would be intractable. It can be rendered manageable, however, because discussion of the policy context has shown that in any given case only a limited number of acquisition strategies can be considered feasible. That number may be large, it may be small: it is impossible to generalise. What can be said is that, as in any cost-benefit calculation,

- it should be possible to define the feasible range of options fairly readily (for example, by inspection of key characteristics);

- it should then be possible, by coarse calculation if necessary, to identify those courses of action within that set which seem to merit more detailed analysis;

- information can then be displayed for decision-makers in the form of 'if.... then....' statements, which in the present setting would

SELECTED ACQUISITION METHODS		
Mode	Potential for Production Economies	Rating on Political Attainability
Full, unconstrained Specialisation (e.g. free trade)	Very High	Very Low
Partial, managed Specialisation (e.g. 'Family of weapons' concept)	Fair	High
Sub-system Specialisation	Fair	Fair
Licensed Production (e.g. AV-8, Roland)	Fair-Low	Fair
Bilateral, Trilateral, Multilateral Collaboration (e.g. Tornado)	Fair-Low	Fair-High
Simple Co-production	Low	Fair
Complex Co-production (e.g. F16)	Low	Fair
Independent National Effort (numerous instances)	Very Low	High

Fig. 5

(This diagram is reproduced, as Fig. 11, in Chapter 9 below where the several acquisition methods listed are described and some argument is offered in support of the entries in the right-hand column.)

be statements expressing the budgetary pay-offs associated with specific feasible procurement arrangements.

It is the juxtaposition and systematic comparison of such statements which, of course, sheds light on the substance of the savings/participation trade-off. That is to say, a statement might take the form:

> If a particular co-production arrangement were adopted for acquisition of (say) a common mechanized infantry combat vehicle (MICV)
>
> then, compared with separate national production (or some other envisaged scheme), the budgetary impact over a designated procurement run would be:
>
> a saving (benefit) of ..$1.5 billions..
>
> or an additional expense of .....

This lends itself to interpretation as a $1.5 billion price tag on non-co-operation, compared with the designated alternative mode of acquisition.

It goes without saying that neither in this case nor any other could such information be regarded as decisive. As has been noted, whether $1.5 billion would be rated a worthwhile benefit in relation to the social and industrial consequences of adopting the co-production scheme is a matter of judgement. Similarly, were the calculation to yield an additional expense of, say, $1.0 billion, the question would be: would the military (and any other) benefits from the possession and operation of a standardised MICV be worth this extra outlay (on the assumption that only by adopting the specified co-production formula requiring this expense could standardisation be assured)? In short, the assessment of attainable budgetary benefit in different circumstances is a contribution to better-informed policy choices and emphatically not a substitute for political judgement.

Giving content to the 'if.... then....' statements that have been described requires, it will be apparent, not only identification of the 'feasible alternative procurement arrangements' on which information may be useful but also application of appropriate cost reduction factors to benchmark budgetary data. In other words, at the third stage of the assessment there is an integration of

- information about trans-national procurement opportunities as identified by inspection of budget data and armaments planning schedules;

- information about the savings potential which empirical evidence, as summarised in cost reduction factors (or other measures), suggests may be realisable on different assumptions about the organisation of production;

  and

- information about the candidate acquisition strategies that merit consideration.

The result, however, is differentiated measurement of the potential budgetary impact of plausible routes to the designated policy goals. The third stage involves, in short,

> Stage 3 Generation of alternative (or differentiated) estimates of attainable budgetary benefits under feasible procurement arrangements based on the application of 'cost reduction factors' (Stage 2) to benchmark data (Stage 1).

Table 2

INFORMATION REQUIRED

There would be little merit in developing an assessment procedure appropriate to a particular policy purpose if there were no prospect of acquiring the information necessary to exercise it. The elaboration and provisional testing of the suggested method in later Parts of this study confirms that sufficient information for at least a preliminary demonstration of its possibilities is obtainable (or, where the exact data required cannot be brought to bear, acceptable proxies can be found). Even so, it is useful at this juncture to review data requirements and to pinpoint actual or potential sources of relevant information. In this way the Chapter stands as a reasonably self-contained statement of the method.

Budget Data and Procurement Schedules

Most of NATO's member nations use planning, programming and budgeting systems of one sort or another. Thus there exists for each state a defence programme-in-being, with associated budgetary projections. In a few there is even a forward-looking functional analysis (output budget), though where these are compiled officials are usually at pains to point out that beyond the immediately forthcoming financial year or years the figures should be regarded as no more than rough approximations. Projections of intended spending on major inputs are made too, being the counterparts of national manpower and armaments planning decisions.

Such national information is the only source for definitive and detailed budgetary data. However, for the purpose of establishing the total outlays each country envisages and appraising the salience of equipment spending within these planned expenditure totals, use can be made of the financial

data which member nations are required to submit to NATO in their annual Defence Planning Questionnaire (DPQ). This has the additional merits of being standardised (up to a point) and authoritative within the Alliance. The series of particular interest are,

- the basic defence expenditure series (NATO definition) which most, but not all, countries submit up to a 3, 4, or 5 year distant planning horizon. (Thus the 1977 DPQs contain information on expected spending to either 1980, 1981 or 1982 for at least half the members; but five or six reveal intentions only for the immediately forthcoming financial year.)

- the series showing planned spending on major equipment (input category 2x in the NATO format). In general the horizon for this series is the same as for the basic expenditure series.

What would improve the method, and doubtless please NATO's Assistant Secretary-General for Defence Planning and Policy, is conformity among the Allies in furnishing data for the medium-term.

Information on particular procurement plans is also solicited in the annual DPQ. Unfortunately there is no consistency in the pattern of members' responses. The Federal Republic of Germany is the only country which produces detailed cost/quantity data i.e. information on the numbers of particular items which it is proposed to acquire, over what period, <u>together with the forecast and budgeted total procurement cost</u>. If such material were available across-the-board it would be ideal for the purpose of the present exercise (especially if proposed production rates were explicitly stated rather than having to be inferred). It should be an aim of the Alliance to induce others to disclose their intentions in this fashion, if 'coalition-mindedness' is to mean anything. But, for

the time being, only national defence ministries - or the intelligence community - can provide definitive detail on the financial aspects of procurement. (The format used in the Federal Republic's DPQ is illustrated in Ch. 4).

The broad shape of nations' procurement intentions is communicated to NATO however; and, for the purpose of identifying the zone of discretion within which there might be opportunities for the establishment of multi-national acquisition arrangements, this is all that is necessary. The information required - it will be recalled - concerns the scope and status of member nations' armaments plans, the argument being that procurement strategy options remain open only for projects which have not yet passed from the project definition stage into development. (This may be too stringent a definition, given that in the past schemes for multinational production have occasionally been constructed around a system already developed in one participating country. It is a simple matter to relax the constraint, however.)

The requirement is satisfied by the schedules which NATO has recently begun to compile under the aegis of the Conference of National Armaments Directors (CNAD). As has been widely reported, one of the responses to early pressure for rationalisation of allied defence efforts was a proposal for establishment of a Periodic Armaments Planning System (PAPS). The feasibility of such an innovation was examined by the CNAD which concluded (in 1977) that, although full co-ordination of defence equipment planning should remain the Alliance's long-run aim, introduction of a fully-fledged PAPS might be premature. At the same time the case for trying to improve prospects for standardisation (and interoperability) in the shorter

term was duly acknowledged. The CNAD accordingly instituted, among other things, a systematic review of national defence equipment plans.

This undertaking has been designated the NATO Armaments Planning Review (NAPR, for short) and at the time of writing is still in its Trial Phase. Within the framework of the exercise, however, the CNAD has begun the regular collation of national equipment (replacement) schedules. These are constructed according to a format originally devised by and for the Independent European Programme Group (IEPG). In fact, the Consolidated NATO Defence Equipment Schedules produced to date use information initially prepared for the IEPG, together with compatible schedules provided by Canada and the United States. The significance and value of the NATO compilation, from the standpoint of gauging the zone of discretion within which armaments co-operation options remain open, is that it is authoritative within the Alliance and comprehensive; but, most important, it records the 'current national procurement status' for all equipment plans reported. (The format used in the Consolidated Schedules is illustrated in Ch. 5).

Evidence on Production Economies

For Stage 2 of the benefit measurement procedure what would ideally be required is a body of empirical evidence about cost conditions in defence-related industry (broadly-defined) throughout the North Atlantic Alliance. Sufficient information would be needed to distinguish among outputs at least to the level of detail found in the NATO equipment schedules just mentioned - which is nominally 83 items (of which several require sub-division to be meaningful for industrial cross-reference and one is in any event a

'miscellaneous' category). To have real value, however, even this would be insufficient; for among potentially feasible acquisition strategies there are many based on exploitation of the international division of labour at the sub-systems and components level. And whether the availability of empirical data on costs affording even this sort of detail would be completely satisfactory is open to doubt. Military production is often breaking new technical ground, where the past may not be a reliable guide to future possibilities. In addition it is apparent that if, for example, nations opted for single-source production of a familiar product formerly manufactured piecemeal among them this might imply a scale of output beyond any experience and beyond any reliable prediction based on experience. The conclusion is: pursuit of the ideal is a wild goose chase.

However, this does not mean that it is necessary to rely exclusively on judgement, i.e. intuition, or on a handful of examples which might be atypical. Still less does it mean that it is necessary to resort to blind faith: 'since everyone talks about the cost reductions that should be obtained there must be some'. There <u>is</u> a limited amount of econometric research work on the production function. Some empirical data <u>does</u> exist on cost-output relationships in American and European manufacturing industry and on the concept of minimum efficient scale in different lines of production. In addition there <u>are</u> studies of international competitiveness which can shed light on the potential gains from trade liberalisation in the defence equipment field. It is simply a matter of, first, surveying this body of knowledge, noting not only conclusions drawn from defence-related industry but also whatever insights studies of non-defence industries might afford, and then bringing the results to bear on the problem at issue.

So far as the first of these tasks is concerned two surveys of the relevant literature have been conducted especially for this study. Each is of interest in its own right and the surveys are therefore appended to the main body of this text. It should be stressed, however, that the work is based exclusively on the open literature. It seems possible, indeed likely, that a substantial amount of material exists within the United States' and other allies' procurement organisations which could usefully be scrutinised in a similar fashion. There is certainly a limit to the weight of inference and prediction which the evidence compiled and reflected upon for this study should be asked to carry.

As for the second task, which is to render the results of the specially-conducted surveys into a form suitable for use within the framework of the assessment method, the device required is some encapsulation of the key conclusions about cost-output relationships and the concept of minimum efficient scale. In Chapter 8 the notion of cost reduction factors is developed for this purpose.

Feasible Procurement Arrangements

What needs to be known about feasible procurement arrangements, to implement Stage 3 of the proposed procedure, is not something which can be specified in advance. The essence of the earlier argument about provision of information to decision-makers on the potential budgetary impact of alternative modes of acquisition is that for any given case there is an almost infinite variety of imaginable possibilities but only a limited number of participation options that are likely

to be viable. In line with the practice in most public sector policy appraisal using cost-benefit analysis, the only sensible procedure in such circumstances is to require the decision-maker to select from among the many theoretically feasible options the few practically possible courses of action among which choice will in fact have to be made. The analyst can offer to conduct coarse calculations over a large number of possibilities, as a preliminary aid to choice. Indeed it should be possible to devise rules of thumb which could be of value in this connection. (For example, in co-production arrangements, what is the likely relationship between the (algebraic) size of the budgetary benefit and the number of participating states?) None of this, however, should detract from the essential point: that the decision-maker facing a choice should be able to solicit information to assist in making that choice in whatever form best meets his (or her) needs. An array of statements, of the kind,

> If course of action n were adopted,
> then benefits would be:
>
> ...(+) or (-) $x..

will usually serve the policy purpose best.

It might be argued that this does not meet the need of the policy adviser who, before matters reach the point of imminent choice, is charged with identifying the alternative courses of action that seem most likely to yield desired outcomes so that these can be actively canvassed. It should be apparent, however, that the procedure called for is essentially the same. The adviser is required, in effect, to simulate the decision process. That is clearly the obligation when facing the dual problem identified earlier:

WHERE should initial effort be directed in pursuit of standardisation and related goals?

and

HOW should the objectives be pursued; by promoting which acquisition strategies, in which areas?

The answers can only be found after inspection of an array of 'if.... then....' statements cast in precisely the form specified above.

CONCLUSION

It would be tiresome to try to recapitulate the argument of this Chapter in a few concluding sentences. At the same time some summary statement is required, of the method of assessment elaborated in the first section and the information requirements discussed in the second. Such a statement is provided in Fig. 6 overleaf. That tabulation also serves as a guide to the remaining Parts of this study, which address in turn the budgetary setting, the estimation of production economies and the budgetary impact of alternative equipment acquisition methods.

MEASURING CERTAIN ECONOMIC BENEFITS FROM INCREASED NATO STANDARDISATION : SUMMARY		
METHOD OF ASSESSMENT	INFORMATION REQUIRED	DECISION-MAKER POLICY/ADVISER
Stage 1 Construction of total budget and procurement budget profiles to provide benchmarks against which cost reduction opportunities can be measured and to expose where armaments planning has not foreclosed acquisition strategy options.	(a) Defence Expenditure Series Major Equipment Series (NATO DPQs) (b) Future Procurement Plans (NATO Consolidated Equipment Schedules) [National Data : Intelligence Services]	Rejection of - unpromising areas - areas where options are foreclosed
Stage 2 Derivation of 'cost reduction factors' from empirical evidence on the economies of scale/learning and comparative costs in principal systems areas.	Empirical Data on: - cost/output relationships - minimum efficient scale - international competitiveness (Surveys: Appendices I and II) [Internal sources : Industrial Sources]	
Stage 3 Generation of alternative (or differentiated) estimates of attainable budgetary benefits under feasible procurement arrangements based on the application of 'cost reduction factors' (Stage 2) to benchmark data (Stage 1).	Benchmarks (from Stage 1) Cost Reduction Factors (From Stage 2) Feasible Arrangements	Selection of alternative arrangements for detailed analysis

Fig. 6

PART B THE BUDGETARY SETTING

Chapter 4

PROCUREMENT IN SELECTED NATO COUNTRIES' BUDGETS

The subject matter of Part B is the budgetary setting. There are two aspects to be considered. The first is the salience of equipment expenditures in NATO member nations' defence budgets, and is dealt with in this Chapter. The second - taken up in Chapter 5 - is Alliance members' armaments plans for the 1980s and beyond, with special reference to those whose status is such that acquisition strategy options remain open.

The scale and significance of NATO countries' current and planned expenditures on equipment invite attention for a number of reasons. It is clearly useful to establish the context of the budget impact analysis which is this study's main preoccupation. It is of particular interest to gain a sense of the size of the cost reductions which standardisation and related initiatives would have to achieve in order to make a discernible impression on total defence spending. In this sense ascertaining the scale of resource allocations to procurement of major systems creates a general benchmark against which cost reduction opportunities can be measured.

It would be helpful if one could go beyond this to identify, for each individual NATO member (and hence the Alliance as a whole), the financial provision made for procurement in each major equipment area. That would enable particular benchmarks to be defined with which estimated savings

from specific system acquisition options would be directly comparable. This aim does not appear to be realisable however. One or two countries do submit to NATO full information on the number of systems they plan to buy, over what period and at what forecast and budgeted cost. But most do not. Moreover many might find it difficult. In more than one nation such is the domestic political atmosphere that defence ministries are unwilling to communicate their procurement intentions beyond what they have asked their Parliaments to sanction. That does not mean that the necessary information might not be forthcoming - on a privileged basis - for in-house analysis on the scope for armaments co-operation, either within the Department of Defense or under the aegis of a NATO-wide armaments planning system (cf. Ch. 5 below). It does, however, pose a problem for the present exercise.

In fact there is a general difficulty, encountered not only here but also elsewhere, which it is worth a brief digression to explain. The aim of this study is to devise and describe a policy analysis methodology, and to demonstrate it. Care has been taken to avoid the waste of effort involved in framing a procedure whose information requirements could not possibly be met. But circumstances arise where the position is more ambiguous. After initial 'devising and describing' it turns out that data are required which, although not readily available, are thought likely to be obtainable or are known to exist in classified sources. This means that 'demonstration' must be incomplete or inhibited. What should be done in such circumstances? Should the suggested approach be modified to make it free of this sort of dependence? Or is it preferable to persist with the preferred procedure, accepting that this precludes definitive demonstration and compels resort to limited, stylised indication of how the method might be applied and what results might emerge?

The dilemma is a real one and not unfamiliar. It has been resolved in this work by allowing the obligation to develop a sound and appropriate methodology to prevail. The main consequence is that, having aspired to 'prove' the system in this and certain other Chapters, it has been necessary to settle for partial, preliminary and provisional demonstration. There is more 'this is what might be done' and less 'here is what can be done' than originally intended.

THE SCALE AND SIGNIFICANCE OF EQUIPMENT EXPENDITURES

The problem occurs even with such an apparently uncomplicated matter as registering the scale and significance of intended equipment expenditures within NATO members' budgetary projections for the short- and medium-term.

Data about the past cause little difficulty; and figures on the share of defence expenditures taken up by major equipment purchases, 1973-77, are given in Table 2 overleaf. The information is as provided to NATO under the annual Defence Planning Questionnaire (DPQ) procedure, which explains why even this table's coverage is incomplete. For some time and for their own good reasons, France and Greece have not participated in this annual routine and Turkey ceased to do so in 1975. (Iceland is not covered because it has no defence organisation.)

However, interest lies in current and planned spending on equipment. What of future intentions? Inspection of the national submissions to the 1977 DPQ exercise reveals that there is no uniformity about data provision. Leaving aside France, Greece, Turkey, Iceland and also Luxembourg (whose defence effort is miniscule), there

Table 2

MAJOR EQUIPMENT EXPENDITURES AS
A PROPORTION OF DEFENCE BUDGETS

Percentages

	1973	1974	1975	1976	1977
Belgium	8.4	8.8	9.1	11.1	10.3
Canada	7.3	5.9	6.3	8.0	9.1
Denmark	17.2	19.3	19.0	19.4	17.3
FRG	12.1	11.9	11.8	13.2	13.3
Italy	15.2	15.2	13.9	13.1	14.0
Luxembourg	1.3	2.4	1.0	3.4	2.9
Netherlands	11.2	13.2	15.6	15.2	18.2
Norway	11.7	13.4	14.4	13.3	16.6
Portugal	4.5	3.1	1.9	1.9	2.2
Turkey	4.9	5.0	3.0	-	-
UK	19.3	17.2	19.3	20.6	21.8
USA*	(12.3)	(12.0)	(11.8)	(12.2)	(13.0)

Source: NATO * Two-thirds actual proportion (see text)

are TEN national presentations of financial information
The pattern of coverage is set out in Fig. 7 (overleaf)
It is clear that, notwithstanding the privileged nature
of the Alliance forum, countries do not as a general ru
include in the financial sections of their DPQs any
information - even about aggregate expenditure on major
equipment - which has not already been submitted to, if
not approved by, national legislatures. (Among other
things this state of affairs prompts the observation
that standardisation in statistical reporting to NATO
would be a good place to begin if the organisation
seriously wishes to bring greater coherence and rationa
to the allocation of resources.[1])

COVERAGE OF FINANCIAL DATA IN DPQs, 1977.

x Figure supplied : - no Figure available

Fiscal Year beginning in	Defence Expenditure					Major Equipment (2x)				
	1978	1979	1980	1981	1982	1978	1979	1980	1981	1982
Belgium	x	-	-	-	-	x	-	-	-	-
* Canada (a)	x	x	x	x	x	x	x	x	x	x
* Denmark	x	x	x	x	-	x	x	x	x	-
* FRG	x	x	x	x	-	x	x	x	x	-
Italy	x	-	-	-	-	x	-	-	-	-
* Netherlands	x	x	x	x	x	x	-	-	-	-
Norway	x	-	-	-	-	x	-	-	-	-
* Portugal	x	x	x	x	x	x	x	x	x	x
* UK (a)	x	x	x	-	-	x	-	-	-	-
* US (b)	x	x	x	x	-	-	-	-	-	-

Note: (a) Fiscal year is April-March
(b) Fiscal year is October-September
(All others: fiscal year is calendar year).

Fig. 7

It should now be apparent why 'Procurement in Selected NATO Countries' Budgets' is the title of this Chapter. Because it is current and planned spending on equipment that is of interest there is little merit in evading the problem of inadequate data about the future by simply looking back, basing judgements exclusively on what the share of equipment in national budgets has been in the past. Better to extract what one can from the material that is available - albeit having resorted to several assumptions - in order to indicate the nature of the calculations that might be made and the inferences that might be drawn therefrom. This can be done with reference to the SEVEN countries whose entries in Fig. 7 are marked with an asterisk; that is, for the NATO members who have intimated at least some information concerning their expenditure plans beyond 1978.

For illustrative purposes a simple analysis has been made of the budgetary position for these selected countries. Use has been made of

- the hard data, such as it is, extracted from their 1977 DPQs;

- estimates/extrapolations, based on fragmentary evidence from other sources or - in the absence of any such supplementary guidance - straightforward assumptions

  (1) that total defence expenditure might rise by 3 per cent per year.

  and

  (2) that the budget share of major equipment outlays in years for which no figure is available might correspond to the average share in preceding years,

  both of which are (in present circumstances) reasonably plausible assumptions.

So far as the United States is concerned a further assumption has been made: that one-third of expenditures in the relevant category either relate to strategic programmes or are for some other reason not directly attributable to provision for the North Atlantic and European theatres.[2]

The results of this analysis are given in Table 3 overleaf. For the seven countries in question expenditures on major equipment for NATO area forces (expressed at constant 1976-77 prices) are planned to run at $22-26 billions a year over 1978-82. The United States' procurement budget dominates this total, of course. Overall, these intended outlays represent a steady 14 per cent of total planned expenditure on defence. (And incidentally, this is a proportion which would not be exceeded were the computation done for all NATO's fifteen nations.)

Given the limited nature of the calculation and the arbitrary character of some underlying assumptions it would be ill-advised to try to infer too much from Table 3. However it is admissible to observe that, if outlays on major equipment account for no more than one-seventh of NATO defence budgets, then the expectation that standardisation and related initiatives in this area can make a significant impression on Alliance expenditure are almost certainly unwarranted. On this evidence, acquisition strategies capable of yielding direct savings amounting to 20 per cent of planned equipment spending across-the-board would benefit total budgets by less than 3 per cent. Looking at it another way, to achieve a modest 5 per cent impact on aggregate outlays by this means procurement arrangements would have to be devised capable of equipping member nations at two-thirds of the present expected cost.

Table 3

MAJOR EQUIPMENT EXPENDITURES IN SEVEN
NATO COUNTRIES' BUDGETARY PROJECTIONS

$ billions at 1976-77 prices/percentage shares

	1978	1979	1980	1981	1982
Total Expenditure $ bn	162	169	176	181	181
Major Equipment (2x) $ bn	22	23	24	25	26
Proportion overall %	13	14	14	14	14
Individual nations %					
Canada	11	13	15	16	16
Denmark	17	16	16	16	16
FRG	13	13	13	14	14
Netherlands	18	17	18	18	17
Portugal	3	2	2	3	2
UK	19	19	20	20	20
US*	(12)	(12)	(12)	(12)	(12)

Source: See Text * Two-thirds actual proportion (see text)

Supplementary Note

As explained in the text France does not submit an annual DPQ. However, information broadly comparable to that in the table can be found in documents on the current French defence programme. See, for example Les Armees Francaises de Demain : Programmation 1977-82, SIRPA, Dossier d'Information No. 49, October 1976.

A sense of proportion is important in these affairs; data of this sort help to provide it. In the first place they afford a useful corrective to the more inflated rhetoric that has featured in the standardisation debate, some of which may have given the impression that even limited progress in armaments co-operation on major systems might transform the economics of Alliance defence. In the second place, they underline the importance of judicious priority-

setting in the implementation of United States' (and NATO) policy. Discovering the procurement areas where worthwhile budgetary benefits are to be found is imperative. A random, opportunistic approach producing negligible savings here, a modest pay-off there and sizeable benefits only occasionally will make no impression at all on aggregate Alliance expenditures.

Parenthetically, the latter conclusion also prompts questions about the appropriate emphasis in the pursuit of rationalisation generally. Only limited leverage can be exerted on total costs by attention to main items in the capital budget. To be sure, there is the hope that, indirectly, this will lead to savings in current operations and maintenance outgoings, e.g. on logistics. Yet, as has been shown, the scope for these is limited, in the short- to medium-term and from step-by-step movement towards equipment commonality. Would options for effecting economies in support <u>directly</u> therefore repay greater attention? Is it in fact wise to stress the equipment budget, implicitly assuming that the manpower budget is less amenable to influence? Notwithstanding the policy commitment to co-operation on major procurement items responsive to Congress and Callaghanism, would rationalisation be better served by endorsing the conviction - expressed by the Joint Chiefs and others - that '...emphasis should go first to improve interoperability in the near to mid-term...'?[3]

However, pertinent though they are, these questions lie outside the ambit of the present study. A policy position <u>has</u> been taken up. It calls for affirmative action in armaments co-operation, with standardisation as one objective and with the promotion of transatlantic trade (viewed as means and end) very much in mind. That extravagant expectations may have been entertained concerning the

economic advantage accruing to such action does not absolve the Department of Defense and other agencies from the responsibility of making wise choices in policy implementation.

PARTICULAR PROCUREMENT PLANS

Measuring the budgetary benefit from different possible modes of acquisition - on the partial basis, directly related to defined options, which has been judged the most appropriate for the policy purpose - means setting costs under the candidate procurement arrangement against the expense of the alternative, i.e. whatever would otherwise have been done. Establishing particular benchmarks in this manner is obviously highly problematic. Is there comprehensive and detailed information about the procurement plans of NATO members, by major systems areas, showing how many it is intended (or hoped) to acquire over what time-scale and at what cost, and including systems about which thinking is still at the formative stage?

As explained in the opening paragraphs of this Chapter, there is not; and this is a major obstacle in the way of the preferred approach to benefit estimation. Yet there is no reason in principle why such information should not be collected and collated (accepting that estimates would be extremely tentative the further out towards the procurement planning horizon one ventured). In fact the material is solicited by NATO in the annual DPQ exercise. However, as with the reporting of future plans generally, there is no uniformity about member states' submissions. For instance, the United Kingdom contributes a simple list of projects in progress. The Belgians and the Dutch offer some fragments of material in the 'ideal' form. Only one country, the Federal Republic of Germany, responds with comprehensive

data as envisaged here. The style of the West Germans' communication is illustrated at Fig. 8 below.

FORMAT OF INFORMATION ON PRINCIPAL PROCUREMENT PROGRAMMES CONTAINED IN THE WEST GERMAN DPQ 77

	No.	Period	Cost (DM million)
Anti-Armour			
			....
LEOPARD 2	1XXX	198X-	6XXX
WIESEL (for TOW)	1XX	198X-	3X
....			
Artillery			
			....
FH155	2XX	1978-8X	3XX
Fire Control/ Command System	-	197X-8X	3XX
....			
Air Defence			
			....
GEPARD	4XX	1975-8X	3XXX
ROLAND	1XX	1977-8X	2XXX
....			
Recce/Surveillance			
			....
DRONE CL-289	XX	198X-	6XX
VBH 1	-	197X-8X	2XX
....			
Engineer Support			
			....
Ribbon Bridges	XX	197X-8X	XX
Wheeled Graders	2XX	197X-	XX
....			

Fig. 8

To the extent that this study is concerned with methodology, 'devising and describing' even where 'demonstrating' is impracticable, there is therefore an obvious solution to the difficulty. The Alliance might require that in their DPQ submissions all nations conform to 'best practice ' - i.e. the West German model. Alternatively member countries could be invited to give a rough indication of the funds which particular procurement lines are expected to require along with the information on their equipment plans which they submit for the armaments planning review (of which more in Chapter 5). Failing these expedients there would be no alternative but to resort to either intelligence sources, or coarse estimation, or a combination of the two.

Some effort in generating this information would be well worth making, and not only to produce benchmarks against which to appraise alternative co-operative acquisition strategies. Inspection of such data would itself reveal unpromising areas: where the chances of composing a multinational arrangement would be virtually nil, because of the small number of interested parties; or where it would evidently not be worthwhile, because of the (comparatively) trivial sums involved. Indeed this may be the single most compelling reason for not neglecting the budgetary setting. It would be absurd, for instance, to conduct an elaborate analysis revealing a potential 40 per cent saving from a doubling of the production run for air-portable combat recovery vehicles to find that over the next 14 years only three countries had a requirement for such equipment and that their total annual budgetary provision for the items amounted to less than $10 million.

As a final word on procurement in NATO budgets it is appropriate to meet two objections which could be made to the analysis as presented: that (a) concentration on

major items in assessing the salience of equipment expenditures understates the scope for beneficial change through standardisation; and (b) considering only data reported to the Alliance gives a misleading impression of the availability of information on particular procurement plans. On the first argument, the contention is that, while all equipment does indeed account for a larger share of budgets (in the United Kingdom's case for c. 35 per cent of all spending, cf. Table 3), this is really beside the point. For only major systems enter the reckoning when fashioning co-operative acquisition arrangements. Moreover, the stance taken on such systems determines the overall pattern of materiel requirements. As for the notion that standardising ammunition, fuels and the like is as important as getting equipment commonality, it must be remembered that crucial though this may be for interoperability it is unlikely to yield significant budgetary benefits. On the second objection, it is true that material giving procurement intentions with forecast/budgeted cost data can often be found in national documentation, e.g. the United States' Secretary of Defense's Annual Report. The point is: for present purposes, fragments of information compiled on non-uniform definitions are of limited utility. Data in 'standardised' formats would be more useful.

REFERENCES
(to Ch. 4)

1. For a similar observation see Standardization in NATO : Improving the Effectiveness and Economy of Mutual Defence Efforts, Report to the Congress by the Comptroller General of the United States, General Accounting Office PSAD-78-2, January 19, 1978, p.35.

2. Department of Defense, First Report to the Congress on The Standardization of Military Equipment in NATO and Other Related Actions, (C), 1975, p.26.

3. See Department of Defense, Fourth Report to the Congress on Rationalization/Standardization within NATO, January 1978, p.89

Chapter 5

NATIONAL ARMAMENTS PLANS FOR THE 1980s AND BEYOND

In earlier discussion of the policy context it was noted that there is current pressure, first, for early evidence of progress towards standardisation and related objectives; and, secondly, for achievements which promise not only to yield direct budgetary benefits but also to fulfil aspirations for wider armaments co-operation, with attendant participation requirements. (Chapter 2 above, pp.35 and 36.) According to the argument at the end of Chapter 4, information on the financial dimension of particular procurement plans would be helpful in setting priorities by making it possible to reject at an early stage areas unpromising from the point of view of budgetary pay-offs. In a similar way, information on the status of NATO members' armaments plans would be useful, indeed necessary, for identifying those areas offering the best prospects for multinational acquisition arrangements. Obviously, where nations have taken their equipment planning beyond the concepts/study phase of the procurement process through feasibility study and project definition to full development or production most co-operative acquisition options have been foreclosed. (Most, not all: there is the possibility of licensed production or co-production of a system already developed by one country.)

The purpose of this Chapter is to indicate how the relevant zone of discretion (to use a phrase coined earlier) can be delineated, using information from the equipment replacement

schedules which all NATO members have recently prepared - and undertaken regularly to revise - within the framework of the procurement rationalisation efforts being made by the Independent European Programme Group (IEPG) and NATO's Conference of National Armaments Directors (CNAD).

EQUIPMENT SCHEDULES : CONCEPT AND FORMAT

Credit for the concept of regularly-produced equipment replacement schedules, and for the format now in use in NATO, goes to the Europeans.

European Origins

The idea that European countries should get together to develop and produce weapons jointly has been canvassed for the best part of three decades. Until the early 1970s all efforts foundered, among other things because of the practical difficulties associated with the long life-cycles of modern weapons and the nonsynchronous equipment replacement plans of potential collaborators. The EUROGROUP Ministers made a modest start at getting to grips with this problem in 1970-71. First, they conducted the EUROSCHED reviews to identify areas in which two or more countries had both military requirements and replacement timetables similar enough to offer prospects of co-operation. Secondly, they institutionalised the process, under the aegis of the European National Armaments Directors' meetings (EURONAD), as part of a broader effort to promote joint procurement ventures. But conditions at this juncture were not propitious for a major breakthrough, and the choice of setting for the initiative was in any case inauspicious

because France, identifying the EUROGROUP with NATO's integrated activities, would not participate.[1]

By 1975 however military, economic and political circumstances had changed (as discussed elsewhere); and in November of that year, to give France the opportunity to join in any new developments, the EUROGROUP decided to explore 'the potential for extending co-operation in European armaments collaboration in an independent forum open to all European members of the Alliance'.[2] An expression of French willingness to take part was forthcoming within a month. A few weeks later, in February 1976, the Independent European Programme Group (IEPG) was formed.[3]

The main work of the IEPG since early 1976 has been conducted by three Panels (with associated sub-groups and exploratory groups). The task assigned to Panel I was (and is) confirmation of 'the future armaments requirements of the participating states and the phasing out and phasing in of weapons systems'.[4] To enable it to fulfil this function the Panel first devised a format for, and subsequently undertook the compilation of, equipment replacement schedules covering the IEPG's 12 member countries. (The 'independence' of the forum has made it possible to accommodate not only France but also Greece and Turkey.)

Alliance Adoption

In December 1976 the IEPG nations submitted their equipment replacement schedules for the next five years to a NATO Study Group tasked, as part of the wider rationalisation movement, with exploring the feasibility of an Alliance-wide Periodic Armaments Planning System (PAPS). In August 1977 the NATO Conference of National Armaments Directors (CNAD) received a report from this Group which counselled a

cautious approach to such an innovation. Its recommendation was for a more limited NATO Armaments Planning Review (NAPR) - essentially, a systematic survey of national defence equipment plans - and it is this scheme which has been introduced, on a trial basis, for 1977-78.[5]

The heart of the exercise is the collation of national equipment (replacement) schedules and for this purpose the CNAD has chosen the obvious expedient. It has adopted the format designed by the IEPG; and, to avoid needless duplication of effort, has taken the compilations prepared for the IEPG (covering 12 nations) and invited Canada and the United States to submit information in a compatible form.

The result is that there now exists a 14-nation collection of Consolidated NATO Defence Equipment Schedules (with the prospect of regular updating).

The current compilation is based on IEPG schedules of November 1977 together with those provided by Canada and the United States. It records national procurement intentions or requirements for equipments with planned in-service dates through to the 1990s, for a total of 83 items, with information under eight main headings. The latter include the planned in-service data of new (replacement) equipment plus the period over which procurement will continue, the 'current national procurement status' for each entry, and an indication as to whether acquisition is envisaged on a 'national project' basis or under some other arrangement (from direct purchase to co-production). The format is illustrated in Fig. 9 below. Projects are listed by nation under each of the 83 equipment categories (for which see Table 4 at the end of this Chapter).

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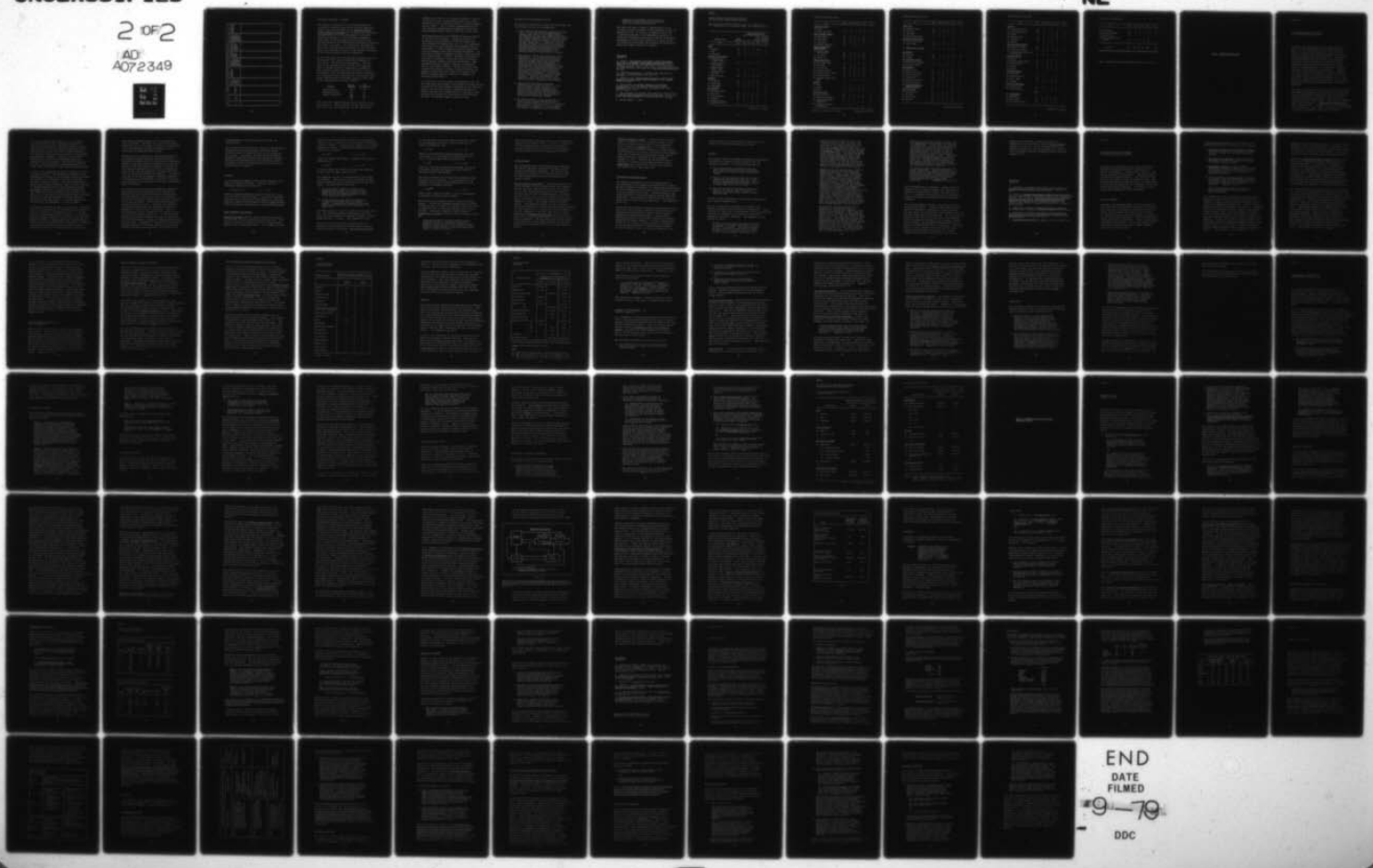

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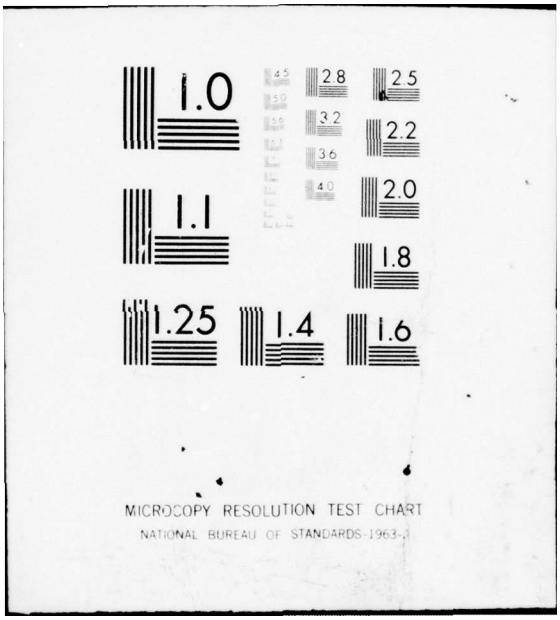
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FORMAT OF NATO CONSOLIDATED DEFENCE EQUIPMENT SCHEDULES									
(A) Nation	(B) Task or Mission	(C) Existing equipment in service	(D) Planned in service date of replacement equipment or new equipment (and period over which procurement will continue).	(E) Name of intended equipment; (and quantity envisaged).	(F) Method of replac. intended or desired (eg national project collaboration in R&D, collaboration in production, production under licence, direct purchase, etc)	(G) Any relevant reference documents eg CNAD project groups, MAS working parties	(H) Current national procurement status (eg feasibility study (FS), project definition (PD), full development (D), in production (P)).	(J) Timetable of all main future decision points (eg commencement of feasibility study (FS), of project definition (PD), of development (D), of production (P)).	(K) Additional Remarks (for example suggestions for collaborative possibilities)

Fig. 9

EQUIPMENT SCHEDULES : ANALYSIS

The absence of information on the expected budgetary incidence of armament plans (and on possible acquisition rates) limits the usefulness of the Consolidated NATO Defence Equipment Schedules for the purpose of establishing good benchmarks for benefit measurement, as has been observed in Chapter 4. But the material provides a sound basis for pin-pointing those areas within which the best prospects for multinational procurement arrangements are likely to be found. To indicate how this might be done, and at the same time to register the fact that the margin for manoeuvre is limited in this regard, an analysis of the current schedules has been undertaken.

In the first place, for each equipment category (item) the entries under the 'status' heading were examined and classified. The results are interesting. Out of a total of 991 entries no less than 429 (or 43 per cent) refer to systems already in development or production and, therefore, beyond reach from the point of view of formulating a fully multinational procurement arrangement, i.e. incorporating some participation in development work. Of the remaining 562 the breakdown among the three other status classifications used is as follows:

Status	No. of Entries	% of all Entries
Concepts/Study	300	30
Feasibility Study	116	12
Project Definition	146	15
	562	57

This is the most generous measure of the size of the 'zone of discretion'. Among these 562 entries, however, more than 10 per cent were designated - in col. (F) of the

schedules (see Fig. 9) - as 'national projects'; that is to say, even at the pre-development stage the relevant equipment was one on which the country concerned envisaged going it alone. Thus a narrower interpretation of the area offering opportunities for armaments co-operation would encompass almost exactly 50 per cent of the field.

The detailed results of the analysis are given in Table 4 at the end of this Chapter. Because of the lack of information about quantities (in many instances) and about forecast or budgeted cost (in all), it is impossible to identify with any confidence those equipment areas in which effort to devise acquisition strategy options with wide participation might most profitably be applied. On the basis of informed judgement, however, there would seem to be opportunities - so far as the simple attainability criterion is concerned - within such areas as maritime guided weapons, torpedoes and naval helicopters; army equipment generally (weapons, vehicles, helicopters); and air force guided weapons. Cursory inspection also suggests that there are a number of these categories (or groups of categories) within which the concept of NATO Weapons Packages, based on 'families' of weapons, has promising possibilities.[6]

At a later stage it will clearly be pertinent to ask: do the areas where there appear to be prospects for multinational co-operation (on this evidence) correspond to the industrial sectors in which cost reduction opportunities might be greatest because of the possibilities for exploiting scale and learning economies or international cost differences or both? The question will be taken up, later.

CONCLUSION ON THE BUDGETARY SETTING

The principal conclusions arising from this Chapter and the preceding one may now be summarised.

- Major NATO-related equipment purchases account for c. 14 per cent of the planned defence spending for 1978-82 of the SEVEN members of the Alliance for whom some budgetary projections are readily available (and it is unlikely that this figure would be exceeded if one had data for NATO as a whole). Savings on the major systems' budget can thus exert only limited leverage on member nations' total expenditure. The expectation that new departures in multinational armaments co-operation on such systems can transform the economics of Alliance defence is accordingly ill-founded.

- This prompts certain questions about policy priorities. But it also reinforces the obligation on policy advisers to identify those procurement areas where discernible budgetary benefits may be obtainable. Information on the forecast/budgeted cost of particular acquisition programmes in NATO countries' plans would facilitate this, as well as providing the necessary specific benchmarks for measuring the benefits of co-operative arrangements. Unfortunately relevant data are not communicated to the Alliance. However, West Germany's DPQ submission shows what might, and arguably should, be done to remedy this shortcoming.

- Consolidated NATO defence equipment schedules indicate that 562 out of a total of 991 projects (major and minor) in member nations' current armaments plans have not yet reached full development or production and may therefore be regarded as potential candidates for incorporation in multinational acquisition schemes.

- The policy advisers' other obligation - to identify those systems categories within this zone of discretion for which the prospects for armaments co-operation are best - can be discharged, by inspection of the schedules; but absence of information on the financial

dimension of procurement plans means that judgements can be made about attainability only, not potential profitability.

What does this mean in terms of implementation of the procedure outlined in Chapter 3 (and summarised in Fig. 6)? Essentially this: by scrutiny of budgetary data alone it should be possible, as the methodology requires, to reject both financially unpromising areas for co-operative procurement and areas where acquisition strategy options are effectively foreclosed thus narrowing the field within which more complex analysis is required.

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6. Fourth Report.... p.92.

Table 4

SUMMARY ANALYSIS OF THE STATUS OF PROJECTS IN
NATO CONSOLIDATED DEFENCE EQUIPMENT SCHEDULES

Abbreviations for procurement status in cols. (c)-(e) below are:-
C/S - Concept/Study: FS - Feasibility Study: PD - Project Definition

Category/Item	Total Projects	No. of Projects of Pre-Development Status				
		C/S	FS	PD	cols. (c)-(e) total	of which National Projects
(a)	(b)	(c)	(d)	(e)	(f)	(g)
SHIPS						
1. Frigates	20	4	2	6	12	3
2. FPBs	8	2	-	3	5	2
3. Submarines	13	4	-	2	6	-
MARITIME GUIDED WEAPONS						
4. Surface-to-air (v.short range) / 5. Surface-to-air (short range)	17	4	3	1	8	-
6. Surface-to-air (medium range)	8	4	-	1	5	-
7. Helicopter-borne anti-ship	5	2	-	1	3	-
8. Other anti-ship	21	4	5	5	14	3
TORPEDOES						
9. Lightweight	14	7	2	2	11	-
10. Heavyweight	13	4	1	1	6	1
11. NAVAL MINES	6	2	1	3	6	2
SONAR SYSTEMS						
12. Helicopter-borne	8	2	-	2	4	2
13. Ship-borne	14	4	1	-	5	1
14. Submarine-borne	8	2	-	3	5	-
15. Sonobuoys	12	2	-	3	5	-
16. Airborne Sonobuoy processing systems	5	1	1	1	3	-

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(a)	(b)	(c)	(d)	(e)	(f)	(g)
NAVAL HELICOPTERS						
17. Small	9	3	-	1	4	1
18. Heavy (ASW, MCM)	8	4	-	2	6	1
ARMY ANTI-TANK WEAPONS						
19. Short-range	19	9	2	2	13	1
20. Medium-range	15	7	3	1	11	
21. Long-range	11	4	2	1	7	1
22. Helicopter-mounted	4	-	2	1	3	
ARMY SURFACE-TO-AIR GUIDED WEAPONS						
23. Very low level (man-portable)	11	4	4	2	10	-
24. Low level	16	5	3	2	10	1
25. Medium SAM	13	7	1	3	11	-
GUNS/ROCKET SYSTEMS						
26. Anti-light armour	8	3	-	2	5	1
27. Anti-tank	6	2	1	-	3	-
28. Anti-aircraft	16	7	2	1	10	1
29. Artillery rockets	9	4	1	2	7	1
30. Artillery 105mm & below	8	3	2	1	6	-
31. Artillery 155mm	19	3	3	3	9	-
32. Artillery greater than 155m	2	-	1	-	1	-
MORTARS						
33. Light	7	3	-	-	3	-
34. Medium	7	4	1	2	7	-
35. Heavy	5	2	1	1	4	-
ARMY MINE SYSTEMS						
36. Mines anti-tank	18	4	3	3	10	1
37. Mines anti-personnel	12	4	1	2	7	1
38. Minefield clearance (explosive)	2	2	-	-	2	-
* 39. Minefield clearance (mechanical)	7	4	1	2	7	1

* There is no item 40 in the source.

Continued on next page

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(a)	(b)	(c)	(d)	(e)	(f)	(g)
SMALL ARMS						
41. Personal weapons	15	3	2	2	7	-
42. Light MGs	10	4	-	1	5	1
43. Medium MGs	8	6	1	-	7	-
44. Vehicle-mounted MGs	5	3	2	-	5	-
BATTLEFIELD SURVEILLANCE						
45. Wpn-locating radars	12	4	3	-	7	-
46. Other radars	12	1	2	3	6	2
47. DRONES, RPVs, TARGETS	15	7	3	2	12	-
ADP SYSTEMS						
48. Artillery	11	3	3	2	8	3
49. Command	14	3	2	1	6	4
ARMY COMMNCTNS SYSTEMS						
50. Tactical area systems	12	3	-	2	5	2
51. Net radio systems	7	2	1	1	4	-
ARMY VEHICLES						
52. Below 1 tonne	14	6	1	1	8	2
53. Between 1-20 tonnes	14	3	1	3	7	2
54. Tank transporters	3	1	1	-	2	1
55. Infantry CVs	16	7	2	3	12	2
56. Armrd Recce Vehicles	7	5	-	-	5	-
57. Main Battle Tanks	15	3	3	3	9	-
58. BRIDGING/AMPHIBIOUS CROSSING EQUIPMENT	18	5	1	5	11	-
ARMY HELICOPTERS						
59. Reconnaissance	11	6	1	1	8	1
60. Anti-tank	10	2	3	2	7	2
61. Special armed	4	3	1	-	4	-
62. Transport	13	6	2	3	11	-

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(a)	(b)	(c)	(d)	(e)	(f)	(g)
AIRCRAFT						
63. Interceptor/Air Def	18	6	-	1	7	-
64. Strike/Attack/Recce	25	7	-	5	12	1
65. Trainer	8	4	-	-	4	1
66. Maritime Patrol	13	6	1	1	8	-
67. Transport	10	7	-	-	7	-
68. Tankers	1	-	-	-	-	-
AIR FORCE GUIDED WEAPONS						
69. Air-to-air (short)	12	3	1	3	7	1
70. Air-to-air (medium)	12	3	1	2	6	-
71. Air-to-surface (other than anti-ship (8))	14	4	2	-	6	-
BOMBS AND ROCKETS						
72. General	9	-	2	3	5	-
73. Optical/IR/Laser-guided	10	-	2	3	5	2
74. Airfield attack	3	-	1	-	1	-
75. Cluster	8	-	2	2	4	-
76. Rockets	4	-	2	1	3	1
AIRCRAFT EQUIPMENT						
77. Active ECM	11	3	-	-	3	-
78. Portable Lndg Aid	4	-	-	-	-	-
79. Recce Radar	14	3	-	2	5	2
80. AI Radar	6	1	-	1	2	-
AIR FORCE HELICOPTERS						
81. Air/sea rescue	8	5	-	1	6	1
82. Utility/logistic	6	2	-	2	4	-
	(846)					
83. MISCELLANEOUS						
(a) SHIPS MCMVs	19	5	4	2	11	1
(b) SHIPS others	16	1	-	1	2	-
(c) Naval Equipt/Gunnery	25	2	4	2	8	1

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Continued from previous page

(a)	(b)	(c)	(d)	(e)	(f)	(g)
(d) Army Equipt	31	4	4	5	13	2
(e) Electronic Warfare	22	4	3	-	7	3
(f) Tank Gun Ammo.	3	-	-	-	-	-
(g) Other (including IFF Systems)	29	8	3	5	16	-
T O T A L S	991	300	116	146	562	(63)

Source: Consolidated NATO Defence Equipment Schedules, (NC), 1978.

PART C PRODUCTION ECONOMIES

Chapter 6

ESTIMATING PRODUCTION ECONOMIES
(1) BASIC CONCEPTS AND METHODS

Savings on the acquisition costs of major systems can exert only limited leverage on NATO defence budgets. There is also a limited number of areas within which armaments co-operation arrangements capable of engaging wide participation appear to be feasible. Nevertheless, within the context of broader efforts to improve the efficiency of Alliance defence resources management, a formidable political momentum has been given to the pursuit of standardisation - in the sense of 'identical equipment for as many Allies as possible'.[1] Moreover, the value of what direct benefits in reduced resource costs are obtainable by common procurement is not to be gainsaid. Hence two practical questions arise. Where are these benefits likely to be greatest? Where, then, should initial effort towards achieving the set goals be directed?

The first of these questions invites an immediate riposte: the greatest acquisition costs savings will be found where there is the greatest potential for exploiting economies of scale and learning in production and for utilising lower-cost sources of production. However such a response really begs the question. Where exactly might this be? That is the question. (Furthermore, if it can be answered the second of the initial queries - on priorities for effort in policy implementation - takes care of itself.)

It might be thought surprising that it is necessary to pose the question at all. Armaments co-operation, leading to standardisation, has been adopted as a policy goal not only as a means to the end of enhanced combat effectiveness but also as an end in itself, because of the prospect of economic gain in the form of cost savings *via* production economies. (See Fig. 3, p.34 above.) Presumably this would not have happened unless the expectation of such economies - and resultant budgetary pay-offs - were well-founded, implying awareness of the likely scale and character of cost reduction opportunities.

In fact, as the discussion in Chapter 2 showed, the truth is rather different. The principal protagonists in the standardisation debate of the mid-1970s invoked 'assertions and examples' and 'estimates...not based on detailed analyses of empirical data'.[2] This has carried over to policy pronouncements themselves, where one finds virtually no reasoned argument based on firm evidence but rather *ex cathedra* statements to the effect (for example) that with 'procurement on an Alliance or multi-lateral basis, there can be a reduction in overlapping programs, increased economies of scale and production, and more effective equipment for the same price'.[3] In short, *the* question has not really been addressed, let alone answered.

The point of departure for Part C of this study - elucidating Stage 2 of the methodology for budgetary benefit estimation outlined in Chapter 3 and summarised in Fig. 6 - is that this is an unsatisfactory state of affairs. It should be possible to adduce evidence in place of assertion and reach beyond the handful of examples upon which statements about potential cost savings have hitherto been made.[4] Certainly it would seem to be worth mustering whatever relevant empirical data there is on scale economies, learning and

international competitiveness for such illumination as they can provide. The effort may, moreover, be deemed worthwhile even if the outcome is essentially confirmation of the 'guesstimates' and intuitively-based rules of thumb that have dominated debate to date.

Needless to say to embark on an exhaustive appraisal of all relevant evidence, examples and empirical data on production economies would be a major research undertaking. Nothing so ambitious could be attempted in this exercise. However, it has been possible to conduct two surveys of the analytical and empirical literature on economies of scale and the learning phenomenon; and these shed some light on the reality behind recent rhetoric. In addition, the scope of one survey extends to coverage of material on international cost differences, providing a basis for some speculation on the potential gains from intra-Alliance trade in armaments.

The surveys are the work of two professional economists: Keith Hartley of the University of York, England and Benjamin P. Klotz of Temple University at Philadelphia. It is believed that they take in most of the relevant material in the English language which is readily available in the open literature. They are therefore clearly of interest in their own right. Hence they are presented, in the form in which they were originally prepared, as Appendices to the main text of this study. What the following pages of Part C consist of is a summary overview of their key themes and conclusions. It has not proved possible, in the time available, nor would it necessarily have been advantageous, to conduct a comprehensive synthesis of the surveys. Accordingly in the following pages there is frequent reference to the fuller argument and additional material contained in the Appendices, which must be seen

as complementary to the present Chapter and the two following ones.

The remainder of this Chapter is a precis of the preliminary discussions of the basic concepts and methods of the economic analysis of production costs in the Hartley and Klotz papers. The results of their reviews of applied research on production economies are summarised in Chapter 7. Conclusions and consideration of how the material might be brought to bear on the policy problem at issue are the subject matter of Chapter 8.

CONCEPTS

It is customary to represent input-output relations in the form of a production function. Given the level of technology, output can be written as

$$Q = F(L, K, M) \qquad \ldots\ldots\ldots(1)$$

Where Q is output produced per period of time, say a year; L is the flow of labour services; K is the flow of capital services; and M is the flow of other inputs e.g. materials. This basic equation most naturally refers to plant production where input/output relationships are technically determined.

Scale Economies and Learning

Economies of scale occur if, when all inputs are increased by x per cent, output rises by more than x per cent. This allows unit costs of production to fall as output expands, assuming input prices remain fixed. It is normally assumed

that such economies do occur and there is some empirical basis for this. Hence the familiar practice in elementary economics textbooks of presenting as typical U- or L-shaped average cost curves. Because scale economies cause unit costs to fall, clearly

$$Y = f(Q) \qquad \ldots\ldots\ldots(2)$$

where Y is average total costs; a relation which can be specialised to

$$Y = aQ^{b'} \qquad \ldots\ldots\ldots(3)$$

in which a and b' are constants, b' being the elasticity of unit costs to output (and negative).

Both Equations (2) and (3) assume constant input prices as Q expands. This will not occur, of course, if plant expansion drives up prices, offsetting cost savings from scale. Two things follow from this:

- If the foregoing argument is applied to an industry, since rising input prices are more likely than if only one plant expands, unit costs may not fall despite economies of scale at the individual plant level.

- A similar argument may apply if a firm (i.e. a collection of plants under one control) expands. Administrative complexity may cause rising costs despite technical economies at the plant level.

The latter point may in fact be relevant at the plant level too. The textbook accounts of diseconomies of scale typically cite managerial diseconomies (although, as Klotz notes, this may be a cheat) (See Appendix II, p.2.)

This production and cost function approach does not acknowledge the possibility of falling costs because of experience gained in production, the learning phenomenon.

If the efficiency with which inputs are used does depend on the experience gained by a plant through its past volume of production, then

$$Y = f(X) \qquad \ldots\ldots\ldots(4)$$

where X is the cumulative output produced by the plant in the past, i.e. the length of the production run to date; a relation which can be specialised to

$$Y = aX^b \qquad \ldots\ldots\ldots(5)$$

which is a log-linear learning curve formula, with a and b constants, b being the elasticity of unit costs to cumulative output (and negative).

The relation between cost functions and learning has been discussed in the literature. If a in Equation (3) is allowed to reflect the learning phenomenon in (5), for instance, it is possible to write

$$Y = aX^bQ^{b'} \qquad \ldots\ldots\ldots(6)$$

where b and b' need not be equal; and this relationship is amenable to testing, after a fashion.

The relation is not normally noted in policy discussion, however. In fact the distinction between scale economies (related to level of output) and learning (related to length of production run) is frequently blurred or just simply confused. The General Accounting Office Report on Standardization in NATO of January 1978, for example, states that

> 'Potential production savings primarily involve economies of scale. Currently weapons are produced in small quantities for national markets. Producing weapons for the total NATO market would result in longer production runs which historically result in lower unit costs.'[5]

This is by no means the only instance of this particular confusion that could be cited. (Nor is it a trivial one. As will be argued later, in armaments co-operation arrangements the benefits of scale and the benefits of the long production run may not both be attainable.)

Other Concepts

The distinction between scale economies and learning is the central conceptual clarification necessary in the analysis of production economies. But, anticipating the empirical evidence of the following Chapter, there are other concepts which have proved serviceable in applied research.

Minimum efficient scale (mes) As has been stated, it is usually assumed, with some justification, that long-run average cost (LAC) curves will be either U- or L-shaped. In fact, the U-shape normally found in the elementary textbooks does not seem to occur frequently in practice: as Klotz states, it is 'a notional region that is "out there" as a warning to the overly ambitious entrepreneur'. (Appendix II, p.2.) The L-shape appears to be more typical. This being so, special interest attaches to the level of output at which the LAC curve becomes horizontal (or near horizontal), i.e. where scale economies appear to have been 'exhausted'; and this level of output may be designated the minimum efficient scale (mes) (or, less felicitously, minimum optimum scale) of production for the output in question. The 'serviceability' of this concept in empirical work arises because investigating the cost implications of operating below mes is a useful focus of inquiry.

Concentration/Market Shares. Economists have sometimes found it necessary to rely on indirect evidence of the presence of scale economies, such as that provided by data on industrial concentration (i.e. the number of firms/plants in a particular industry in a given country). As Hartley notes in his survey, one British study concluded 'that over 70 per cent of the variation in the level of concentration can be explained by scale economies'. (Appendix I, p.8.) Elsewhere he records that there is evidence of 'a positive relationship between a firm's market share for a product and its unit cost advantage over smaller rivals' (loc. cit, p.42).

International Competitiveness

The foregoing discussion relates to concepts useful in the examination of cost-quantity relations within a nation. For the elucidation of possible cost differences between nations the same essential tools of analysis remain relevant, however. It is the questions that change. Interest centres on the relative position of LAC curves between nations rather than their shape; on the absolute values of the cost functions rather than the values of their parameters. (See Appendix I, pp.15 & 16.)

Having said that, however, there are certain specific notions which enter the analytical reckoning when the question of international cost differences and the related issue of comparative advantage are addressed. Leaving aside definitional matters and the tricky exchange rate problem (discussed by Hartley, Appendix I, p.50-2), concepts which feature in the applied research literature, principally in the indirect measurement of competitiveness include: a nation's exports' share in world exports generally, the

trend of imports in domestic markets, balance of trade indices and comparative productivity measures.

METHODS

The essential nature of methods of estimating the potential for production economies follows naturally from the conceptual framework. The operative questions are

- In particular types of production what are the values of the elasticities of unit costs with respect to level of output and cumulative output?

- Where is the mes point and what are the cost implications of operating below mes? (Or, putting the question more positively, what are the cost implications of moving from a level of output below mes to that level?)

- What are the relative positions of different nations' LAC curves; and, for present purposes, how does European industry compare with American?

Answers to these questions can give general indications of cost reduction opportunities.

But what of the particular problem of assessing cost reduction possibilities from armaments co-operation? Klotz concludes his essay with a specification of how this particular issue may be illuminated by a method derived from the conceptual foundations described. His argument is worth quoting at length.

> 'Assume we have the price and output quantities of a product, each year, produced by a number of different producers. And assume the price is set as a constant markup above unit costs of production...It would be useful to compute the cost savings resulting from specializing

production at the lowest cost site...The total production at other (nation) sites is added to that at the lowest cost site. This results in a specified percentage increase in annual output at this site; it also implies a specified percentage increase in cumulative output (i.e., the sum of past output at the site). The former percentage can be used to compute unit cost savings resulting from economies of scale; the latter percentage allows us to calculate the cost reductions stemming from the learning curve. We can thus estimate the unit cost savings in two ways if we have a measure of both scale economies and learning curves in the production of this output.

Assuming Y is unit costs we use $Y = aQ^b$ to compute savings due to scale economies: Percentage change in Y = b x (Percentage change in Q). Annual budget data should reveal current Y and Q so it is a simple matter to compute the percentage change in unit costs Y, if we have an estimate of scale economies b. The problem is that evidence on b is very sketchy for defense industries. Most studies of scale economies examined above referred to non-defense industries. However, Pratten (Table 2) concludes that a halving of aircraft production will force up unit costs by 20 percent. Conversely, a doubling of output from this lower level (back up to the optimal-scale output) will reduce unit costs by 16 percent (20/(100+20)). This suggests a b in the range .15-.20, with a negative sign of course. But scale-economy estimates are lacking for other defense products, such as missiles.

We could fill the gap of missing scale parameters by assuming they vary in proportion to the variation observed in the learning-curve parameter. Thus, ships and planes would be assigned the greatest scale economies (with b = .15-.25); missiles would get b = .05. The intermediate case of tanks would have b = .10...Thus, at some risk of misestimating the true b for a weapon, we can compute the unit cost savings from reshuffled production using only a knowledge of the current unit cost (or price) and the current percentage change in annual output required to achieve specialization. This all follows from the unit cost equation $Y = aQ^b$.

> However, we can do better than this if we also know cumulative output to date of a weapon at a national site. In this case, the increase in annual output to achieve specialization (at this lowest cost site) can be expressed as a percentage of cumulative output X, and the percentage change in X can then be used to predict the fall in unit costs (and prices) using the learning curve $Y = aX^b$. This curve implies that the percentage change in unit costs = b x (Percentage change in cumulative output X). We have direct evidence on b in this equation because it is a simple transformation of the learning parameter depending on the specific weapon in question.
>
> The method outlined above can be employed with several variations. Future projections of output (based on replacement needs plus desired increase in the stock of weapons) can be used to obtain the percentage increase in future output and this can be used to compute the future cost savings from specialized production.' (Appendix II, pp.19-20.)

Klotz discusses other 'variations' - specialisation of production at the current dominant site, consolidation of output of substitutable weapons - but the point is made. In principle, estimating production economies is a matter of putting real numbers into the theoretical constructs.

What the real numbers might be is the subject matter of the following Chapter. However, before looking to the results of empirical investigations of cost functions, the mes concept and international competitiveness, there is one final obligation to be discharged. It is to sound the cautionary note that, for the most part, the analytical models of production discussed in the 'concepts' section of this Chapter, and the applied research based on them, rest on an elaborate framework of assumptions. As Hartley points out in an important section of his work these include assumptions about pricing policies, market imperfections (or rather their absence), the internal

efficiency of enterprises, absence of friction in adjustment and the economist's catch-all ceteris paribus. (Appendix I pp.17-20.) In the interpretation of the results of estimation exercises deciding what is and what is not reasonable inference is perhaps the most difficult problem of all.

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Chapter 7

ESTIMATING PRODUCTION ECONOMIES (2) EMPIRICAL EVIDENCE REVIEWED

The purpose of this Chapter is to review the empirical evidence on production economies as reported in the surveys at Appendices I (Hartley) and II (Klotz). The Chapter consists of four sections. The first describes the types of evidence available. The second and third deal with the results of the two surveys in turn; for, although addressing the same questions, the essays differ in structure and texture and it is convenient to summarise their main findings separately. The fourth and final section draws together the main conclusions.

TYPES OF EVIDENCE

As noted in the previous Chapter the focal questions in empirical inquiry on production economies in the plant or firm relate to the elasticity of unit costs to level of output (scale economies, the slope of the LAC curve); the elasticity of unit costs with respect to cumulative output (the learning phenomenon); and the identification of minimum efficient scale (mes). So far as international differences are concerned, it is on the position of LAC curves that attention rests (and on other, indirect, indicators of relative costs).

On plant/firm scale economies the techniques used in investigation fall into the following four categories.

- econometric studies of the production function, typically regressions of value added (a measure of output) against the two inputs, labour and capital.

- statistical cost analysis, based on available and actual cost data for enterprises producing at different levels of output.

- engineering estimates, using interview/questionnaire methods to ascertain from managers or engineers the fall in unit costs which they would predict were output to be expanded by specified quantities.

- the less rigorous, survivor method, which rests on the notion that there is 'natural selection' in industry: that is, 'an efficient size of firm is one which meets any and all problems (i.e. survives)'. (Appendix I, p.6.)

(All but the first of these are methods in which identification of the mes may be the focus of interest.)

Each technique has its own limitations, even shortcomings. Econometric studies tend to be unsatisfactory in their treatment of capital services and, more generally, because of the use of industry-aggregate data. Capital is also a problem which bedevils statistical cost studies. Engineering estimates are sometimes believed to reveal a bias towards finding economies from large-scale production, because it is often the best managers who are interviewed and they tend to be optimistic about their abilities to exploit scale economies. As for the survivor technique, whether it is 'a brilliant short-cut through the complexities of measuring scale economies' or more worthy of Friedman's dismissive 'foolish questions deserve foolish answers' is a matter of dispute. (See Appendix II, p.8 and Appendix I. p.7.)

Learning has been investigated mainly by econometric studies of varying degrees of sophistication. A problem with the application of the results of these inquiries arises because, although there are studies which use labour, or capital, or materials, or some composite input, most use labour alone.

Research on international competitiveness which dir tly addresses the question of relative costs appears to be comparatively scarce. The tendency in the applied economics community would seem to be to favour indirect evidence, e.g. observation of 'revealed comparative advantage' or investigation of international differences in productivity. International comparison of industrial concentration is another form of indirect evidence (as intra-national data on concentration are indirect evidence of those industries where cost conditions particularly favour large-scale production, or where the mes is large).

The general question which presents itself at this juncture is: whatever the technical merits and demerits of available evidence on production economies, is there information which is reliable and relevant for the practical policy-illuminating purpose defined? So far as reliability (or adequacy) is concerned, there are technical limitations to be borne in mind when considering virtually all empirical data in this field. These arise because of the complications posed by multi-product plants and firms, and by a variety of measurement problems. When it comes to international comparison additional difficulties present themselves because of factor price differences (which mean that the best technique of production for one nation is not necessarily the best for another), international differences in accounting conventions regarding the value of capital and so on. (See Appendix I pp.29-31 and passim.)

As for relevance (or appropriateness) for practical purposes in setting priorities for United States' policy in pursuit of standardisation and related objectives, several observations are in order. In the literature surveyed there is not a lot of evidence directly drawn from experience in defence-related industry and with defence outputs. But there is more general information from industries which produce for the military market; and these can yield proxy values for incorporation in a budgetary benefit assessment methodology. Thus there is evidence enough for a rough-and-ready exercise of the policy analysis approach envisaged. Among other things this can identify where better data - such as might be available from internal work in the Department of Defense (or elsewhere) and from industrial sources - could be brought to bear. To enable policy makers to be better informed about cost reduction opportunities in armaments co-operation, however, there should ideally be a systematic effort to generate better information than exists at present on scale economies, learning and international competitiveness.

EVIDENCE FROM THE SURVEYS...(1)
(Klotz, Appendix II)

Klotz's survey reviews material on both scale economies and learning. Under the first heading a distinction is drawn between empirical work which amounts to 'computer-assisted econometric manipulation of existing numbers' and the efforts of students of industrial organisation who have sought to 'cut through econometric complexities and data shortages by creating data of their own through the use of extensive interview questionnaires'; and the general finding is that the latter are more illuminating than the former. (Appendix II, p.10)

Scale Economies: Econometric Studies

Since the original formulation of the Cobb-Douglas production function, as expressed in the 'Concepts' section of the preceding Chapter, literally hundreds of economists have tried their hand at regressing a measure of output against measures of labour and capital inputs. According to Klotz the results are 'appallingly monotonous' in exhibiting constant returns to scale. However, the use of industry-aggregate data (rather than the more proper plant or firm data) and the crude measurement of capital services cast doubt on the validity of many of these investigations and 'the nagging suspicion has remained that there are substantial economies of scale'. (Appendix II, pp.6 & 7.)

Statistical cost studies, involving regression of total cost (or average cost) against a curvilinear (usually quadratic) function of output to test whether average cost falls as output expands, seem to have confirmed this suspicion. Many of these have found increasing returns to scale. Unfortunately the weight of this evidence is to some extent diminished by, first, dubious treatment of capital services and, secondly, the identification of increasing returns principally in those industries - especially public utilities - where common sense suggests that technology should allow them.

Nor are inquiries using the so-called survivor technique particularly instructive. As Klotz points out, these studies tell us there are economies of scale but they do not specify how cost savings might be attained by transfer of production from sub-optimal plants to those with lower costs of production. Regarding other investigations using 'short cut' techniques the conclusion is similar among other things because of the absence of good time-series data on output. (See Appendix II, pp.7-9).

Scale Economies: Industrial Organisation Studies

It is in the less numerous but generally more thorough studies by industrial economists that the most authoritative information on scale economies is found. The most notable of these address directly the operationally interesting question: how responsive are unit costs to changes in the level of output? In order to do so, however, they investigate average costs at widely-spaced intervals of output. A favourite device is the identification of the minimum efficient scale (mes) of production (the level of output at which average costs either reach their minimum or stop falling perceptibly); and the assessment of the elasticity of average costs with respect to output below this level. The main study of United States' industry (by Scherer) - now some 13 years old, incidentally - focuses on the increase in average cost associated with operation at one-third of mes. The leading work on industry in the United Kingdom (by Pratten) looks at the increase associated with operation at one-half of mes. (Appendix II, pp.10-12.)

Problematic though the form of this information is for present purposes, it is the best available. The evidence is summarised in the accompanying table (Table 5). This reproduces the values from Pratten's British study. The figures in Scherer's American study have been 'converted' to show an imputed average cost increase at one-half mes by assuming that fully three-quarters of the cost increase associated with operation at one-third mes would be felt at one-half mes. (That is to say, the presumption is that the cost-quantity relationship is linear over the relevant range. This injects a bias in favour of a higher cost increase at one-half mes than is likely and, therefore, suggests greater scale economies over the range one-half mes to mes than would probably obtain.)

Table 5

EMPIRICAL EVIDENCE
ON SCALE ECONOMIES

Industry/Product	Percentage Increase in Average Cost at Output One-half Minimum Efficient Scale	
	UK (Pratten)	US (Scherer)
Aircraft	20+	-
Cement	9	19
Electric Motors	15	-
Cylinder Blocks	10	-
Chemicals	9	-
Marine Diesels	8	-
Electronic Capital Goods (e.g., radar, computers)	8	-
Electrical Appliances	8	-
Glass Bottles	-	8
Steel	5-10	8
Automobiles	6	-
Anti-friction bearings	-	6
Refrigerators	-	6
Cotton Textiles	-	6
Oil Refining	5	4
Turbo-generators	5	-
Machine Tools	5	-
Diesel Engines	4	-
Auto-batteries	-	4

Sources: See Text

Only data on selected industries have been reproduced in Table 5. There is fuller information in the Appendices and, of course, the source works themselves.

From the empirical evidence there is some basis for inferring as Klotz does that 'similar scale economies for the same industries in the United Kingdom and the United States' are to be expected. But, more important, the actual values seem lower on the whole than is generally supposed. Certainly the more familiar textbook expositions suggest more steeply sloped long-run average cost (LAC) curves than the evidence of less than 10 per cent cost increases at one-half mes in many industries implies.

Learning

Like those on scale economies the empirical data on learning reviewed in Klotz's survey fall into two categories: those derived from formal investigations of the learning curve and values obtained by inference from more sparse information. It is not self-evident that one class is necessarily superior to the other however, for there are a number of statistical caveats to be attached to the work of even the most professional researchers and there is a general problem associated with the tendency for labour learning to have been more thoroughly explored than the wider relationship of costs to cumulative output. (See Appendix II pp.14-15.)

In Table 6 the information on the learning phenomenon which Klotz has unearthed is brought together. Where he has quoted data on labour learning (unit labour requirement at a particular level of cumulative output as a percentage of that at half the output run) the value has been translated into a unit cost-related term on the assumption that the reduction in unit production cost is about one-half of the reduction in

Table 6

EMPIRICAL EVIDENCE
ON LEARNING

Industry/Product	S Values		
	Reduction factor attributable to Doubling of cumulative factor		
	Labour	Unit Cost	Unit Cost*
Steel (a)	0.70-0.80		0.80-0.90
Machine Tools	0.80		0.90
Electrical Appliances		0.88-0.92	0.88-0.92
Glass Products	0.50-0.55		0.75-0.78
Paper Products	0.84		0.92
Ships (b) ...(1)	0.78-0.84		0.89-0.92
...(2)		0.70-0.80	0.70-0.80
Army Missile Systems		0.85-0.92	0.85-0.92
Main Battle Tank		0.90	0.90
Artillery Howitzer		0.88	0.88
Aircraft (f/w) (c) ...(1)	0.75-0.80		0.87-0.90
...(2)	0.80		0.90
...(3)		0.83	0.83
...(4)		0.94	0.94
Helicopter		0.85	0.85
Air Force Missiles		0.84-0.93	0.84-0.93

*Labour learning information translated into a unit cost related value.

Sources: See Text and Appendices I and II.

Notes

(a) Modal range for several plants. See Appendix II pp. 15 & 16.
(b) Line (1) see Appendix I, p. 10; line (2) see Appendix II, p. 17.
(c) Line (1) see Appendix II, p. 16; line (2) see Appendix I, p. 10; line (3) see Appendix II, p. 17; line (4) see Appendix II, p. 18.

direct labour costs alone. This is an heroic assumption. However it corresponds (according to Hartley) to the broad assumption made about learning in the aerospace industry in RAND cost studies of the early 1970s. (Appendix I p.75.)

On the pattern of S values in Table 6 Klotz draws the following conclusions:

> '...it seems that S is greater the larger the production target for the weapon... Conservatism suggests an S = 0.90 - 0.95 for weapons produced in the tens of thousands, S = 90 for weapons [produced] in the thousands and S = 0.70 - 0.75 for weapons made in quantities of less than one hundred. (Appendix II, p.18.)

This observation is based, it should be noted, on the raw S values as shown in the first two columns of the table.

EVIDENCE FROM THE SURVEYS...(2)
(Hartley, Appendix I)

It is indicative of the relative sparseness of good empirical work on scale and learning economies that some of the main sources of information which Hartley has tapped are the same as those referred to by Klotz. Thus use has been made of Pratten's study on Economies of Scale in Manufacturing Industry, the source for United Kingdom data in Table 5 above; and Hartley also cites most of the main studies on learning used in Table 6 above.

The distinctive features of Hartley's analysis are:

- the furnishing of data on the minimum efficient scale of production itself (from Pratten's work and elsewhere);

- allusions to indirect evidence, e.g. on concentration, which add a gloss to the main findings on scale;

- arguments on the applicability of British data to other West European countries;

  and

- extensive discussion of international competitiveness (a theme not developed in Klotz's essay).

In the following paragraphs attention is focused on these matters; the basic information on scale and learning, which is broadly common ground between the two surveys, is not repeated.

Minimum Efficient Scale. Clearly data of the sort presented in Table 5 can be related to the standardisation policy questions only if there is some appreciation of the actual scale of production that corresponds to minimum efficient scale (mes). Hartley has reproduced the key facts on mes from the main primary source study on the United Kingdom (in his Table 2.2). The value of this information lies not so much in its direct applicability to speculation about the 1980s and beyond as in its demonstration, first, that the mes concept can be given content and, secondly, that in the later 1960s there were a number of industries - including some of defence interest (e.g. in electronics) - for which the assessed mes was equal to or greater than the United Kingdom's total annual output. This is prima facie evidence for the existence of potential benefits from armaments co-operation, which must be reinforced by the argument that mes increases over time. (See Appendix I, pp.33-35 and 41-42).

Concentration. The limited amount of material which is available for the United Kingdom on concentration (and

market shares) provides some indirect evidence of scale economies and their significance. The inference is that, although present, the cost advantages associated with scale are not to be over-estimated. Data presented in a recent official review of British monopolies and mergers policy, for instance, suggest that firms from three to four times the size of lesser brethren (measured by market share) enjoy unit cost advantages of little more than 7 per cent compared with those smaller enterprises. (Appendix I, pp.42 et seq., especially Table 2.5).

The European Dimension. In his survey Hartley comments on the paucity of data on scale economies and mes by individual industries for the major European nations. This is a problem for detailed, differentiated assessment of benefits from alternative acquisition modes involving European participation. The not wholly satisfactory means of circumventing the difficulty is to regard British information as an acceptable indication of the position in Western Europe generally. There is some support for this expedient. Hartley cites the finding of Scherer's 1975 study on The Economics of Multi-plant Operation - based on the experience of France, West Germany, Sweden, the United Kingdom, the United States and Canada - that there was

> 'little divergence among the views of producers in the six nations with respect to basic process options, nor did perceived limits on the size of plants which could be managed successfully vary much... (Appendix I, p.45).

He also emphasises Scherer's recording of unanimity in estimates of minimum cost plant size. Thus it does seem admissible to suggest that 'the opportunities for exploiting scale economies are likely to be similar between the UK and Europe as a whole'. (Appendix I, p.48.) Furthermore, the inference from the North American views which Scherer

notes is that similar opportunities may exist in the United States (and Canada) too, wherever plants are operating below mes. This permits both a simplification of and yet adds a complication to the present analysis. The derivation of general - i.e. not nation-specific - values for potential scale and learning economies from Tables 5 and 6 above would appear to be legitimate (and this will be done in Chapter 8). At the same time, however, knowing what mes is, and where particular nations' industries actually are in relation to it, becomes crucial. Fulfilment of Stage 3 of the policy analysis procedure that has been outlined requires judgement on this issue.

International Competitiveness. For guidance in exercising such judgement it is natural to turn to what indications there are of international competitiveness. Hartley has dealt with this theme at length. (Appendix I, p.50 et seq.) Among the salient points in his treatment are the following.

- There is a daunting exchange rate problem in this area, nowhere more so than in relation to R & D. One implication of this is that international specialisation in weapons procurement based on exploiting lower-cost sources of supply may point to development work falling to one nation (or group of nations e.g. Europeans) with the main production effort being undertaken by others (e.g. Americans). (For fuller argument on this, see Appendix I, pp.50-52).

- There are several product groups for which 'revealed comparative advantage' in the United States' favour is discernible. However, according to Wolf's recent essay on 'Trade Liberalization as a Path to Weapons Standardization in NATO' (International Security, Winter 1978), there does not seem to be 'any distinct pattern with respect to the "high technology-low technology" distinction'. (Appendix I, cited at p.56).

- The American advantage would appear, therefore, to derive from production conditions: specifically, 'differences in rates of output and length of production runs'. (Appendix I, p.58).

Evidently the argument here runs into circularity: if looking to data on international competitiveness for clues as to where costs might be lowest because of scale and learning economies leads to the conclusion that those countries which do enjoy these benefits are the most competitive internationally there has not been much enlightenment. At the same time a pertinent question is raised: are the principal gains from Alliance-wide procurement arrangements now to be found by exploiting potentials not at present tapped, implying attention to candidate producers whose current position appears uncompetitive?

CONCLUSIONS

The conclusions yielded by this review of the empirical evidence reported in the two specially-conducted surveys may be summarised in the following fashion:

- From the studies of scale economies and learning, and in a limited way from the material on international competitiveness, a basis can be found for broad-brush appraisal of the likely pattern and scale of acquisition cost savings from alternative procurement strategies. But the material is sparse, both overall and where specific data on defence-related industry are concerned.

- The range of cost reduction that might follow from co-operative arrangements allowing the level of output to rise from one-half minimum efficient scale to that datum level is probably 4-16 per cent (Table 5, with values converted). Values at the lower end of this range may well predominate and perhaps the econometric evidence on constant returns to scale should not be discounted altogether.

- The further cost reduction potentially attainable through doubling of the total production run might fall in the range up to 20 per cent, only exceptionally higher (Table 6, with values converted). This is on the assumption that 'credit' can be claimed for both scale- and learning-related cost advantages. In practice this might not be possible under many, perhaps a majority, of feasible procurement strategies. (There is a further complication, not satisfactorily resolved in the surveys, that many estimates of scale benefits probably incorporate allowance for learning associated with plant operation at a higher rate.)

- These values probably reflect the position in both North America and Europe. The essential difference seems likely to lie in the fact that in contrast with American counterparts many (if not most) European enterprises operate below, or further below, minimum efficient scale.

Regarding the application of the information gleaned from empirical work on cost conditions to the benefit measurement task with which this study is concerned, two things follow from these points. First, additional information from internal or industry sources should be used to augment that reported here, including (where necessary) material generated by cost estimating relationships. Secondly, great care must be taken to assess correctly whether both scale and learning factors can legitimately be applied in any given case; and, depending on where industries stand in relation to mes, what value is appropriate.

It seems reasonable to presume that, for the most part, additional relevant data should be available; but, even so, the applicability of scale and/or learning factors must be a matter for ad hoc decision on a case-by-case basis, as must the precise values to be assigned. In

sum, the empirical evidence that has been reviewed takes us so far but no further.

How the material might be brought to bear on the policy questions at issue is dealt with in the following Chapter which concludes Part C of the study.

Chapter 8

SCALE ECONOMIES, LEARNING AND INTERNATIONAL COMPETITIVENESS

To implement the methodology outlined in Chapter 3 - and summarised in Fig. 6 - the material reviewed in the previous Chapter, augmented as might be possible from internal or industrial sources (including data generated by cost estimating relationships), needs to be set alongside procurement intentions or aspirations. How might this be done?

If it is supposed that information on weapons acquisition plans can be obtained either in the form of the West German submission to NATO's annual DPQ exercise or by the introduction of a forecast/budgeted cost column in the NATO Consolidated Defence Equipment Schedules, then the task is relatively straightforward, at least in principle. For each of the 83 systems categories of the Consolidated Schedules, appropriately sub-divided where procurement on a sub-system basis is both feasible and a potentially interesting acquisition mode, cost reduction factors (CRFs) can be derived from the empirical and other evidence to indicate:

- how forecast/budgeted cost might be affected by exploitation of the economies of larger-scale production, yielding a CRF for scale (or CRF(S) for short); and

- how forecast/budgeted cost might be affected by realising cost reduction opportunities through learning associated with the lengthening of the total production run, i.e. a CRF for learning (or CRF(L) for short).

For ease of computation CRFs expressed as 'multipliers' would be preferable. In other words, if the reasonable expectation is that (say) a doubling of the scale of production - from half minimum efficient scale (mes) to full mes, for example - would permit a unit cost reduction of 16 percent, then a CRF(S) of 0.84 would apply.

THE PROCEDURAL SETTING

The procedure for gauging the likely impact on costs of one or more alternative acquisition strategies would then involve three steps.

> Step 1. Specification of the benchmark (budgetary) cost for the procurement line in question for each country, which might typically be based on the independent national procurement initiative. Included in this figure would be exclusively system-related pre-production development expenses, non-recurring production costs (i.e. facilities, tooling, testing), recurring production outlays (including any relevant integration/assembly costs), necessary expenditure on peculiar-to-system support facilities (like the F 16 Avionics Intermediate Shop) and the cost of initial spares.
>
> Step 2. Application of CRFs, on different assumptions, with values as judged appropriate for the specific alternative procurement strategies under consideration. The exercise of judgement in this connection would entail taking cognizance of (1) the scale of production envisaged in relation to an assessment of minimum efficient scale, and (2) the cumulative output (production run) envisaged as compared with the benchmark programmes. Whether any additional costs would be inextricably bound up with a given procurement strategy and whether allowance for these should be included in calculation of the CRF is debatable. On the whole, it would appear preferable to generate a revised baseline cost figure - reflecting any

identifiable incremental non-recurring production costs or integration/assembly outgoings on a multi-national programme - in order to maintain the 'integrity' of the evaluation of cost reduction attributable to scale and/or learning. The outcome of Step 2 would be a procurement option (budgetary) cost.

Step 3. Calculation of budgetary benefit (+ or -), defined as benchmark cost(s) for a nation or group of nations less procurement option cost(s) as yielded by Step 2.

This operational procedure can be summarised in the following way,

Budgetary Benefit (BB) equals Benchmark Cost (BMC) minus Procurement Option Cost (POC)

where

Procurement Option Cost (POC) equals Revised Baseline Cost (RBC) [or BMC] times CRF(S) times CRF(L)

As noted, RBC might be equal to or greater than BMC and either CRF(L) or CRF(S) or both might be entered as unity (meaning no cost reduction opportunity attributable to scale and/or learning).

COST REDUCTION FACTORS

At this juncture, however, the question of interest is: what values might the CRFs take in a calculation of this kind? In particular, what does the review of empirical evidence conducted in Chapter 7, against the conceptual background sketched in Chapter 6, have to say about likely values?

It follows from the discussion on procedure that there can be no question of specifying exact CRFs which are directly applicable in all cases. At best, what can be presented as generally valid are datum cost reduction factors based on:

- where scale is concerned, the unit cost reduction that would be associated with an expansion of the level of output from one-half mes to mes itself;

- where learning is concerned, the unit cost reduction associated with a doubling of the production run (cumulative output).

Such datum factors, which might be designated CRF*s, are readily derivable from the values for unit cost increase associated with operations at one-half mes (Table 5 above) and the so-called S values for learning (Table 6 above). In the former case, a simple arithmetic conversion is all that is necessary: an estimate of 20 percent unit cost penalty on operation at one-half mes, for instance, translates into an estimate of 16.7 percent cost reduction with an increase in scale of production from that lower level to mes itself. In the latter case, the unit cost-related S values are at first sight already in the appropriate form. They cannot be used directly as multipliers, however. This is because, following the usual conventions in analysis of the learning phenomenon, they identify unit cost for a particular tranche of output and not overall average cost at that level of output. A simple transformation is therefore necessary here also. It is a straightforward matter to interpolate or extrapolate on the basis of CRF*s generated in this fashion, if need be using different assumptions, in order to produce the 'appropriate' CRF(S) or CRF(L) relevant to particular circumstances. What is involved is illustrated in the next Chapter.

But there is a further difficulty to be overcome before the empirical evidence can be brought to bear on information about procurement. The data in Tables 5 and 6 are cast in a form related to industries or products as determined by the coverage of the studies from which they come. There are no values produced specifically for the systems categories, or items, in which procurement intentions are expressed in the NATO Consolidated Defence Equipment Schedules (as in Table 4 at the end of Chapter 5). Nor is there any completely satisfactory way of dealing with this problem. It is necessary to use particular industry/product values (or ranges of values) as 'best estimates' of the datum cost reduction 'multiplier' applicable to a particular procurement category/item.

This is what has been done in Table 7 at the end of this Chapter, in a partial, illustrative way. The 'category/item' headings of the procurement schedules are used as the basic organising device. For a selected cross-section of systems categories best estimates of CRF(S)* and CRF(L)* values are given, the figures being derived as described from the empirical data. Numbers shown in parenthesis identify values for which the cross-reference is problematical. The rationale for the other figures is reasonably sound. At the same time to avoid giving an impression of spurious accuracy to the estimates <u>all</u> the numbers in the table are rounded to the nearest 0.05. The possibility of treatment at the sub-system level is illustrated by the sub-division of item 19 (short-range army anti-tank weapons) and item 57 (main battle tanks). No doubt internal and industrial sources of information could be used to permit sub-division under other headings (and, indeed, generally to refine these coarse estimates).

It will bear repeating that the datum cost reduction factors in Table 7 <u>are</u> rough-and-ready estimates. For any actual

application, in the context of the budgetary benefit estimation method which is the subject matter of this study, the crucial question to be asked is:

> Are the conditions such that the datum factors CRF*s) apply or is some adjustment necessary, including the setting of one, or maybe both, CRF values equal to unity (because with the procurement strategy under consideration either scale economies or benefits from learning would <u>not</u> be attainable)?

The final qualification in this question is of the utmost importance. It is not difficult to imagine circumstances in which, for example, a co-production arrangement might be devised with provisions for multi-plant manufacture of a (standardised) system under which no establishment or country would be able to operate at a production level yielding economies of scale. Equally, it is easy to envisage conditions in which access to learning benefits might be impeded by technology transfer problems or their value might be out-weighed by 'teaching' costs.

THE INTERNATIONAL ASPECT

The CRF* estimates in Table 7 are presented as generally valid, applicable to European and to United States' production. This reflects the conclusion drawn in reviewing the surveys of empirical evidence. There are three ways in which the international aspect of the benefit measurement problem might be accommodated.

First, as the preceding Chapter's material suggested, in many sectors of defence-related industry plants in the United States are probably at or near minimum efficient scale, whereas in Western Europe - even allowing for factor

price differences - operation below mes may be more typical. Thus, it is in the actual CRF(S) judged applicable in any specific exercise of the method that account can be taken of the difference in potential for exploiting scale economies.

Secondly, American production runs do tend to be longer than European. The relative importance of any increment to cumulative output to producers in the United States is accordingly less than for their counterparts in Europe, in terms of further learning benefits. In the actual CRF(L) judged applicable in any particular instance this can be taken into account.

Thirdly, recalling the outline of 'the procedural setting' with which this Chapter began, the actual difference in absolute cost levels between the United States and Western Europe (and among West European nations themselves) is obviously embodied in the expenditure figures to which the CRFs are to be applied. This goes for either the benchmark cost value (BMC) as extracted from procurement planning information, or the revised baseline cost (RBC) as assessed on a case-by-case basis.

CONCLUSION ON PRODUCTION ECONOMIES

The principal conclusions arising from this Chapter and the two preceding ones may now be summarised.

- In the standardisation debate to date expectations of significant budgetary savings through the exploitation of production economies have been engendered. But discussion of the possibilities has been characterised by a lack of clarity about the conceptual basis of such economies;

and, in general, speculation about the likely size and pattern of attainable benefits has rested on assertions and examples rather than detailed analyses of empirical data.

- In two specially-conducted surveys of materials on production economies, in the English language and the open literature,

  (1) methodological clarification has been attempted, exposing the formal distinction between scale economies (related to level of output) and the learning phenomenon (related to length of production run) and also noting the existence of other serviceable concepts for analysis;

  (2) the results of such empirical work as has been done in the subject area have been reported and recorded.

  These exercises indicate that, while establishing a method for precise, authoritative assessment of scale economies, learning benefits and international competitiveness is a daunting prospect, it should be possible for the Department of Defense to develop - by judicious use of available evidence, augmented by whatever might be available from internal and industrial sources - more refined estimates than have been available hitherto of the budgetary benefits that might accrue from alternative procurement strategies.

- The empirical data on scale economies suggest that the range of acquisition cost savings that might follow from co-operative arrangements allowing <u>scale</u> of output to rise from (taking a datum point) one-half minimum efficient scale to that level is probably <u>4-16 percent</u>. However, values at the lower end of this bracket may predominate and some econometric work points to the possibility of constant returns to scale.

- Cost reductions amounting to a further <u>20 percent</u> at best (typically less) might be attainable from the greater <u>learning</u> attributable to a

doubling of production runs, although whether in fact both scale and learning benefits could be obtained in any given instance is doubtful.

- Datum cost reduction factors (CRF*s) can be derived from the empirical evidence - for both scale (CRF(S)*) and learning (CRF(L)*) - to serve as a baseline for generation of the actual cost reduction factors (CRFs) which it would be appropriate to use in any specific iteration of the benefit measurement procedure. (See Table 7 below).

- Within the framework of the overall three-Stage approach to assessment outlined earlier (Chapter 3, especially Fig. 6), these actual cost reduction factors could be incorporated in a three-Step procedure - essentially operationalising Stage 3 of the overall method - involving

  (1) specification of benchmark cost (BMC),

  (2) application of the CRFs to this value, or a revised baseline cost (RBC) if necessary, to yield a procurement option cost (POC),

  and

  (3) calculation of the budgetary benefit (BB) value (where BB = BMC - POC).

  The individual BB figures arising from this process would be the key ingredients in the sequence of 'if..., then...' statements envisaged as the policy-relevant outcome of Stage 3.

One of the principal tasks of the fourth and final Part of this study is to elaborate this last point and to illustrate how Stage 3 of the policy analysis might be conducted. A broad indication can also be given of the sort of results that might be expected to emerge from calculations related to the main acquisition modes which appear feasible.

Table 7

SELECTED DATUM COST REDUCTION FACTORS (CRF*s)
FOR SCALE (CRF(S)*) AND LEARNING (CRF(L)*)

By NATO Defense Equipment Category/Item
(cf. Table 4 above)

Category/Item	Datum Cost Reduction Factors (CRF*s)	
	CRF(S)*	CRF(L)*
SHIPS		
1. Frigates	(0.90)	0.85-0.90
2. FPBs	(0.90)	0.90-0.95
3. Submarines	(0.90)	0.90-0.95
- - - - -		
NAVAL HELICOPTERS		
17. Small	0.80	0.90
18. Heavy (ASW, MCM)	0.80	0.90
- - - - -		
ARMY ANTI-TANK WEAPONS		
19. Short-range	(0.90)	0.85-0.95
19.1 Propulsion system		0.92
19.2 Radar guidance system		0.85
19.3 Control systems		0.85
19.4 Launcher assembly		0.85
20. Medium-range	(0.90)	0.85-0.95
- - - - -		
BATTLEFIELD SURVEILLANCE		
45. Wpn-locating radars	0.85-0.95	0.90-0.95
46. Other radars	0.85-0.95	0.90-0.95
- - - - -		

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Category/Item	Datum Cost Reduction Factors (CRF*s) CRF(S)*	CRF(L)*
ARMY VEHICLES		
56. Armd Recce Vehicles	0.90-0.95	(0.90)
57. Main Battle Tanks	0.90-0.95	0.95
57.1 Frame	?	?
57.2 Engine	?	?
57.3	?	?
57.4 Weapon	?	?
- - - -		
57.8 Fire Control	?	?
AIRCRAFT		
63. Interceptor/Air Def	0.80	0.90-0.95
64. Strike/Attack/Recce	0.80	0.90-0.95
- - - - -		
AIR FORCE GUIDED WEAPONS		
69. Air-to-air (short)	(0.90)	0.90-0.95
70. Air-to-air (medium)	(0.90)	0.90-0.95
71. Air-to-surface (other than anti-ship (8))	(0.90)	0.90-0.95
- - - - -		
AIR FORCE HELICOPTERS		
81. Air/sea rescue	0.80	0.90
82. Utility/logistic	0.80	0.90

Sources: Table 4 (Chapter 5) for Category/Item column.
Table 5 (Chapter 7) for CRF(S) values (converted/rounded).
Table 6 (Chapter 7) for CRF(L) values (converted/rounded).

PART D ACQUISITION METHODS AND THEIR BUDGETARY IMPACT

Chapter 9

ALTERNATIVES AND ASSESSED SAVINGS

The underlying thesis of this entire study is that to assist decision-making on where initial effort in pursuit of standardisation goals should be applied and on how objectives should be pursued (i.e. by what pattern of procurement arrangements) there is a need for more refined estimates of the potential impact of policy initiatives on NATO members' budgets. The three-Stage process suggested as a means of addressing the policy problem entails

- examination of the budgetary setting, on the argument that

  (1) construction of total budget and procurement budget profiles for NATO members provides the benchmarks against which cost reduction opportunities can be measured;

  and

  (2) inspection of this information by decision-makers or policy advisers is directly useful itself, making possible a narrowing of the field within which elaborate analysis is required by rejection of areas which are financially unpromising for co-operative arms acquisition or within which procurement options are effectively foreclosed.

  It was concluded in Part B that existing data may be inadequate for establishing exact benchmarks but that attention to the budgetary setting is none the less valuable as a means of rendering the analytical effort more manageable.

- elucidation of the scope for production economies by reference to empirical evidence - on economies of scale and on learning - and the derivation therefrom of datum cost reduction factors, which in turn provide the basis for the assessment of actual cost reduction factors (or 'multipliers') for any particular application. It was noted in Part C that there are empirical data which can be pressed into service in this fashion; and that cost reduction factors can be embodied in a simple procedure to yield a measure of the (net) budgetary benefit from one or more procurement options.

- generation of specific statements, in an 'if..., then...' format, related to acquisition methods and their budgetary impact, i.e. differentiated estimates of attainable budgetary benefits under feasible procurement arrangements.

The purpose of the present Chapter is to develop the 'specification' for this third and last stage of the policy analysis method. Underlying the argument is a theme already mentioned: that what benefits might be attainable depends crucially on the acquisition mode. There is a trade-off problem regarding (a) the achievement of wide participation, which is a political imperative as well as a necessity for achievement of equipment commonality objectives; and (b) the achievement of cost reductions, which may also be an imperative in times of stringency and is self-evidently required if there is to be desired budgetary gain.

Fulfilment of this purpose calls for examination of the following sequences of questions:

> What are the acquisition methods that make up the agenda for choice in procurement strategy selection? What are their characteristics from the point of view of political feasibility and from the point of view of potential for production economies?

How, then, might Stage 3 of the assessment procedure be conducted? In what contexts are revised baseline costs likely to be necessary, because of the structure of the co-operative procurement mode under consideration? In which situations would one expect datum cost reduction factors to provide direct guidance on savings opportunities and in which would one expect scale benefits to apply but not learning benefits (and vice versa)?

In a hypothetical example what sort of calculation might be made? What sensitivity analyses could usefully accompany application of the method?

In the three sections into which this Chapter is divided each of these groups of questions is dealt with in turn. The general conclusions which can be drawn about the budgetary impact of alternative procurement strategies and the clues which this discussion provides concerning where and how initial effort in policy implementation might be directed are outlined in the following Chapter, the final one of the study.

ACQUISITION METHODS

It is convenient to attempt a fairly formal delineation of the acquisition methods which make up the agenda for choice in procurement strategy selection and to record at the same time their key characteristics from the standpoint of potential for production economies and political feasibility.

At one limit of the spectrum of theoretical possibilities is full and unconstrained specialisation in development and production of new systems with most (or, ideally, all) NATO countries purchasing off-the-manufacturer's-shelf, or

more plausibly off-the-production-line. This would permit large-scale nationally-based manufacture as part of an international division of labour based on lowest-cost sources. The potential for scale and learning economies plus exploitation of international cost differences is highest in this mode, provided it is the least-cost source for the consolidated production run that is chosen and not the current least-cost source. (The possibility of cost reduction opportunities having been exhausted in particular countries must be acknowledged.) Nevertheless there are some difficult technical questions associated with this approach quite apart from political inhibitions. In many instances the total NATO requirement for a given category of equipment hitherto produced on a fragmented national basis would call for either a scale of production beyond experience or for production extended over a considerable period of time. In the former circumstances plants might run into diseconomies of scale or, having reached minimum efficient scale, quickly enter the zone where additional output has a negligible effect on unit costs. In the latter case there would arise troublesome problems of delivery scheduling: who gets the tail-end of the long production run? Moreover very long runs rarely yield the commonality that might be supposed: early F-4s are emphatically not the same aircraft as later ones. But these difficulties pale into insignificance by comparison with the political obstacles to this procurement strategy. It would involve radical structural change in Alliance defence-related industry which many would be unwilling to countenance on socio-economic grounds. It would also mean a high degree of dependence by individual countries on their partners' defence industries which could scarcely be reconciled with national aspirations to preserve a measure of independence in security dispositions.[1] (This is not to say that there is unwillingness to indulge in

occasional, piecemeal specialisation. Rather the contrary, political hurdles are rarely put in the way of acquisition of a desired system for which the purchaser has no capability at all. Furthermore, important efforts are being made to relax some of the constraints that have impeded freer intra-Alliance trade in arms to date. The bilateral Memoranda of Understanding (MOUs) which the United States has concluded or is negotiating with certain allies testify to that.)

Because of political - incorporating social and economic - inhibitions, interest naturally turns to a variant on full and unconstrained specialisation which might be described as partial and managed specialisation. The Anglo-French helicopter 'package' composed for the Puma, Lynx and Gazelle was a limited bilateral exercise of this nature. Current initiatives under the 'family of weapons' rubric also conform to the model. For instance, the notion that in procurement of the next generation of anti-tank weapons there might be an agreement that the United States should concentrate on developing and producing the longer-range systems with West European industry taking responsibility for shorter-range systems is an attempt to overcome reservations about outright specialisation. It implies less radical structural adjustment and hence the preservation of jobs and competences. It implies mutual interdependence but not 'total' customer (or client) status. At the same time scale and learning economies need not be forgone under this arrangement. However, the 'managed' aspect of the approach - that is, the obligation to guarantee a measure of reciprocity - does mean that the least cost source of production might not invariably, indeed would not normally, be chosen for all elements in the package.[2]

Sub-system specialisation (with single- or multi-country assembly) is another variant which meets the principal

political objections to full and unconstrained total system specialisation, but entails the potential cost penalties of partial and managed specialisation plus those associated with cross-hauling, integration and assembly.

The familiar device of production under licence, usually following a single country's development effort, is also one which overrides many of the political inhibitions concerning full specialisation (though by no means all) at the cost of forgoing some production economies. The 'residual' political objections are self-evident. Licensed production safeguards jobs and capacity, but it does not help sustain the licensee's R & D base. For his part the lead producer may fear the loss of competitive edge involved in the technology transfer which is part and parcel of such arrangements. West European sensitivities are especially acute on both these points. Regarding cost saving, obviously the mirror image of technology transfer is that the licensee starts down the learning curve. As for standardisation goals, it is clear that in principle licensed production furthers them. But it is frequently alleged that such is the impulse to 'naturalise' systems that this can never be taken for granted.[3]

The common strand in the political objections to each of these procurement strategies, whether it be rooted in socio-economic concerns or a more general reluctance to sacrifice freedom of manoeuvre, is that nations resist the abrogation of sovereignty inherent in them. For this reason the co-operative acquisition mode that has appealed most to Europeans to date is the ad hoc, multilateral - often simply bi- or trilateral - collaborative venture. The Anglo-German-Italian Tornado (formerly MRCA) project is an effort of this kind. With its single procurement authority (the NATO MRCA Management Agency (NAMMA)) and

its single main contractor (the joint company PANAVIA GmbH) the project has the merit of a certain administrative simplicity, at least nominally. It is regarded as having brought within reach of the participants an advanced combat aircraft development which it would have been beyond the resources of each to mount singly; and in the detailed structuring of the arrangement it has been possible to satisfy the participants' wish to maintain productive capacity and to stay in touch with advanced technology in the system area. But costs on joint projects are generally held to be higher than a single-nation venture of similar overall size would have been, for what that favourite comparison is worth. Certainly there are 'inefficiencies endemic to collaboration'.[4] These produce cost increases and time delays (which themselves occasion expense) associated with reconciling differences of national emphasis in mission needs and suchlike. Estimates of premiums on unit cost of 5 percent or thereabouts attributable to the production-sharing and the attendant cross-hauling/integration/assembly involved in such projects are commonplace. There is even a formula for computation of the relationship between overall project costs (loosely defined) and development time-span on the one hand and the number of states participating in a collaborative enterprise on the other: they are proportional, respectively, to the square root and the cube root of the number of participant countries. In sum, this acquisition method is one which finds political favour because interdependence a la carte implies a less complete diminution of sovereignty than other options. Whether it presents opportunities for exploiting production economies is questionable and, in any event, not really the point.[5]

In multilateral collaborative ventures the typical method of working has comprised joint development effort followed by joint production, with several variations on the latter:

sub-system specialisation plus single final assembly plant, dual lines or even a final assembly facility for each participating state. To nations with a strong indigenous R & D base the approach commends itself because of the shared development aspect. The organisation of production is primarily a matter of satisfying felt needs to underpin employment in defence-related industry (and in specific regions or localities) and to ensure the utilisation of capacity for military production. Another mode - co-production following a single nation's development work or a competitive R & D phase - essentially reflects a response to the latter impulse and has accordingly appealed largely, though not exclusively, to states with a limited defence technological base.

It is worthwhile to distinguish between simple co-production, where comparatively straightforward provision is made for a number of countries to manufacture a selected system; and complex co-production where the terms of the 'deal' embody a complicated matrix of transactions and obligations to satisfy the participation priorities of the partners. So far as political attainability is concerned clearly complex arrangements have the edge; the very purpose of the complexity is to ensure that differing national needs can be satisfied. Whether the co-operative solution finally arrived at allows for exploitation of scale and learning economies, or reflects international competitiveness, is another question. The most notable example of complex co-production of current interest is the F16 advanced combat fighter programme, the relationships among whose participants are shown in Fig. 10 overleaf. It is felt by most observers of this programme that for certain European Participating Governments (EPGs) the net benefits from the undertaking are dubious at best, while for the United States additional costs have been incurred because

of the European connections which may just be offset by the scale/learning benefits accruing because the total volume of output will be greater than if the aircraft were being acquired for the USAF alone.[6] (There

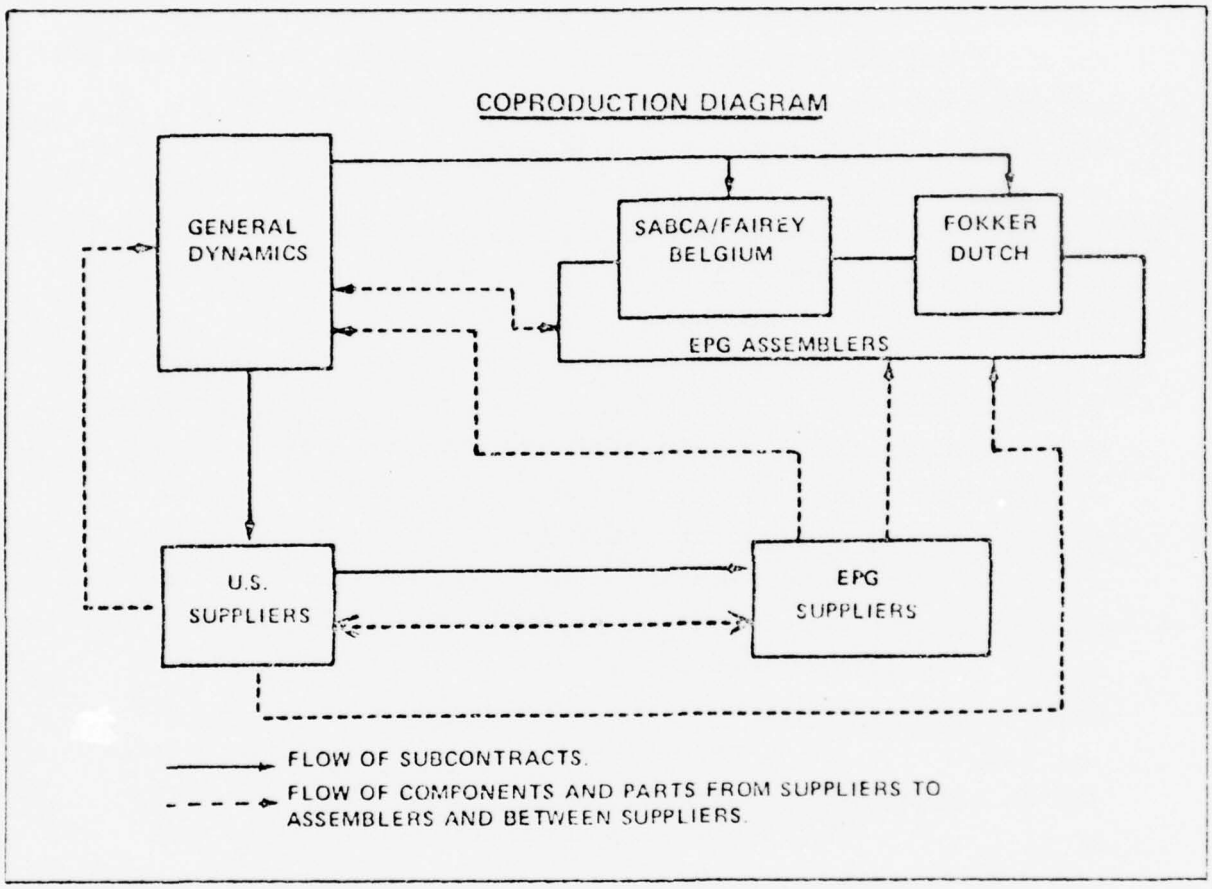

Fig. 10

Reproduced from Sharing the Defense Burden: The Multinational F-16 Aircraft Program, Report to the Congress by the Comptroller General of the United States, General Accounting Office PSAD-77-40, August 15, 1977, p.8.

are further details on this in the Annex to this Chapter: a note on 'The F16 Experience' which has been prepared, using material from the 1977 General Accounting Office Report on the project supplemented by information from

other sources, because of current interest in the programme and the belief in many quarters that co-production along these lines offers the best prospect for obtaining wide participation in armaments co-operation aimed at promoting commonality of equipment.)

Complex co-production is widely regarded as one of the more viable potential strategies for rationalisation of NATO defence efforts with standardisation and related goals in mind. Yet, because the very complexity may involve a dissipation of theoretically attainable production economies, as an acquisition method it would appear to lie far removed from the full and unconstrained specialisation mode on the spectrum of procurement policy possibilities. Indeed the next and final option to be mentioned is that generally regarded as the opposite pole: independent national effort or self-sufficiency. Given the widespread concern about sovereignty questions and the preservation of indigenous capacities among NATO countries the political obstacles to 'going it alone' in systems development and production are rarely formidable. As for costs, clearly there are no reduction opportunities when it is the benchmark policy that is pursued.

Juxtaposition of a footnote to the discussion of complex co-production and first mention of independent national effort as a procurement option presents very starkly the essence of the trade-off problem at issue here. Complex co-production is seen as a route to standardisation with the military benefits and perhaps - when commonality obtains across-the-board - the support cost savings it might bring. If complex co-production is the method required to elicit the participation required to achieve standardisation there may be no substantial, immediate budgetary pay-off at the acquisition stage however. There might even be a net cost compared with separate

national development and production or unconstrained 'shopping around'. Independent national effort exacts its price in the operational penalties of fielding non-standardised systems. Standardisation may exact its price, if what is 'achievable in light of current pressures' is the guideline, in greater expense than free choice would entail, including choice of self-sufficiency in many instances.

It goes without saying that this summary review of acquisition methods is not exhaustive. Each of the main modes distinguished admits of many variations. More generally, every particular procurement arrangement is to some extent sui generis. Even so there is merit in displaying the essential conclusions of the account, to highlight the broad judgements that have been entered regarding the 'rating' of the eight methods in terms of their potential for production economies on the one hand and political attainability on the other. This has been done in Fig. 11 overleaf. A couple of observations are in order at this stage. First, the tabulation confirms that there is an underlying inverse relationship between potential cost savings (at the procurement level) and political attainability. But, secondly, there are 'deviant' cases: partial, managed specialisation, as is involved in the 'family of weapons' approach, offers the prospect of fair potential for exploiting production economies without facing the more inhibiting political obstacles; ad hoc multilateral collaboration - or armaments co-operation a la carte - can in certain circumstances yield significant budgetary pay-offs and, by definition, poses fewer political problems since each case is appraised on its merits; and, precisely because these options in their different ways seem to beat the basic trade-off problem, they are perhaps worth special attention. A related inference from Fig. 11 is that

SELECTED ACQUISITION METHODS

Mode	Potential for Production Economies	Rating on Political Attainability
Full, unconstrained Specialisation (e.g. free trade)	Very High	Very Low
Partial, managed Specialisation (e.g. 'Family of weapons' concept)	Fair	High
Sub-system Specialisation	Fair	Fair
Licensed Production (e.g. AU-8, Roland)	Fair-Low	Fair
Bilateral, Trilateral, Multilateral Collaboration (e.g. Tornado)	Fair-Low	Fair-High
Simple Co-production	Low	Fair
Complex Co-production (e.g. F16)	Low	Fair
Independent National Effort (numerous instances)	Very Low	High

Fig. 11

the complex co-production case, widely regarded as a sound formula for engaging wide participation for commonality's sake, may well not produce the savings that are a parallel aim; and examination of the F16 experience in the Annex to this Chapter raises some further questions about the enthusiasm for this approach.

ASSESSMENT

In Chapter 3 the essence of Stage 3 of the benefit measurement procedure suggested in this work was described as follows:

> Stage 3 Generation of alternative (or differentiated) estimates of attainable budgetary benefits under feasible procurement arrangements based on the application of 'cost reduction factors' (Stage 2) to benchmark data (Stage 1). (p.62 above and Fig. 6.)

It was pointed out, however, that for decision-making purposes a comprehensive and exhaustive listing of the budgetary benefits that would accrue to each of the multiplicity of imaginable procurement policy possibilities need not be necessary. Rather, as in any economic appraisal, there might be (a) definition of the range of feasible options, (b) identification of the courses of action worthy of detailed analysis and then (c) display of information for choice in the form of 'if..., then...' statements. (p.59-60 above).

In Chapter 8, following the discussion of empirical evidence on production economies, it was argued that to provide the content of such statements one might proceed through three

simple steps.

(1) specification of benchmark cost (BMC)

(2) application of cost reduction factors (CRFs) to this value, or if necessary to a revised baseline cost (RBC), to yield a procurement option cost (POC)

and

(3) calculation of the budgetary benefit (BB) value (where BB = BMC (or RBC) - POC).

The individual BB figures arising from this process would be the key ingredients in the sequence of 'if..., then...' statements. (p.135 above.)

Assuming that in different contexts there might be a need to evaluate each of the eight (in practice seven) principal procurement strategy options listed in Fig. 11 against the benchmark of current intentions, it is pertinent to record what can be said, in general terms, about

- the situations in which estimation of revised baseline costs might be necessary, because of the characteristics of the acquisition method;
- the situations in which the datum cost reduction factors (CRF*s) of Table 7 might provide direct guidance and those in which adjusted values might be required;
- the situations in which a cost reduction factor for scale (CRF(S)) would be applicable, those in which one for learning would be applicable (CRF(L)) and those in which neither would be applicable.

In this way what the different acquisition methods' potentials for production economies mean for the kind of results the benefit measurement method might yield can be exposed.

Full, unconstrained specialisation is the mode for which one would expect cost reduction for both scale and learning, on the argument that the sole least-cost producer selected should be able to function at minimum efficient scale (mes) and exploit, within the single plant (or firm), all the learning benefits theoretically obtainable for the given production run. Whether the datum CRF*s would apply would depend on (a) where the producer(s) in question stood in relation to mes and (b) the scale of the expansion that production for the full Alliance market might permit.

Under partial, managed specialisation there would be a reasonable expectation of obtaining, within each element of the 'package', both scale- and learning-related cost reductions. The exact CRF(S) and CRF(L) values applicable in any specific calculation would depend, as in the full specialisation case, on producers' positions in relation to mes and on the expansion factor. The obligation under a managed regime to provide some business for all parties might, however, necessitate calculation of a revised baseline cost (RBC): for example, in cases where a piece of the action were allotted to a higher-cost manufacturer.

For the sub-system specialisation mode the same arguments hold. There would be a definite requirement for a RBC calculation in this case, however, to reflect the inescapable additional expenses of cross-hauling, integration and assembly.

With licensed production arrangements one would look for some cost reduction for learning for licensees, assuming the transferability of the lessons of the lead producer's experience. Cost reduction attributable to larger-scale manufacturing operations would be the exception rather

than the rule, since there can be no presumption that the option of producing under licence induces nations to equip themselves with more than they would otherwise produce (although this could be the case).

As noted earlier, the general presumption about multilateral collaborative ventures is that costs are higher than if the total output envisaged were undertaken by a single state, although since that is not the relevant 'counter-factual' case the significance of the calculation is dubious. Even so it must be supposed that a RBC would have to be worked out for evaluation of this option because of (a) the need for harmonisation/liaison and suchlike in development and pre-production and (b) the outgoings of cross-hauling, integration and assembly. What allowance should be entered for savings from scale/learning against the revised benchmark, is a difficult question. The essence of multilateral collaborative ventures, at least so far as experience to date is concerned, is that they are undertakings which it would not be possible for the parties to embark upon in any other context. Any attribution of benefits must therefore be to some extent arbitrary. It need not, on that account, be random or capricious; it ought to be possible to gauge the relationship between the level of output that the arrangement permits and minimum efficient scale for sub-system or part producers; and ingenuity might be exercised in forming a parallel assessment of their opportunities for learning.

The co-production modes - simple and complex - are instances where, if experience on current programmes is anything to go by, the reasonable expectation must be that (a) basic costs will stand higher for all but the least efficient participants than if independent national production had been attempted; but, depending on the

precise configuration of the work-sharing and contractual relationships, (b) some scale and possibly learning benefits may accrue to the main contractor(s); while (c) whether any such advantages arise for smaller sub-contractors or assemblers depends on where individual enterprises stand in relation to minimum efficient scale and precisely how fragmented an effort has had to be arranged in order to consummate the 'deal' in the first place. If speculation on this is admissible, one would hazard the guess that some learning might occur but that the benefits of large-scale production might well not be obtained.

Speculating in a more general fashion about the 'accessibility' of scale savings, the likelihood is that in many co-operative undertakings involving European countries (especially perhaps the smaller states), these would not be obtained if only because a high level of output is not necessarily what such countries are interested in. The impulse to join in a co-production scheme, to collaborate or undertake licensed production is often to maintain in use productive capacity which the state wishes to have in its own right. The interest may therefore be in ensuring that the production run extends over a sufficiently long time-span to sustain the plant until such time as work on the next generation of equipment may be forthcoming.

CALCULATION AND SENSITIVITY ANALYSES

At this point it is instructive to offer a hypothetical example of the sort of calculation that might be made at Stage 3 of the benefit measurement procedure. Some indication of what sensitivity analyses could usefully accompany application of the method is also in order.

Hypothetical Calculation

Suppose that information were obtainable from armaments planning schedules indicating that, over a time-scale sufficiently synchronous to make a co-operative exercise feasible, five NATO countries envisage acquisition of (for example) a new generation 'fire-and-forget' anti-ship missile,

- in quantities ranging from 2200 units for the largest buyer (say, the United States) down to 300 units for the smallest (say, Norway),

- over procurement periods of 3 or 4 years,

- at forecast/budgeted unit costs (based on independent national efforts) of from $1.50 million to $2.00 million,

and that, given the relative factor prices and state of technology in the would-be purchasers' domestic industries, the minimum efficient scale of production for the equipment in question is 550 units per year in the most 'advanced' country, 400 units per year in a group of three countries and 300 units in the fifth. The benchmark information for this example would then be as set out in Table 8(i) overleaf, whose 'bottom line' is a total expense of $7.64 billion for the five separate programmes.

One feasible alternative procurement arrangement might be a straightforward co-production formula. For simplicity's sake this could be imagined as emerging from a joint evaluation of the concepts/study and feasibility study work already undertaken by individual countries, yielding agreement on a single (standardised) product with a baseline unit cost for separate national manufacture equal to that forecast or budgeted by the collaborators. The co-production formula, it might be supposed, would provide

Table 8

BUDGETARY BENEFIT MEASUREMENT
- A HYPOTHETICAL CALCULATION

8(i) The Benchmark Calculation

Country	Requirement (units)	Timescale (years)	Forecast/ Budgeted Cost ($mm)	Min. Eff. Scale (annual output)	Benchmark Cost ($bn)
A	300	3	2.00	400	0.60
B	2200	4	1.50	550	3.30
C	800	4	1.75	400	1.40
D	600	3	1.80	400	1.08
E	700	4	1.80	300	1.26
	4600				7.64

8(ii) The Co-Production Calculation

Country	Assigned Output (units)	Benchmark Cost ($bn)	Cost Reduction Factors CRF(S)	CRF(L)	Procurement Option Cost ($bn)
A	-	-	-	-	-
B	2200	3.30	1.00	1.00	3.30
C	1200	2.10	0.90	0.95	1.80
D	1200	2.16	0.80	0.90	1.56
E	-	-	-	-	-
	4600				6.66

for production by three of the participating states: these might be the country with the largest requirement (the United States); the country with the next largest requirement (the United Kingdom perhaps); and a third nation with a special claim to competence in the system area, or a particular requirement to sustain capacity or employment in the relevant industry, or some other qualification (like a strong bargaining position in this particular system acquisition debate).

Calculation of the co-production case's procurement option cost might then take the form set out in Table 8(ii). The 'assigned outputs' in this illustrative example have been set arbitrarily. The application of cost reduction factors reflects reasoning along the following lines.

> CRF(S): for the largest purchaser/producer, Country B, no benefit from larger-scale operation is available; Country C is able to move half way towards its minimum efficient scale of production, permitting a 10 percent scale-related cost reduction. Country D's assigned output allows it to plan operations at minimum efficient scale, permitting a 20 percent reduction.
>
> CRF(L): the largest purchaser/producer looks for no additional gains from learning, total output in its plant or plants remaining as it would have been under independent arrangements. Learning does take place in the other countries, however, as indicated.

The 'bottom line' in Table 8(ii) is total outgoings for the acquisition of the required systems under the co-production scheme of $6.66 billions.

Budgetary benefit, defined as benchmark cost minus procurement option cost, is accordingly $0.98 billion (or 13 percent) in this example. It is also a simple

matter to calculate the expense that would be involved for direct off-the-production-line purchase of the system from Country B, assuming that buyers took their requirements either from later production or from a second plant opened-up in Country B. The 4600 systems would be obtained at $1.50 million apiece; that is, for a total expenditure of $6.90 billions. Budgetary benefit for this option would thus be $0.74 billions.

Simplistic though this illustrative example is it does suffice to show how the 'if..., then...' statements identified as the policy-relevant outcome of the procedure might be generated.

(1) If the particular co-production arrangement were adopted for acquisition of the anti-ship missile system envisaged

then, compared with separate national production the budgetary impact over the designated procurement run would be:

a saving (benefit) of .....$0.98 billions.....

(2) If the anti-ship missiles were acquired by off-the-production line purchase from the (originally) least-cost producer

then, compared with separate national production the budgetary impact would be:

a saving (benefit) of .....$0.74 billions.....

Preparation of information in a comparable form would clearly be possible for any number of other procurement arrangements regarded, by decision-makers or policy advisers, as worthy of attention and appraisal. In fact these two calculations themselves suggest a third option of considerable potential interest: assignment of a larger share of output to Countries C and D both of whom, when able to exploit the cost reduction opportunities

of higher scale of operations and a longer cumulative production run, obtain unit cost figures below those of Country B. That the budgetary benefit from the co-production arrangement which engages them in manufacture - Statement (1) above - is greater than that for the straight purchase from Country B - Statement (2) above - is the clue to this possibility.

Sensitivity Analyses

Needless to say, because of the judgements and assumptions implicit in computations of this nature, it would be a foolhardy analyst who conducted only one set of calculations for each procurement option. For the hypothetical case cited it would be illuminating to 'run' the data with variations such as (a) different forecast/budgeted unit cost values, (b) different output assignments and (c) different values for the cost reduction factors (including alternatives based on different assessments of the minimum efficient scale of production in one or more countries). As in other forms of economic appraisal for policy choice the most valuable purpose that such iterations would serve might be in elucidating the sensitivity of the final budgetary benefit values to change in particular components of the calculation.

Sensitivity analyses of this sort conducted in relation to the anti-ship missile acquisition 'problem' (cf. Table 8) could serve to expose:

- what increases against forecast/budgeted unit costs, i.e. cost escalation, could be 'tolerated' in Countries C and D before eroding the budgetary benefit of co-production vis-a-vis purchase from Country B;

- how the budgetary benefit from co-production would be affected by marginal adjustment to the output assignments;

- the effect of realising unexpected scale/learning benefits in Country B, or of failing to realise expected advantages in Countries C and D;

and, indeed, whatever other possibilities a policy adviser might judge worthy of investigation or a decision-maker might require.

Summarising this specification of the third stage of the policy analysis method developed in this study, it has been shown that,

- acquisition methods do differ from the point of view of political feasibility and potential for production economies, confirming both the centrality of the participation/savings trade-off and the importance of differentiated benefit estimation;

- assessment along the lines suggested should be feasible, and also illuminating, because of the likelihood of scale/learning economies in some circumstances but not others and of significant cost reduction under certain conditions but negligible savings - even additional expense - in others;

- undertaking relevant calculations, with sensitivity testing, is a straightforward matter and capable of yielding the kind of array of budget benefit statements useful to decision-makers and policy advisers.

From the point of view of the principal methodological purpose of the present exercise that is virtually all that need be said. However it is appropriate to, first, recapitulate the essential argument of the study and, secondly, record what general inferences about the budgetary

impact of alternative procurement strategies can be drawn and what clues a brief, preliminary and provisional demonstration of the measurement technique offers regarding where and how initial effort in standardisation policy implementation might be directed. These themes are taken up in the following and final Chapter.

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(to Ch. 9)

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NOTE: MAIN TEXT CONTINUES AT P.162,
FOLLOWING THE ANNEX TO THIS CHAPTER

Annex to Chapter 9

THE F 16 EXPERIENCE

In discussion of how NATO might achieve greater efficiency in weapons procurement by standardisation, favourable reference is frequently made to the multinational F 16 air combat fighter programme. At the same time the co-production model developed for this programme is often referred to as an example of how to achieve European participation in weapons system developments, thereby enhancing acquisition of common hardware. It is instructive, therefore, to relate the development of the F 16 as depicted in agreements and documents and to compare this with the actual experience to date.

BACKGROUND AND FORMAL UNDERSTANDINGS

After a one-year evaluation period Denmark, Norway, Belgium and the Netherlands decided in May 1975 to acquire 348 General Dynamics F 16 air combat fighters. The USAF had decided to put the aircraft into full scale development, with a view to production for its own inventory, earlier that year. The general sentiment was that an important step had been taken in the direction of standardisation within NATO.

The basic document regulating the F 16 multinational programme is the Memorandum of Understanding (MOU) signed in May and June 1975 by the US Secretary of Defense and the Defence Ministers of the four European Participating Governments (EPG). The 40-page document sets forth the general agreements between the parties. It is not a contract: rather, it is written like the Constitution of the United States, and this flexibility has been proven both advantageous and the source of much friction.

The United States' Government is committed, according to the MOU, to

- acquiring 650 F 16 air combat fighters and basing a substantial number of them in Europe in peacetime;
- using European facilities for maintenance for the USAF F 16 based in Europe;
- managing the F 16 procurement programme;
- releasing most elements of the F 16 aircraft for technology transfer;
- ensuring that European industrial participation in the F 16 programme equals 58% of European F 16 procurement costs.

The figure 58% is arrived at through assurances to the EPGs of 10% participation in the initial USAF acquisition of 650 F 16s (65 aircraft); 40% participation in the initial European acquisition of 348 F 16 (139 aircraft); which amounts to the value of 65 + 139 = 204 aircraft, i.e. 58% of the procurement value of the EPGs 348 aircraft. In addition, the Europeans will have 15% participation in any third country acquisition of the F 16.

The four European governments are committed to the following:

- acquiring 348 aircraft;
- paying for all material and services necessary to their programme and funding a pro rata share of the programme costs as required for acquiring production long-lead items and production implementation;
- paying a pro rata share of the US Government's non-recurring costs to develop the F 16 aircraft system;
- funding development and production costs for equipment peculiar to the aircraft.

Separately, the four EPGs signed bilateral preliminary contracts with the US government, establishing funding arrangements, delivery schedules, performance specifications and configuration requirements. The initial financial commitments covered in these contracts were $114 million as opposed to the $2,120 million in the MOU (based on a not-to-exceed price of $6.091 million (January 1975 price level) per aircraft). The definitive Letters of Offer and Acceptance (LOAs) were to have been finalized in the autumn of 1975 (but see below).

RESPONSIBILITIES UNDER THE MOU

The overall management responsibility of the F 16 programme is held by the US Government. Formally the aircraft built by the Europeans are to be built for General Dynamics. General Dynamics will transfer the aircraft to the US Government. The US Government will supply the aircraft to the purchasing European nations. The programme is managed day-to-day by the F 16 System Program Office (SPO), Aeronautical Systems Division, Air Force Systems Command. The SPO monitors and directs the performance of the prime contractors and coordinates the international aspects of the enterprise through a Multinational Fighter Program Steering Committee. A special office has been established in Brussels to provide management in Europe.

The Steering Committee has one principal member from each participating nation (i.e., five members). It meets regularly to resolve problems and to provide advice to the USAF SPO director (who is a Major General). If the Steering Committee is unable to resolve an issue it can go to the five defence ministers, but so far this has never happened.

General Dynamics (GD) is the prime contractor for the F 16 airframe and is also responsible for total systems performance. Pratt & Whitney is responsible for the F 100 engine. Each contractor is responsible to the US Government for achieving specific levels of European co-production.

The GD F 16 office at Fort Worth provides overall guidance and direction for the European programmes. Pratt & Whitney manages the F 100 engine programme through the Government Products Division at West Palm Beach, Florida. Both companies have a Program Office in Brussels as well.

As for sub-contractors, GD sub-contractors have co-production programmes with European industries for aircraft components; and parts will be used for all F 16s produced (including any third country sales). The European sub-contractors supply components and parts to GD sub-contractors, to EPG assemblers for the European-built aircraft, and also to General Dynamics directly. (The scheme is illustrated in Fig. in the text of Chapter 9.)

THE CURRENT STATE OF THE PROGRAMME
(Summer 1978)

Since June 1978 when Denmark, the Netherlands and Belgium exercised their options under the MOU the nations will acquire the following numbers of aircraft:

Belgium	116
Denmark	58
Netherlands	102
Norway	72
Total	348

Although this represents substantial procurement for the EPGs, in the 1982-84 time-frame they will have to make another decision about replacement of the other half of their air forces. Moreover, full standardisation will be achieved only if this choice - affecting Belgium's Mirage Vs, Denmark's F 104s and Drakens, the Dutch F 5s and Norway's F 104s - goes in favour of the F 16.

The two European assembly lines will produce the aircraft as follows:

Fokker, Netherlands	-	174 for the Dutch and Norwegian air forces
Fairey-Sabca, Belgium	-	174 for the Belgian and Danish forces

The production rate will be, at the most, 36 aircraft per assembly line per year over 1979-1984. At that production rate it would take the General Dynamics Fort Worth plant 39 years to produce the 1388 aircraft foreseen for the USAF inventory. An inference is that the EPGs may have difficulties in bringing in production for third country sales. It is possible that they expect further F 16 production for their own air forces in the period 1985-1990.

THE EXPERIENCE

In financing and implementing the programme a number of problems have arisen which illustrate the potential perils and pitfalls of a complex co-production arrangement. Some of the more significant are noted here.

- The LOAs were submitted only in January 1977, instead of in September 1975 as first envisaged. They were signed in May 1977, eighteen months later than expected.

- A relatively low rate of production is set for the EPG assemblers, among other things because European plants look for steady employment over time, not maximum output per year to achieve scale economies. In addition, proposing the working of three, or even two, shifts meets opposition from labour unions.

- The unit procurement cost for the EPG F 16s is now likely to be around $7.9 million (January 1975 dollars) not $6.09 million as in the MOU; a 30% increase. The $6.09 million figure in the MOU is itself a curious mixture of fly away cost and unit procurement cost, calculated as follows:

	$ millions
Airframe	3.450
Engine	1.445
Rader	0.372
GFAE	0.153
FSD share	0.470
Industry management	0.005
Duplicate tooling	0.196
	6.091

(GFAE: Government Furnished Equipment; FSD: Full Scale Development)

Since the radar had not been selected in May 1975 its price was set arbitrarily as was the R&D share. No ground support equipment is included in this 'price' which is fly away plus some R&D cost. The tooling cost included in the price is $68 million for 348 aircraft, as compared to a likely eventual $127 million of US Government Furnished Tooling (i.e.-a 100% increase). Further, it has been estimated that spares, ground support etc. may add 55% to the aircraft cost, not 25% as is usually the case. As a result, since the USAF F 16 cost is $5.56 million, or about $2 million less per aircraft, it would appear that nations without aircraft industries such as Norway and Denmark could have saved money in buying the F 16 off the shelf.

- Cost has gone up because the engine is more expensive than was foreseen and also because of the Avionics Intermediary Shop (AIS). This is a new testing system developed for the F 15, but for several reasons much more expensive in the F 16 case. Total cost is estimated at $1 billion. Usually 1 AIS would be needed per 50 aircraft but, mainly because of geography, nations are likely to procure the following:

	Aircraft (No)	AIS (No)	AIS Cost ($ million)	AIS Cost per Aircraft ($ million)
Norway	72	2	100	1.4
Belgium	116	3	150	1.3
Netherlands	102	2	100	1
Denmark	58	1	50	1

- It appears that Belgium, the Netherlands and Denmark will have to pay 10% EEC customs fees on US F 16 parts. This was not foreseen in the MOU.

- Achieving the 'offset' goals that are the essence of the co-production arrangement is proving difficult. Leaving aside the problem of the baseline for the calculations--on which the General Dynamics (and US Government) position is at odds with that of some European interests--the 58% 'offset' against the present contract procurement value of $2,830 million may not be reached (and certainly not in a balanced way). As the Table on the next page shows, the EPGs have achieved 53% out of 58% co-production, but the differences between the nations are substantial. Both Norway and Denmark fall $125 million short, whereas Belgium has exceeded its 'share' by $200 million but is nevertheless some $220 million short of 100% co-production.

- One reason why the Europeans have difficulties in achieving co-production is that GD released some offers for bids very late in the vendor selection. After acceptance of Engineering Change Proposal 006 (in January 1978) and establishment of the baseline costs, the USAF requested that non-competitive EPG co-production be funded by GD profits. As a result very little further co-production is foreseen for the EPG. In third country co-production more than 15% was offered the EPGs in Iran's case in order to bring EPG co-production closer to 58% in all. (About $140 million EPG co-production will result from Iran's 160 aircraft.) But in the case of Israel and other third country sales EPG co-production is not expected. For one thing the EPGs cannot follow all USAF negotiations with third nations. Moreover the avionics package especially will continuously change and avionics industries in EPG nations will

not have the same products available, thereby losing their co-production. The only way to reach 58% would be in a European support facility; but that will probably be based in Germany, outside EPG territory.

- Third country sales have in any event run into political difficulties in Scandinavia and the Netherlands. Public opinion is against co-production in case of Iran, South Korea, Arab nations etc.

CO-PRODUCTION/OFFSET: TARGET AND ACTUAL VALUES

EPG	Contract Procrmnt $m	Target Offset $m	%	Actual Offset $m	%	Difference $m
Belgium	988	573	(58)	769	(78)	+196
Denmark	429	249	(58)	121	(28)	-128
Netherlands	761	441	(58)	354	(47)	- 88
Norway	652	378	(58)	253	(39)	-125
TOTALS	2830	1641	(58)	1497	(53)	-144

Chapter 10

SUMMARY AND CONCLUSION

This study deals with a topical policy issue. After almost three decades in which little more than lip-service has been paid to the need for rationalisation of NATO defence efforts, several recent initiatives have been taken to establish this as a central objective of United States' policy. The emphasis is on the promotion of equipment standardisation and interoperability; and the effort has evoked a response in the Alliance as a whole under the rubric of the Long Term Defence Programme which was formally endorsed at the May 1978 Washington Summit.

In this context Department of Defense Directive 2010.6 assigns to the Assistant Secretary of Defense (International Security Affairs) responsibility for, among other things,

> 'monitoring the political and economic factors which affect standardization and establishing intermediate goals which are achievable in light of current pressures.'

These pressures include the expectation that there will be early evidence of progress towards declared objectives, which in turn include reductions in costs and greater co-operation in armaments planning and production. The overall scope of recent initiatives is more extensive than this however, incorporating the several elements depicted in the frame of reference overleaf. (Fig. 3 from Chapter 2.)

With a complex set of objectives as tabulated here clear priority-setting for policy implementation is imperative. In particular it is important that those measures be identified which should both yield budgetary benefits and engage wide participation among NATO member nations. But that dual obligation involves a complication. Simultaneous maximisation of savings and participation

RECENT INITIATIVES FRAME OF REFERENCE		
PURPOSE	RATIONALISATION Increased Efficiency in the Utilisation of Alliance Resources (with special reference to equipment)	
AIMS	Combat Effectiveness Benefits (Military Gain)	Reduced Resource Costs (Economic Gain)
requiring....	1. Improvement in possibilities for interoperation 2. Improvement in possibilities for mutual support 3. Teeth-Tail Ratio improvements	1. Elimination of wasteful, duplicative R & D 2. Production Economies 2.1 Scale/Learning 2.2 Least-cost sources 3. Support Cost Savings (O & M, especially logistics)
....therefore GOALS	INTEROPERABILITY COMPATIBILITY	Armaments Co-operation (implying common systems)
requiring/ entailing	Interface devices STANDARDISATION (doctrine, procedures, C^3) STANDARDISATION (equipment)	[Alliance Armaments Planning e.g. PAPS, NAPR]* STANDARDISATION (equipment)
* See Ch's 3 and 5 below		

is out of the question. To assign highest priority to financial pay-offs would be to rule out equipment acquisition strategies capable of eliciting wide participation. To lay greatest stress on extensive involvement of Alliance members would preclude adoption of the lowest-cost procurement arrangements. In short there is a trade-off problem. Hence a crucial, if not the crucial, information requirement for sensible policy choices is more refined estimates than have been available hitherto of the potential budgetary impact of alternative courses of action. Specifically, decision-makers and their policy advisers need some means of assessing the pay-offs likely to be associated with feasible alternative procurement arrangements - i.e. illumination of the trade-off problem.

PROCEDURE

It is suggested that a three-stage analytical procedure would meet this requirement. Its essentials are set out in the diagram overleaf. (Fig. 6 from Chapter 3.)

The Budgetary Setting

The point of departure for this policy analysis method is examination of NATO members' intended defence expenditures and equipment plans. Construction of total budget and procurement spending profiles can provide a general yardstick and also particular benchmarks against which cost reduction opportunities might be measured. Equally important, it can expose where armaments planning has and has not foreclosed acquisition strategy options.

MEASURING CERTAIN ECONOMIC BENEFITS FROM INCREASED NATO STANDARDISATION : SUMMARY		
METHOD OF ASSESSMENT	INFORMATION REQUIRED	DECISION-MAKER POLICY/ADVISER
Stage 1 Construction of total budget and procurement budget profiles to provide benchmarks against which cost reduction opportunities can be measured and to expose where armaments planning has not foreclosed acquisition strategy options.	(a) Defence Expenditure Series Major Equipment Series (NATO DPQs) (b) Future Procurement Plans (NATO Consolidated Equipment Schedules) [National Data : Intelligence Services]	Rejection of - unpromising areas - areas where options are foreclosed
Stage 2 Derivation of 'cost reduction factors' from empirical evidence on the economies of scale/learning and comparative costs in principal systems areas.	Empirical Data on: - cost/output relationships - minimum efficient scale - international competitiveness (Surveys: Appendices I and II) [Internal sources : Industrial Sources]	
Stage 3 Generation of alternative (or differentiated) estimates of attainable budgetary benefits under feasible procurement arrangements based on the application of 'cost reduction factors' (Stage 2) to benchmark data (Stage 1).	Benchmarks (from Stage 1) Cost Reduction Factors (From Stage 2) Feasible Arrangements	Selection of alternative arrangements for detailed analysis

When the budgetary setting is examined in this fashion the following conclusions arise,

- Major NATO-related equipment purchases account for around 14 per cent of planned defence spending for 1978-82 of the SEVEN members of the Alliance for whom budgetary projections are readily available (and it is unlikely that this figure would be exceeded if there were 'standardised' data for NATO as a whole). Savings on the major systems' budget can thus exert only limited leverage on member nations' total expenditure. It follows that the expectation that new departures in multinational armaments co-operation on such systems can transform the economics of Alliance defence is ill-founded.

- Consolidated NATO defence equipment schedules indicate that about one-half of all major and minor equipment projects in current armaments plans have not yet reached full development or production. On a stringent definition only these can be regarded as potential candidates for inclusion in multinational acquisition schemes. The zone of discretion for collaborative procurement policy planning is therefore tightly circumscribed.

These conclusions are of interest in their own right. So far as the procedure for benefit measurement is concerned, they confirm that by inspection of data on overall spending plans and intended equipment expenditure it should be possible to reject both areas financially unpromising for co-operative procurement and areas where acquisition strategy options are effectively foreclosed, thus narrowing the field within which more complex analysis is required.

Production Economies

For fuller analysis the central question is: where are the greatest savings in acquisition costs, principally production expenditures, to be found? Concentration

on production outlays is justified because the scope for savings on R & D efforts and in the logistics area is negligible when it is the effects of partial and shorter-run initiatives that are at issue.

The answer to the question is: where there is greatest potential for exploiting economies of scale and learning in production and for utilising lower-cost sources of manufacture. Empirical data on production economies may be scrutinised for indications as to where this might be. The material is sparse. But it furnishes a basis for rough-and-ready appraisal of the likely scale and pattern of savings from alternative procurement strategies.

The evidence suggests two things.

- From co-operation arrangements which allow the scale of production in particular plants to rise from, taking a datum point, one-half minimum efficient scale to that level, the range of cost reduction is probably 4-16 per cent. Values at the lower end of this bracket might well predominate however; and there is a good deal of econometric research which points to constant returns to scale.

- The further cost reduction from learning that is potentially attainable through, for example, doubling production runs might fall in the range up to 20 per cent. (This is assuming that both scale- and learning-related cost advantages arise. In practice that might not be the case under many, if not a majority of, feasible procurement strategies.)

From the methodological point of view the evidence on production economies, augmented as might be possible from internal and industrial sources, can be used to develop cost reduction factors (CRFs) for setting alongside information about intended equipment acquisitions. These CRFs can be incorporated in a simple budgetary benefit measurement calculation involving (a) specification of

benchmark cost (BMC); (b) application of the CRFs to this value - or to a revised baseline cost if appropriate - producing a measure of procurement option cost (POC); and, finally, (c) the calculation of budgetary benefit (BB), where BB = BMC - POC.

Acquisition Methods and their Budgetary Impact

Following these steps permits the generation of specific statements, cast in an 'if..., then...' format, indicating the estimated budgetary impact of alternative acquisition methods. Obviously the range of alternatives is vast. However, in any given instance, the number likely to be feasible is limited; and coarse calculation may enable some of these to be eliminated, leaving a manageable assessment task.

In general terms the spectrum of possibilities runs from full, unconstrained specialisation to independent national effort (self-sufficiency). Examination of the characteristics of the principal options reveals that there is indeed an underlying inverse relationship between potential cost savings and political attainability - cf. the trade-off problem already noted. But there are also 'deviant' cases. Partial, managed specialisation such as is involved in the 'family of weapons' approach to co-operation offers reasonable prospects for production economies without encountering the more formidable political obstacles. Multilateral collaboration - or armaments co-operation a la carte - is another mode which can, in certain circumstances, promise significant budgetary pay-offs while posing relatively few political problems (because each case is appraised on its merits). Complex co-production on the other hand, though widely regarded as a sound formula for engaging wide participation in pursuit of commonality, may well not produce the financial

savings that are a parallel aim. In fact the F16 experience raises many questions about the enthusiasm for this approach.

The essential conclusions regarding benefit measurement, however, are these.

- Assessment along the lines suggested should be feasible, and also illuminating;

  and

- Undertaking relevant calculations is a straightforward matter, capable of yielding meaningful budget benefit statements.

In sum, it is practicable to implement the third and final stage of the policy analysis method, producing the differentiated estimates of budgetary benefit required for setting standardisation policy priorities.

INFERENCES AND PRIORITIES

In the introduction to the material germane to the first stage of the envisaged benefit measurement procedure, dealing with the budgetary setting, the main aim of the exercise is stated as to devise and describe a policy analysis method and to demonstrate it. However, data limitations preclude definitive demonstration. Faced with this difficulty a preference has been followed for elaboration of a sound and appropriate approach notwithstanding the fact that, having aspired to 'prove' the system, this means settling instead for a partial, preliminary and provisional demonstration with more of 'this is what might be done' and less of 'here is what can be done' than originally intended. Accordingly no attempt has been

made to deal directly with the two core questions: how and where should initial effort in standardisation policy implementation be directed? The argument establishes that application of the suggested benefit measurement technique should make possible better-informed choices. But there is no explicit speculation about what the outcome of those choices might be. Are there in fact any general inferences to be drawn about the budgetary impact of alternative procurement strategies, and hence guidance to be offered about priority-setting?

Modes of Acquisition

Arising from the discussion in Parts C (on production economies) and D (on the feasibility of alternative acquisition methods and the cost reduction opportunities associated therewith) there are observations to record about choice of procurement strategies.

- On the negative side,

  (1) the scope for full, unconstrained specialisation - i.e. freer trade, based on unfettered operation of economic forces reflecting comparative advantage - appears very limited on political grounds, although the greatest potential for production economies lies in this approach;

  (2) the most widely-canvassed method for engaging broad participation - complex co-production (on the F16 model) - is scarcely more promising because, with the elaborate matrix of system and sub-system contracting which it appears necessary to evolve to gain political acceptance, the likelihood of obtaining budgetary savings is very low indeed.

  What this means is that the favoured modes of some of the principal protagonists in the standardisation debate turn out to be less

attractive than has been supposed. (It may be worth paying a price for commonality, of course. But wider analysis incorporating systematic, quantitative assessment of military advantage vis-a-vis socio-economic values - like industrial/regional interests and technological stature - is necessary to establish whether, and where, this is so.)

- On the positive side, there is a *prima facie* case for greater attention to:

  (1) partial, managed specialisation such as is involved in the currently-favoured 'family of weapons' approach (always provided that the management aspect, which is where equity considerations play their part, does not entail neglect of efficiency objectives);

  (2) co-operation *a la carte*, in the form of the multilateral collaborative venture which West Europeans - approaching each opportunity on a pragmatic case-by-case basis - have favoured for some time.

  More detailed examination of these possibilities, against the background of the consolidated equipment schedules (and with a willingness to learn by doing), would certainly be worthwhile. Intuitively one would expect the 'family of weapons' concept to find greatest favour in procurement areas where assignment of simultaneous and complementary development and production effort is possible. The *ad hoc* collaborative undertaking is more appropriate for the major system acquisition (e.g. warship, main battle tank, front-line combat aircraft).

- The acquisition method dealt with least satisfactorily in this study is 'sub-system specialisation' among NATO members, whether achieved within the framework of contractual relationships or by extensive 'teaming' arrangements evolved by industry. There is insufficient evidence for confident speculation on either potential budgetary pay-offs or political acceptability for this approach.

It goes without saying that these are *observations*. It is no part of the purpose of this exercise to make firm

recommendations, other than that there should be rigorous formal analysis of options rather than continued reliance on the rhetoric of assertion and example to guide policy.

Equipment Categories

It is easier to enter observations about modes of acquisition than about systems categories. But setting the limited information on procurement plans presented in Part B in relation to that on production economies in Part C prompts the following remarks.

- There are a number of equipment areas where several nations have registered more or less synchronous replacement intentions and have not yet proceeded with their plans beyond the concepts, feasibility study or project definition stages of the acquisition cycle. These include,

  (1) maritime guided weapons, torpedoes and naval helicopters;

  (2) army equipment generally (weapons, vehicles, helicopters);

  and

  (3) air force guided weapons.

  The composition of NATO Weapons Packages for at least some of these categories would appear both feasible and desirable.

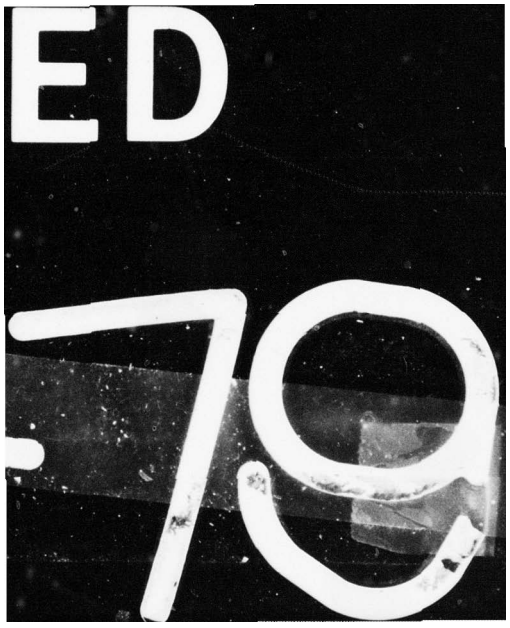
- Budgetary pay-offs from co-operation in arms acquisition are unlikely to be substantial even in the most favourable circumstances. Any arrangement that offers the promise of, say, 10-15 per cent cost reduction through larger-scale manufacture together with some further benefit because of longer production runs is a high pay-off venture on this study's reckoning. Generalisation about where savings of this magnitude might be obtained is hazardous. But it is noteworthy that,

(1) among the selected datum cost reduction factors (CRF*s) that it has been possible to produce are values for a few systems categories which suggest that savings of this order may be realisable here and there;

(2) much depends on where producers stand in relation to the minimum efficient scale of production for particular outputs. (The presumption that on the whole American defence contractors are nearer this level than their European counterparts may or may not be well-founded; and, where it is, the conclusion to draw may be that the greatest new opportunities for exploiting production economies lie in Western Europe and not the United States.)

The most important conclusion, however, is that precisely because generalisation is hazardous only case-by-case assessment of potential benefit - in the manner described - can ensure that pricrities are rationally set.

That final remark should in fact be strongly underlined so far as the 'where?' question is concerned. Only careful calculation based on specific and well-defined options can provide a satisfactorily firm foundation for deciding the best directions for major effort in policy implementation. The argument thus comes back to methodology. Only limited guidance arises from this exercise about precisely <u>how</u> and exactly <u>where</u> initial affirmative action in pursuit of standardisation and related policy objectives should be attempted. Whatever claim to merit it may have rests on its indication of <u>what</u> policy-relevant calculation needs to be done to facilitate better-informed choice and of <u>why</u> this is necessary.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