THE FUNDAMENTAL ISSUES STUDY

WITHIN THE BRITISH BMD REVIEW

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The Fundamental Issues Study

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Prefatory Statement

The Fundamental Issues Study (FIS) as here proffered for consideration in the public domain is virtually unaltered from when it was submitted to the Ministry of Defence in September 1996. Nothing has been added either to the Executive Summary or to the main text. Very, very little has had to be deleted to protect classified facts or attributions. All those concerned on that side have been not merely punctilliously correct but eminently reasonable.

All of which is gratifying. So, too, are the firm indications that the MOD has taken FIS fully on board in its in-house deliberations. Having said that, however, I am mildly surprised to learn (via ministerial correspondence with a colleague last month) that, in both this government and its predecessor, Ministers have stuck rigidly to the prescribed formula which is that the written guidance on BMD officially submitted to them should take the form of a single integrative statement presented through the Permanent Under Secretary. As a matter of principle, I am not sure that this routine, hallowed though it is by many precedents, is always conducive to expansive thinking at governmental level or, indeed, to independence of thought.

Still, quite the most important thing in the particular case of FIS is the awareness of having had very adequate exposure within the in-house debate. To make that averration now has been needful for this reason. One or two people inclined towards the Left have wondered whether giving such an assignment to an academic like myself was ever anything more than window dressing. Meanwhile, one or two well to the Right have suggested that a collectivity of voices within the Ministry has been dismissive of FIS on account of its being too 'liberal', in the American interpretation of that term.

In so far as I may ever have entertained each or either apprehension, I do so no longer. Furthermore, I am fortified in that reaction by recalling how this time last year the Rightist element just alluded to was sure that publication of FIS had already been vetoed. It never had been, of course.

May I now make just four more specific points and then hold my peace. The first concerns the extent of British influence government-to-government on the USA. Always this will hinge on sundry contingent factors. But other things being equal, it is liable to be greatest when American opinion nationally is in a very divided state. Assuming that Bill Clinton is not forced out of office this summer, the Americans will remain riven these next two years over the unedifying subject of where dubiety mainly resides. Is it in the White House or among those who censure? Given that grim situation, Britain's scope for leverage may often be considerable and her duty to exercise it manifest. There is sure to be throughout an extensive Anglo-American agenda.

However, BMD as such now looks unlikely to become, within that time frame, a very prominent theme in diplomacy. Nevertheless, it could still be one with major implications for the future. Our primary responsibility in this sphere must surely be to do what we may to dissuade Washington from inclining towards comprehensive National Missile Defense (NMD) under the influence of what may soon be strong Republican majorities in both Houses of Congress and high Republican hopes for the millennial Presidential. The argument stands that comprehensive National Missile Defense might not merely flout pre-existing

commitments on arms control and the global environment. It could also be instrumental in revitalising the golden calf of Fortress America isolationism.

One omission from FIS I have since come to regret is the question of overall control of the AirBorne Laser (ABL), assuming this weapons system can be developed satisfactorily for missile defence in theatre war and also that it will be available for certain allies to procure. We might usefully initiate an official dialogue with Washington about the desirability of any ABL force being subject, in whole or in part, to multinational manning and command, following thereby the precedent NATO created with its Airborne Warning and Control System (AWACS) echelon. Granted, private discourse has revealed initial scepticism on the ABL score among informed Americans. However, all concerned might do well to ponder the value of such an arrangement as a structured guarantee against indiscriminate use. Should a 'death ray' connotation ever come popularly to be attached to the lethal laser as a weapons genre, antipathy towards it might rapidly become extremely widespread within the alliance and across the world. Weight is added to this consideration by indications of a burgeoning interest within the MOD in the ABL option.[1]

Then there is the, to me, most vexing question of the arrested evolution of European naval power. Although the subject is only tangentially within the rubric of missile defence as such, the BMD debate speaks volumes about it. Granted, the members of the European Union do not yet have a common strategy for political and military action out of area. In fact, they may never have. But the point at issue here is that, in so far as they may wish to come together contingently for maritime force projection, their existing force structures will badly circumscribe their ability to do so with due effect.

Take naval manpower, as good a yardstick as any. The navies of the European members of NATO currently have about 335,000 on the active list; in the United States Navy there are just on 400,000, a mere twenty per cent more. Yet even if one presumes for the sake of argument that the European political resolve to respond to some distant contingency might be absolutely total, the Europeans would be quite unable, as things stand, to match an American naval response.

The key to cracking this contradiction could be the surface-to-surface missile. The cruise missile, in particular, has a capability for pin-point strikes against locatable targets deep inland such as to give a new definition to the term 'naval bombardment'. Currently, the Tomahawk is quite the best suited weapon system within this genre to spearhead such a campaign. The Americans have Tomahawk cruise missiles distributed widely across the fleet. No European navy has anything comparable in service at present, though Britain does now have plans to install just a couple of dozen Tomahawks in submarines. The fact of the matter is that frigates or other vessels with such weapons borne ought to appeal strongly to European governments who may respectively find that (a) the cost of aircraft carriers is either very onerous or utterly prohibitive, and (b) they need an ability to assemble naval power *ad hoc* on a modular basis as and when individual EU members have agreed on a multilateral crisis response.

Lastly, the on-going BMD debate is peculiarly prone to throw into high relief the acute crisis faced by the academic discipline known as strategic studies, this in the wake of the Strategic Revolution effected these last ten years. If in spite of everything one has continued to focus exclusively on the precepts of the Cold

War (deterrence; containment; manoeuvre warfare....) then BMD may come to be seen as the cherished afterglow of a bygone age: 'the last show in town'. But suppose instead one avails oneself of the bit of elbow room created by the victorious conclusion of the Cold War. Suppose, that is to say, one extends the international security agenda to embrace such themes as climate change, syndicated crime or, indeed, the political instabilities latent in the aimless alienation these days so endemic throughout advanced Western society. One may then be the more disposed to take a measured view of BMD as part and parcel of a surer perception of the ordering of future priorities. So may I now conclude by dedicating FIS to the memory of General Sir John Hackett. For myself, as for others in the generation coming on behind his own, this distinguished soldier and man of letters was a source of solid support as well as inspiration. My confidence is high that he would have endorsed wholeheartedly the perspectives just enunciated apropos the Strategic Revolution.

Neville Brown

Mansfield College
7 February 1998

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[1] Group Captain S. Rance, 'Extended Air Defence', *Air Clues*, vol.51, no.12, December 1997, pp.445-9.

THE AUTHOR

Professor Brown's career has been based on an unusual interaction between the humanities and geophysics; and also between global ecology and strategic studies. He read Economics with Geography at University College London; and then History at New College, Oxford. Between 1957 and 1960, he served as a forecasting officer in the meteorological branch of the Fleet Air Arm, specialising for about half that time in upper air analysis. His entrée into strategic studies came with his winning the Trench Gascoigne Prize in 1960.

He was elected to a personal chair in International Security Affairs at the University of Birmingham in 1980. He has held Visiting Fellowships or the equivalent at the International Institute for Strategic Studies; the National Defence College, then at Latimer; the Australian National University; the Stockholm International Peace Research Institute; and the School of Physics and Astrophysics at the University of Leicester. From 1965 to 1972, he worked as a defence correspondent in various parts of Afro-Asia, successively accredited to several leading Western journals. From 1981 to 1986, he was the first Chairman of the Council for Arms Control, an all-party body dedicated to multilateralism.

In 1985 and again in 1987, he paid extended visits to the Strategic Defense Initiative Organisation (SDIO) in the Pentagon. The first was at the invitation of Allan Mense, then Acting Chief Scientist; and the second as the guest of O'Dean Judd as Chief Scientist. In 1987, he did a tour of China lecturing on SDI, a tour hosted by the China Institute for Contemporary International Relations. In 1990, he was elected a Fellow of the Royal Astronomical Society in recognition of his book, *New Strategy Through Space.*

Also in 1990, he moved to Oxford University to join the Environmental Change Unit. He is a Professorial Associate Fellow of Mansfield College, attached to the Oxford Centre for the Environment, Ethics and Society (OCEES). His academic focus is currently very much on historical climatology. He will soon be completing a book on the influence of climate change on the history of Europe from AD 212 (arguably, the high water mark of the Roman Empire) to 1450. This will be followed by a book on climate 'in a Eurocentric world', from 1450 to 1988. Meantime, he and Professor Issar of the Ben-Gurion University of the Negev are the Co-Editors of the Proceedings of an International Workshop entitled *Water, Environment and Society in Times of Climate Change*. This essentially historical project has had UNESCO sponsorship; and the Proceedings are to be published by Kluwer this autumn.

From April 1994 to the summer of 1997, Professor Brown was attached to the Directorate of Sensors and Electronic Systems (within the Procurement Executive, UK Ministry of Defence) as the Academic Consultant to the Pre-Feasibility Study on BMD policy. In December 1995, the University of Birmingham conferred on him an official Doctorate of Science in Applied Geophysics.

Foreword

My remit, as the member of the PFS team responsible for the Fundamental Issues Study, (FIS), has been to conduct a synoptic and independent assessment of the approach Britain should adopt to BMD. Among the aspects considered have been geopolitics, threat development, the technological environment, the operational context, the principle of comparative costing, arms control, pollution effects, industrial collaboration, and participation in Space. I have not been involved in the PFS predictions of how particular systems would perform in specific scenarios. Nor have I been concerned with the life-cycle costings of alternative options. My main aim has been to think laterally about the linkages between issues, not least as between technical/operational considerations and geopolitical or philosophical ones. My academic record reveals a predilection in favour of such activity; and this experience has, hopefully, been helpful.

However 'objective' one may like to think one's appraisal has been, there is always the question of 'where one comes in from'. My disposition has long been in favour of what is called a robust defence posture. As much is evident in a number of published works. In November 1964, I urged, one gathered to some effect, that the newly-elected Wilson government should not interpret Labour's then strong dislike of our independent deterrent as meaning that Britain's role as a nuclear power should simply be abandoned.[1] Three years later, in the context of the 'East of Suez' debate, I argued against the complete relinquishment of what today would be called an 'out-of-area' capability.[2] In 1985, I joined with Sir Anthony Farrar Hockley in opposing any adoption by the Atlantic Alliance of a strategy of 'no first use' of nuclear weapons.[3] My views on these three questions remain unchanged.

Meanwhile, my attitude to arms control has on the whole been positive. The chairmanship of the Council for Arms Control (1981-6) was considerably about reminding the CND and its sympathisers that disarmament did not have to be synonymous with pre-emptive surrender. Along with that pitch has gone an insistence that social, economic and ecological stress should be recognised as major factors in the strategic equation globally.[4] My academic work these last five years has been in the field of historical climatology. What History tells us is that, as and when societies or polities are under acute pressure for more general reasons, climate change may tip the balance one way or the other. This thesis bears particularly upon North Africa and the Middle East. It does so because, across much of that region, global warming is liable to worsen a water crisis that will, in its turn, accentuate a general crisis.[5]

Also, in the 1980s, I came out against (on environmental and military grounds) the weaponisation of Space.[6] One recognises, of course, that the PFS terms of reference explicitly exclude Space-based interceptors for Britain, just as they do nuclear-tipped ones. But we ought still to weigh carefully the connotations of whatever we may do BMD-wise for powers more continental than ourselves.

I have been invited to indicate in FIS my policy prescriptions. That is fine. I have been aware, none the less, that a most important contribution of FIS has to be its presenting in as full and balanced a fashion as possible the pros and cons of all

the various options open to Britain in respect of BMD. In pursuit of this aim, I have sought to take due advantage of the flexibility inherent in this assignation by talking, subject to classification, to a wide range of people, both within and outside the British public service. Those outside have included scientists, industrialists, retired officials and political figures in this country and the United States and, to a limited extent, Japan. They have also included, needless to say, officials in these last two countries. I have everywhere been struck by the generosity with which people have shared their thoughts and experience.

As part and parcel of this broad approach, the literary sources I have drawn on have largely been open as opposed to classified. Quite often, the open literature endeavours to peer further into the future than in-house commentaries, in whatever field, are wont to do. In general, the former may nurture the lateral or holistic thought that may enable FIS to counterpoise whatever may emerge as Ministry mainstream thinking. The understanding that MOD 'would be wasting their money' were FIS merely to reflect their own views is not something to make a fetish of. But neither is it a tenet that can be ignored.

Quite apart from the voluminous extent to which 'other men's flowers' have been garnered in the form of their published work, many scores of people have contributed to the preparation of this study. Alas, a whole mix of factors militates against my presenting a roll of acknowledgements that would be at all comprehensive or representative. A special thanks is due, none the less, to my staff manager in SES 26, Squadron Leader Clive Harrison, for his support and guidance. Also to the Whitehall Library of the Ministry of Defence. Its staff have sustained a flow of up-to-date information and background material that has literally been invaluable.

10 September 1996 Neville Brown

Executive Summary

The Fundamental Issues Study looks up to a quarter of a century ahead. That span takes us into an era in which many aspects of ecological and social stress are liable to worsen globally, probably with adverse geopolitical consequences. During these decades, too, the military electronic revolution will be working itself out. It will help maintain the technological ascendancy of the West, particularly the United States. It will specifically benefit BMD, notably through development of (a) the laser and (b) the multispectral imaging of incoming threat clouds. But the mechanical aspects will progress less dynamically. Nor will the offensive side be dormant. The ballistic missile is becoming a weapon that can be deadly accurate even over intercontinental distances. Terminal guidance will clinch this evolution in military affairs.

Meanwhile, most of us have tended to discount unduly the introduction of submunitions: the dozens of bomblets or minelets or whatever that may separate out from the nose of a rocket after burn out and, quite possibly, while it is still ascending (see Chapter 4)[1]. But interest in submunitions is now burgeoning within the American debate for two reasons. The one is their eligibility for chemical and biological delivery, the latter being poised to displace nuclear warheads as the way Less Developed Countries may most readily acquire a means of mass destruction. The other is that submunitions used in shells and aerial bombs already incorporate terminal homing by sensor fusing.

One question to ask concerns the stress imposed by descent into the atmosphere, stress that progressively worsens as the horizontal range increases beyond 1000 km. The ultimate extent of dispersion if release takes place early must also be considered. Nevertheless, how formidable a challenge is posed by the ascent release of submunitions is acknowledged by Richard Garwin on the scientific liberal Left. So is it by Henry Cooper, the last Director of SDIO and now identified with the hard Right.

So Pentagon opinion is likely soon to pitch much more towards Boost-Phase Interception, not least by the AirBorne Laser (ABL) being developed under the aegis of the USAF (Chapter 4). Therefore Britain would be ill-advised to commit herself to procure forthwith surface-based BMD. She would be well-advised to resume her traditional 'intelligent customer' role by monitoring as closely as may be possible the progress of the ABL. The USAF hope is that it may enter service in 2006.

However, the brief history of lethal lasing is studded by theoretical hopes not being realised in practical application. In due course, too, those concerned with the ABL may run into ethical objections to 'death rays'. Meanwhile, it is uncertain how much lased energy may be needed to destroy a rocket or how readily target registration might be achieved. Nor has beam corruption by the atmosphere been mastered decisively. Nor, to my knowledge, is it confirmed that allies will be invited to acquire the ABL.

All the same, the ABL has influential support in the Pentagon. Nor can one ignore its attributes in relation to certain tasks. One of these is the protection of expeditionary forces during initial debarkation. Another may eventually be the BMD protection of naval task forces on the High Seas.

This is very much a time of flux in the American BMD debate, not least as regards fundamental issues like National Missile Defense (Chapters 4 and 7). A comprehensive review of the BMD development and procurement policy has lately been launched by the Pentagon. Even before this, turning points lay ahead. The Corps SAM/MEADS programme was due for a major evaluation in 1998. The Clinton

administration had delayed for four years the completion of THAAD procurement. The choice of naval 'upper tier' BMD was to be made after a THAAD versus Standard Leap fly-off in 2002.

Then again, the infra-red Space and Missile Tracking System (SMTS) cannot start flight tests until 1998-9. Yet that testing will be vital for that programme's validation. Moreover the multi-spectral and multi-directional threat cloud analysis by dint of SMTS will be imperative for the surface engagement of large and sophisticated rocket attacks (e.g. by Russia or China) to stand any chance.

Besides, the British defence community needs a breathing space in which to develop a conceptual framework for making sound BMD choices. Speaking generally, one can identify four distinct settings (the maritime domain apart) within which active BMD may be thought desirable, provided the cost-exchange ratios seem not intolerably adverse. The first is defence in the forward areas, the exposed peripheries of NATO Europe or coalition enclaves out-of-area. In this context, BPI looms large. But a fundamental issue to raise is whether it makes much sense to try and intercept single rockets at boost phase as opposed to hitting launch sites, either reactively or pre-emptively. That leads one into the whole question of the future land battle and the role of pre-emption within it.

The next setting to consider is the 'thin screen' defence of wide areas, perhaps ones of continental dimensions. By 'thin screen' is usually meant warding off perhaps ten Re-Entry Vehicles (RVs) at a time. In principle, this is a quite legitimate response to probing actions or what may appear as wildcat release. The problem is that the notion of thin-screen can phase into something that is putatively much more solid.

On that score, one does have to say that any vision of the leak-proof protection of any nation or major region against attacks that are at all heavy is pure illusion. Throughout the SDI/BMD debate all analysts have accepted there would be too many imponderables in a situation so novel. In any case, such a posture would do nothing to curb (and might even exacerbate) the threat from terrorist infiltration. Nor could it cope with the long-range cruise missile nor with the submarine lying offshore, its missiles trained on coastal cities.

A complication at the present time is the political pressure from the Republican Right in the USA against admitting all this. Take the advice to me this February that a Dole administration would pursue National Missile Defense (NMD) through the deployment of 200 interceptors in each of six sites, including one apiece in Alaska and Hawaii. It can fairly be seen as a response to the pressure just referred to.

The fact is, though, that those most insistent on thick-screen NMD for the USA are nearly all persuaded that this can only be provided, other than in the very short-term, by Space-Based Lasers (SBL) (Chapters 3, 4 and 7). The host of difficulties that remedy would generate are indicated below. Suffice now to suggest that it is incumbent on smaller nations (most notably, Britain, Israel and Japan) to make no moves that will encourage the big continental countries (the USA, Russia and China) to interpret NMD too extravagantly, whether via SBL or a surface-based mode.

The fourth setting here identified arises out of the veritably pin-point precision long-range ballistic missiles can be expected to achieve in the not distant future. This will necessitate the close-in defence against high explosive (or the less lethal forms of chemical attack) of those military assets within national homelands that are crucial to any response to crises elsewhere. The active as well as the passive defence of these assets may be needed. One especially has in mind strategic nuclear facilities; BMEWS; and points of embarkation.

Not that these are the only conceptual themes to explore. Another is the imperative need to integrate BMD into the structure for air defence. A threat as presented in theatre war could well be a mix of ballistic missiles; cruise missiles; hybrid ballistic-cum-cruise missiles; plus manned and unmanned aircraft, both monoplanes and helicopters.

The cruise missile has come up the threat agenda these last several years (Chapter 2). Its inherent disadvantage as against the ballistic missile is its being conspicuously slower and less economic over continental ranges. These may also be a problem of overflying neutral territory. Its biggest advantage is that its launch sites are easier to conceal. A less sophisticated (e.g. an improvised) cruise missile may be a lot easier to shoot down than its ballistic counterpart. Conversely, a sophisticated cruise missile, one that can jink and contour-hug, may be a sight more difficult to intercept, overland at any rate. Indeed, its engagement may require radical solutions - e.g. focussing on the point defence of likely objectives, perhaps using helicopters or aerostats to gain height advantage.

A big issue is where to strike the balance resource-wise between active defence and passive: the latter involving hardening, deception, concealment, mobility and dispersion - usually in that ascending order. So far as theatre war is concerned that judgement has to be made as part of a holistic interpretation of the future land battle. This is one reason why it is essential the Army be fully involved in the formulation of our BMD policy.

Interception high in the atmosphere of warheads of mass destruction poses a command-and-control challenge of a quite singular kind, one that in the European context can only be resolved on a multinational basis because of the spill-over effects. Before addressing that and other European matters, however, it is necessary to look at the revaluation of threat that may now be in progress.

Awareness is growing that in neither Russia nor China is rapid economic change promising to generate a political and social culture so akin to that of a liberal democracy that conflict between them and the West is inconceivable. On the contrary, each is likely to remain imbued with an authoritarian chauvinism supercharged with resentment; and this may make them determined to challenge the hegemony of the West and of the United States in particular. To an extent, indeed, they may act together, a common political theme being resistance to the 'cultural pollution and social decadence' of the modern West.

What measure of outright belligerency that might lead to is impossible to predict. What does seem certain is that, in both cases again, long-range missiles are liable to figure in any confrontations. Granted, one is envisaging circumstances unlikely to develop that drastically for a decade from now at the earliest. But that is well within the span relevant to BMD policy.

On the other side of that coin, too, the outlook is in flux. In the Middle East and North Africa, the acquisition of strategic missiles is liable in the near term to be constrained more than was once anticipated by the strategy of counter-proliferation the United States formulated in 1993. At the same time there has been more of a disposition, particularly in Israel and therefore in the United States, to link the proliferation question with that of sponsorship of international terrorism. Iran has been the prime focus of concern in this regard of late.

The two key strands in counter-proliferation are (a) the Missile Technology Control Regime (MTCR) and (b) the strategic pre-emption of any attempt by identified 'rogue' states to acquire either warheads of mass destruction or the means of their

delivery long-range. Though not entirely leak-proof, for reasons both technical and political, the MCTR is being applied more thoroughly and comprehensively than before (Chapters 2 and 5).

As regards pre-emption, Libya's progress towards a chemical deterrent and Iran's tendency towards a nuclear one are being closely watched by a Washington that has made crystal clear it will not tolerate either trend reaching fruition. Israel is backing this line forcefully. Britain and France show every sign of being willing to back, and probably join in, action to preclude a Libyan 'bomb' though alliance unity is less assured apropos Iran. Meanwhile, Iraq would find it more or less impossible to break right out of the monitoring regime. Nor does Syria have much scope for posing a strategic threat to Europe nor a lot to gain from so doing. Nor should we forget that her economic weakness and diplomatic isolation are now obliging North Korea to accept a form of detente with South Korea and the United States that has her own nuclear disarmament as its centrepiece. If, as is more than likely, Pyongyang tries to twist or bludgeon her way out of this, it will be disposed to do so by picking a quarrel with Seoul rather than by confronting the Americans in the Middle East.

It is a state of affairs that can hardly last indefinitely. Any distancing of themselves from the West by Russia and China will both weaken the MTCR and make the pre-emption option more risky diplomatically. Nor may biological warheads prove as easy to monitor as other means of mass destruction. Nor, indeed, could strategic pre-emption be contemplated anything like as easily against any of the larger states (e.g.China or India) that could conceivably confront Europe or America. For the next several years, however, the situation does look like being tightly constrained by the counter-proliferation regime. That surely means that no threat could build up from that quarter against the heart of Europe in less than a decade.

To which one may add the corollary that European involvement in a Gulf War-style expeditionary coalition is also improbable within that time frame. Were other things equal, after all, European forces would be far more likely to go in strength to the Middle East at this juncture in world affairs than to anywhere else. They will almost certainly not go to the Indian subcontinent or Latin America or anywhere else except just possibly Korea.

Several decades hence, of course, the parameters of global strategy may be utterly different. Nor does anything that has just been said rule out the near-term possibility of more localised interventions around the world, the Middle East included. What relevance they may have to BMD requirements is examined at some length in Chapter 9.

In working out what BMD policy should therefore be, it is enormously important to proceed on an alliance basis. This elementary point is stressed for political reasons as well as for operational ones. BMD could prove an emotive and divisive subject, both within alliance member states and between them. Its potential for being this is increased by its coming to a head in the aftermath of the strategic revolution of 1989 to 1991: that is to say, in an era when public perception of 'the threat' is hazy and when both NATO and EU seem committed to expansion territorially, regardless of the dubious implications for military geography.

Under these circumstances, it will not be easy to lend continued credence to the principle that has been the *sine qua non* of the Atlantic Alliance since 1949: the principle that an attack on one is an attack on all. It is therefore doubly important that neither America nor Britain nor anybody else takes major defence initiatives on a unilateral basis. The moral for ourselves is that we must not be tied to the 1993 PFS

scenarios as the basis on which to build actual policy. Taken in the round, they are not only too insular but too imperial for this purpose.

A big complication institutionally is the uncertainty that currently surrounds the relationship between NATO, the EU and the WEU. Britain has lately been laying some emphasis on the Maastricht precept that the WEU should evolve as the 'defence component' of the EU and as, subject to existing NATO obligations, a means of strengthening the European pillar of the alliance through the formulation of a common defence policy. Unfortunately, we have run up against a bloc of opposition consolidating around Paris and Berlin. The nub of their counter-argument is that, Maastricht notwithstanding, the EU must generate its own security policy. This is because a grand strategy for peace in Europe and abroad must be based very considerably on civilian power. The military dimension will be a necessary but not a sufficient part of the whole.

That much must be true to the point of banality. But it does not mean that the military side of things need not be addressed. Nor does it gainsay the argument that, from everyone's point of view, the better body for this is the WEU. Most fundamentally, this is because it excludes from full membership of itself those members of the EU that are not also members of NATO.

WEU could not begin to match NATO/SACEUR *vis-à-vis* staff work in depth nor in C41 structures adequate for the intricate European theatre. But it does now possess an emergent capability for strategic Space reconnaissance. It may also soon make contingency plans for joint task forces operating out of area. It has also taken on active interest in BMD. So it is not unreasonable to suppose that it might usefully elevate to a doctrinal level European perspectives on BMD and related matters. One might thereby progress towards an Atlantic doctrine on this subject area, a formulation conspicuously lacking at the present time. The issues that urgently need addressing are rules of engagement, peripheral deployments in Europe, thin-screen area defence, systems selection, passive defence and arms control. Close-in defence against precision attack is one that will follow on later.

'Rules of engagement' is a subject that here derives from two considerations. The one is that tactical warning times will be too short to allow of positive control. The other is the environmental impact from mass destruction warheads exploded high above the ground. The guiding principle ought to be that, when strategic intelligence and other evidence indicate to the multinational authority that incoming RVs may have such warloads, no interceptions should be allowed below, say, 30 kilometres. An argument is advanced at the end of Chapter 8 for believing that intelligence collaboration through WEU for this and related purposes does not have to weaken Britain's exclusive intelligence links with the United States.

The timing of initial deployments ought considerably to be determined in the light of threat development, constrained as this will be a while by the existing arms control regime and counter-proliferation strategies. The SDI experience in respect of Moscow shows that a well-judged preparedness to deploy can decisively strengthen the influences towards moderation and compromise in adversary countries. Actual deployment too comprehensively too soon may weaken those influences. This caveat is relevant apropos Russia and, no less so, the Arab-Iranian world.

What does seem clear, none the less, is that priority attention should be given to how best to protect the prospective forward areas in the South and East of NATO Europe. The first task has to be the establishment of an early warning radar network, important not only for interception but also for threat source location and for giving

both troops and civilians enough warning to reduce casualties. The next would be the protection of those sites and of the points of debarkation.

With the emphasis so heavily on the threat 'from the South', much interest has been taken in the role warships in the Mediterranean might play in providing BMD cover. Undoubtedly there has been a tendency to overstate the naval possibilities. As and when BPI across desert shores is required, this may the better be by means of an ABL. Meanwhile, some literally incredible claims have been made about the extension of maritime BMD cover across the Graeco-Turkish arc. The inherent operational difficulties are compounded by geopolitical uncertainties. What part would Turkey herself feel willing and able to play? What would be the geographical limits of NATO, and of the EU, across the Balkans. Beyond which lies the vexatious problem of how best to uphold deterrence opposite Russia. One answer for BMD on all these counts may lie in strategically mobile reinforcements (e.g. ABL?) eligible for rapid deployment forward as the situation warrants.

The 'thin-screen' area defence of NATO Europe is complicated by geographical depth from East to West as well as from South to North. Designing a ground-based system of adequate range and speed to meet the requirement could prove singularly difficult. But it is a contingent requirement European governments and industrialists might usefully address.

Accepting that outright competition with established American programmes can be rather pointless if not (as with the SMTS) impossible for the foreseeable future, there are other developmental niches in the realm of missile war that might be filled through European collaboration extended perhaps into trans-Atlantic partnership. An obvious example is missiles designed for high precision deep-strike overland in theatre war, including deep strike from the sea. Another is point defence against the high-performance cruise missile. A third might be the technologies of tactical pre-emption; and a fourth close-in defence against precision strikes. Throughout, governments would have to be alert to the strategic importance of sustaining within Europe a viable capacity for indigenous aerospace manufacture: viable in terms of overall capacity, technological diversity and patterns of collaboration.

Absolutely central to this concern at the moment is MEADS. The interpretation adopted in this study has been that the MEADS/Corps SAM programme is still robust; and that the prospects for Britain's enlistment, in due course and on acceptable terms, look good.

Of course, the whole idea of ground-based BMD in theatre may lose out to engagement boost phase or earlier But, if not, Britain will have to choose fairly soon a system for low-to-medium aerospace defence at brigade level; and this choice will probably be a straight one as between Corps SAM and PAC-3. May one simply express the hope that having to wait several years more will not be seen as an insuperable objection to Corps SAM? The indications thus far are that its being next generation will confer significant advantages in terms of data-handling; dexterity against the high-performance air breathers; and added mobility, tactical and strategic. It could also be our entrée to MEADS and further collaboration beyond.

Arms control remains fundamental to the containment of the offensive missile threat as well as being part and parcel of a quest for a new world order able to address other global problems: peacekeeping, ecological disturbance, pandemics, syndicated crime, drugs ... . Fundamental to preserving the arms control regime is not discarding the Anti-Ballistic Missile treaty of 1972 until something more solid can be put in its place.

What needs urgently to be resolved in furtherance of these objectives is the American NMD strategy. Britain may be well-placed to make an important contribution here, just as during the 1980s she played an invaluable part in ensuring that SDI-strategy remained alliance-friendly and conducive to detente. This next time round, she would be expressing more overtly than before a general European perspective, arrived at perhaps through the WEU. But Washington may well be coming firmly to the view that a special relationship with London is now only meaningful within the context of Britain in Europe.

Though plenty of room remains for debate about structure and timing, the principle that the United States deploy 'thin-screen' NMD across her home territory is not unreasonable. Much as has been said in regard to Europe, it could be a hedge against probing actions or wildcat releases. Where irrationality would come in is through going beyond that, driven by a Pat Buchanan-style isolationism coupled with an overweaning quest for immunity from casualties in armed conflict achievable nowhere in this day and age.

Trying to achieve it regardness would lead the United States into the deployment of Space-Based Lasers. Yet even this would not render herself or any allies inviolable against ballistic missiles. The philosophical grounds for not believing in faultless defence would still apply. More specifically, the technical problems associated with the ABL would reappear in accentuated form with the SBL. Worst of all, an orbital speed of 8 km/sec. would make beam lock-on to target hard to sustain long enough and with the required finesse. Then there is the 'dwell time' problem, the small proportion of time that a platform in low orbit will be in line of sight to any given location on our rotating Earth. This means that a constellation of SBL platforms intended always to have, say, a dozen over North Korea would *ipso facto* have to have a 1000 above the Russian Federation. That or anything like it would greatly complicate the strategic arms balance with Moscow without ever restoring to the Americans a meaningful measure of superiority. Russia could always swamp an SBL canopy by concentrating mobile offensive missiles in certain areas. Then there are the circumventions: the submarine, the long-range cruise missile, the terrorist ... .

More broadly, too, the negative connotations would ramify. The 'dwell time' issue alone would shatter strategic arms control. The rest of the arms control regime would duly unravel. Alliance relationships would sunder in all directions. Once the arms race had extended into Space in this fashion, it would be liable to do so in other respects as well. Ominous, too, would be the psychological oppressiveness imposed by weapons in orbit. As implied above, this might actually intensify the terroristic aspirations of extremist regimes or insurgent movements. Certainly, it would alienate the broad swath of moderate opinion around the world. It would because of contemporary aspirations to develop the 'universal common' of Space as beneficial economically, ecologically and scientifically. But the alienation would stem, too, from much more primordial notions of 'the Heavens above' as a sacred realm to be regarded with awe and wonderment.

Yet this is not to celebrate the ABM treaty as a sound basis on which to proceed to the next century (Chapters 4 and 5). There is a widening discordance in spirit and substance between the its text and what has been going on around the world with the involvement or connivance of Washington and also Moscow. Thus the first sentence of Article V commits each of the two signatories 'not to develop, test or deploy ABM systems or components which are sea-based, air-based, Space-based or mobile land-based'. Then again, the treaty's preamble indicates its prime aim was to curb the

strategic arms race. Since then, however, technical dexterity and geopolitical upheaval have blurred the difference between 'strategic' and 'tactical' weapons, be these offensive or defensive. Even the neat distinction between anti-missile and anti-aircraft has been fading. The crux of the matter is that the 1972 text deals with a category of weapons that has since lost its singularity. A no less obvious anachronism is that the treaty is between just two States whereas others are now acquiring relevant capabilities.

Nowhere are the contradictions this state of affairs throws up more obvious than in the Washington-Moscow negotiations to try to exempt Theatre Missile Defence (TMD) from the 1972 prohibitions, on the basis of the maximum speed allowable for (a) an interceptor missile and (b) its target RV. This endeavour is flawed in various respects. The other side's fly-out speeds cannot easily be monitored. Relevant, too, is the tendency, over theatre distances, for interceptors to move faster than their targets but, over intercontinental ones, for the converse to hold true. Yet here again, there is no simple correlation. All else apart, a longer-range ballistic missile does have to be fast but a shorter-range one does not have to be slow.

Accepting that the requisite diplomacy will have to be very carefully timed and judged, the ABM treaty ought surely to be superceded by a multinational accord that draws the line against the positioning in Space of actual ordnance as opposed to surveillance and communications facilities. This distinction is definable and tangible, not least to public opinion around the world. It would be a clear refutation of the jibe so often heard from ultra-conservative opinion that arms control is only feasible when it is unnecessary.

The last question the study poses is this. Should one be working towards an international system for Global Protection Against Collisions with Extra-terrestial objects - with meteorites, comets and rogue asteroids? It merits investigation as a serious defence issue.

Introduction

Approaching the FIS task, the first decision to make is how far ahead to look. The best answer seems to be a quarter of a century in general terms, a decade more definitively. The several systems for surface-based Theatre Missile Defence (TMD) that may enter American service within five or ten years are being costed on the assumption they could remain in service two decades. Beyond them, further remedies are being addressed, including two that could between them mark a double generation advance. The one is the Airborne Laser (ABL) actively being developed by the United States Air Force (USAF), the bold aim being to achieve initial operational status in 2006. The other is only a generic concept still. It is the Space-based Laser (SBL). It would appear as a follow-on to the ABL ; and come perhaps ten years after it. In the light of such possibilities, one can understand why people in the Ballistic Missile Defense Organisation (BMDO) at the Pentagon aver one must try and look 20 to 25 years ahead. At what stage within that time frame will certain remedies be needed? At what stage beyond that may those same remedies become obsolete?

Missile offence and defence can most usefully be regarded as ramifications of military aerospace. This being so, it is pertinent to note how poor our track record has been, virtually all down this century, at predicting what the longer term holds in this sphere. H.G. Wells has long been celebrated as a technological prophet, above all because of his prediction in 1913 of a strategic war in 1959 involving the exchange of 200 'atomic bombs': the scenario that, through the 1950s, we were indeed consumed with avoiding. But as regards air power in the round, he was, across four decades, usually cognisant of its importance but invariably wrong about its modalities.[1] Nor did long-term prognosis prove much sounder after so much of it had become collective, institutionalised and systematic. Moreover, skittish radicalism was every bit as prone to error as blimpish conservatism. In 1967, the then Controller of Aircraft at the Ministry of Technology recalled the impact the advent of the 'guided missile' in the 1940s (principally the V-1 cruise missile and the V-2 ballistic missile) made on air staffs and others. He observed how some prevalent errors, among them a failure to anticipate how intractable the problem of low-level interception would prove, 'could well have led one to predict a demise of the manned aircraft at the latest by the mid-1960s, had one been required to look so far ahead'.[2] Likewise, in the first 30 years after World War Two, many predictions were made in the West of the comparative status of Soviet versus American or Western technology, especially as appertaining to military needs. They gyrated from initial optimism to, by the late 1950s, acute apprehension; and then swung back to an almost euphoric assurance. Each peak of confidence was an extravagant perception of the real prospect. The trough of the late 'fifties was veritably an inversion of it.

Lately, prediction has become steadier and more confident as experience has been gained and methodologies developed. Even so, some particular problems are posed apropos the BMD arena. The most fundamental is that the crucial comparisons are not between like and like. Take the ramifying development of offensive missilry. This is never a trivial task, least of all for a developing nation. But it may be made easier by one truism. This is that the finished products do not have to be better than, or even as good as, their counterparts on the other side.

At this time we are ill placed to predict just how readily an ability to manufacture or operate missiles and their warloads will spread round the world through the first decade or two of the next century. We have not yet properly gauged

the implications for the diffusion of technical skills of the information explosion that gathers pace so dramatically. Not least do uncertainties persist in regard to applied biology, germ and toxin bombs included. Nor have we yet enough experience with the matrix of institutional restraints on weapons proliferation, a matrix that is still being extended and refined. It includes *inter alia* the Missile Technology Control Regime, the Chemical and Biological Weapons Conventions, the Non-Proliferation Treaty, the International Atomic Energy Agency, and the proposed Comprehensive Test Ban.

Above all, we cannot be at all sure about developments politically. After all, we are still in more or less the immediate aftermath of the strategic revolution of 1989-91, a philosophical and geopolitical upheaval of a kind to be expected only every century or two, maybe but once every several centuries. Big reverberations are bound to continue awhile. One thing this means is that there are an unusual number of countries whose relations with the West will in ten years' time, say, be either decidedly more adversarial or else markedly less so than is the case today. Among them are both Russia and China. So are Algeria, Cuba, Iran, Iraq, North Korea, Palestine and Syria (see Chapter 6).

What all the variables tend to do is widen the gap between worst-case assessments of threat and median judgements about it. At present, however, the trend is towards a more relaxed view of the near term. Take the continental United States. In its September 1995 report to Congress, the Ballistic Missile Defense Organisation (BMDO) quoted the intelligence community as believing it to be 'at least 8 - 10 years in the future' before a rocket with a unitary warhead could be fired at mainland America by one of the new missile states.[3] Six months earlier, General Malcolm O'Neill, the Director of BMDO, had sought a full-blown National Intelligence Estimate (NIE) review of this question. This January, the NIE conclusion duly was that it would be 'at least a decade' before any rogue nation could present such a threat.[4] The distinction between that and what BMDO cited is subtle though maybe important in relation to such matters as the dialectic between Congress and the White House over National Missile Defense (NMD). But one could surmise that both predictions have erred towards pessimism because of an ambient disposition to underrate the difficulty of intercontinental re-entry (see Chapter 4).

Origins

In Britain, the possibility of Ballistic Missile Defence was first explored in the winter of 1944-5 against the background of Germany's V-2 rocket offensive. Radar-cum-predictor prognosis of the time and place of individual rocket impacts was brought to a high level of precision in a matter of weeks. What did not follow was any hope of interception with anything approaching a tolerable cost-exchange. One estimate was that fields of shrapnel produced by 230,000 shells would be needed to proffer the 'likely kill' of a single V-2.[5]

Nevertheless, the subject was not allowed to go away, not in the United States at any rate. Eventually, Sputnik was to give it a big fillip. For it connoted a rocket of such power and accuracy that its alternative use was the delivery of thermonuclear warheads against cities the other side of the Northern Hemisphere. In January 1958 (three months after the launch of Sputnik I), US Secretary of Defense, Neil H. McElroy, urgently moved to resolve renewed bickering between the US Army and the USAF by assigning the development of Anti-Ballistic Missiles (as the defensive rockets were then called) to the former. Sputnik had lent a fresh impetus to the strategic arms race despite its rocket motor being of the costly and cumbersome liquid-fuelled genre.

Yet, ironically, it was the USSR that lost out. She did so thanks to a double American breakthrough in 1961-2 : reconnaissance satellites in orbit and solid-fuel strategic rockets in the form of (a) the Minuteman InterContinental Ballistic Missile (ICBM) and (b) the Polaris in submarines. That breakthrough soon gave to the United States what was for a while to be a first-strike capability against the whole of the Soviet ICBM field. This goes far to explain both the origin and the outcome of the Cuba crisis in the autumn of 1962. By then, too, each Superpower was deploying, in warships or on aircraft, nuclear-capable cruise missiles, albeit ones of limited range.

But by 1967 or thereabouts, the two Superpowers had reached a stalemate in the realm of strategic deterrence. Each had by then some hundreds of solid-fuelled ICBMs solidly emplaced as well as their counterparts in submarines. So it seemed inconceivable, for the foreseeable future, that either Moscow or Washington could launch an all-out attack against the deterrent forces of its chief adversary without incurring the retaliatory destruction of the couple of hundred cities on which its own strength and cohesion crucially depended. From 1964, US Secretary of Defense, Robert McNamara promoted the term Mutual Assured Destruction (MAD) to describe this novel situation.

Meanwhile, exploratory work on ground-based BMD gave neither side any sure grounds for optimism. The bottom line, certainly for the Americans, was the cost-exchange ratio. To build defences that might shield the continental United States against attack by a thousand Soviet rockets, say, would cost several times as much as the Soviets might expend on another thousand rockets ready to swamp those defences. Duly, the Americans did a paper study of a proposal called Ballistic Anti-Missile Boost Interceptor (BAMBI). The notion was that up to 3600 satellites might revolve in near-Space poised to launch mini-missiles against ICBMs during their boost phase. In 1963, BAMBI was cancelled, most crucially because various components would need to be orders of magnitude more dependable than was immediately in prospect. Since then component dependability (as expressed in Mean Time Between Failures) has much improved throughout the aerospace realm.

Acceptance of MAD found expression in the Strategic Arms Limitation Talks (SALT), a bilateral dialogue begun in the autumn of 1969. Those concerned were mindful, too, of linkage between this diplomacy and the containment of regional conflicts in Vietnam and the Middle East. They also felt obligated to set an example on nuclear arms control, this in the light of the signing of the Non-Proliferation Treaty (NPT) in 1968 (see Chapter 5). In short, the cross-links between BMD, arms control and general diplomacy were well appreciated.

In 1972, a SALT-1 pact was signed in Moscow by President Nixon and Secretary Brezhnev. It comprised an interim agreement curbing the inventories of offensive missiles and a treaty delimiting the deployment of Anti-Ballistic Missiles (ABMs). To be exact, the latter allowed each Superpower to deploy two ABM screens, each to include not more than 100 static ABM launchers and the associated radars. One of them could be to defend the national capital whilst the other could cover an ICBM field.

The MAD Crisis

A protocol signed in 1974 committed each party to settle for one ABM mode or the other. So the Soviets continued with the former as the Americans were to briefly with the latter. The Soviets had begun to deploy ABMs around Moscow in 1966 just as China was entering upon the orgy of manipulated craziness known as the Cultural Revolution. Indeed, the protection of as large and soft a target as Moscow could not

have been viable except perhaps against a weak and unsophisticated Chinese strike. The next year, a reluctant McNamara had launched the United States into the Sentinel programme for ABM deployment, responding obliquely to the Soviet departure but more overtly to events in China.

By 1969, however, the Cultural Revolution was being constrained by the intervention of the Chinese military. By then, too, the Beijing authorities were (a) satisfied that the American will to stay in Vietnam was broken and (b) concerned to move closer to Washington as insurance against the military build-up conducted by the Soviets all along the common border since 1966. So President Nixon announced that March that, under the Safeguard revamping of Sentinel, the emphasis would switch from a 'thin-screen' defence of American cities against a modest and uncomplicated Chinese threat. The prime aim was now to be the active defence of one or more ICBM fields against the heavy and sophisticated onslaught it was feared the USSR might contrive in the decade ahead. But Safeguard was to be terminated by opposition 'on the Hill' in 1975. A major source of Congressional doubt was whether it could ever be effective against the Multiple Independently-targeted Re-Entry Vehicles (MIRVs) the Soviets, like the Americans, had lately been installing.

Subsequently, MAD continued to engender nagging anxiety within the United States. Concerns continued to be expressed about the vulnerability, in the none too distant future, of all ICBMs in emplacements. But so were they about how far the mobile ICBM, the obvious alternative, might (a) vitiate arms control surveillance and (b) impinge on civil society. There was also a disposition to overstate grossly the susceptibility of Fleet Ballistic Missile (FBM) submarines dispersed at sea to advances in Anti-Submarine Warfare (ASW). Yet so, too, was there one to ignore the dependence of these vessels on a few home ports and communication nodes, all of them very open to attack.

Meanwhile, the liberal wing of opinion was manifestly less inclined than might have been expected to extol MAD as a foundation on which to build arms control or, at the very least, to manage warlike crises more coolly and sensibly. Dr Herbert York, who had been a key figure in defence science policy in the fifties and sixties, warned in 1975 that 'there are now five nuclear powers and there will be more someday, and if any of them ever makes a technical, political or military nuclear mistake ... a substantial chance that the whole civilized world would go up in nuclear smoke ... We must find some better form of international relationship than the current dependency on a strategy of mutual assured destruction'.[6]

What such a quest would necessarily involve was the formulation in depth of a coherent strategic doctrine. The continuing absence of this was in part a reflection of a general dearth of philosophical and political thought. But it was also because of how the new discipline of 'strategic studies' had emerged, from the late 1950s onwards. It had done so largely as an offshoot of 'international relations', a field of study itself usually seen as part of political science. Therefore it tended to attract logicians little versed in history (military or otherwise) or, indeed, geography. In the first several years after the foundation of the Institute for Strategic Studies[7] in 1958, much was written about nuclear deterrence. But there was little inclination to evolve this rather banal precept into more profound thought.

To SDI and Back

Nor did doctrinal evolution gather pace during the 1970s. One result was that policy relating to missilry tended to be driven by technological opportunism. Not least was this true of Directed Energy Weapons (DEWs), alias beam weapons, as applied to Ballistic Missile Defence. We are told by the official historian of SDI that progress with DEW 'more than any other development excited renewed interest in deploying an ABM system'.[8] The upshot of that renewal was, of course, President Reagan's keynote speech of 23 March 1983, the speech that launched what soon we were to know as the Strategic Defense Initiative (SDI) : the programme of exploratory research into comprehensive BMD, not least as positioned on satellites in orbit.

The Reagan announcement stimulated a whole raft of ideas about BMD measures and countermeasures. Many of these are still in vogue. What is to be observed, however, is the virtual absence then of several themes now prominent in the BMD debate. Very full account was taken of the likelihood of offensive rockets being fitted out with up to a dozen MIRVs or unguided kinds of RVs. Decoy balloons received much attention as did chaff. But little or nothing was said about those incoming rockets delivering, additionally or alternatively, scores of small submunitions, maybe for release in the ascent phase.

Noticeable, too, is the very limited interest taken (in SDI circles at least) in the use of laser weapons other than for interception boost phase from weapons in orbit. Really close-in terminal defence was little considered at all except in the form of 'swarm-jets', a cluster of tiny rockets intended to intercept an RV a kilometre or so from its impact point. No reference was made, to the best of my knowledge, to the proposal the USAF had made in 1961 for the close-in anti-missile defence of ICBM silos using gatling guns. James Abrahamson, Director of SDIO from 1984 to 1989, dismissed as 'absolute hogwash' the notion that SDI should concern itself with silo defence at all.[9] Much discussed, on the other hand, was the exposure to attack (e.g. by 'Space mines') of weapons platforms in orbit.[10]

After three or four years of intense research and debate, a technical and geopolitical reassessment of SDI was under way in Washington. It was an assessment Britain made a considerable contribution to (see Chapter 7). A mode was by then being sought that would be less costly, more manageable and more relevant to a changing world than the pristine vision of a many-layered 'peace shield' intended to blunt a full Soviet strike. In February 1988, Vice-President George Bush warned that 'Premature deployment of something that isn't totally effective would do nothing but cause the Soviets to break out of the ABM treaty and overwhelm what we've got'.

The upshot was the passage in President Bush's inaugural State of the Union address of January 1991 in which he said that 'Looking forward, I have directed that the SDI programme be refocussed on providing protection from limited ballistic missile strikes, whatever their source'. Evidently, this pitch was very different from that President Reagan had adopted in March 1983, expressing as he then did the hope that the research would be so successful as to render nuclear weapons 'impotent and obsolete'. None the less, the Bush commitment led to the Missile Defense Act of 1991, the first legislation to call explicitly for actual deployment.

Its prime stipulation was the development, for deployment not later than Fiscal Year 1996, of 100 Ground-Based Interceptors (GBIs) along with the requisite radar stations and satellites, the purpose being to defend the continental United States. All these GBIs would initially be located at just one American site so as to comply *pro tem* with the 1972 treaty as qualified by the 1974 protocol. Grand Forks, North Dakota,

was soon the site chosen. The Act also called on the President to 'Pursue immediate discussions with the Soviets' of treaty modification, hopefully to achieve (a) scope for additional interceptor and radar sites, (b) flexibility in regard to the eventual application of more advanced ABM technologies and (c) clarification of the scope for flight testing and also of the relationship between National Missile Defense (NMD) and Theatre Missile Defense (TMD). The notion was that, in its first generation, the NMD dimension might cope with up to 200 enemy Re-Entry Vehicles (RVs).

This concern with innovation relates to a further commitment enshrined in the Act. This was to the 'robust funding' of technologies for Global Missile Defense (GMD), basically by means of platforms orbiting in near Space. Specific mention was made of the Brilliant Pebbles programme that had emerged the last several years. In essence, a manifestation of recent progress with the compaction of computing, it sought to enhance survivability and responsiveness by having just one missile per platform instead of the 5 to 20 previously envisaged. Accordingly, the platform came to be depicted more as a 'sleeve' or 'life jacket', as in this official account: 'each life-jacket provides on-orbit power, low-rate altitude control, surveillance, communication, thermal controls, navigation and survivability'.[11]

Renewed Reassessment

The 1991 legislation passed through the Senate with solid Republican support but with the vital backing also of a group of Democrats led by a Senator Sam Nunn anxious to restore his reputation for firmness after some ill-starred responses to the Gulf crisis. The Democrat opposition was led by another Southerner, Albert Gore. Once again, the big bones of contention in both Senate and House were the weaponisation of Space and, most particularly, the threat posed to the ABM treaty.

It was only to be expected that, with the election of Al Gore as Vice President in 1992, the legislative and executive instruments of power would have to accommodate a further strategy change on BMD, as reflected in recast Missile Defense Acts. The nub is that, under the Clinton-Gore administration, the emphasis has switched from NMD for the continental USA or, indeed, GMD and towards TMD in locales like the Gulf or Korea. Barely a sixth of the 17-billion dollars allocated to BMD in 1994 for the four fiscal years ahead was for the development of 'options for the contingency deployment' of NMD as and when the world situation might warrant. On the other hand, the Republicans are still committed, as part of their 1994 'Contract with America', to actual NMD deployment 'at the earliest practical date'.

So where do America and the rest of us stand at this stage in the emergence of missile-centred warfare? Is the alliance getting its priorities right? Or are we still paying too much attention to missiles as opoosed to other innovations in ordnance? Too much attention to ballistic missiles as opposed to cruise? Too much to missile defence as opposed to offence? Too much to active defence rather than passive? Too much to the protection of civil society rather than of war-fighting capability? Too much to land warfare as opposed to naval? Too much to regular military threats as opposed to that of terrorist infiltrators bearing suitcase bombs? How well-founded are our geopolitical assumptions? Conclusions about Britain's BMD policy cannot simply be derived from these general issues. But they do have a bearing on it.

2 - A Singular Means of War?

It does now appear that the advent of SDI made a singular contribution to the end of the Cold War. Beforehand, some of us had apprehended that this endeavour would invoke a hardline response from the Soviets : in effect, a revival of the 'garrison state' mentality, militarily as well as in other spheres.[1] Nor can anybody say that could never have happened against the background of the USSR's deepening internal crisis, a crisis precipitated by utter political immobility coupled with underachievement in just about every sphere bar certain aspects of military or Space-related high technology. In the event, however, things crumbled the other way. The panache SDI betokened convinced powerful circles, military and party, in Moscow they could no longer compete because they lacked not only resources but also the right ethos. Never mind the critiques of SDI emanating from within their own Academy of Sciences[2], critiques much more factual and incisive than previous Soviet disquisitions on modern military science.

Allowing that the definitive verdict of history is still awaited, the evidence has built up thus. By 1986, Raymond Garthoff had concluded, as the senior Brookings analyst of Soviet military affairs, that central to Moscow's concern over SDI was a view of it as a fount of technological spin-offs all across the panoply of theatre war.[3] Meanwhile, Westerners in contact with Gorbachev and his entourage at the Reykjavik summit and elsewhere were receiving indications that SDI had persuaded the Soviet leadership the Cold War was unwinnable.[4] Lately, Lady Thatcher has advised us that this was just what Ronald Reagan had predicted, two years before.[5] Moreover, this interpretation was confirmed at Oxford in the Spring of 1992 by Roald Sagdeev, who through the middle 'eighties had headed the Institute for Space Research at the Soviet Academy of Sciences.[6] Putting the case, he came over as eminently reasonable and trustworthy.

Arguably, the crunch came in February 1987 when Richard Perle, visiting London as US Assistant Secretary for Defense, extolled a strong SDI as the keystone of a tough stance on arms control. He waxed confident that the USSR could not afford to miss the chance of arms reductions an early summit might proffer, a chance unlikely to recur until the next incumbent of the White House had played themself in. By then, well over 20 billion dollars would have been spent on SDI, an investment the Russians could never hope to overhaul.[7] A fortnight later, Gorbachev did agree, in principle, to a binational treaty on Intermediate Nuclear Forces (INF). Such a treaty was duly signed that December. Essentially speaking, it secured the abolition worldwide of the Soviet SS-20 rocket in exchange for the same treatment both for America's Pershing 2 rocket and for her BGM-109G cruise missile.

All the same, none of this proves Moscow would have come to terms even more readily had SDI been pursued with undiminished zest. March 1987 brought the resignation of Richard Perle. That year was also to see the departure from political office in the Pentagon of four other SDI stalwarts: Frank Gaffney, Fred Iklé, John Lehman and the Secretary of Defense himself, Caspar Weinberger. Though each gave his individual reasons, it would seem that a common factor was a burgeoning disposition within the administration to rein SDI back, especially as regards Space-based weapons. The timing of that new approach, one much encouraged by Vice-President Bush, suggests it was cause as well as consequence of the developing rapprochement with Moscow. There may be lessons here about the subtle modulation of dissuasion and detente, lessons that are still pertinent to BMD and, indeed, to counterproliferation (see Chapter 5).

Evidently, whatever special significance may attach to missile defence viewed in the round must derive from the two genre covered, in modern military parlance, by the word 'missile'. The one is the 'cruise' missile, the crewless one-way bomber that depends on air for oxygen and for lift. The other is the 'ballistic' missile. After an initial boost from a rocket integral to itself, it is in 'free flight' - i.e. subject, in principle, only to gravity. In practice, however, that boost is unlikely to take less than a tenth of the total flight time and may take much more. Air resistance and wind drift always have some effect, too. Further steering may be provided in the near-terminal phase of flight, the thrusts coming from vanes or ancillary rockets.

To opinion at large, the word 'missile' does connote still a kind of ordnance that is peculiarly menacing. The firing of a few unguided rockets can attract world media attention, as militants from the Bosnian Serbs to the Hezbollah know full well. Even if an episode is brief and its effect negligible, it is still held to betoken unyielding defiance. Likewise, the sinking of an Italian battleship by Luftwaffe guided missiles in 1943 ; of an Israeli destroyer by an Egyptian Styx missile in October 1967 ; and of two British ships by Exocets during the Falklands War entered the annals in a way most individual acts of war never would. Obversely, a strong Serb and Russian reaction was reported after the United States Navy fired 13 Tomahawk cruise missiles at Serbian air defences around Banja Luka in September 1995. The upshot in this case is said to have been that any future Tomahawk strikes would have to be individually authorised at senior political level in Washington.[8]

Sometimes one has to cope not just with mystique but with illusion. An aspect of the latter is the notion that, nuclear or CBW missions apart, missiles fired at targets beyond the battle zone will merely be 'terror' weapons, devoid of any war-waging utility. Remarks to this effect are often heard in respect of the attack force in each of the only two anti-missile campaigns conducted to date. The first was that to defend Great Britain in the face of the V-1 cruise missile and then the V-2 ballistic missile offensive of 1944-5 while the second was against the Iraqi firing of modified Scuds into Israel and Saudi Arabia during the 1991 Gulf War. What ought to be admitted is that the V-1s, in particular, could have been much more than terror devices had Hitler followed military advice and directed them not against London but against our Second Front invasion ports. General Eisenhower was among those on our side who inclined to this view: 'I feel sure that if he (Hitler) had succeeded in using these weapons over a six month period, and particularly if he had made the Portsmouth-Southampton area one of his principal targets, Overlord might have been written off.'[9] The fact that the Fuhrer preferred to squander his V-weapons largely on London, maybe in the hope of killing Winston Churchill, tells us as much about his psychotic personality in its penultimate agony as it does about the respective attributes of those then novel instruments of war. The Messerschmitt-262 jet-propelled interceptor was no less vengefully squandered in tip-and-run bombing raids.[10]

Saddam Hussein might have dislocated the allied coalition had he been lucky enough to kill so many civilians as to goad Israel to enter the Gulf War or to hit a big ordnance dump, as he once nearly did, on the Saudi coast. His Scuds would then have been seen as a grimly apposite compensation for his deficiencies in manned aviation. A port of entry is perhaps the prime example of an objective that might be put out of action (probably through the exiting of the dock labour force) even by rockets as inaccurate as is the Scud. The Circular Error Probability (CEP) very generally cited for Scuds B and C is 500 metres. The formal definition of CEP is the radius from their respective aiming points within which half the warheads in a salvo can be expected to impact.

The macabre aura long-range missiles (and especially rockets) have had about them is similar to that acquired by 1939 by what George Orwell, himself no pacifist, used glumly to speak of as 'black bombing machines'. We can anticipate that, to an extent, they will merge into the general perception of the new panoply of war. That was what the bombers did, to an extent, in their day. By the same token, bomb explosions in city centres far from any recognised front line will be no more and no less unnerving whether they emanate from rockets or from terrorist suitcases. Much the same will apply to the delivery of means of mass destruction.

From the standpoint of the attacker, the surreptitious delivery (by suitcase or fishing smack or whatever) of death-dealing materials has some obvious advantages over rocketry or economic sanctions or any other coercive means. Nor may volunteers for such missions be hard to find in the mushrooming slums of the developing world, particularly among communities imbued with a historic sense of grievance. Also, there may sometimes be an element within the target society that could facilitate or conduct the terrorism required.

In which connection, we do well to remember what Libya's main response was to the US air strikes against her (partly from British bases) in April 1986.[11] It was not what is so often recalled, the fatuous dispatch of that a single Scud in the general direction of the US facility on the Italian island of Lampedusa. Rather it was huge shipments of arms to the IRA. Before the strikes, launched to curb Libyan sponsorship of terrorism elsewhere, the IRA had been losing out militarily as well as via the ballot box. With the shipments, they revived a bit. Deaths from political violence numbered 55 in 1985 and 62 in 1986 but then were 93 in 1987 and again in 1988.[12] Once more the solid resilience of the Ulster people took the strain well; and the death rate was to drop to 62 in 1989 and 76 in 1990. Undeniably, however, some extra clout had been given to an organisation with a hard-core 'active service' membership of only about 80.

Nor may it be a question of straight choice between recourse to rocketry or to terrorists. The former may be sought as a back-up to the latter or vice versa. Such a complementality has provenance in terms of revolutionary doctrine and practice. Take the career within Communist China of Lin Piao. In the 1930s he had led the vanguard in the epic Long March from Kiangsi to Yenan. In 1959 he was brought out of semi-retirement, just as the Sino-Soviet split was opening up, to take charge of the People's Liberation Army (PLA). In that capacity, he inspired a rejuvenation of the PLA's tradition of guerrilla resistance backed up by mass mobilisation. Witness how, during the Cultural Revolution (1966-9) he emerged as the exemplar of the true Maoist way. At the same time, however, he masterminded the development of the military-cum-heavy industrial complex and, above all, of nuclear tipped strategic missiles. The 'four-point military guidelines' subscribed to by North Korea since 1962 emulate this dualism quite closely.

Ballistic or Cruise?

But in professional circles even now, the nub of the 'singularity' debate is not as between what we call 'missiles' and all other weapons. It is between the ballistic and the cruise modes of missile propulsion. Not that the two can any longer be separated neatly. Take a line of development for long-range air-to-air and air-to-ground missiles lately explored by MATRA-MARCONI and the French aeronautics agency, ONERA. Each model receives its initial boost from a solid-fuel rocket. Then another rocket charge, one with only a low oxygen content, ablates so as to produce inside a ram-jet a combustible air-fuel mix.[13] A variation on this theme looked at by the United States and Japan is the

'ducted rocket'. Combustion of the single rocket charge is completed by means of air drawn into a secondary combustion chamber.[14] A more conservative hybrid is one in which the power for most of the flight path comes from a ram jet or gas turbine but a booster rocket is fired to get up speed initially or else for a terminal dive. Certainly, interest in the ram-jet is reviving once more.[15] So hybridisation may be an incipient trend, not least at sea (see below). Likely, in any case, is concurrent employment.

Usually posited at the moment, however, is the straight choice between 'ballistic' and 'cruise'. A singular attribute of the ballistic missile is the way its range increases more than proportionately to its burn-out speed because the parabolic flight path the warload assumes phases into orbital motion as the distances covered become a progressively more substantial fraction of the Earth's circumference. Assuming throughout a 'minimum energy' trajectory, the relationship between speed on burn-out and range covered is as follows. One kilometre per second means a range of 120 km; and twice that speed, 500 km. Three kilometres a second achieves some 900 km; and four, twice that range. Six kilometres a second means 5000 km; and seven kilometres a second, twice that. The kinetic energy (i.e. energy of motion) a warload/RV will possess is proportional to its mass and to the square of its velocity.

Something of a natural break occurs at a range of 600 km, this being the one for which the 'minimum energy' trajectory lifts at apogee just above the atmosphere, as defined in Chapter 3. So one has reached the threshold beyond which much mechanical and thermal stress is imposed by abrupt retardation on re-entry. Above 1000 km or thereabouts, both the design of a Re-Entry Vehicle (RV) and the materials it incorporates have to be of superior quality. Beyond that, the stresses build up progressively as a direct function of the kinetic energy on re-entry. Many analysts are worried lest North Korea, say, moves within a decade from developing theatre-scale rockets of 1300-km range to the production of intercontinental ones. But Pyongyang may find that progression difficult for re-entry reasons alone.

The supreme attribute of an advanced cruise-missile has to be its ability to jink (at about one or two $g^{[15]}$) or else to contour-hug closely and at trans-sonic speeds. As it does so, however, it may consume fuel several times as fast as it would on its most economic flight profile. Even without this added burden, fuel load tends to be a limiting factor over the more extended ranges. Proscriptions on the overflight of neutral territory will sometimes be another constraint.

Nevertheless, cruise missiles intended to strike deep into the respective continental heartlands were deployed on submarines by each Superpower towards the end of the Cold War. The United States Navy brought the Tomahawk (range, 2500 km) into service in 1983 while its Soviet counterpart, the SS-N-21 (range, 3000 km) was first deployed in 1987. No fewer than 288 Tomahawks were launched from warships or submarines during the Gulf War as the key element in a cruise missile campaign against political and military command nodes ; chemical and oil facilities ; and the Iraqi electric power grid. Somewhere between 65 and 95 per cent hit spot on their precisely designated targets. Contour-hugging of the kind a Tomahawk may effect does, of course, depend on the storage on-board of a mass of terrain data and on an adaptive built-in radar.

In the world of missile defence, attitudes have shifted even these last two or three years, especially in respect of theatre war. Beforehand, the cruise missile was seen by more or less everyone concerned with BMD as an otiose distraction. Today people like Republican Senator, John Warner press in committee for a greater emphasis on cruise missile engagement while the Pentagon itself has considered the establishment of a

Cruise Missile Defense Organisation either integral to or parallel with BMDO.[16] An early indication of attitudinal change was the report published in 1992 by a private and ad hoc Strategic Defense Initiative Committee. It had met under the chairmanship of Dr William R. Graham ; and its members had included Drs Edward Teller and O'Dean Judd, the latter having lately been Chief Scientist at SDIO. The committee noted that 'Sixty-six countries are reported to possess aerodynamic missiles. Cruise missiles are generally less expensive to buy, and the fact they can readily be placed in canisters makes them particularly easy to maintain and operate in harsh environments. Moreover most countries with ballistic missiles in their inventories first bought and deployed aerodynamic missiles.'[17] Training in the operation of cruise missiles may take but a few weeks. Reasonably well maintained, their shelf life should exceed 20 years. Not least, a cruise missile launch site is much easier to (a) improvise and (b) conceal than is a ballistic one.

Granted, a simple cruise missile (e.g. a converted light aircraft) ought to be easier to intercept than its ballistic counterpart. It may be flying sufficiently straight and level and high above the surface to be engaged either from there or else by a plane on Combat Air Patrol (CAP) maybe many thousands of feet above. A really advanced cruise missile, on the other hand, may be harder to destroy, except perhaps over the sea, than any ballistic equivalent. Indeed, it is a challenge that may require radical solutions. In which connection, it is pertinent to note that in January 1996, following some disconcerting trials and simulations, the Pentagon instructed the US Army to spend $500 million over the next six years on the development of radars mounted on Unmanned Aerial Vehicles (UAVs) or slung under tethered reconnaissance balloons to help ground defences against cruise missiles.[18]

What must remain in doubt, none the less, is whether quality diffuses as readily in the cruise missile field. The main institutional constraint on each genre is the Missile Technology Control Regime (MTCR) established by seven founder members in 1987 expressly to curb the spread of missilry able to wreak mass destruction; and which now embraces some 28 member states with several others having agreed, in principle, to abide by its provisions. Those who have done so include the Czech Republic, Israel, Poland, Romania, the Ukraine and, ostensibly at least (as from 1992), China. Slovakia, South Korea, Taiwan and Turkey may join or conform to the MTCR in due course.

This regime seeks to inhibit the transfer not just of 'complete systems' but of key components and 'production facilities'. Ballistic systems also include, for this purpose, Space launchers and probes. Cruise systems also include target and reconnaissance drones. The aim, as of December 1995, is to curtail the spread of missiles tailor-made or adapted to deliver a warload across a range of 300 km or more. A stipulation that a warload here meant 500kg or more was dropped in July 1993, probably because biological bombs may be made much smaller than that. Five hundred kilograms was still considered minimal for a primitive nuclear device. But since that January, 'mass destruction' had explicitly included biological and chemical warheads.

Admittedly, anxiety is sometimes expressed that the regime is less stringent for cruise missiles than for ballistic. Performance is harder to define and determine with the former. Then again, a concern not to impede the employment of manned aircraft means loopholes are left. Take the approval a couple of years or so ago by the US Commerce Department and the Pentagon of the sale to China of Garrett turbofans. The US intelligence community was apprehensive lest these be used to upgrade the HY-2 anti-shipping missile, enabling it to carry its warload (c. 500 kg) across 600 km instead of the mere 95 km achievable at the moment.[19] On the other hand, the sub-systems a cruise

missile needs in order to operate at the frontiers of current performance may have to (a) involve technologies more diverse than what is required on the ballistic side and (b) need often to be designed just as specifically to achieve tailor-made compaction. All in all, really advanced cruise missiles may not proliferate as readily as their ballistic equivalents, not unless and until straight transfers occur in the aftermath of a collapse of the MTCR.

Over the next two decades, ballistic missiles may close the accuracy gap as between themselves and aerial delivery. They, too, may come more regularly to register what amounts to pinpoint accuracy over whatever range. Thus far the genre has not achieved this because of attributes that are, in other respects, positive. The downside of an ability to leave the atmosphere is the need to re-enter it, with all this entails in terms of stressful retardation and associated tumbling. Economy over extended ranges has its downside, too. Assuming a 'minimum energy' trajectory throughout, it requires an increase in burn-out velocity of less than ten per cent to increase the range from, say, 9000 km to 18000. The obverse is that a small error in a velocity vector can, unless corrected terminally, induce a big miss distance.

Yet in spite of these inherent difficulties, much progress was made with ballistic missile accuracy in the period 1970-85. The Pershing 2 was a special though instructive case in that a CEP of 30 to 40 metres was adjudged achievable, given terminal correction (for inertial error and wind drift) by means of a built-in combination of radar and digital mapping. More generally, the progressive refinement of inertial guidance was still the key at that stage. Part and parcel of it, in the case of large and sophisticated rockets, was the introduction of the multiple warheads, each directed towards a particular target by a programme updated on board at the time of separation. With these Multiple Independently-targettable Re-entry Vehicles (MIRVs), a CEP of 100 metres can now be registered at intercontinental range. That value has been cited for the MX Peacekeeper.[20] Even without MIRV, a CEP of 150 to 300 metres might normally be feasible across a wide spectrum of range.

Though impressive in themselves, such accuracies still do not match the 20 or 30 metres or so now regularly registered by cruise missiles or guided bombs. In fact, for the 44 Tomahawks launched against Iraq early this month (September 1996) a CEP of 12 metres has been claimed. Though that contrast will matter little if the warheads bear some means of mass destruction or else are directed against a port or a logistics park or some other large soft target, it could still be of operational consequence when using high explosive against compact targets like bridges or bunkers. But now the elixir of near-perfect terminal precision may be accessible to the world of ballistic missilry via the intelligent submunition. At the 1994 Farnborough Air Show, Textron exhibited a canister of standard dimensions that, dropped from an aircraft, opened up to release a dozen bomblets, one or two hundred metres above - let us say - tanks in open formation. Each bomblet would then home, by means of an image-comparing sensor, on an individual tank. It was stressed that the technologies incorporated in this Sensor Fused Weapon (SFW) were thoroughly state of art. The components had been bought off the shelf except for some machined to fit particular niches. No reason was seen why China, for instance, should not have this technology in a decade or two. Nor why the warhead capsule for a theatre rocket could not readily incorporate the SFW principle on either a multiple or a unitary basis. Normally, too, shrouding should enable sensors to withstand the shock of high speed atmospheric re-entry. Credibility is lent to such prognoses by such ordnance having arrived in aerial service very much on schedule in relation to the decadal lead time characteristic of modern weapons. It was being predicted for the middle 1990s in the public debate in 1984-5.[21]

Long-Range Precision

All of which further serves to confirm a neglected but important truism. It is that the warloads borne on long-range ballistic missiles will not always have to be mass destruction, not even for strikes across intercontinental distances against compact, hard-point targets. It is a truism that, in relation to strategic deterrence, was dismissed too readily for too long. Throughout what one may call the classic SDI years (say, 1983-7), both the academics and the policy-forming communities regularly closed ranks to discount any middle way between our adversaries fitting out their ICBM or SLBM capsules with nuclear charges and their packing them with back numbers of *Pravda*. Not even chemical delivery was much allowed for. At least one cogent attempt to remind everyone that high explosive might be delivered intercontinentally went virtually unremarked.[22] Never mind that, by September 1987, the USAF was at a 'critical point' in the development of high-explosive warheads intended for installation in Minuteman 3 ICBMs modified to home in on the emissions from enemy master radars.[23]

Also little remarked within the SDI debate were those grim warnings the USSR had issued in 1956 and 1960, during the crises over 'Suez' and the Lockheed U-2 reconnaissance flights respectively. Granted, a good case can be made for saying the rocket threat against London and Paris, made by Marshal Bulganin on 5 November 1956 in his capacity of Soviet co-leader, was pure gesture politics. It came a solid week after hostilities had commenced, by which time American and international pressure was obliging Britain, France and Israel to cease firing as a preliminary to withdrawal. Granted, too, any attacks on U-2 forward bases (certainly those in Turkey, Pakistan and Norway) could as well have been made by bombers as by the rockets Moscow again mentioned. But on each occasion, it was easier to believe that any strategic missiles that were launched would be non-nuclear.

Within the USAF and the USN, interest in precision ballistic delivery across strategic distances has lately resurged, even though any expansion of their own missile inventories to exploit this option could vitiate the arms control reciprocation with Moscow in train under the rubric of the Strategic Arms Reduction Talks (START). The USAF now envisages non-nuclear warheads being used 'versus hard-to-destroy targets such as buried command bunkers ... including facilities related to the manufacture of nuclear, chemical or biological weapons and command-and-control sites'.[24] The USN has tested a Trident D5 Submarine-Launched Ballistic Missile (SLBM) with a non-nuclear precision warhead incorporating metal rods so as to penetrate up to 20 feet of concrete. We are advised, too, that this D5 might be guided onto a target by Global Positioning System (GPS) satellites (see Chapter 3).[25] Sensor fusing is not even mentioned in this prospect of precision.

A Shift Towards Cruise?

However close the correspondence between ballistic missiles and the cruise variety may become overall, certain attributes will still be different. The use of the 'cruise' long-range may be constrained by proscriptions on the overflight of neutral territory. Nor may the cruise missile ever match the facility of its ballistic counterpart for engaging, almost in real time, manoeuvre forces on land or for being synchronised to effect at theatre level or above one paralysing first strike. But it may be the better instrument for presenting an ultimatum in tangible form. Its longer flight time will give the enemy more time to reflect; and it should be easier to destroy in flight if he duly caves in. A cruise missile will generally be the better vehicle, too, for the dispensing of a biological or chemical attack (see Chapter 5).

Most significant in respect of BMD, however, is the reality that, for many purposes in theatre war, the advanced cruise missile may be still better adapted than is the ballistic simply because it may be harder either to find and destroy on launch platforms as well as to intercept in flight. At the very least, its interception will require resources over and beyond any committed to BMD or, indeed, traditional air defence. It may, for instance, involve heavy dependence on the point defence of vital targets. So the readiness with which it may proliferate among our potential adversaries will be an important question.

It will also considerably be one of prediction not just of technology but of geopolitics and, indeed, military philosophy. It has lately been observed that 'Third World customers for Scud equivalents have not yet appreciated the advantages of cruise missiles. The widespread availability of GPS-based flight control systems is likely to change this perception, and the proliferation threat may shift from tactical ballistic missiles to more economical cruise missiles'.[26] It is germane to note that Russia has, since the late 1950s, given the cruise missile considerable emphasis in spite of rocketry being veritably a part of the Muscovite culture thanks to the inspiration of Konstantin Tsiolovsky (1857-1935), 'the father of Soviet spaceflight'. The Russian Federation is reckoned currently to have in service 26 types of nuclear-capable offensive missiles. Eleven of them are cruise. Of these, six are submarine-launched, their ranges spread from 100 to 3000 km. Four are air launched, with ranges between 200 and 1600 km. One, the SS-C-1b, is ground launched. It can travel up to 450 km.[27] So neither the spirit of Tsiolovsky nor the sexiness of ballistic missiles paraded in echelon has entirely prevailed.

Club Mad?

A theme that surfaces not infrequently in discussion of missile defence is that we are into a new situation in that we are dealing with adversaries (especially in the Middle East) who are not susceptible to reason and therefore impervious to deterrence through the threat of overwhelming retaliation Active defence duly assumes a singular importance, not least the defence of one's homeland against weapons of mass destruction.

This view is not to be dismissed lightly. A case can be made for saying that rationality and positivism are under threat the whole world over as we slide deeper into philosophical and cultural chaos and as ecological stresses build up.[28] But the point is not clinched beyond all argument by the entrances and exits of young suicide-bombers, Islamic or whatever. Communism in its heyday was a faith that inspired, required and enforced similarly sacrificial dedication. Think of the countless human wave attacks on the Eastern Front, in Korea, at Dien Bien Phu ... . But those involved in such episodes have always had different motivations from those who make the strategic calculations at the top of any such polity. The latter are never indifferent to the survival of themselves or their regime.

Nor can we just say that deterrence cannot work because the revolutionary leaders are clinically insane, almost by definition. This also is nothing new. You could not be madder than Josif Stalin was to judge by much of his behaviour on the home front. Take the entirely gratuitous purge of the Soviet armed forces in 1937-8, undertaken at the very time Hitler was building his strength up. Altogether some 35,000 officers and commissars were executed or simply vanished. All but five of the 80 members of the Higher Military Council were liquidated. So were 90 per cent of all colonels; and so on.[29] Yet in his dealings with other world leaders, Stalin displayed a cool and ruthless shrewdness much more often than not, just as the lunatic Hitler did. Much the same

could be said about Mao Tse-tung[30] or Kim Il Sung (see Chapters 6 and 5 respectively). So could it about Saddam Hussein. Such men are prone periodically to making some massive strategic blunder, this as often as not through underestimation of the resolve of their opponents. But that is not madness *per se*.

Even if one does accept that insane behaviour is becoming more prevalent in world affairs, that may not be a good enough reason for erecting comprehensive BMD as soon as possible. All else apart, that may present the madmen with a challenge to overcome or somehow circumvent. Above all, it is important not to judge too hastily what measure of protection it is sensible to aim for and what form this should take.

However, one difficult judgement that has always to be made is the soundness or otherwise of the oppositions' procedures for crisis command and control. The modalities are examined, in so far as that is possible, in Chapter 6. How apposite they are will depend as well on how vulnerable to destruction on base the other side's strategic forces may be. That will be a function of their scale and their character. High vulnerability on the part of one side is bound to increase the risk of war through strategic miscalculation by either side.[31]

Missilry is is comparatively easy for a backward country to use and even, after a fashion, to manufacture. On both counts, it may be singularly suitable as the weaponry of the 'poor man'. What also is fair to say that the singularity of the missile in modern war becomes the more evident the further you move beyond or back from the Forward Edge of the Battle Area (FEBA). Those two propositions are connected to an extent.

3 - The Space Milieu

Discussion of the prospects for BMD customarily starts with the drawing of a Space-related distinction. It is that between interception below or above the altitude at which the resistance offered by the air to fast-moving objects becomes negligible. This divide is described as being that between 'endoatmospheric' and 'exoatmospheric'.

Atmospheric Effects

A recognised indicator is the velocity in air at which a surface of iron starts to ablate: the less resistant the air, the higher this threshold. As one ascends from 80 to 120km, it increases from 6.5km/sec. to 58. That is a much more rapid change, proportionally speaking, than occurs either higher up or lower down. The point is well confirmed by this being the zone within which meteors so suddenly yet visibly burn out. Accordingly, a 100 km is taken as the boundary up to which atmospheric resistance has tangible significance whether in regard to a warhead re-entering, a missile homing or a satellite orbiting: that is to say, the divide between 'endo' and 'exo'. During the early 1960s, the great majority of governments came to accept this as also the legal boundary between national air space and Outer Space.

The physical interpretation is as follows. The density of the atmosphere decreases rapidly with height. By 80 km, it is less than one part in 100,000 of what it is at the Earth's surface. But around 100 km, this trend is sharply accelerated by a tendency for gas particles to break up under the influence of short-wave radiation. Molecules break down into atoms. At the same time, the atoms tend to ionise: that is to say, electrons separate from nuclei. Meanwhile, those elements with lighter atoms tend to become more dominant. It is the first and last of these three effects that bring about a more abrupt fall in the density of air and hence in the resistance it offers to moving objects.

The edge of the atmosphere as here identified is also deemed important in relation to the absorption of electromagnetic radiation. Sometimes, indeed, too much has been made of the contrast as when it has been suggested that for a warhead capsule to fly even a few kilometres below the 100-kilometre level may be for it to become 'invulnerable' to infra-red surveillance from above.[1] All the same, there is no denying that the general question of absorption, highly differential in respect of wavelength as well as of air composition and density, is of great import in the civil and military realms, very much so for BMD. The electromagnetic spectrum is outlined in Table 1.

Band	Frequency	Wavelength
Very low frequency (VLF)	0 - 30 kc/s	Above 10,000m
Low frequency	30 - 300 kc/s	10,000 - 1,000m
Medium frequency	300 - 3,000 kc/s	1,000 - 100m
High frequency (HF)	3 - 30 mc/s	100 - 10m
Very high frequency (VHF)	30 - 300 mc/s	10 - 1m
Ultra high frequency (UHF)	300 - 3,000 mc/s	100 - 10cm
Super high frequency (SHF)	3 - 30 kmc/s	10-1 cm
Extremely high frequency (EHF)	30 - 300 kmc/s	10 - 1mm
Infra-red	-	1,000,000- 800nm
Visible light	-	800 - 400 nm
Ultra-violet	-	400 - 1nm
X-rays	-	1 - 0.001nm
Gamma rays	-	0.001- 0.00001nm
Cosmic rays etc.	-	Below 0.00001nm

kc/s = kilocycles per sec = 1,000 cps
mc/s = megacycles per sec = 1,000,000 cps
kmc/s = kilomegacycles per sec = 1,000,000,000 cps

A term now regularly employed to indicate frequency is the hertz, its meaning being 'one cycle per second'. Correspondingly, a kilohertz is a thousand, a megahertz a million and a gigahertz a billion cycles per second.

nm = nanometre = a billionth of a metre

For active sensing or data transmission it has often been important to operate on as high a frequency (i.e. as short a wavelength) as possible, using coherent radiation. What 'coherent' here means is that all the waves being emitted are in phase, with every wavelength effectively identical or, at the very least, in close and systematic relationship. If the radiation from an aperture of given width is of shorter wavelength/higher frequency, it will be less divergent, a big advantage in BMD target registration. Also if the task is sensing, short waves can be more definitive. If it is communication, they can carry more channels on a given bandwidth. The advent of the laser has reinvigorated the quest for high frequency combined with adequate power. All the same, a lot of radar transmission still is in the VHF to UHF range and of radio in the HF to VHF.

The most basic yardstick for the 'passive' receipt of radiant energy from elsewhere is heat radiation off a 'black body', a hypothetical object that is a perfect absorber and likewise a perfect radiator at all wavelengths. Then the peak wavelength will be a linear function of how far the temperature of this body is above absolute cold, the state in which matter is drained of all energy. That state is close to -273 degrees on the Celsius or Centigrade scale which is zero degrees on the Kelvin, one degree covering the same temperature range in each case. According to Wein's 'displacement law':

$$\lambda T = 2{,}898{,}000$$

where λ = the peak wavelength in nanometres (nm)

T = the temperature in degrees Kelvin (K)

Thus at 500K, the peak emission will be 5796 nm; and at 5000 K, it will be 580nm.

What this relationship connotes for passive surveillance can be more fully illustrated by noting certain characteristic temperatures. The mean temperature of the atmosphere at Mean Sea Level (MSL) is close to 290 K. That of deep Space is only several degrees above absolute zero. The surface of our Sun is usually at about 6000 K. The flame of an aircraft's gas turbine may be at 2500 K; and that of an ascending rocket at a rather higher value. The plasma that forms around a warhead capsule on re-entry may briefly reach several thousand degrees. What has to be remarked, however, is that the lower the temperature range the flatter is the graph for heat emission plotted against electromagnetic wavelength.[2] That does nothing to assist the passive discrimination of objects of interest to BMD.

The attentuation of radiation through absorption, by a particular gas or by the atmosphere in general, is measured in decibels, usually decibels per kilometre. A decibel is a ratio of power or energy expressed in terms of logarithms: calculated, as often in other contexts, in relation to 10 as a base. One decibel is that ratio of initial to end strength which, multiplied by itself ten times, would produce the answer, 10. This ratio is just over 1.25; and so its reciprocal is just under 0.80. Therefore an attenuation of one decibel represents a power decrease of just over 20 per cent. A loss of five decibels amounts to one of just over 68 per cent. One of 60 preserves only one part in a million.

At or near MSL, absorption by the atmospheric mix of gases becomes significant as one moves from longer wavelengths into the SHF. Through the EHF, attenuation gets worse quite steadily. Even in the 'windows' of relatively good penetration that occur between the sharp absorption peaks, there is an upward absorption trend from a typical 0.02 decibels per kilometre to 3.5. Through the infra-red, absorption rates sharply vary but are often high. Then at 900 nm a remarkably good window begins and extends to around 300nm. That covers, of course, our optical spectrum. After that, opacity is dominant though fairly good windows occur twice between 90 and 35nm. A window in that sector tends to have an absorption coefficient of somewhere below 0.5 db/km at MSL : something like 10 to 15 per cent per kilometre.[3] In the rarer air at high altitude, however, all absorption rates would be

much reduced. Relevant, too, is the near absence in the stratosphere and above of water vapour, a strong and exclusive absorber at certain wavelengths.

For passive sensing across what is, as a rule, quite a wide spectrum, the critical limit on clear reception tends to be the 'thermal noise' generated within or immediately around the sensor itself. With active sensing by either standard radar or laser, on the other hand, the limiting factors are (a) beam divergence and (b) the rate of atmospheric absorption at the transmitted bandwidth. Beam divergence is, as noted above, directly proportional to the wavelength but is also inversely proportional to the width of the transmitting aperture.

The airborne laser the USAF is enthusiastically developing for the Boost Phase Interception (BPI) of ballistic missiles reportedly has an iodine-oxygen lasant. If so, it will be transmitting pulses on 1315 nm. That may in itself be compatible with USAF claims of intense energy flux on targets perhaps two hundred kilometres away across the stratosphere. But any such compatibility will mean little if various collateral problems are not adequately resolved (See Chapter 4).

The 100-km boundary is by no means the only one to recognise as, in one's mind's eye, one transects the atmosphere in a vertical plane. A much sharper divide geophysically will have been the 'tropopause', the discontinuity that occurs between the troposphere (the lower atmosphere) and the stratosphere. Naturally, molecular diffusion occurs across it quite extensively. To an extent, too, horizontal fields of pressure and wind formed within the troposphere continue above. But vertical currents of air rarely make the transition. Accordingly, the stratosphere contains little water vapour and is virtually devoid of clouds. It never rains there. The thin air can warm up or cool quite rapidly. Otherwise there is no very obvious 'weather'.

The height of the tropopause fluctuates. Typically it is at 11 kilometres above MSL in our latitudes. Around the North Pole, eight is more the norm; and near the Equator, 16. The interception below the tropopause of warheads of mass destruction would self-evidently be liable to present acute problems in the vicinity, especially as rain washes Earthwards clouds of contamination. Conversely, the interception above it of such devices would impact more broadly; and this impact might often transcend national boundaries. Either way, these threats derive in part from its being adjudged a relatively simple task to 'salvage-fuse' a nuclear warhead: that is to say, prime it to explode the moment it is intercepted. But they relate as well to the diffusion of contaminant cloud - nuclear, chemical or biological.

Within the stratosphere, another benchmark, as one might say, is afforded by the ozone layer. This is mainly to be found in the altitude band, 20 to 30km. Ozone is a variant of oxygen that has three atoms per molecule instead of the usual two; and is formed through interaction with hard ultra-violet radiation from the Sun. It thereby affords protection from this waveband to complex organic molecules. As the thin and fragile ozone layer absorbs this solar energy, it warms the stratosphere considerably. But at 50km one enters the mesosphere, the zone in which cooling with height resumes. At 80km, this is deemed to give way to the 'ionosphere', the finely articulated zone hundreds of kilometres deep that is highly active electrically by virtue of the molecular and atomic dissociations referred to above.

Salvage-fusing in this zone can produce the ill-understood phenomenon known as Electro-Magnetic Pulse (EMP). Strictly defined, this is the release of electrons through the ionisation that occurs almost instantaneously upon nuclear detonation. However, the term is customarily extended to include the follow-on electron surges across many minutes. EMP can cause acute interference with and, indeed, obscuration of electromagnetic reception though rather more across those frequencies likely to be used for BMD communication than in the higher ones employed by its sensors. Edward Teller has long seen our inadequate comprehension of this effect as a powerful reason why the West should not have entered into the Partial Test Ban treaty in 1963.[4]

Pollution Through Interception?

Most readily apparent near to the MSL is the threat posed to life forms by the lethal quality of the shorter-wave emissions from an initial nuclear flash; and the threat posed more generally by the sheer volume of heat then released. Given the absorption patterns outlined above, one could expect the former aspect not to be too damaging beyond a few kilometres, even from a large burst within a clear atmosphere. The latter may impact more extensively. Estimates made early in the missile age (around 1960) put the slant range at which dry paper was liable to ignite, if no cloud supervened, at five kilometres for a 'nominal' (20-kiloton or Hiroshima scale) explosion and 20 kilometres for a megaton one. These figures related to 'air bursts' only two or three kilometres up and should be extended appreciably for explosions above the tropopause. Moreover, one singularly macabre effect (retinal scarring) can occur twice as far out as may tinder ignition. Such reckoning qualifies somewhat the assertion, not infrequently made, that salvage fusing more than 15 kilometres up would cause little damage at ground level. Interception above the ozone layer might be safer.

With any air burst, however, the cloud of radioactive contamination would be nothing like as intense as that from a ground burst of similar strength. This is because no solid particles would have become entrained. Moreover, its activity would progressively diminish as various chain reactions worked themselves out. With chemical and biological spillage, the dilution prospects would be determined more completely by the ambient conditions. Contamination above the tropopause is borne away on lighter winds than occur below. On the other hand, gases and particles diffuse more readily in the rarer air. When chemical or biological agents are especially potent, dispersal can mean more lethality. When they are weaker intrinsically, it may mean dilution to a level at which they become innocuous. In the case of radioactive fall-out, there seem to be no lower thresholds.

The current view at Porton Down is that any germs would be hard put to survive the cold and, above all, the aridity of the upper atmosphere. In addition, the fierce radiation encountered above the ozone layer is often deemed able to decompose quickly chemical and biological agents. Yet it may not be efficacious against every substance, least of all some of the spores that may be genetically engineered for hardiness as the current revolution in biology works itself out. It is known that some three dozen of the simpler organic compounds (e.g. formaldehyde, H_2CO) survive journeys across deep Space. Moreover, some eminent scientists this past century (among them Sir Fred Hoyle, the astronomer, and Francis Crick, the co-discoverer of DNA) have been persuaded that spores and micro-organisms can do likewise, in a state of suspended animation.[5] Studies continue, within the context of BMD, of how lethal clouds evolve at high altitude. In the meantime, one does have to remember that dispersion from intercepted RVs may occur in the form not of clouds but of submunitions.

Yet whatever scientific analysis reveals, novel dilemmas will still be posed about (a) when BMD batteries might open fire, and (b) down to what altitude interception might be allowable on a specific occasion. The difficulties will be compounded by short warning times : never more than 30 minutes and, much more typically, well under five. This would surely preclude the positive control from a senior level of particular engagements, unless these were only against a shot or two across the bows - a gesture Lampedusa-style or as in the Taiwan Straits this Spring.

Two reasons thus emerge why any BMD command-and-control must be multinational in theatres like Europe. The one is the cardinal need to pool intelligence, not least as regards the likelihood of enemy recourse to warheads of mass destruction. The other is the plain fact that cloud dispersal cannot be constrained by national borders; and that the actual dispersion patterns will be impossible to predict with any precision on any given occasion. Witness

Chernobyl. So Britain, say, could hardly decide unilaterally to protect its own people, livestock and habitats by even appearing to put those of France at risk. An adverse continental reaction might be none the weaker if it were less than fully informed or entirely rational. So agreed rules of engagement will be essential. It is a relief to observe that BMDO is more cognisant of this consideration than was the case a year or two ago.

Nor is it just when coping with the means of mass destruction that BMD can pose a pollution threat in near Space. A lesser but still important cause is the way in which an impact at some kilometres per second between an interceptor warhead and an RV could generate millions of new fragments, thousands of which would be centimetres and more across. Any of the larger pieces that then happened to enter orbit would menace Space platforms, probably disintegrating them should collisions occur at closing speeds around 15 km/sec. Even particles a millimetre across may pit unshrouded sensing surfaces.

Cascades of debris from orbital or near-orbital collisions first caused concern in the 1970s as fragment totals built up, mainly from seven firings of US Delta launch rockets plus eight Anti-Satellite (ASAT) test interceptions by the Soviets. In 1978 and again in 1981, the Soviets actually had a satellite wrecked in orbit, apparently through debris encounter. But from 1981, the Deltas were made to burn out lower down while, in 1982, Moscow suspended ASAT tests. Soon, however, the advent of SDI, with its heavy emphasis on what Moscow regularly castigated as 'Space-strike weapons', was to revive the spectre with a vengeance.

In the wake of SDI, the debris danger has remained not least because of the manifold uses, civil more than military, to which Space is being put. The number of significant fragments (i.e. ones at least several centimetres across) is still slowly rising. The situation is most serious within the 500 to 2000 km altitude band and again at the geostationary height, that at which a satellite automatically keeps constant station above the same point on the Earth's equator because it is itself revolving in an equatorial plane at the same angular velocity as the Earth is rotating. That height is about 36,500 km. It is of singular importance for communications relay and for continuous surveillance.

Proponents of BMD fairly argue that the trial interceptions now in train are unlikely to aggravate the debris situation much because impacts will occur well below 500 km and between two objects, neither of them on trajectories that are even approximately orbital. They might further argue that even if, in pursuance of Boost Phase Interception (BPI), weapons-platforms are eventually placed in orbital trajectories (see below), the altitudes at which they revolve are likely to be well below 500 km.

On the other hand, such BPI platforms would depend for overall direction on a limited number of satellites higher up, in some cases in or near a debris zone as defined above. The geostationary level is of particular interest in the context of BMD. Besides which, any BPI deployment in Space would have to be global even were the intention merely to achieve a capability in one particular theatre. The reason is 'dwell time', the small proportion of time that a platform in low orbit will be in line of sight to any given point on our rotating Earth. True, the BPI platforms can be so orbited as not to overfly any latitude higher than that of the territory they are targetting. All the same, a constellation of platforms that was to have a dozen above North Korea, say, at any one time would *ipso facto* have to have about a thousand above the Russian Federation. Therefore orbital BPI would be bound to complicate the strategic balance between the major powers, probably to an extent that made codified arms control unfeasible. At which point, concern for geopolitical stability fuses with that about environmental congestion.

Deep Emotions

The governance of Space ought not to be simply a matter of calculation, in any case. One strand in public opinion, certainly in the United States, throughout the SDI era was a sentiment that weapons platforms in Space (always the supreme manifestation of the SDI vision) were aesthetically and spiritually unacceptable. From the counter-culture school came admonitions that Space 'had been the last place safe from human wars ... the last refuge of a sacred presence in the universe'.[6] Continuing depletion of the ozone layer is not a military-related problem but does reinforce the sense of desecration.

Nor did the late Lord Zuckerman seem far removed from such anguish when he warned in 1987 that certain kinds of Space-based laser weapons would ignite substances on the Earth's surface.[7] Granted, the sort he apparently had in mind, Free Electron Lasers of adequate power and appropriately tuned, were rather unlikely then and are extremely unlikely now to figure in any BMD conspectus.[8] Moreover, the SDIO fraternity were always quick to discard their normally laid-back mien to protest with vehemence that sweeping the Earth with 'death rays' was no part of their agenda. BMDO would do the same today. Nevertheless, the words of Solly Zuckerman should be heeded on such matters. In World War Two, he was a highly successful pioneer of the application of operational research to tactical aviation. Later on, he was Chief Scientific Adviser to the Ministry of Defence (1960-66) and to the British government (1964-71).

Surely, it is likely that any suggestion of the Earth's surface coming under orbital domination by anybody would generate a syndrome of resentment around the world. The fact that 'death rays' have been a staple of science fiction since H.G. Wells indicates how the mere mention of them evokes from deep within our psyche some graphic folklore : the 'evil eye', the basilisk's stare, lightning shafts and the firedrake. Even the prosaic *Anglo-Saxon Chronicle* tells how, among the 'foreboding omens' that 'wretchedly terrified' the people of Northumbria in the year 793, were 'lightning storms and fiery dragons ... flying in the sky'. However phantasmagoric any latter-day revival of such concern may appear to strategic analysts, they would do well not to dismiss it out of hand. What we may have here is something like a mirror-image of Lyndon Johnson's justifying Project Apollo on the grounds that he was not prepared to go to sleep under 'the light of a Communist moon'.

Further weight is lent to this caveat by the lead role orbital satellites have assumed in the global revolution in telecommunications. Albania, Iran and Libya are among the authoritarian states that either have failed or are failing to check the arousal of dissent through the proliferation of satellite receiver dishes. Saudi Arabia and China are among those that continue dourly to resist. The former still maintains an official ban on receiver dishes, though the privileged flout this. The latter has been striving to oblige all its urban dwellers to abandon private dishes in favour of cable television from which every inkling of serious comment has been excluded. Witness, too, Rupert Murdoch's admission in June 1994 that he had felt obliged to have the BBC's round-the-clock news service removed from his Hong Kong-based Star satellite broadcasts in order to placate Beijing. The consensus among Western commentators is that such obfuscation must fail in the longer-term, given China's trade liberalisation coupled with a technical trend worldwide towards dishes 'as small as 50p coins'. If so, the powers-that-be in Beijing may be all the more disposed to vent their aggravation skywards, rhetorically at least.

Meanwhile, concern is burgeoning the world over lest imagery beamed from on high creates 'cultural deserts' as it erodes traditional mores in favour of a Hollywood cosmopolitanism with its accent on mindless titillation - pornography, violence and trivia. Within Europe, France has assumed the lead in exploring the political scope for resistance. In various religious traditions, of course, anything that smacks of a 'craven image' is deeply suspect.

What the future actually holds is still uncertain. Everything hinges on the huge expansion in the number of satellite channels (to 500 or so?) that new techniques of digital compression will make possible. Will this preserve cultural diversity or will there be a supersaturation effect instead? The pessimists fear little choice upmarket and a plethora downmarket. At all events, there will be an added premium this next decade or two on handling with due sensitivity anything that smacks of dominion from Space by the United States or anybody else. Military aspirations in this domain will need to be carefully judged, not least interception by laser. Mounting distaste at any idea of lasers being used against humans in ground war is likely to heighten sensitivities further all round. A year last autumn, an international ban came into effect on low-energy anti-retina lasers.[9] The United States duly cancelled a laser countermeasure weapon intended for use against electronic sensors. It did so because Washington allowed it might also impair the human eye.

Demilitarise?

All of which might be taken to imply that we should demilitarise Space completely. What every analyst accepts, however, is that such a departure would be neither desirable nor feasible. It would be undesirable since such militarisation as has taken place to date has been strongly conducive to world peace. Communications satellites have aided crisis management. Reconnaissance from Space (initiated by the Americans in 1961) has helped the West operationally and reassured it strategically, partly through arms control verification and partly through revaluation of threat. A not untypical view in 1955 was that the Soviet army would be able to mobilise, through reserve recall, some 300 divisions within six weeks and 450 within six months.[10] But by 1965, its order of battle was generally accepted to be 140 divisions; and not more than half of these were seen as at or near combat readiness. We are sometimes encouraged to attribute this to the laconic objectivity disported by the Kennedy administration on its assumption of office in early 1961. In fact, the start of the revaluation predates them. It owes much to overhead transits of the USSR most notably by U-2 monoplanes from 1956 to May 1960; and then by orbital reconnaissance satellites from the autumn of 1961.[11] The knowledge continually acquired thus has remained indispensable to stable deterrence as well as to arms control.

Besides, demilitarisation would be unfeasible, most basically because of the huge overlap that already exists between civil and military tasks. With meteorological reconnaissance, the concurrence is complete except that military forecasts often need to be very detailed for localised areas in the hours immediately ahead. With telecommunications, navigation and asset surveillance, the overlap is considerable and increasing.

Take the case of the US Global Positioning System (GPS) navigational satellite network. An endeavour is made to preserve a distinction between the military and the civil facility, this in order to ensure that the former falls not into hostile hands. The remedy is to transmit two different signal modes. The Precision or P-code is designed for authorised military users and can be encrypted. The Coarse Acquisition or C/A code is always less accurate; and can be further downgraded, should the situation demand, by the US military. This generally available C/A code is normally accorded a resolution of 50 to 100 metres while the P-code achieves one of several metres. However, deployed forces that are static or slow-moving can narrow the C/A resolution severalfold by the integration of multiple readings.

Efficiency in asset surveillance is also expressed most basically in terms of 'resolution': this being measured in this case by the width of the smallest spot that can normally be distinguished against a contrasting background. What was the world's first civil Space-based Earth-imaging system, the US Landsat, provides a 30-metre global resolution on the open market to anyone anywhere. Much of this information 'is sold via licensing agreements and

directly downlinked from the satellite to ground stations in a number of foreign countries, where the data is produced and distributed locally'. Yet Landsat data was also 'put to good use by US forces during Desert Storm'.[12]

As of early 1994, some eight countries plus the European Space Agency (ESA) were engaged in optical surveillance by civil satellite. Those countries were Brazil, Canada, China, France, India, Japan and, of course, Russia and the United States. Resolutions were then mainly in the 10 to 80 metre range. Upgrades were planned, generally to the 5 to 20 metre range. However, Russia was said to be trying to market two-metre imagery of virtually the whole Earth while the CIA was reported to be contemplating the sale of one-metre products. If those departures bear fruit, commercial optical surveillance will come close to military in terms of definition. American optical reconnaissance by military satellite now has a resolution of about a fifth of a metre. The Russian military, having been in this field since 1963, are unlikely to be far behind. Israel and maybe China are also involved. Meanwhile, France has assumed a lead role in the development of a multi-factor surveillance capability for WEU. That has implications for BMD (see Chapter 8).

What certainly cannot be said is that Space surveillance, civil and military, no longer engenders any resentment among the less advanced countries. On the contrary, improving definition on the civil side may recharge such reaction. At the present time hostility is being evinced in three countries - Brazil, India and Pakistan - that are themselves by no means excluded from the world of high technology in Space and elsewhere. In Brazil, there is protest against ecological surveillance data being processed outside the country. Meanwhile, India and Pakistan are reportedly objecting to monitoring from Space being provided for in a Comprehensive Test Ban.[13] All of which serves to confirm the sensitivity of world opinion towards 'Outer Space': a realm identified in the evocative terminology of the 1987 Brundtland report as one of the three 'global commons', the other two being the Oceans and Antarctica. It speaks of 'growing concerns about the management of orbital Space', not least as regards the threat of weaponisation.[14]

Non-weaponisation

So accepting that the non-militarisation of Space is not a viable option, what of the possibility of nailing the principle of the non-weaponisation of that realm? Here, too, there are difficulties of definition. Take a BMD battery deployed on the Earth's surface. The first assistance rendered from orbit is likely to be early warning. Next, satellite transmissions may 'cue' it: that is to say, increase maybe two-fold the effective range of the battery radar by indicating the sector of sky it needs to scan. Sensing satellites may then be crucial to discriminating between the warheads in the threat cloud and the accompanying decoys and debris. Some people would say that, even with existing technology, the whole satellite constellation gets so intricately involved in target acquisition that it has to be seen as integral to the ground-based BMD. Against that, however, one can insist that the term 'weaponisation' be confined to the deployment of the actual ordnance, be this interceptor missiles or laser beams. If it can be agreed that these should not be deployed in Space, the precept of 'non-weaponisation' can thereby be upheld.

If that is accepted, two derivative questions have to be addressed. One is whether the 'non-weaponisation of Space' ought still to be pursued under the rubric of the Anti-Ballistic Missile treaty of 1972 or whether this ought to give way in due course to a new arms control regime. The other is how far arms control helps or hinders legitimate alliance aspirations in the field of BMD. These questions may assume great importance in our dialogue with America, especially Republican America (see Chapter 8).

4 - Interception and Arms Control

The Arms Control Dimension

Writing a monograph about European Security in 1972, this author devoted six pages out of 164 to arms control and disarmament.[1] Looking back, that input seems inadequate even for those days. Now so weak an emphasis would be absurd. That is true for the topic just mentioned but no less so for BMD. The reason is threefold. One aspect is that, particularly since the Cold War, we in the West have sought consensus on defence on the basis of ever firmer acceptance of the philosophy that informed the Harmel Report on *The Future Tasks of the Alliance* adopted by NATO Council in December 1967. The outcome of a review proposed twelve months earlier by Pierre Harmel, then Belgian Foreign Minister, this report stressed that 'Military Security and a policy of *détente* are not contradictory but complementary'. Therefore the Alliance should pursue these twin objectives. Arms control is, in effect, an institutional expression of *détente.*

Furthermore, some restraint in strategic arms expenditure by the West appears part and parcel of our lending moral support to the forces of moderation within the developing nations. Positive engagement with these forces will be of increasing importance in coping with terrorism, syndicated crime, drugs, pandemics, ecological degradation and cultural debasement - menaces that loom with ominous strength across the contemporary world. Accord on the promotion of democracy and human rights will be important as well, not least in view of the weight given these days to the proposition that free societies are less likely to be aggressive. Yet progress will be compromised in all three directions if even moderate or traditionalist leaders in the Less Developed Countries (LDCs) perceive the West applying double standards on arms limitation. BMD is liable to be a touchstone, these next 20 years.

Finally, BMD may need certain forms of arms control itself to stand a chance of being at all viable. The Missile Technology Control Regime (MTCR) springs immediately to mind. As already noted, however, there is a whole network of arms control provisions that may constrain the offensive missile threat. However, many would insist that BMD preparations and, by the same token, those for cruise missile defence can play a big part in discouraging the proliferation of attack missiles and the associated means of mass destruction. The relationship is reciprocal.

Patterns of Conflict

In the American deliberations about BMD through the late 1960s (see Chapter 1), a distinction was regularly preserved between comprehensive and 'thin' screen defence of the homeland. The latter was to ward off either a limited strike from the USSR or else a maximum attack from China. At present, the American public debate tends not to recognise any such dicotomy.

All the same, BMDO has drawn up a table of generic threat scenarios for the National Missile Defense (NMD) of the United States that can be summarised as in three layers. The lowest order ranges from four simple unitary warheads (ST1) up to twenty sophisticated MIRVs (ST4). It is thought the four might be indigenously prepared (albeit not less than 8 to 10 years into the future) by such countries as North Korea, Iraq or India, were their political situations ripe for this. The twenty might be presented by a former constituent state of the Soviet Union, this either directly or else through transfer - licit or otherwise.

The topmost layer depicted is a deliberate mass attack with a thousand or more warheads. Though everyone might agree this to be 'highly unlikely', nobody could deny that it remains the ultimate possibility should deterrence fail comprehensively. What may be the least plausible is the intermediate layer: Global Protection Against Limited Strikes (GPALS), meaning ones involving the accidental or unauthorised release of up to 200 warheads or RVs.[2] It is hard to envisage that many being released simply because some well-intentioned training officer had casually depressed the wrong actuation switch. Nor is it easy to imagine 200 being fired off against the West by a dissident group within a fragmenting nation state.

Nor, indeed, does it seem plausible to talk of any central government firing 200 RVs at the American homeland any time these next ten years. Clearly, that level is far above what 'a shot across the bows' might require. Nor is it very credible that any regime could afford at this stage to expend that many strategic RVs in a high-explosive or, indeed, chemical bombardment of the United States. Nor, on the other hand, can one readily identify a secondary nuclear nation that might release warheads of mass destruction against the Americans on that scale. France could. So could Britain. Neither ever would. So one is left with China in maybe 15 years' time.

Nevertheless, the threshold of 200 has been associated with GPALS ever since President Bush enunciated the concept in 1991. But that figure may have owed little to a strictly strategic appreciation. It probably owed far more to the need George Bush felt to sustain a balancing act within the Republican party as he led the United States away from fully-fledged SDI. Since then, however, '200' has been identified in some quarters as a kind of eternal verity. It is expressly part of the rationale behind the rather apocalyptic calculations the Republican Right is currently engaged in (see Chapter 7).

The basic alternatives posited, since 1991, have simply been National Missile Defense (NMD) of the United States and Theatre Missile Defense (TMD), most notably in Europe and the Mediterranean and in North-East Asia. But it is well understood in Washington that TMD in Korea or Japan or Israel or the more densely-populated parts of Europe could partake of national missile defence so far as those territories were concerned. It would do so if the system selected could cover a wide area in relation to the local geography.

Lockheed Martin are quite explicit about this in their promotion of Theater High-Altitude Area Defense (THAAD) as a system the Europeans and, indeed, the Japanese may care to purchase. Take, they say, a THAAD battery deployed to protect the Ballistic Missile Early Warning System (BMEWS) at Fylingdales in Yorkshire. With its slant engagement range of 140 km in all directions, it would also offer fairly thin-screen protection to much of the industrial North of England. This is why, in contemplating an area defence weapon like THAAD, we have to be so careful about creating thus an NMD precedent unless and until we and our allies are clear-minded how it may be interpreted and whether we are happy with that interpretation (see Chapter 8).

One alternative that may present itself in due course is to focus exclusively on the close-in defence of certain key assets at home or abroad. One thinks, first of all, of military assets. It is not easy to predict how that priority might be read, given the volatility of contemporary opinion. What one can say is that it would not lack precedent. At the height of the Battle of Britain, the overriding concern of Dowding and Churchill was and had to be not London but the viability of our frontline fighter stations. Following the seminal Defence White Paper of 1957, the Royal Air Force

deployed Bloodhound surface-to-air missiles expressly to shield its V-bomber bases. Likewise between 1969 and 1975 the Americans focussed their BMD on a strategic missile field.

Not that the choice between defending military objectives and shielding civil society will ever be an absolute one. There will always be some overlap. Edward Teller observed ten years ago that 'One serious difficulty of ABM defense is that it requires extensive, expensive, vulnerable radar installations. If the radar is put out of action, the defender is helpless. Shielding radar against both the shock wave and the EMP that the explosion of a large warhead would produce is a formidable problem. It was the Achilles' heel of the defence planned in the 1960s.'[3] Suppose one does seek to protect early-warning radars against missile attack. One may not merely be underpinning any posture for active BMD. One may also be preserving the lynchpins in a national alert service directly serving the population as a whole. In 1991, the 38 modified Scuds fired at Israel killed two people, badly injured eleven and slightly hurt 220. So why so few serious casualties? One explanation is that the Israeli populace regularly received several minutes early warning via American orbiting satellites. Comparison has been made between the V-1 and the V-2 in the British experience of 1944-5: the point being that the V-1 did telegraph its arrival a little to the populace below whereas the V-2 did so not at all. The inference has been that just a brief forewarning may cut casualty rates by half,[4] even among civilians. It thereby becomes an invaluable form of passive wide-area defence.

Aerospace Defence

In infrastructural terms, BMD is an extension of the anti-aircraft role just as defence against the cruise missile is. Most essentially, all three modes are concerned with threats from the skies above. To an extent, too, the defensive technologies are becoming more dexterous. Nor should one disregard genre convergence by the offence. The cruise-ballistic hybrid has already been mentioned. So has the ram-jet. The stand-off launch of missiles is now a major role for manned aircraft, not least over the sea. At present, it is largely air-breathers being released by air-breathers (i.e. cruise from monoplanes). But the concept of stand-off rockets has been around ever since the Blue Steel and Skybolt projects of the 1960 era; and may come strongly into vogue once hypersonic penetration to target is called for tactically. A background reality is the continuum from the Earth's surface through the atmosphere into Space. The Americans, in particular, have long perceived 'aerospace' as an indivisible medium of war.[5]

Yet this does not mean that, at the all-important level of command-and-control, synergy is assured. Nor may the quest for it relate easily to the axiom that a network 'architecture' must be optimally adapted to the BMD task *per se* if high rates of interception are to be achieved. Radars intended to cope with low-flying aircraft or cruise missiles have different envelopes of engagement to those required to track RVs approaching via the fringes of Space. And what about the computation rates and revisit intervals required against an RV descending at anything between Mach 4 and Mach 25? A manned intruder would be unlikely much to exceed Mach 2: twice the speed of sound at sea level, that being c.0.36 km/sec. Moreover, an RV or even a submunition (see below) is a much tougher object to destroy than is an aerodynamic platform, manned or otherwise. Fragmentation warheads, in particular, may be far less satisfactory against the former. All in all, must one not talk about heavy extra investment and extensive reorganisation, perhaps at continental level?

Recent evidence from North America shows how readily disjunctions may develop. In 1985, an Air Defense Initiative (ADI) was launched by the USAF to complement SDI; and was accorded the same continental spread as NORAD, the North American Air/Aerospace Defense Command that the USA and Canada had set up nearly 30 years earlier. Two years later, in 1987, the battle management of ADI and SDI was formally integrated. However, a Canadian Defence White Paper that June (significantly, the first since 1971) committed Canada to full involvement with ADI (pp.10 and 56-7) but reserved her position on SDI (pp.19 and 27).[6]

Then again, in September 1991, the US General Accounting Office published a critique of the mis-match between SDI and ADI revealed by President Bush's launching of the GPALS strategy that January. It found the ADI schedule was lagging years behind the stipulated GPALS requirement (p.2). It further found that the 'SDI architecture is proceeding independently of ADI' (p.5) and avowedly without regard to cruise missiles.[7] Achieving any smoother a concurrence within an expanded NATO Europe could prove quite an exercise in political consensus building and bureaucratic accommodation.

Perceptions of Necessity

Part of the problem with BMD arises out of the West's current attachment to the notion that none of its soldiers ought ever to be killed in action. In part, this utopian attitude is a reaction to Vietnam. So is it to the holocaust. But it is fed, too, by the agnostic hedonism of modern Western societies, including those elsewhere which accept Western values. Few young Japanese comprehend the actions of the *kamikaze* pilots of 1944-5 as well as would most Western veterans of that generation. Likewise, the youthful and gung-ho interventionists of the Heritage Foundation in Washington talk almost as if TMD can ensure that never again will any GIs come back in body bags. Even the strong surge towards Unmanned Aerial Vehicles (UAVs) in the USAF is being extolled as making aerial combat a low-risk profession. In future war 'fewer airmen are expected to be exposed to direct combat. Most, including many combat pilots, will never leave the US. Instead, they will fly a large percentage of the penetrating reconnaissance and combat aircraft by remote control'.[8]

This syndrome needs to be faced down, not least as regards the apprehension felt about ballistic missiles even when laden only with high-explosive. Take a Scud-C with a warhead of 700 kg. It would take well over four million of them to match the weight of the bombs dropped by the United States Army Air Force (USAAF) and the Royal Air Force (RAF) on Nazi Germany. It would take over 1400 to match the tonnage the artillery in one American division might have expended in one day in 1950 against a heavy enemy onslaught.[9] These comparisons surely confirm that we must approach in measured fashion this missile problem. What that has to involve is careful judgement as to what priority should be given to BMD however defined; and then how BMD in the round should be apportioned as between active defence, passive defence and counterattack pre-emption.

The Electronic Revolution

A big bugbear for BMD, throughout this last half-century, has been adverse ratios of cost-exchange. By this is here meant that the cost of providing adequate defence against a given number of offensive missiles significantly exceeds what it would cost the adversary to deploy enough extra missiles to swamp the said defences. This argument still runs. However, it needs regularly to be assessed against the background

of an electronic revolution likely to continue a couple of decades and more as technological change follows once again a familiar sequence. The improvement in overall performance, having remained gradual for quite a while, has suddenly become more rapid, this much to the advantage of the West (in particular, the United States) as the side that already has the edge over all likely adversaries. After a further span, however, this improvement will slow right down as the said technologies mature.

In certain aspects of the electronic revolution, a levelling out is already in train or in sight. Basic radar design has become quite stable. The compaction of the silicon chip is near to its limit. Nor may Stealth technology have much growth potential left, after these next few years. On the other hand, laser beams can develop much further yet. Gallium arsenide is coming into its own as a semi-conductor. In it, electrons travel several times as fast as they do in silicon oxide. Furthermore, it is conducive to the progressive replacement, via fibre optics, of electron flows with photonic ones. Photons move still faster and are impervious to ElectroMagnetic Pulse (EMP). Already fibre optics is extensively used in aerospace.

Clearly, these several trends contribute to the big advances in computer hardware still under way. These strengthen BMD. They do so not least through the instant integration of the data from sensors operating, actively or passively, on a variety of electromagnetic wavelengths. A graphic illustration of what may be possible is regularly afforded us by modern astronomy. Galactic maps recorded on several different parts of the spectrum from Long Wave Infra Red (LWIR) to X-rays look very different, one from another, for a given sector of sky. Interpreted together, they give much more of an in-depth picture than any could alone. Likewise the multi-spectral analysis of the objects in a missile threat cloud - the Re-Entry Vehicles (RVs), the decoys, and the rocket debris - improve the prospects of tracking the warhead-bearing RVs while the cloud is outside the atmosphere.

Conversely, it has to be said that the mechanical aspects of interception control are not improving anything like as dynamically. Interceptor missiles typically have to turn several times as tightly as an RV changing course, partly because it can take an interceptor several score milliseconds to respond to a divert signal, during which time the two objects could have either closed or separated by a few hundred metres. Undercorrection leads to immediate loss of target and overcorrection to snaking. The novel divert technology being fitted in the ERINT, the missile in the PAC-3 system, specifically addresses this problem in the TMD context. Over intercontinental ranges, however, it is even harder to resolve because then an RV travels faster (until after re-entry) than an interceptor missile does.

Nor is the electronic revolution entirely one-sided. Terminal correction with inertial guidance may in due course be incorporated into RVs of well below intercontinental calibre. Offensive rocketry will also benefit, over a steadily widening range spectrum, from the sensor-fusing already being incorporated into aerial and mortar bombs (see Chapter 2). Expectations that China, let us say, could have this technology in theatre weapons within twenty years have been strengthened by her progress with a variety of theatre surface-to-surface missiles. Pertinent, too, is an intelligence assessment that, within five years, both she and North Korea will have dispensers in service in battlefield rockets that can release 100 unguided submunitions weighing several kilograms apiece.[10] BMD may not benefit indefinitely from the electronic revolution unless it, too, can adopt novel modes.

Cost-exchange

As of now, cost-exchange ratios (as defined above) are decidedly adverse, even assuming a high probability of kill for any interceptor launched. Much as in the calculations about comprehensive ABM defence originally made in the United States in the 1960s, the cost to an industrial economy of constructing a defensive screen is liable to exceed several times over what it would cost a similar economy to make enough extra rockets to achieve saturation. Feed into that comparison the respective operational infrastructures (launchers, ground-based radars, satellites ...) and the ratio typically exceeds ten. Take THAAD as an example. The first battery has been due to enter US Army service in 2001; and an eventual American inventory of 80 launchers with 800 to 1270 missiles has provisionally been indicated. BMDO has estimated the development and acquisition costs of such a THAAD programme at c.8.3 billion dollars plus 3.7 billion for the collateral Ground-Based Radar (TMD-GBR). That works out at maybe 12 million dollars for each interceptor, some five or ten times what might be expended on an MRBM with a non-nuclear warhead. Moreover, the THAAD operating costs over ten years are put at 2.5 and 2.4 billion dollars respectively.[11] Lately, THAAD has been ill regarded in Congress and elsewhere as an unduly expensive system. But that comparative subtlety is not here at issue. The main point is a generic one.

Perforce, too, the spread of multiple warheading puts much extra pressure on the Defence. It does so the more when dispersion takes place earlier rather than later; and even more if the warheads can home 'intelligently'. This self-homing obliges the defence to seek higher interception rates. Yet here the law of diminishing returns comes readily into play Heavy extra investment in BMD may yield but modest returns.

Two developments under the auspices of Moscow illustrate the present trend. The SS-20, introduced in 1977, was deemed able to deliver three MIRVs across 5000 km with individual CEPs of 400 metres.[12] Now, the SS-X-26, the successor to Scud, is being flight-tested; and one variant is authoritatively reported to deliver submunitions across 400 km.[13] The fact that the SS-20s have been dismantled under the INF agreement of 1987 does not negate this comparison. On the contrary, it well shows the downward spread of multiple warheading (submunitions and RVs); and, in consequence, worsening cost exchange for the defence. Active BMD will be driven more towards radical technical remedies to try and reduce this imbalance.

Cost-exchange ought to figure more prominently in the contemporary BMD debate. Not that one should return to the early McNamara era (1961-4) with its overweaning preoccupation with the econometrics of armed conflict. Too seldom is one able to compare like with like at whatever level. The material and political burden a given defence outlay imposes on a polity that is affluent, consumerist and democratic cannot be measured against that felt by one that is impoverished, technically backward and authoritarian. In some ways, the latter is more susceptible to strain but in others the former. Besides, one may be obliged to defend certain assets or situations even when the cost-exchange as here defined is decidedly adverse. Submarine warfare exemplifies that truism. In 1977 Admiral Sergei Gorshkov (who retired, in 1985, after 27 years as C-in-C of the Soviet Navy) reckoned that, in the First World War, the manpower the Allies dedicated to retaining control of the North Atlantic was 20 times that deployed by Germany in her U-Boat offensive. For tonnage lost, the ratio was close to 100. Nor were things very different in the Second World War.[14] Allowing that his comparisons may be accurate enough, they still do not prove those anti-submarine campaigns did not have to be fought and won. Anti-terrorist campaigns are similarly instructive in this regard.

Offensive Stratagems

In specific situations, no judgements about the operational prospects should be made without bearing in mind the square law F.W. Lanchester enunciated so famously in 1916 : 'the fighting strength of a force may be broadly defined as proportional to the square of its numerical strength, multiplied by the fighting value of its individual units'.[15] While we can forget neat calculations of unit 'fighting value' in the electronic age, we can recognise the enduring validity of his contention that the advantage attaching to superior mass is a square function, not a mere linear one. His prime concern was with rival air fleets battling it out. Translated into the BMD world, that could mean the offensive missile commander seeking to swamp a BMD network sectorally, either to disable it or else to fire straight over it.

It is possible to envisage two geographical contexts in which we in the West could be vulnerable to an adaptive enemy concentrating his effort to achieve sectoral or local saturation. The one is where we are covering only thinly a wide total front. Southern and Eastern Europe present various contingent scenarios. So, too, does the Middle East. The other is as expeditionary forces are establishing a beach- or air-head. In principle, the answer in the latter case might lie in matching a focussing of offensive targetting with a concentration of theatre-mobile BMD, probably seaborne or airborne. An alternative in the wide-front situation is to go just for the point defence of key facilities. That form of BMD has inherent advantages, in any case, in terms of simplified target acquisition.

Is the Lanchester square law still instructive applied the other way about? How likely is it that a salvo of just a few offensive rockets or RVs can be comprehensively eliminated? This question, which has been addressed by PFS in relation to some specific scenarios, is very important *vis à vis* the possible role of ballistic missiles as instruments of graduated escalation or as signals of intent.

Ballistic Performance

Consideration of whether a ballistic warload may survive to target tends to start from the assumption that it will follow a 'minimum energy' flight path, one designed to maximise range and warload for a given thrust. Such a trajectory will always be flatter throughout its mid-course than a truly parabolic ballistic one. Nevertheless, its apogee (i.e. maximum height) will give a good indication of how much of the flight time will be exoatmospheric. A horizontal range of 500km derives from an apogee of 125km; and twice that from one of 225. Then take the two rockets cancelled by the INF agreement of 1987. The Pershing 2 rose to 330km to travel 1800km. The Soviet SS-20 rose to 900 km to travel 5000. One may note that all these apogee values exceed the operational ceilings of any surface-based BMD systems at all close to full development.

Sometimes trajectories are not 'minimum energy' because they have been either lofted or depressed to improve penetration prospects. In the 1991 study cited with some disapproval in Chapter 3, estimates were made of how far 'depressed' trajectories might limit ranges, hopefully in exchange for some immunity mid-course from the infra-red homing sensors of interceptor missiles conceivably being fired from above. As already intimated, the judgements about immunity from homing devices seem to me to have been too arbitrary. But that opinion, valid or otherwise, does not bear on the calculations of RV atmospheric drag which can be more objectively conducted. The two authors analysed two ballistic weapons, the *al Abbas* (the Iraqi extended-range version of the Scud) and the Chinese DF-3, alias the CSS-2. They

concluded that lowering the apogee of *al Abbas* from 190 to 100km cut its range only from 830 to 720 km; and that lowering that of the DF-3 from 550 km to 100 cut it by less than a half, from 2780 to 1550 km[16]. In these cases, too, interception from the Earth's surface might be harder against a shallower descent.

Writing in mid-1992, they took a different tack. They addressed the strategic threat a salvo of Submarine-Launched Ballistic Missiles (SLBMs) could pose. Now their concern was to show how much early warning could be reduced by trajectory depression. Their contention was that well-flattened trajectories 'with apogees of roughly 90 km' might cut the time of flight for a range of 1850km, say, from 12.5 minutes to 7.1. Lower the apogee to 60 km or less, on the other hand, and frictional resistance would preclude further reduction. The two of them reckoned that the angle of re-entry (as measured from the local horizon) would decrease from 40° on a 'minimum energy' path to 5 or 10 on a depressed one.[17] The term 're-entry' is here being loosely applied, as it very often is in such discussion.

Nobody believes, of course, that SLBMs are likely to proliferate to the Iraq's or North Korea's of this world. After many years of toil and tribulation, China brought her first strategic missile submarine into service ten years ago. Its CSS-N-3 missiles (of which it bears 12) are believed each to dispatch a two-megaton warhead across something close to 3000 km.[18] No sister vessel has yet joined it. However, the argument about foreshortened warning times is every bit as applicable to land-based systems of comparable range.

Interception boost phase (that is to say, while the motor rocket is still attached and active) may, in principle, be an attractive option, not least because no dispersion of the warload can yet have taken place. But all may depend on burn-out not being too low down. Air resistance then retards interceptor missiles too severely and/or overheats their homing sensors operating on passive infra-red. Likewise, laser beams may be too prone to absorption , thermal blooming and diffraction within the atmosphere as well as to the divergence inherent in their geometry, shall we say in their quantum mechanics.

However, the probability is that, in theatre war, most ascending rockets will burn out deep within the atmosphere, even on trajectories that are minimum energy. Take the 'minimum energy' flight of a two-stage ballistic missile designed to travel 600 km in six minutes, just lifting above the atmosphere for its midcourse apogee. Half a minute after launch, it will be travelling at 400 metres per second (m/s), having reached an altitude of just over five kilometres. Twenty seconds later, it will have reached 880 m/s and 15 kilometres. Another 20 seconds will take it close to 1700 m/s and to 32 km. It will finally burn out after 80 seconds, having attained a speed of 2200 m/s and a height of 45 km, still deep inside the atmosphere. What is more, up to half of this boost phase may have been spent beneath cloud cover.

Yet not even in an intercontinental exchange is burn-out exoatmospherically the only possibility. True, all the older models of ICBM exceed this threshold by a wide margin. Thus Russia's SS-18, which entered service in 1982, burns out, after 300 seconds, at a height of 400 km. But in 1986, the USAF began to deploy the MX Peacekeeper ; and this burns out, after 180 seconds, at 200 km. So, too, does the SS-25, the mobile and single-warhead ICBM design first deployed by Moscow in 1985.[19]

Nor do these figures connote a lower limit for ICBM acceleration boost-phase. Within a month of President Reagan's keynote speech of 23 March 1983, two panels had been established to study the technical and the political dimensions respectively. The former was headed by James Fletcher, the head of NASA. One thing this Fletcher

panel foresaw, when it reported in 1984, was ICBMs designed to burn out after only 40 seconds, 90 km up. Concurrently, Pentagon studies confirmed that, with just a 25 per cent sacrifice of warload, an MX could reach burn out in less than a minute at only 80 to 90 km.[20] No doubt, too, theatre-range missiles can be made to burn out much lower in the atmosphere than minimum energy considerations would lead one to expect. That could pose major problems for Boost Phase Interception (BPI) in terms of engagement time and assured acquisition.

Threat Cloud

However, a caveat is regularly entered, particularly as regards the larger and more sophisticated missiles. After burn-out a missile capsule or 'bus' is poised for the programmed release of MIRVs or decoys - metal balloons, reflectors, chaff and so on. The same applies to the dispersion of submunitions. So how well might this 'debussing' be conducted within the atmosphere, this low enough down to gain immunity from BPI? Take the statement that, at 80 km, air density is one part in 100,000 of what it is at Mean Sea Level (MSL). That hardly seems liable to impede the inflation and flight of a decoy balloon, say. Lower down, the atmosphere would be more obstructive. Debussing might have to be simpler and rougher. At 25 km, atmospheric density is 250 times greater than it is at 80.

Ignoring for the moment deliberate transfer from more advanced states, how readily can LDCs master the skills of threat cloud creation? This subject is discussed much less than is the spread of the means of missile propulsion or, indeed, of nuclear or CBW warloads. None the less, it may be very critical. A provisional answer should probably be that one or two of the standard remedies might readily be resorted to. Chaff looks accessible enough. After all, it remains one of the most favoured countermeasures throughout the realm of electronic warfare. It involves the dissemination of tiny metallic strips, each cut to such a length as to resonate within a selected frequency band. A cascade of them produces on radar screens either misleading blips or else a generalised 'white out'. It is said that a mere kilogram may be so dispersed as to present an image equivalent to 30 square metres head on and solid in all directions and across all frequencies from, say, one to ten billion cycles a second which is quite a wide spectrum in the UHF and SHF.[21] In Space, chaff does not appreciably retard, always a drawback during motion within the atmosphere.

What the Pyongyangs of this world could never independently gain, however, is experience of a threat cloud, real or simulated, seen literally from the standpoint of a defender accoutred with a diversity of orbital and ground-based sensors. Accordingly, they would find it hard to design and deploy, unaided, a decoy mix that could deceive such a panoply of surveillance. They would likewise be unsure about the effects of EMP or even of active jamming. This is one reason why LDC regimes may become progressively more interested in using submunitions in their warhead capsules. What can be said without fear of contradiction is that once a field of submunitions was well dispersed, it could not possibly be engaged comprehensively. The cost-exchange would be quite outrageous. What might eventually be feasible, given the right technology, is the close-in defence of small, soft and high value targets (e.g. master radars) against particular submunitions.

One should not overlook how fast the use of submunitions is extending throughout the ordnance realm; and this because they also have attractions in terms of lethality. For one thing, the spread of blast and fragments obeys something close to a cube root law. Take a 25 kg unitary charge of high explosive. Unconcealed troops

will be in considerable danger several tens of metres away from its ground-burst. If instead the charge is of 1000 kg, the lethal distances are multiplied only several times more, nothing approaching the 40 times a linear scaling would lead one to expect. But against compact hard-point targets (for example, bunkers and permanent road bridges), explosive submunitions may be ineffectual. The prospects when the targets are compact but soft (for example, radar antennae) need to be the subject of close technical evaluation (see Chapter 9).

Submunitions may be more liable to re-entry stress than are the larger and more structured RVs. So are they to atmospheric drag in general. Excessive or too random dispersion, especially after ascent phase release, can also be a weakness. All these aspects require close technical monitoring. But let us just note that studies early on suggested submunitions lent themselves well to airfield attack by warplane or theatre missile. Modelling at RAND in the mid-1980s indicated that, delivering cratering bomblets, six to eight SS-23s (Soviet ballistic missiles with ranges of 500 km) would stand a 90 per cent chance of temporarily closing an 8000-ft runway and parallel taxiway.[22] Take also a study done on the Pershing 2 a bit earlier. A variant of this very accurate rocket was envisaged which could deliver up to 76 bomblets. Each would weigh 18 lb, a fifth of this being high explosive. The conclusion was that the dispatch, as war commenced, of a hundred Pershings might cut the Warsaw Pact's initial air sortie rate by 35 per cent.[23] Nor was that calculation surprising. For such a salvo would, in fact, have meant one Pershing for every third airfield available to the Pact in Central Europe.[24]

Interception Techniques

A key distinction to draw in BMD ordnance is that between interceptor missiles fitted out with proximity-activated fragmentation warheads and those which bear 'hittiles', unitary warheads that impact directly on incoming RVs. Fragmentation warheads have been seen as suitable for engagement within the atmosphere in that differential drag causes any decoys and debris to lag behind RVs that may, in any case, be swerving or tumbling too much to take precise aim at. Nevertheless, hittiles, too, may be designed to intercept endoatmospherically as in the American ERINT/PAC-3 programme (see below). In the main, however, the 'hit-to-kill' consummation would be exoatmospheric. At any rate, that has been the received wisdom to date.

However, Pentagon preference has been trending more towards the hittile even though it needs to be accurate to within a metre across maybe scores of kilometres and at closing speeds of up to 10 km/sec. After all, explosive fragmentation has the cardinal weakness that the fragments may be insufficiently energetic to destroy RVs. Suppose a fragment impacts with a vectored velocity a third as great again as a unitary warhead could achieve but that its mass is only a sixth of the latter's. Then the destructive energy it imparts to the RV will be barely a third as great. The negligibly low rate of interception Patriot PAC-2 achieved versus the Scud warheads in 1991 does suggest that, unless and until proximity-fused fragmentation can be made very directional, it will be little use against objects that nuggety. Nor may it do enough even then against a descending RV bearing not a unitary charge but submunitions. Granted, proximity-fusing, then only in its infancy, did more than any other technique to defeat the *kamikaze* campaign against the American and British fleets in 1944-5. But the *kamikaze* planes were 'thin-skinned' air-breathing platforms, manned equivalents of the cruise missile.

Lethal impact is the very nub of the operational effectiveness of BMD: the acid test of how well mechanical evolution may keep abreast of electronic in this sphere. Herein is the ultimate reason why nobody should enter into systems procurement of BMD from anywhere until they are satisfied that validation through flight testing as well as simulation has been as thorough as possible. It has been disconcerting to learn that the main criterion for THAAD's progressing from the Demonstration/Validation (DEMVAL) phase to that of Engineering, Manufacturing and Development (EMD) is to be a single successful interception, regardless - one gathers - of all that has gone before. The full THAAD development schedule provides for just 14 interception flight tests. The first three have failed though Lockheed Martin do stress that almost all the particular criteria have been validated on at least one of these occasions.

Right from the start of the SDI debate, all sides have allowed that protection against ballistic missiles could never be 100 per cent successful in the face of a massive attack nor proffer a 100 per cent guarantee against a weak one. A standard explanation has been that command and control could never be perfect. This tenet has embraced everything from errors in the software, either syntactical or logical, to human frailty or sheer inexperience and ill-luck in such time of novel crisis. But the nub of this argument has always been that the architecture could never match perfectly requirements 'on the day'. The permutations are so numerous and often so critical. In 1985, the Eastport Study Group (drawn from industry, government and academia) reported to SDIO on 'battle management and command, control and communication (BM/C^3), the paramount strategic defense problem'. A salient conclusion was that the feasibility of battle management is 'much more sensitive to the system architecture' than to the choice of software engineering.[25] At first sight, TMD looks more straightforward in these terms. But there will always be the question of whether the architecture and the rules of engagement match a very particular geography or a very singular contingent threat throughout what may be a fast-evolving politico-military crisis.

Another SDI axiom still upheld is that any BMD should be multilayered. This is partly to avoid utter dependence on some weapon that then turns out to be flawed. But it has more to do with diminishing marginal returns. Suppose you look for an attrition rate of 80 per cent against a predicted threat with a single layer in place. Suppose, next, you decide to raise this expectation to 96 per cent. Adding a second layer, more or less distinctly, is likely to prove an easier means to this end than trying to force the performance of that first layer up from 80 to 96. The layering of TMD remains very much alive across the Pentagon with much talk of upper and lower tiers, not to mention pre-emption or even arms control. However, the philosophy for any National Missile Defense (NMD) of the USA itself is not as yet clearly enunciated in this regard. But the prior question for the Americans is whether to settle just for a thin NMD screen, if one at all, or whether to go for something more ambitious.

With all engagement outside the atmosphere, the crux has to be discrimination between the RVs and the decoys or debris in a threat cloud. It is for this that the Americans plan to bring into play their orbital Space and Missile Tracking System (SMTS). Most of its 20 to 50 satellites will be dedicated to an evolved variant of the passive infra-red sensing formerly known as Brilliant Eyes. The concept is that, as the threat clouds created by a missile salvo progress through mid-course, cooling will occur. Other things being equal, this will be slower with the weighty RVs than with the decoys or debris. Hopefully, the contrast will be discernible.

Unfortunately, other things never are equal. Factors other than bulkiness bear on cooling curves, sometimes within a deception plan. Colour is an added complication. Nor is it easy, with sensors peering down from above, to distinguish objects in near Space from the terrestial background. A big problem, too, is the fact that across the temperature range in question, the profile of energy emission is so much lower and flatter than at temperatures like those of the solar surface (see Chapter 3). This and the other factors just noted make an object's peak 'black body' wavelength, and hence its temperature, hard to determine. An indication of how much there is still to learn about the ambient conditions (terrestial, solar and cosmic) is that only this year have flights begun of the Midcourse Space Experiment (MSX). This is a multisensor satellite specifically designed to collect such information.

More intrinsic to SMTS design is a need to cool deeply the infra-red sensors to reduce internal noise and thereby enhance sensitivity. Here the distinction drawn is that between Short-Wave and Long-Wave Infra-Red (SWIR and LWIR), the boundary between them conventionally being set at 10,000 nanometres. Ten years ago, one was being told that cooling to 50K was needful for SWIR and to as low as 5K for LWIR. Since then, the computer resolution of blurred signals has made rapid strides. So now the respective limits are 10 or 20 degrees higher; and should be achievable, certainly in the SWIR. But difficulties remain, including sensitivity to EMP effects. Producing a SMTS network that can meet its goals while preserving the compaction, low weight and low cost customarily associated with passive sensing is not proving easy. The flight tests scheduled to start in 1998 may be quite critical.

Suggestions from the more zealous proponents of surface-based radar that the Near Space inputs to BMD discrimination are but optional extras seem wide of the mark, certainly if advanced penetration aids are to be reckoned with. The complementality of different modes of observation from locales that are different, both geodetically and on the electromagnetic spectrum, can be all-important. Some twelve years ago a particular point made in this connection by the then Chief Scientist of SDIO was as follows: ' Decoys can perhaps be readily distinguished from warheads if we can observe the birth of decoys at the very instant they are deployed'.[26]

Operational contributions from Near Space that are prior to the discrimination task are early warning and cueing. By the latter is meant the orienting of surface-based radar towards the incoming RV salvo, thereby achieving a significant increase in the range of target acquisition and hence in the interception prospects. With more localised or lower tier defence systems (such as the PAC-3), the proportional gain in effective range may be two-fold or more. This especially applies in the less benign environments - e.g. those affected by EMP or other electronic countermeasures or bad weather.

SMTS satellites in low orbit may assist early warning and cueing. But the primary contributions would come from infra-red satellites in geostationary orbit which means, as of the present time, from the Defence Support Platforms (DSP) network. With DSP as with SMTS, ensured access to this American data becomes critical, there being no alternatives foreseeable. Europe is acquiring various relevant skills. Witness the lead role the European Space Agency (ESA) has taken in the Infra-Red Space Observatory (ISO) now coming to fruition. But Europe in whatever guise is still a very long way off its own SMTS or DSP network (see Chapter 8). So American offers of a regular sharing of data from DSP (and, no doubt in due course, from SMTS) ought to be consolidated, perhaps contractually, as and when any BMD deal is made.

Overall, one is left the more aware of how critically the utility of surface-based BMD would depend on the specifics of a situation. Even so, one could anticipate its usually being of little use towards the Forward Edge of the Battle Area (FEBA), not in a high density/high intensity war such as the Golan in 1973 or Korea in 1950-3. Most rocket trajectories would be too low in profile. The threat presented would be compounded by defence suppression by means of jamming and attrition. Nor might there be much point in attempting BMD if one could not shield one's forces against all other forms of bombardment at close quarters. Still, some people very committed to BMD (e.g. Dr Edward Teller) would think that too negative.

What must be admitted is that all concerned are still groping towards doctrine appropriate to wars characterised by high intensity, continual tactical manoeuvre and huge information flows. The US Army is placing more emphasis on deep strike, including against missile launch sites.[27] Witness how its TMD/Deep Strike simulation centre in Louisiana is tasked with training and doctrine development in the co-ordination of deep strike with active and passive TMD. At the same time, moves are afoot to link the USAF Combat Integration Capability nodes with the Army's Deep Operations Co-ordination Centers and TMD Tactical Operations Centers. This evolution is firmly towards a Joint Tactical Ground System (JTAGS). It represents a follow-through of integrative notions that first appeared as the 'air land battle' in 1976 and were further articulated in the Air Land Battle Doctrine in the 1982 version of *Field Manual 100-5.* Evidently, the accent is on swiftly achieving a decision through escalation in depth. Pinpoint and hit back at missile launch sites sufficiently fast and furiously to prevent further launches. Evidently, too, the tendency in the forward areas is for TMD to interweave with wider trends towards more dynamic action. Last November, the Space and Strategic Defense Command, US Army launched a collateral review of needs and concepts in the cruise missile field.

As one moves back through friendly territory, BMD is more readily perceived as having a distinct task, though still within the broader ambience of aerospace defence. Usually, too, the balance shifts more towards its successful prosecution. Even so, all still depends on architecture seen in relation to geography and to the scale and character of any attack. It may often be unfeasible to attempt much more than the point defence of key assets. One must remember, too, that over the longer ranges (say 500 km and above) the sheer speed of the incoming RVs would make interception harder.

National Missile Defense

Moving up the ladder of geographical escalation, it is necessary to examine further what the Americans know as National Missile Defense (NMD) - protecting the continental United States plus, less assuredly, Hawaii and Alaska against predicted threats. Since BMDO currently rates as 'unlikely' the GPALS threat scenario of some tens of boosters projecting up to two hundred MIRVs, its current focus is on achieving a potential against system threats in the ST1 to ST4 bracket : the four or 20 incoming warheads with maybe, in the latter case, a complex threat scenario. In pursuing this quest, it accepts compliance with the ABM treaty. Presently, this means that the Americans would be limited, under the agreed interpretation of the treaty text coupled with the 1974 protocol, to deploying no more than 100 interceptors along with 100 launchers at Grand Forks, North Dakota.

It also means that they, like the Russians, are considerably constrained as regards the ABM radar cover they can provide. The particulars, as they apply to the USA, are

two large phased-array ABM radars; and up to 18 smaller ABM radars (Article III of the 1972 Treaty). Moreover, neither country can 'deploy in the future radars for early warning of strategic ballistic missile attack except at locations along the periphery of its national territory and oriented outward' (Article VI). Nor should other radars be modified to or tested in an ABM mode.

About this last constraint, BMDO comments as follows: 'Existing early warning radars can provide, with some software modifications, track data ... . However, ... they are susceptible to simple countermeasures (e.g. UHF jammers) which can severely degrade their ability. ... Real-time algorithms and processing needed to discriminate strategic threat objects (decoys, debris, etc.) have yet to be developed. In addition, some of these radars are on foreign soil, a fact that might limit United States options to upgrade or use them. Because of early warning radar shortcomings, it is necessary to provide a more robust capability. The addition of a prototypical National Missile Defense - Ground Based Radar (NMD - GBR) derived from on-going TMD technology can provide this capability against limited threats. ... if deployed in a multisite configuration, which would not be ABM Treaty compliant, but might become necessary under some future circumstances. The NMD - GBR and Upgraded (UEWR) combination could provide substantial protection against the ST3 threat ... Reconfiguration of the TMD - GBR hardware for NMD- Radar Technology Demonstrator (NMD - RTD) use will be completed in Fiscal Year 1998 ready for the start of testing to validate NMD unique algorithms for target acquisition, tracking and discrimination performance. The Fiscal Year 1999 Exoatmospheric Kill Vehicle flight test will be used as a verification and measurement for the NMD - RTD'.[28] ST3 is defined as a four-RV high-complexity strike occasioned by accidental or unauthorised release or by deliberate action, quite possibly by a belligerent regime with a small though not unsophisticated military-industrial technology base (see above).

Last June, General Malcolm O'Neill gave the Senate Appropriations Committee defense panel his assessment, as head of BMDO, of the outlook near term. It was as follows. A bigger booster would be needed for the NMD interceptor. So would SMTS be required for 'early detection and accurate tracking'. A treaty compliant system might then 'provide an effective defense of the United States against a thin attack or accidental launch of a strategic ballistic missile; 100 interceptors at a single site cannot provide a defense of the territory of the country against a large strategic missile attack'. He entered the further caveat that 'a different shade of protection' would be afforded Alaska and Hawaii. It would be 'fragile and brittle'. Meanwhile, the USAF was suggesting that interceptor enhancement could be achieved by fitting a Minuteman booster to a LEAP interceptor.

This January, a spokesman explained that General O'Neill believed that, with treaty-compliant upgrades, all the fifty states could be protected, with 90 per cent effectiveness, against an attack by up to five RVs.[29] Maybe this claim had been toned down to (a) protect security classification and (b) reassure the Russians about strategic stability. Even so, those figures imply low rates of interception by what could be, after all, up to 100 ExoAtmospheric Kill Vehicles.

All the difficulties associated with wide area defence will be accentuated when some RVs bear warheads of mass destruction. It is partly that exceptionally high kill rates will have to be achieved, from the outset and preferably at heights above 30 km. It is also that, with nuclear salvage fusing, EMP (see Chapter 3) could compromise the acquisition of incoming targets. Interest is still being shown in the possible inhibition of salvage fusing, whether of nuclear warheads or CBW ones, by hitting an RV sharply at a

selected 'sweet spot'. However, this remedy might rest on false premises about RV construction and would require, in any case, accuracy to a few tens of centimetres. It is just possible, too, that LDCs or others might be able to prime RVs to explode on registering the weak atmospheric shock wave that could precede a disabling projectile. Additionally or alternatively, any CBW canisters that were ruptured might release submunitions that then tumbled Earthwards. This outcome much exercises Porton Down. For one cannot exclude the possibility that germs, toxins or chemicals encased thus could survive even high-speed re-entry well enough to remain lethal. Take germ populations in particular. Sheer weight of numbers is on their side.

Interception Boost Phase

For a given RV or submunition, the thermal stress imposed during a re-entry phase of but a few seconds will be very much a function of speed at re-entry; and that in its turn will be near to, as a rule virtually identical with, the speed on burn-out. It will therefore correlate closely with maximum range. So compare (a) a theatre missile that burns out at 1.5 km/sec (or just over Mach 4.0) with its warload then rising just above the atmosphere to traverse 500 km and (b) an intercontinental missile that burns out at 7.5 km/sec (or Mach 21.0). An RV or submunition from the former will re-enter with only a twenty-fifth of the kinetic energy possessed by a similar object from the latter, given that this energy of motion is proportional to the velocity squared.

Therefore the survival through to impact of any lethal contents will always be that much more assured in an exchange at theatre level. This contrast might even apply if these contents are a high explosive charge. After all, the thin gaseous plasma that surrounds an object on intercontinental re-entry may heat to several thousand degrees Kelvin, much the same temperature range as a chemical explosive does on ignition. This by no means proves that enough heat would be transferred inwards during re-entry to cause instability. But it does encourage the suspicion that even an HE submunition might be hard to deliver unblemished intercontinentally on the basis of ascent stage dispersion. In a theatre war, doubts on this score do not arise. BMDO reckons that, on 'minimum energy' tracks of less than 1000 km, re-entry problems in general are minimal.

The implications for TMD explain the lively interest burgeoning in the United States (and, no less so, Israel) in aerial BPI, this in spite of the severe challenge short burn times present. Lock onto the ascending rocket, which will be large and hot and thin-shelled. Preclude thereby any debussing and dispersion. 'Boost-Phase' is interpreted for this purpose as embracing not just the duration of the booster rocket but also the more gradual but sustained acceleration afforded by any second-stage. It may also include the start of debussing. A typical estimate has been that interception below an altitude of 70 km would preclude any ascent release of submunitions. What assumptions were made about required accuracy is not clear.[30]

As in SDI days, two modes of BPI are being explored. Directed Energy Weapons (DEWs) and Kinetic Energy Weapons (KEWs). Now the former means simply laser beams; and the latter just mini-missiles. As currently envisaged, this ordnance would most likely be fired from airborne platforms, probably unmanned ones. The laser genre would be airborne initially but might ultimately be mounted in orbit. In its 1994 Report to Congress, BMDO extolled the Space-based Laser (SBL) with amazing presumption. This 'system can acquire, track and point the high energy beam over thousands of kilometers of Space to a meter or less accuracy ... and destroy thrusting missiles very early in their boost.' The SBL is 'the only major US technology under

development that can provide global, 24-hour, early boost phase intercept of both theater and strategic ballistic missiles'.[31] This cavalier sally (not, it seems, repeated in 1995) will have been a legacy of Ambassador Henry Cooper as the last Director of SDIO. The actual allocation of money by BMDO to SBL research is still only $150 million for the next five years.

It is salutary, in relation to our current concerns, to have been so authoritatively advised that, through 1980, progress with DEW 'more than any other development'[32] revived interest in BMD deployment (see Chapter 1). For this excitation proved a false dawn. Take the nuclear-pumped X-ray laser, a device intended for lofting into orbit in time of crisis. President Reagan was among those unhappy that an SDI 'peace shield' intended to make nuclear weapons 'impotent and obsolete' might have, as one of its 'layers', a device that worked by momentarily channelling down its directional rods some of the self-destructive energy of a nuclear burst. But Edward Teller and his colleagues at Lawrence Livermore saw what even the sceptical Freeman Dyson at Princeton acknowledged to be a 'beautiful piece of physics' as essential to redressing the disadvantages otherwise inherent in BMD. By 1987 some 500 million dollars a year was going (via the Department of Energy) into this programme.[33] Now it is forgotten, except by the historically-minded.

There was, too, the notion that, looking a quarter of a century ahead, the Free Electron Laser (FEL) 'holds out most promise' for BMD. It had been invented, in the middle 1970s, principally at Stanford. The FEL is not a laser in the strict sense. Coherent pulses of radiation are produced not through a chemical lasant but by the interaction between an electron stream and a series of magnets. Pulse wavelength is a function of electron energy and magnet architecture. Therefore an FEL can be wavelength-tuned, maybe in order to minimise absorption. It was even hoped that an FEL might beam from the ground onto targets beyond its horizon, using orbital reflectors. However, FEL development for SDI remained, as late as 1989, two orders of magnitude short of the requisite power flux.[34] It is no longer worked on in connection with BMD.

Another case in point was the particle beam, used in two ways. The one was to be for lethal interception; and the other as a means of interactive discrimination. The latter idea was that a beam playing off an incoming object would cause it to vibrate, slow down, warm up or give off distinctive radiation. How an object reacted might be an indication of its structure and composition. In 1986, Dr Louis Marquet, then SDIO's Head of Directed Energy Weapons, praised as 'remarkable' Lawrence Livermore's use of lasers to create plasma paths for charged particles in the high atmosphere.[35] That same year, Dr Harold Brown (formerly Secretary of Defense and by then head of Caltech) allowed that deployment of Neutral Particle Beam weapons could well take place in 2002 to 2008.[36] But this line of enquiry, too, has died out. On the KEW side, the same goes for the ElectroMagnetic Launcher (EML) in whatever mode.

For all these programmes, things were at a dead end by the time President Bush announced GPALS in 1991. This is why he stipulated that, in the 'robust funding' of the technologies that would be needed for any Global Missile Defense, the all-important Space dimension would be provided by Brilliant Pebble mini-missiles. Never mind that this KEW solution had previously appeared most uneconomic. Lawrence Livermore, its originators, once estimated that no fewer than 100,000 would be needed against a full-scale Soviet attack.

The AirBorne Laser (ABL)

All of which ought to be borne in mind as one judges the significance of the USAF's current AirBorne Laser programme So, too, ought the successive false dawns of lasers in the surface-to-air context, including notions about shipboard defence or that the Bundeswehr might field, by 1998, a lasing anti-aircraft tank.[37] Is there really a chance that an ABL can be operationally effective by 2006? Is not the very quest for it an adverse commentary on some of the surface systems we are evaluating? Has it to be seen as another example of a recurrent tendency in the BMD field to expect of technology more than it can provide? What then of the $650 million the USAF has committed to ABL research over the next five years?

Through the SDI era, controversy raged about whether laser beams could 'lock on' to the casings of ascending Soviet rockets firmly enough for long enough to effect explosive penetration. One underlying uncertainty was how tough these casings would be in the face of laser fluxes. In 1984 Ashton Carter, a member of the Pentagon team in the Clinton administration, spoke of a ten-fold range of guestimation on that score.[38]

It is said that the USAF currently has an Airborne Laser programme because, several years ago, Democrat majorities in Congress so distrusted SDIO as to exclude ABL research from its remit, ostensibly because this research was 'long term'. If that is how it was, those concerned may have made a bad mistake. Now a programme that is drawing unto itself much moral support is outside the monitoring processes of BMDO. That may also make it harder for ourselves in Britain to keep in contact with what is actually going on.

What is striking is how much positive comment the ABL has lately attracted from rather unexpected quarters. John Pike has long been a caustically anti-military spokesman on Space and related matters for the Federation of American Scientists. But while unable to eschew the taunt that the ABL has more to do with keeping the USAF's Phillips Laboratory in being than with meeting plausible threats, Pike has reportedly said that the ABL looks like the best form of TMD because of its ability to head off non-unitary warloads.[39] About the same time, Sheila Widnall, the Clinton administration's Secretary of the Air Force, averred it was 'quite possible' that the ABL would prove to be among those very few instances of an innovation 'that revolutionizes our operational concepts, tactics and strategies'. Meanwhile, National Security Council staffer, Robert Bell is quoted as saying that ABL could have 'an extremely impressive capability against regional outlaw states'.[40]

The iodine-oxygen pulsed laser, a high-energy version of which is to be on board the ABL Boeing 747, gets referred to as 'new'. It was, in fact, invented by the Phillips Lab in 1977. But this High Energy Laser (HEL) application is new enough in relation to the BMD debate. At 1315 nanometres, its wavelength is just below half that of the hydrogen-fluoride laser in vogue for SDI a while in the 1980s Therefore its divergence angle will be only half as great, for a projecting mirror of a given width.[41] What is more, a pulsed laser can be about twice as effective as one with a constant energy flux; and its effectiveness less simply a function of the thickness or character of the target casing. So with a mean power output not too far short of the megawatt range at present, it looks *a priori* possible that lock-on for two or three seconds, say, would pierce a rocket casing up to 400 km away.[42]

Buoyed up by this possibility, the USAF has formulated a programme whereby an ABL 747 demonstrator flies in 2002 ; and seven operational aircraft come into service between 2006 and 2008. The capital cost of this programme might be 15 billion dollars. An ABL on patrol could carry fuel for 100 engagements. It is intended

to be lethal against some 30 types of ballistic missile LDCs might operate between now and 2010.

The short wavelength of the iodine-oxygen laser not only produces narrow divergence in terms of quantum mechanics. It also places the transmission within a sector of the electromagnetic spectrum where atmospheric absorption tends to be moderate, of the order of 10 per cent per kilometre at MSL. Moreover most of the absorption in that particular sector is by water vapour[43], the gas little present in or above the stratosphere which is where the ABL laser beam would mainly be projected for TMD. However, levels of absorption do vary erratically with wavelength. So what these generalisations connote for 1315 nm has to be subject to technical assessment.

Meanwhile, familiar doubts surface once again. A 747 would normally patrol about 12 km up, easily low enough for lasing to be much affected by turbulent variations within the ambient atmosphere; and by thermal blooming caused by the energy of the beam itself. As with SDI lasing in the 1980s, we are assured that these sources of diffraction can be corrected for by 'adaptive optics', the use of segmented mirrors to adjust for path distortions as revealed by reflections of the beam off the target. The question, as usual, is not whether the remedy can ever work. It is whether it will do so consistently.

Even with good beam alignment, target-hold across the distances and intervals of time required will never be easy. Jitter is always present. Moreover, one is talking about beam divergence of the order of a microradian; and that means a spot 40 centimetres across at a distance of 200 kilometres. That spot would have to remain for some seconds on the same part of a rocket moving at maybe 2000 metres per second; and accelerating at perhaps 50 metres per second, an acceleration that would tend to increase as fuel is expended. One assumes the acceleration increase would be smooth but it might not be. Variations in grain size can affect burning rates. Nor should one overlook such countermeasures as making the casing reflective, especially at the wavelength anticipated.

Not to be ignored either is the 'death ray' connotation liable to be read into the ABL by many people throughout the West and further afield, unless it could be most convincingly demonstrated that the beam could never be aimed downwards. Such demonstration would not be easy. For one thing, the energy flux needed to ignite dry tinder, say, could well be a thousand times less intense than would puncture a rocket casing. Yet the beam intensity at, say, a slant range of 10 kilometres would, other things being equal, be 400 times what it would at 200 km. So unless absorption or diffraction in the lower atmosphere was much stronger than seems likely, a beam pointed Earthwards might readily cause tinder ignition, not to mention the scarring of living tissue. Moreover, across the first one or two hundred kilometres into enemy territory, many military targets might present themselves. All else apart, there are always strong arguments in favour of carrying the logic of BPI one stage further and attacking TBM squadrons in situ. The number of launchers is usually fewer than the number of missiles. Not infrequently, the ratio has been as low as one to ten.

It would be helpful if these complications could be more openly addressed; and a bit less said about BPI having the supreme attraction of making all the dirt fall back upon the enemy.[44] Things are hardly likely to work out in that retributive way in practice. The Saddam Hussein's of this world do not launch much from their palace gardens. Their preference is to operate out of the territories of oppressed minorities, the Kurds or the Basra Shias or the Marsh Arabs.

BPI by UAV

One attraction of the Unmanned Aerial Vehicle (UAV) for Boost-Phase Interception using KEW is its relatively low visibility when loitering in contested air space. A current US Army concept calls for UAVs that carry up to six lightweight intercept missiles while flying at 65,000 feet (c. 20km) for as long as 48 hours, a span of time that might connote an intrusion of over 1000 km.[45] These craft might fire a derivative of the Advanced Interceptor Technology (AIT) kill vehicle with its weight scaled down by half to 18 kg. To this AIT would be fitted a booster that would accelerate it to 2.9 km per second to travel up to 150 km. So twenty UAVs airborne could cover a 'Gulf-war'.[46] The AIT is a paper study of KEW interception from Space originally funded till Fiscal 1994.

Meanwhile, Loral has been looking at a flying-wing concept intended to carry a 5000-kg payload at 80,000 feet (c. 24 km) for 60 hours; and to travel at up to 300 mph.[47] Those parameters are not so very different from some the Israelis are working to. The quest for extra altitude is driven in part by the need to limit atmospheric drag Applied to KEW, reduced drag means longer interception ranges and less heating of the homing sensors. Shrouding and cryogenic cooling cannot easily be used to obviate overheating when weight is so much a concern. High-flying should also secure more immunity from interception.

However, this Loral concept would have a wing area of 1350 square feet, not an easy expanse to make low observable from directly below. Then a doctrinal question to address throughout is how far UAVs ought to be employed pro-actively and maybe long-term above adversary territories. This means doctrine at a higher level than the military operational.

The Maritime Dimension

Used at lower altitude and more locally, UAVs clearly have a maritime role to play, in missile defence and in other regards. Their relevance is enhanced by the priority being given, post-Cold War and post-Gulf War, to the projection of naval power into conflict situations ashore. This accenting has been made doctrinally explicit in two joint statements by the United States Navy and the Marine Corps.[48] The vision these encapsulate derives from two axioms. The one is that navies can shield ports of entry or beach-heads. The other is that mobility confers on task forces at sea a measure of immunity from long-range missile attack, especially ballistic missile attack.

The former tenet rests on the historic ability of navies to concentrate firepower wherever offshore is required. However, this notion may be endorsed less assuredly in the BMD context today than it initially was in Washington. Awareness may be growing of how defined a target a port presents to diversified attack: ballistic, cruise and hybrid missiles; manned warplanes; insurgents ... . The delivery, ballistically or however, of a few minelets might close a harbour for days. Explosions along the waterfront might scare the dock labour force off for the duration. Beach-heads are less fragile. Their configuration is usually more open; and their resilience that of the troops within them. The impacting of a few missiles will be unlikely to close them down, not with chemical explosives for sure.

The 'immunity through mobility' tenet is linked with dispersion, operational depth and wide flat horizons. Not least does such disposition favour a Co-operative Engagement Capability (CEC) 'seamlessly' interwoven between assets at sea, in the air and, indeed, on land. Worthy of note is the confidence the USN exudes about its Aegis fire-control and radar acting as a cornerstone for TMD co-operative engagement. From

the year 2000, forty-seven of the USN's E-2C Hawkeye carrier-borne surveillance aircraft are to be adapted to CEC in the Aegis TMD environment, cruise-missile attack included.[49] With Aegis itself, the phased-array radar and C3 back-up are being adapted progressively. This whole evolution stands in contrast with the advice one often receives this side of the Atlantic about the utter impracticality of adopting ground-based air defence radar to TMD. So, for that matter, does the BMDO discussion, cited above, of the possible application of air defence radar to NMD.

Some of us have lately found more support within naval staffs in Washington than in London for our view that, over a 20 to 25 year period, maritime task forces will become vulnerable to theatre missile attack, particularly if Russia and/or China prove more bellicose than has lately been assumed. More in the way of visual exposure might then be available to all sides. If so, a particular menace to warships may then be the hybrid missile that cruises into the target area to make a sensor-fused rocket dive onto a selected objective. A threat of that sort may ultimately be coped with only through CEC utilising novel short-range weapons. One option is lasers. Another might be steerable shells, a defensive development of the rocket-assisted shells used for bombardment in Vietnam.[50] Much will depend on how the threat evolves under the influence of geopolitical change. One does well to remember that, in the Middle East and South Asia, shore-to-sea ballistic missilry cued by over-the-sea surveillance has not appeared within the decadal time frame seen by one respected commentator as 'nearly certain' just before the end of the Cold War.[51]

Arguably, awkward questions about BMD aim and purpose overland could be circumvented by recourse to BMD screens at sea. One can imagine ships extended in battle line down the English Channel or along the Mediterranean, in the Straits of Taiwan, each side of Korea, across the Sea of Japan and so on, serving as physical protection and as expressions of commitment to the coasts on one side or the other. It looks on the face of it like a classic exercise of sea power.

However, the on-going cost of carrier-based air power has customarily been two or three times that of its land-based counterpart.[52] One can imagine the ratios being no less with BMD. Nor are navies easy to expand or modernise in this day and age. Construction costs are great; marine arthitecture often hard to adapt; and lead times long. Nor was provision made for BMD in Project Horizon, the Anglo-French-Italian new generation frigate.

So in those terms, contemporary sea power is inflexible, a truism the more pertinent because of the number of ships BMD role could demand. The marinised version of the THAAD could screen a stretch of ocean some 200 km across. Yet that could still mean 18 frigates on station to shield a line from Gibraltar to Cyprus. Even then, performance half way between successive vessels would be problematic because an RV engaged at this limit would be crossing the field of view of each shipboard battery. Not merely are crossing targets harder to track than more directly approaching ones. The destructive energy released on interception will be reduced the less head-on the impact. The only thing about a sea-based cordon is that the enemy might be unsure, at a given time, where the half way positions were.

A THAAD missile is terminally guided by an infra-red sensor that points it towards the RV, subject to predictive correction by on-board computer. At the outer limit, such a pursuit might too easily end up as a tail chase. No marinised THAAD is likely to overtake from astern an RV travelling from, let us say, Damascus to Paris. If it did, the energy imparted would be minimal. Likewise, off South Korea, it would be hard to vector hittile interception against RVs coming down from the North.

Another geographical reality, one that some American analysts have been too disposed to ignore, is that a great circle track from, say, Tehran to Berlin would skirt the Caucasus and cross the Crimea, widely outflanking any flotilla in the Mediterranean. Yet transit of the Dardanelles by non-Turkish warships is subject to tight circumscriptions under the 1936 Montreux Convention. In July 1976, the Turks conceded a major precedent by allowing the passage of the Soviet carrier *Kiev* because it was an 'anti-submarine cruiser': a designation which, if really applicable to that 37,000-ton vessel, would have been an awful commentary on Muscovite naval wisdom. Soon afterwards, two American destroyers entered the Black Sea although, through bearing guided missiles, they were in contravention as well. Nevertheless Montreux remains a subject of acute sensitivity. The Turkish Straits have been for 200 years.

Nor, in fairness, do those concerned seek to square this circle by advocating that BMD Aegis cruisers do enter the Black Sea. Rather they claim that such vessels located in the Aegean could co-operatively engage with radar facilities in Turkey. The American sites there, which monitored the first Soviet tests of long-range missiles 40 years ago, must today be TMD capable to an extent. But there would be a problem yet again with interceptors vectored at very oblique angles.

Still more worrisome would be political uncertainty. Never since the Cyprus crisis of 1963-4 has Turkey been as unequivocally pro-Western as she was at the height of the Cold War, a commitment epitomised by the valour of the troops she sent to Korea. In 1974, she invaded Cyprus. In 1975, she closed various of the American sites in her homeland for what proved to be a good three years. In 1979 she declined to permit the monitoring from her soil of SALT 2 compliance.

The most acid test of late has been her reaction to the Gulf crisis of 1990-1. She made a big contribution to the Coalition victory by (a) closing the Kirkuk pipeline, (b) letting allied warplanes execute offensive operations from her territory and © herself presenting a silent but visible military threat to Northern Iraq. But in consequence her economy suffered badly, while her own Kurdish problem was exacerbated. Nor did the episode yield any benefits in terms of Cyprus or eventual admission to the European Community. The upshot was the defeat of the ruling Motherland Party in a general election that autumn as the balance of political advantage swung more towards the nationalist Right.[53] In the next general election, last December, the Welfare (i.e. Islamic) party made substantial gains. Meanwhile, Ankara's long quest to join the EU threatens to end in frustration and bitterness.[54]

So Turkey may well be very reluctant to make commitments to BMD that are too heavy and unconditional. She would be unlikely to permit the stationing of BMD weaponry on her territory, partly because that weaponry might well be ineffective against missiles trained directly on herself from the Fertile Crescent. She might not be keen to admit cueing capabilities. If not, a gap would be left that sea power would be conspicuously unable to fill.

None the less, Ambassador Henry Cooper has called for the modification of the twenty-two Aegis cruisers to deploy worldwide a total of 650 upper tier BMD interceptors, starting at the end of the century. To be effective, they would have to be freed from proscriptions, under the ABM Treaty, against receiving data from external sensors. Then they could, in his judgement, defend the United States (and likewise North-East Asia and Europe) against 'a limited number of missiles launched from anywhere on Earth'.

SDI Revisited?

Yet even this remedy is avowedly short term. When in conversation Henry Cooper dismisses THAAD as 'trash', this is partly because the era of ballistic missile submunitions released in the ascent phase is hard upon us. Like the lecture by Robert Bell referred to below, his article alludes approvingly to last July's report in *Aviation Week* about the US intelligence assessment in this sphere. It was said to be that 'the capability to release submunitions from ascending ballistic missiles could be on the world market within five years'; and that China or North Korea could sell such weapons to the likes of Iran, Iraq, Libya or Syria.[55] From that Cooper concludes that Space Based Interceptors (SBI), to be followed by SBL, should be deployed from the turn of the century. He believes SBI would be able to intercept in boost phase 'and throughout most of their flight trajectory' all ballistic missiles with a range exceeding 300 miles. He even foresees an SBL engaging any travelling 75 miles or more.[56] Never mind that a rocket travelling that distance would be unlikely to rise more than 20 miles (c.32 km) above the Earth's surface.

This revival of a distinctly uncritical enthusiasm, on the American Right, for Space-based weaponry owes a lot to UAV successes, now in Bosnia but most famously as Israeli instruments of air defense suppression in the Lebanon war of 1982. Recourse to this genre had been informed by the decision to use no manned platforms in SDI. Unmanned platforms in each domain have been strongly favoured by Dr Edward Teller, the man who remains as much as anybody the inspiration of the modern USAF. He wrote in 1980 that such vehicles could 'easily be made more resistant, more adaptable' than manned ones; and could include an 'improved version of every human sensory ability'. He described microelectronics of the kind required as one of the 'few fields of military technology in which the free world has a real advantage.[57] A similar philosophy has suffused the 15-volume New World Vistas report on the future shape of the USAF released by the Pentagon this February. Remote piloting is to be at the heart of what Secretary Sheila Widnall calls changes 'as profound as when the Navy moved from sail to steam'. The really advanced cruise missile is likely to be a conspicuous legatee but ballistic missiles will also be much refined. Hybrid designs will fast evolve as well.

Arms Control Revisited

However, all these approaches to BMD present problems, not just operationally but also politically. Not the least of them concern the exercise of arms control. Various of the tendencies here identified are discordant with the 1972 ABM Treaty, particularly the commitment under Article 5 'not to develop, test or deploy ABM systems which are sea-based, air-based, Space-based or mobile land-based'. These last couple of years Russo-American endeavours to square that circle have focussed on trying to fence off a realm of legitimate TMD development by delineating maximum speeds for the interceptor and the intercepted. Last December, the essence of an agreement was hammered out ready for consolidation when the ABM Treaty's Standing Consultative Commission resumed work this February. According to judicious leaks, TMD systems with a 'demonstrated' interceptor speed of three kilometres per second or less and being tested only against allowable target missiles will be considered treaty-compliant. Targets that are allowable will have a maximum range of 3500 kilometres and a maximum velocity of five kilometres a second.[58]

Alas, the weaknesses of this approach are manifold. One cannot easily monitor the other side's fly-out speeds. Nor be sure they are holding nothing back or cannot

surreptitiously improve. Relevant, too, is the tendency, over TMD distances, for interceptors to move faster than their targets but, over intercontinental ones, for the converse to hold true. Yet there is no neat correlation here either. All else apart, a longer-range missile does have to be fast but a shorter-range one does not have to be slow. Most anomalous of all is the fact that the target limits set out above would encompass the interception of SLBM that (like the CSS-N-3) were fired from submarines across 3000 km. Yet these could threaten the heartlands of the USA or Russia. The fact that neither Washington nor Moscow currently have in service no missiles in this category does not negate the illogicality.

It may be in the naval arena that these limits are soon put to a most acid test, on the American side. Allusion was made above to the two weapons in contention for selection as the Navy's upper tier BMD, the 'marinised' version of THAAD and the Standard Leap. A competitive 'fly off' hs been scheduled for the year 2002. Already, however, it is very evident that the corporate preference of the USN is for Standard Leap, in spite of doubts about whether its warhead is large enough. It is the latest link in a nautical chain of evolution, the Standard missile family, that can be traced back to the RIM-66 surface-to-air weapon in the 1960s. Vertical launch and electronic enhancement have made the SM-2 Block 4 now entering service of some utility against sea-skimming or deep-diving cruise missiles. The follow-on Block 4A is intended to have some capability, up to intercept altitudes of 25 km, against slow and unsophisticated ballistic missiles. Standard LEAP is being created by giving an enlarged Standard missile a new final stage in the form of a 20-kg Light Exo-Atmospheric Projectile (LEAP) intended originally (i.e. in the 1980s) for Space-based interception. This combination is seen as mainly low exoatmospheric and, like THAAD, credited with a slant range of 140 km. What distinguishes Standard LEAP most sharply from THAAD is that it reaches 5.0 km per second as against the latter's 2.8 or 2.3. The USN attaches importance to the extra speed, not least for littoral BPI. It would be loth to relinquish it just to conform to an arbitrary interpretation of what 'compliance' is about.

In a presentation to the George C. Marshall Institute last October, Robert Bell (Presidential adviser and Senior Director at the National Security Council) worked explicitly from premises so outmoded already as to exemplify the contradictions of this approach to arms control.[59] Having stressed the administration's budgetary commitment to development of the ABL (p.9), he went on also to extol the Navy's upper tier capabilities against targets 'in the ascent phase before submunition dispersal' (p.10). He pledged that the administration would reject Russian attempts to 'ban testing of Navy Upper Tier against targets in the boost phase' (p.10). He presumed that the compliance fence would be defined simply in terms of the range and speed of enemy incoming missiles (p.1). He intimated that neither the Russians nor anybody else would be able to veto Standard LEAP being confirmed for Upper Tier, given its value in the BPI role. What with one thing and another, it is hardly surprising that some arms control liberals in or close to the Clinton administration are coming to feel that compliance should rest, in the ultimate, on informal understandings with Moscow (particularly about deployment totals) rather than reliance purely on neat but arbitrary performance divides. What may most be needed, however, is a really fundamental look at the ABM treaty as such.

5 - Proliferation: The Technical Aspects

There has long been a minority view that nuclear proliferation is inevitable and, to an extent, desirable. But only one brief interval can be identified since 1945 during which Western opinion as a whole appears little worried about the risk of weapons of mass destruction spreading to states that do not yet possess them. This is the middle to late 1950s. The Cold War had been easing in both Europe and Asia. The attractions of nuclear fission in energy supply and other applications (notably medicine) were adjudged considerable. The foundation of the International Atomic Energy Agency (IAEA) in 1957 betokened a faith in 'atoms for peace', in the world community's ability to promote these civil uses without seeding the dragons' teeth. What could those teeth do in any case?

This mood did not last long. The launch of Sputnik, also in 1957, heralded new rounds in the arms race between the Superpowers. China had developed an enriched-uranium fission bomb by 1964 and a thermonuclear one by 1967, amazing achievements seeing that all forms of Soviet economic and technical aid had been abruptly curtailed in 1960 (see below). Warfare became endemic again in Afro-Asia during the 1960s. The Iron Curtain across Europe did not thin much more.

Against this background, the nuclear Non-Proliferation Treaty was launched in 1968. Its signatories have pledged themselves to curb the spread of independent nuclear deterrents and, more specifically, the non-nuclear ones have agreed to accept inspection 'in accordance with the statute of the International Atomic Energy Agency and the Agency's safeguards system' (Article III). At the very outset, however, a number of states in Europe and Afro-Asia that could be described as near to the nuclear threshold orchestrated opposition to the whole idea on the grounds it flatly discriminated in favour of the existing 'nuclear club'.

Attempts were made to meet this objection. Any party could, and can, withdraw at three months' notice should it decide 'that extraordinary events related to the subject matter of this Treaty have jeopardised the supreme interests of its Country' (Article X). Then again, the treaty's preamble commits all concerned to work towards the 'liquidation of all' military nuclear stockpiles. The launching by Washington and Moscow in the autumn of 1969 of their Strategic Arms Limitation Talks (SALT) was in part in recognition of this commitment. The ABM treaty was the centrepiece of the SALT 1 agreement of 1972.

It cannot be said the 1972 accord persuaded many of the sceptical. Among those who had not acceded to the NPT ten years after SALT 1 were Algeria, Argentina, Brazil, Chile, India, Israel, Kuwait, North Korea, Pakistan, Saudi Arabia, South Africa, Spain and Vietnam.[1] Nor have some of them yet.

Yet the converse does not hold true. That is to say, much of the developing world would wax extremely resentful were the ABM treaty now to be cast aside as a 'relic of the Cold War' without anything convincing being put in its place. In the run-up to the 1995 NPT review, there was a disinclination to recognise how much nuclear disarmament had lately taken place as between the USA and the former USSR. With this attitude went a desire to push things forward, globally and decisively. A Comprehensive Test Ban was the most immediate priority in almost everybody's mind even though it would tend (thanks to the development of non-explosive techniques for inspection and testing) to underpin the privilege of 'nuclear club' membership. Moving up the agenda, too, were such objectives as (a) a ban on the production of weapons-

grade fissile material, and (b) turning certain major regions (e.g. the Middle East by the year 2005?) into nuclear free zones.[2]

Even before the Gulf War, concern was being expressed lest a less organised world post-Cold War would give many secondary states both more scope and more incentive to develop their own deterrents. But the discovery, in the wake of Baghdad's defeat, that though she had been regarded as a compliant member of the IAEA and the NPT, she had come within a year or so of fabricating nuclear bombs (not to mention her great strides with chemical warheads) gave a big impetus to anti-proliferation policies. So while much of the Bush administration's energies in this area were directed towards confining nuclear weapons in the former USSR to the Russian Federation itself, it did launch an Enhanced Proliferation Control Initiative to manage the problem in the wider world. American export controls were tightened on dual-use goods, the subject of 24,000 export licences to 'worrisome' countries (so says the US General Accounting Office) between 1988 and 1992.[3] Negotiations within multilateral control regimes (the Missile Technology Control Regime; the Nuclear Suppliers Group; and the Australia Group) led to firmer international controls over certain sensitive items. Military action against Weapons of Mass Destruction (WMD) being acquired by emergent countries also figures in the new conspectus.[4]

Counter Proliferation

Towards the end of 1993, the Clinton administration took things a stage further, enunciating a Counterproliferation Doctrine. It marked a big departure, one that all commentary and policy ought to take proper account of. Needless to say, all the traditional elements in non-proliferation were retained: diplomacy, arms control treaties, IAEA or bilateral safeguards, deterrence through retaliation, export controls, economic sanctions, intelligence, and security guarantees. But two more novel ones were given salience. These were active BMD and pre-emptive elimination.

Not that the notion that BMD has a role in this domain is lacking in precedent. SDI was usually extolled as contributing (if implemented in accordance with the Nitze criteria) to stability as between the two Superpowers. But a wider purpose was also identified, most notably through 1985. It largely derived from an early perception of new and less rational LDC antagonists. Arguing in favour of SDI that September, Henry Kissinger anticipated that 'several Third World countries' would have their own nuclear weapons by the turn of the century; and some would thus have 'a vast capacity for blackmail because they could make the threat of suicide more plausible'.[5] In June, Fred Iklé, testifying to the US Senate as Under Secretary of Defense, had claimed one argument for strategic defence was that 'continued reliance on a threat of revenge' could proffer no protection against 'nuclear terrorism and irrational or accidental attacks in the next century'.[6] In July, Caspar Weinberger suggested that SDI could police a disarmed world.[7]

It is the Weinberger formulation that approaches most closely the current concept which is to have BMD in position to inhibit a breakout in offensive rocket procurement by the other side. As suggested in Chapter 2, however, one does have to consider when it may be better to stand poised ready to deploy BMD than to have a screen actually in position. The answer might be 'as often as not, it is'.

Pre-emptive elimination, novel in the explicit emphasis accorded it in 1993 though not in more absolute terms, also merits careful evaluation. Not least does it by Britain as the country that may most readily join the United States in any such intervention in the Middle East. Allusions by the Clinton administration to this option

were tentative initially but waxed tougher in the light of a favourable international reaction. Ballistic and cruise missiles and other Precision Guided Munitions (PGMs) have been cited as instruments of implementation. So have Special Forces.[8]

A good measure of how world opinion is evolving on this score is the shifting attitude the Israelis wryly observe to their strike against Iraq's Osirak reactor in 1981.[9] Initially they were censured by every government, even the American. With the wisdom of hindsight, that particular action would be widely endorsed today. The same applies to the sabotage in April 1979, by Israel or whoever, of a reactor core then in storage at La Seyre-sur-Mer, France, awaiting shipment to Iraq. Expressive of a new mood, too, is the way the MTCR has both expanded and firmed up.

Libya and Iran

The conclusive excision of Iraq's ability to become a strategic power in these terms remains a vexatious task. At present, however, opinion in the United States and elsewhere is most exercised by the possibility of Iran's becoming a nuclear power and Libya a nerve gas one. Libya's quest for strategic weapons in some form goes back a decade and more. So does the struggle by the West, led by Washington, to preclude this. After the American air strike in 1986, Gadafi said he would have struck New York with missiles 'at the same moment' if he could. The following year, he said Arab nuclear weapons were imperative because Israel was 'working day and night' to become able to fire nuclear missiles at every Arab city.[10]

But faced with the MTCR, backed by widespread and forceful American diplomacy, Libya was to enjoy little success in her worldwide canvass for critical nuclear technologies. Soon she felt obliged to pursue a while a less assertive foreign policy in other directions. Witness her acceptance of World Court adjudication over her territorial dispute with Chad. But in April 1992, she became subject to UN economic sanctions because of her failure to extradite two security agents wanted in connection with the Lockerbie bombing in December 1988.

By then, her quest for strategic warheads had undergone a radical realignment. In 1988, she was found to be building (with assistance from a West German chemical firm) a large chemical warfare plant at Rabta, some 40 miles south of Tripoli. In 1990 Rabta was closed after Washington had threatened to bomb it and had identified certain European companies as having provided equipment. Work started on an alternative facility inside a mountain near Tarhunah, also some distance inland from Tripoli. Reportedly, the CIA produced in 1992 a computer model (based on satellite reconnaissance and espionage reports) that showed this 'Rabta 2' already extending across several thousand square feet. Since interdiction is deemed impracticable, Washington's priority is to inhibit the inflow of equipment and spares. But Asia in general (and Thailand in particular) still lacks a rigorous control regime.[11] It is hard to believe it would, in fact, be impossible to close the entrance to this facility by military force or that this would not be done if all else had demonstrably failed. Announcing on 1 September 1993 the results of his bottom-up defence review, US Secretary of Defense Les Aspin said an 'important category is attack on buried targets because in many of these countries, proliferators are using hardened underground structures to build or to operate special weapons arsenals from'.[12] He did note, however, that before such a mission the consequences in terms of local contamination would have to be assessed. Unfortunately, that assessment might be difficult whatever mode of attack was proposed.

Although Iranian proliferation tends to get mentioned in the same breath as Libyan, it may not be moving at the same tempo. A straight correlation is often drawn because of a disposition in Jerusalem and Washington to depict violence in the Levant as instigated by a Tehran frenetically extreme in all respects. The inference Jerusalem drew at the height of this April's Lebanon conflict was that 'an international coalition will eventually have to trim Iran's nuclear ambitions and its capability to disrupt peace and stability in the region. What is happening now against Hezbollah is merely a sideshow to the main action which is to come.'[13] That Hezbollah and Islamic Jihad are backed materially by Tehran is undeniable. But Hamas 'with Sunni Moslem scorn for Shia Iran, gets money from all over the world: from Saudis, for instance, and from Muslims in America and Britain'.[14] Nor could anyone deny that for decades past violence in the Levant has largely assumed the pattern of action-reaction as between the local protagonists with each ill-judged response inducing the next. To discount that reality in favour of some simple attribution of guilt could be to engage in chop logic. In any case, Tehran might prove more ready to abandon Hezbollah and Islamic Jihad than to forego its prime aim of becoming the strategic power in the Gulf by whatever route.

Interpreting Iran's nuclear aspirations more strictly on their own terms, one finds they date back to the Shah's time. At a press conference in October 1974, he said that his country had already made plans to install 23,000 megawatts of nuclear generating capacity. He further said that, while several reactors were being bought from France, 'We will buy everywhere, both from the Western countries and from the East if they are ready to sell. So it is a complete diversification of markets that we envisage'.[15] The desire to keep all options unconstrained was obvious.

Iran has been convincingly compared with China in that the nuclear aspirations of each are sustained by an awareness of having long been historically at the centre of a regional world that deeply respected not just its political influence but also its culture.[16] Also like Maoist China (and therefore much more than the China of today), revolutionary Iran has an acute sense of the wrongs of recent history. Most seering is the terrible Iran-Iraq war; and, above all, the 'fact that Iraq - which had started the war, had used chemical weapons, had targeted Iranian cities with missiles, and had held Iranian territory that it had occupied by force - was not condemned by the United Nations (UN) confirms for Iran its view that the current international order is unjust and hostile towards it'.[17] Likewise, it sees the 'satanic' United States as ignoring Israel's nuclear status and her non-adherence to the NPT. At the same time, she discounts Iran's adherence to that treaty, using her influence to block exports of nuclear technology from countries such as Argentine, Brazil, Czechoslovakia and India. Underlying this perspective is a more general perception that Islam has been under attack throughout this century. Witness the fall of Jerusalem itself in 1967.

Turning to this matter during an address to the Atlantic Council in August 1994, Lynn Davis, Under Secretary of State for International Security and Arms Control at the State Department, scorned what she depicted as a disposition on the part of the Europeans to give good day-by-day relations with Moscow and Tehran 'priority over their non-proliferation goals' in respect of Iran. But she then went on to describe more objectively the strong constraints currently in place against the Iranians. Russia had agreed to sign no new contracts for arms sales, merely fulfil existing ones. Also any 'withdrawal from the NPT or refusal of IAEA inspections will subject Iran to an immediate cutoff of nuclear assistance, most importantly by Russia and China. These

steps would leave Iran years away from the capability of producing nuclear weapons'.[18]

But what does one mean by 'years away', working to the assumption (however implausible) of no forceful dissuasion from outside? The Israelis and some Americans would say three to five years. Otherwise the general consensus is more like seven to ten. At the May 1995 Moscow summit, President Yeltsin agreed not to sell Iran a centrifuge plant for uranium enrichment while refusing to cancel a contract to sell her up to 2800 megawatts of reactor capacity. Negotiations with China for reactor supply are reported stalled. A safeguards agreement between the Iranians and the IAEA came into force in May 1994 and appears to be working properly thus far.[19]

Even assuming that this regimen is maintained, however, questions remain. There have been indications that, like several other Middle Eastern countries, Iran has incipient capabilities for chemical and biological warfare.[20] Meanwhile, some 400 surface-to-surface missiles (Scud B and Cs; and Chinese CSS-8) are in service with the Iranian Army together with perhaps 35 launchers.[21] How close to operational service are any Nodong missiles North Korea may have supplied (see below) is to me unclear. But in 1992 the United States expressly threatened to apprehend shipping believed to be carrying missiles from North Korea to Iran; and in 1993 she applied similar pressure in respect of a Chinese freighter bound for Iran.[22] The Iranians have some capacity for missile fabrication and assembly though it is doubtful how truly autonomous this is.

North Korea

Still the most challenging case at present is North Korea which, like Iraq, did come disconcertingly close to full strategic development. She, too, had been seen as NPT compliant, having signed the treaty in 1985. Pyongyang has sustained throughout a cult of the personal leader (Kim Il Sung, 1945-94; and now his son and heir, Kim Jong Il) that undeniably has been tantamount to sustained collective madness. Yet at the same time, the regime has conducted against its external foes (and especially Seoul) a campaign of ruthless hostility that has been judged with a chilling exactness in terms of an ability to disconcert without calling forth an effective riposte. It may be the most sinister example to date of how to be orgiastically crazy and brutally rational at one and the same time. Take the record since the end of the Korean War in 1953; and the establishment then of a buffer territory in the form of the Demilitarised Zone (DMZ). There has been repeated infiltration of paramilitaries into the Republic of Korea (ROK); much tunnelling under the DMZ; the seizure of the *Pueblo*, a USN surveillance ship, in 1968; the shooting down of a US EC-121 surveillance plane in 1969; killing the wife of President Park of the ROK in 1974; hacking to death two American officers in the 1976 DMZ tree-cutting incident; blowing up half the ROK cabinet in Rangoon in 1983; and recurrent kidnappings of South Korean citizens.[23]

The intricacies of Pyongyang's nuclear ballistic development cannot profitably be explored at length here. Such an exercise would be (a) decidedly derivative from what has been researched and recorded by others and (b) would have limited prognostic value in respect of a regime that has become an ideological anachronism tormented by economic crisis. Nevertheless, it may be appropriate to identify a few aspects that may bear upon other situations as they arise.

The most distinctive aspect of North Korea's advance towards strategic status has been its development of ballistic missiles. The process began after the Yom Kippur war of 1973 because (a) missilry figured in that war enough to persuade Pyongyang of its potentialities and (b) Moscow was refusing to supply her with Scud Bs.

Exploratory work on reverse engineering (including, it seems, on a few Scud Bs obtained from Egypt) led to an indigenous North Korean Scud Mod B being flight-tested in 1984. In 1990, the Mod C version appeared, more advanced and with a maximum range perhaps as high as 400 km. By then, the Nodong 1 (a multi-engined improvisation with an indicated range of 1300 km) was entering upon what has proved a decidedly patchy flight-testing programme.[24] Whether or not this design is now entering service, there is less reason than before to expect that North Korean indigenously-produced rockets could attack the continental United States as early as the year 2005. Suffice also to note that analysts believe one reason for Pyongyang's supplying Tehran with Scuds and maybe, either now or shortly, Nodongs is that the latter can offer not merely petrodollars but also quite wide open spaces for testing.

The ballistic missile inventory of the North Korean army is reported in *Military Balance* to be but 30 Scud Mod Cs plus 54 of one or another variant of the Frog, another Soviet weapons family with ranges of 50 to 70 km. *Military Balance* is a widely respected annual compilation accessing some good sources. Even so, the combined total of the above seems implausibly low on four counts. The army in question has a standing strength of a million plus 750,000 in the ready reserve.[25] Ballistic missiles could have a spearhead role to play in the sudden blitzbrieg southwards that is the crux of Pyongyang's operational philosophy.[26] The fact that North Korea has been manufacturing MOD Cs for some five years ought to mean quite an inventory; and the same must also apply to the MOD B version that preceeded it by five years. The probability is that both the two figures given really refer to launchers, the yardstick *Military Balance* normally employs. So is it also that increasing numbers of ballistic missiles along with not a few launchers are concealed inside the ferro-concreted infrastructures in which the North Korean military have invested with such notorious lavishness. Much concealed expansion would be consistent with the *Military Balance* reckoning having remained unchanged since 1993.[27] It serves more generally to remind one that, as the years go by, inventories of ballistic and cruise missiles will be even harder to keep track of than has historically been the case with warplanes and battle tanks. Nor has any reference here been made to how changes may be further obscured by recourse to camouflage and to dummy weaponry or even factories. Even in the air age, history affords salutary examples of how effective such deception may be.[28]

The acquisition of fissile material by North Korea has proceeded pretty much in step with the means of delivery. A reactor of 30 megawatts thermal capacity modelled on the British magnox design entered service in 1986; and that can produce each year c. 10 kilograms of Plutonium 239 - roughly enough to make two Nagasaki bombs, after separation (see below). In February 1990, a SPOT-1 French surveillance satellite revealed a plutonium separation plant, partially complete. In accordance with accepted norms, Pyongyang's accession to the NPT in December 1985 was supposed to be followed within 18 months by the signing of an IAEA nuclear safeguards agreement. Yet it was only in April 1992 that the North Korean parliament approved such a pact. A mere eleven months later, Pyongyang announced its intention of withdrawing from the NPT, this against a background of incessant wrangling with the IAEA about how much plutonium was being produced still.

That June the withdrawal was put on hold following talks with the Americans.[29] That set the scene for several bitter months of crisis diplomacy in 1994 with Pyongyang being wildly oscillatory in its attitude to IAEA inspection; and threatening to turn the Korean peninsula into a 'sea of fire' if she was put under too much

pressure. For her part, the United States deployed Patriot batteries to South Korea and pressed for UN sanctions. Russia and China cautioned against these.

The upshot was the October 1994 Agreed Framework plus a supplement signed at Kuala Lumpur in June 1995. Under these accords, North Korea is to abandon her nuclear weapons programme in exchange for two modern 1000 MW reactors from South Korea; more normal relations with Washington; and supplies of oil. However, this Spring saw renewed transgressions by North Korea of the DMZ, abrasive reminders of how much hinges on her internal economics and politics of Pyongyang. They came only three months after a contractual agreement for the supply of the two reactors. Meanwhile, the Pyongyang regime is thought to be well advanced with chemical and biological weapons, even allowing that solid evidence is hard to obtain or do a confident interpretation of.[30]

Peaceful Uses?

With East Asia as a whole (plus or minus Siberia) well en route to becoming the economic power house of the world in the middle of the next century, it is instructive to review attitudes within the region towards civil nuclear power, as a general rule the bedrock of any military nuclear programme. The gist is that the balance of opinion is nothing like as antipathetic as it has become across so much of the West. In the Republic of Korea the percentage of total electrical generation capacity that is nuclear is due to rise (according to a May 1994 briefing by the Ministry of Science and Technology in Seoul) from 26.5 in 1994 to 39.6 in 2006. But about this, as about many things, environmentalist concern burgeons. Take an episode that erupted, coincidentally or otherwise, at the time of the showdown between Washington and Pyongyang in the early summer of 1994. That June, the government was obliged to cancel, after several weeks of local rioting, plans to build storage facilities near Yangsan and Ulchin.[31] None the less, the South Koreans firmly aver they have never had a nuclear accident; and that the cost of nuclear power is very satisfactory, in their situation, compared with that of other energy sources. Economic security is also considered. Coal has to come from as far away as South Africa. With oil, too, there is dependence on distant sources.

Japan deploys similar arguments. Twenty-eight per cent of her electricity was nuclear in 1992; and this fraction is set to rise over the long term. She is sharply criticised (particularly by Washington Democrats) for accumulating recycled plutonium, this in anticipation of a next-century Fast Breeder Reactor (FBR) programme already at prototype stage. All the same, not even those abroad who are most condemnatory, on grounds of principle and precedent, see this as deliberate preparation to go nuclear in the military sense. Japan has too often called loud and clear for consolidation of the NPT/IAEA regime *en route* to complete nuclear disarmament. China, too, has been investing considerably in nuclear power in part to ease demand for coal in provinces not easy to ship it to.

The IAEA remains keen to promote the peaceful use of nuclear energy subject to safeguards. Indeed, its enthusiasm for so doing has been reinforced by the need to limit global warming by curbing the increase in atmospheric carbon dioxide (CO_2) caused by the burning of fossil fuels. An IAEA paper produced internally in 1994[32] showed the nuclear contribution to global electricity production as having risen from 1.6 per cent in 1970 to 8.7 in 1980 and 17.0 in 1993 (Fig.3), in spite of fears about reactor safety and about pollution from nuclear waste. The increase in atmospheric

CO_2 thereby avoided was estimated at half a per cent of the total man-made increment in 1970 rising to seven per cent by 1990.

Projections for the growth worldwide of nuclear power capacity, measured in megawatts of electricity, were from 346,000 in 1995 to somewhere between 338 and 531 thousand in 2015 (Fig. 5). Yet it only requires the continuous and high intensity operation of ten megawatts of electrical capacity to produce in the course of a year the six kilograms or so of plutonium needed for a Nagasaki bomb. Moreover, even with comprehensive inspection (automated surveillance; both regular and unannounced visits; and full access to records) it remains difficult for the IAEA to estimate the amount of plutonium to be expected to within one or two per cent. Nor is the degree of co-operation needed for such a routine by any means assured throughout the 800 nuclear facilities in sixty countries the IAEA has to cover. Obtuseness and obstruction can be encountered from regimes of less sinister intent than those currently ensconced in Baghdad and Pyongyang. The arms control community is probably right to insist that a keystone objective to move towards is the cessation of plutonium ingot production: that is to say, ending the separation of plutonium from the rest of the waste produced by the fuel cycle of a uranium reactor.[33] But this objective does not seem at all close to being realised. Too many governments regard it as too binding in a world still highly fractious.

This does not mean that, in what may be a long interim period, nuclear warheads are bound to proliferate with abandon. Take the more conservative of the IAEA projections for the year 2015 of the global capacity for generating electricity with nuclear fission. Only three per cent of it is expected to lie outside the three key areas: North America; Europe including Russia; and the Far East. These contribute 27 and 47 and 22 respectively.[34] Granted that three per cent might yield enough plutonium each year to make close to 1000 Nagasaki bombs, assuming the requisite facilities for separation were to hand. But political intentions would be much more restrained overall. Access to sophisticated means of delivery would, in any case, be another question entirely.

On the face of it, a general deterioration in the world order might induce proliferation most readily in the Far East. But any crumbling of the institutional arrangements for European collective security (NATO, the EU, the WEU) could open the way to proliferation within our continent. We should not forget the consideration given in Sweden, Switzerland, Yugoslavia and Turkey (at various times between 1950 and 1975) to taking the nuclear option up.[35, 36] Herein lies a strong reason why deterrence (any BMD dimension included) needs to be upheld consistently across the European theatre.

Chemicals

Chemical weapons have been a bugbear of arms control ever since their battlefield introduction by Germany in 1915. After that war, the victorious allies bracketted 'poison gas' with unrestricted submarine warfare and Zeppelin raids as manifestations of a devilish madness said to be singularly Hun. The gases in question (e.g. chlorine, mustard gas) were duly dubbed weapons of indiscriminate destruction though, in twentieth-century terms, they were nothing of the sort. Their effects were localised and usually involved temporary incapacitation rather than permanent disablement or death. But the development of nerve gases, led by Nazi Germany, did extend this particular horror more towards mass destruction. The chemical prospect is

disconcerting for today's field commanders precisely because it is so open ended. It may be helpful to preserve a distinction between pre-1940 poison gas and nerve gas.

Here, again, Saddam Hussein emerges as a contemporary evil genius. In the Iran-Iraq war, Baghdad introduced tear and mustard gas onto the battlefield in 1982; and nerve gas in 1984. Both times round, introduction followed hard upon the commencement of quantity production. More extensive use of chemicals from 1986 enabled Iraq to stave off outright defeat, inflicting 50,000 Iranian casualties in the process. In 1987 and 1988, massive gas attacks were also launched against the Iraqi Kurds.

In June 1992, the UN Special Commission established a Chemical Destruction Group to deal with Saddam's stockpile in the wake of his Gulf War defeat. Over the the next year or so, it destroyed 600 tonnes of mustard gas and 100 tonnes of nerve gas. Altogether it carried out or monitored the destruction of some 65,000 chemical munitions though a mere 74 of these were ballistic missile warheads, the ones intended for the al-Hussein rocket. Therein is another reminder of the need not to overplay the uniqueness of ballistic missiles in the battlefield context.

During the war, Iraq had tried little if at all, to release chemical weapons very even though she had them extensively deployed in the field. Explicit deterrence by dint of heavy retaliation will have been a factor. So will have been (and this tends to get overlooked in discussion) elaborate though imperfect passive defence by the coalition forces. So, certainly in the case of the al-Hussein squadrons, was lack of operational readiness. Adverse weather may have lent further discouragement. Above all, however, the sheer dynamic of the coalition blitzkrieg paralysed the Iraqis' command and control.[37]

Optimistically, the chemical threat will be well contained by the Chemical Weapons Convention (CWC) opened for signature on 13th January 1993, after a quarter of a century of negotiation in Geneva. It requires all chemical weapons to be destroyed and all production facilities to be demolished or converted by 2010 at the latest. As of the end of last year, North Korea appears to be the only significant non-signatory. The monitoring arrangements include challenge inspections 'anywhere without delay'.

Inevitably, however, grounds for doubt remain. Nations under inspection can (ostensibly to protect their trade or national security) remove documents, shroud certain equipment and log off computers. Differences of interpretation exist on the limits placed on the use of riot control agents or herbicides. The question of licit use can be vexed. Take chlorine. Its chemical reactiveness makes it toxic but also very important industrially.

The institutional machinery for imposing CWC sanctions extends back to the UN General Assembly. Obviously, this regime would be among the more fragile if the whole arms control matrix were being undermined in whatever circumstances.

Biologicals

About biological weapons we have fewer materials, as the historians say. That is no justification for euphoria. On the contrary, it justifies apprehension that those materials could be residing in a grimmer future. Biotechnology is evolving at so accelerating a pace and ramifying a diversity as to make it exceptionally difficult to comprehend. But this can be said to start with. A great revolution in industrial chemistry in the second half of the last century made the First World War fightable largely as a high explosive conflict, albeit with poison gas as a major adjunct. The

Einstein-Heisenberg revolution in theoretical physics the first three decades of this century contributed to the strongly electromagnetic and electronic nature of the Second World War, with nuclear energy coming in at the end. Some generalised global conflict in the middle of the next century could well be biology driven.

The risk of that outcome is heightened by the ways in which biological warfare also ranks as a poor man's stratagem. Its possibilities reside very much in natural science as opposed to one of the great engineering disciplines. Therefore much of the basic information is transferred via the scientific press, the peregrinations of scores of thousands of graduate students, and so on. Applications to military usage may then take place on a smallish scale, not too difficult to finance and organise while remaining very hard forcefully to pre-empt. A decidedly macabre illustration is afforded by Imperial Japan in World War Two. Such endeavours as she made to evolve an 'atomic bomb' were always doomed. But her Unit 731 in remote northern Manchuria extensively researched germ warfare on Chinese and Russian prisoners of war. Moreover, the results were widely used against the Chinese population in the 1942 campaign in Chekiang.[38]

Of course, the very fact that such development activity can be so *sub rasa* makes proliferation hard to track. But a 1993 Jane's assessment listed the 'potential possessors' of biological weapons as China, India, Israel, North Korea, South Africa and Syria. Probable or possible developers were identified as Iran, Libya and Taiwan.[39]

What is more, various yardsticks can be applied to demonstrate that biological weapons bring those possessed of them into the realm of mass destruction much more readily than chemical weapons do. It may take 200 grams of chlorine to kill a human being. Were it somehow or other to be successfully disseminated, that amount of Yersina Pestis (the mix of bacterial strains that causes plague) might soon kill 200 million. Casting the argument more pragmatically, a former Director-General of Porton Down has put the downwind hazard characteristically posed by poison gas at up to one kilometre from the release point, by toxins at ten, and by active biologicals at several hundred.[40] The last would be similar to the envelopes of lethal fall-out typical of a high-yield nuclear groundburst.

For our immediate purposes, the crux is ballistic delivery. Comparisons can variously be drawn but one published in 1991 was as follows. Suppose a missile with a throw-weight of one tonne was fired into an extensive but not too densely populated (30 people per hectare) urban area. With a nuclear warhead of 'nominal' yield (i.e. 20 kilotons or Hiroshima/Nagasaki equivalent), it would probably kill 40,000 and injure as many again, in the absence of passive defence. Bearing 300 kg of Sarin nerve gas, it could kill between 200 and 3000. Thirty kilograms of anthrax spores could kill 20 to 80 thousand. One reason why anthrax might be selected for such a mission is that it is non-infectious, an attribute conducive to discriminatory targetting.[41]

Not that anti-urban strikes are the only possibility. Graham Pearson, the former Director General just cited, always stresses the advantages to an enemy of targetting crops and animals instead. But when human beings massed in cities are the intended victims then one has very generally to be talking about entry via the deep lung. That is likely to be effected far more readily when the contaminated droplets are not more than five microns (i.e. five millionths of a metre) in diameter. Needless to say, droplets so small descend to Earth extremely slowly which means that an RV airburst is unlikely to be the best way to get the right extent of dispersion over an urban area. Yet neither would a ground burst be. Another complication is that, without recourse to a fine

mechanical spray, droplets that small are hard to generate in any case. Taken together these two considerations point to cruise missiles or manned aircraft or even ships in coastal waters as the most efficient means of germ warfare delivery. Thirty and more years ago, indeed, experiments proved the efficacy of spray dissemination during transits offshore. In one instance, a ship steamed for 156 miles some 10 miles off the American coast, disseminating the while 450 lbs of fluorescent material in the form of particles averaging two microns across. Traces were detected across 35,000 square miles of land.

As already indicated, however, that does not rule out the ballistic missile alternative. Still less does it do so in view of the awesome advances germ warfare could make this next half century or so, advances that should *inter alia* allow of more flexibility as regards the mode of delivery. At all events, the field is one in which a huge premium attaches to novelty. The immune systems of living organisms respond best to invasions through recall of analogous past experiences. The absence of good analogies handicaps them. This is why, for instance, spontaneous mutations can so readily enable traditionally endemic diseases to make come-backs against modern medicine.

So far nothing has been said about the biological dimension in arms control. The reason is pessimism, personal and general. In April 1972, a Biological Weapons Convention was launched in London, Moscow and Washington. Any state that ratified thereby committed itself 'to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons' (Preamble). No development, production, storage or export were to be allowed (Articles III and IV). Alas, the textual provisions for applying these principles were and remain waffle. No inspectorate is envisaged. Any State Party finding 'any other State Party is acting in breach of obligations' (Article VI) may complain to the Security Council. Nothing is to be done to inhibit the application of biological agents and toxins to peaceful purposes (Article X), a distinction next to impossible to preserve. And what about the offensive development of agents merely in order to practise defence against them?

France abstained from endorsement of the draft text in the General Assembly, complaining of the inadequacy of the controls. China dismissed the whole business as 'a sham'. Among the countries listed in that 1993 Jane's survey as most likely to be involved in biological warfare were three who had ratified this convention within three years of its launch. They were India, Iran and South Africa. In March 1975, the USSR deposited its ratification.[42] In 1992, Moscow formally admitted its research into biological warfare had included an offensive dimension ever since 1946.[43] Biological warfare research had been carried on in several of the USSR's 'secret cities', an archipelago that must have been under American surveillance these past 40 years but about which we heard little or nothing from either side until very recently.[44]

Moreover, proposals for strengthening the convention make thin reading. There appears to be general agreement that what scope for detection there may be derives from (a) the need to protect those involved from anti-human pathogens and (b) the desirability of field testing for anti-crop agents.[45] It is hard to think of a subject that better demonstrates how important it is to curtail the arms race but also how difficult this will be.

Missilry

The possibilities for controlling proliferation, at any rate, look rosier when one turns to missiles (and especially ballistic missiles) as means of delivery. This is partly

because of the formidable challenges always encountered when developing ballistic missiles that are accurate over long ranges. Nor least does this apply in regard to re-entering the atmosphere. A new and excellent review of ballistic missile spread, seen particularly in relation to technology, shows how all past experience indicates re-entry to be 'the most difficult single technical problem for emerging rocket powers, making it extremely difficult for them to create effective ballistic missiles with ranges greater than 1500 km or so'.[46] The only rider to add is one that may reinforce this point. It is that the literature in general may dwell too much on that initial threshold and too little on the velocity-squared build up of thermal stress that continues beyond it. The aerospace community is habituated, after all, to think in terms of the sound barrier in aerodynamic flight, which can loosely be described as a once-and-for-all effect as air flow realigns around aerofoil surfaces.

Two alternative modes of re-entry were defined early on. The one is to have a wide, rounded heat sink at the head of the nose cone; and this requires elaborate testing in a high-performance wind tunnel. The other is to accept the rapid ablation of a very pointed nose cone, the design of which is best determined via a test rocket programme. The latter mode is far less susceptible to wind drift but seems harder to develop. The Chinese seem to have resigned themselves *pro tem* to serious terminal inaccuracies. The French turned surreptitiously to the Americans for assistance in the mid-1970s.

Missile guidance is an aspect liable always to depend heavily on technology transfer: 'Every major missile guidance system can trace its roots from German wartime innovations, through the United States or the Soviet Union'.[47] The prognosis from here on out is that the long-range rocketry of some other countries (and especially China) will gradually catch up with the fluid-bearing inertial systems refined by the USA and then the USSR during the last decade or two of the Cold War. China applied inertial stabilisation in her DF-5 ICBM which became operational in 1981. Previously, she had relied exclusively in this sphere on 'strap-down' systems: ones in which the key elements are bolted to the missile framework rather than brought together on a stabilised inertial platform. The Chinese are likely to introduce fluid-bearing inertial sets within the next 15 years. Meanwhile, even the improved Scuds as developed by Baghdad and Pyongyang still rely on strap down. Cumulative inaccuracy might make this remedy of little value beyond about 900 km.[48] If so, that alone is bound to temper visions of North Korea's developing an ICBM unaided.

This particular point is underscored by the propulsion problem. Seeking efficient increments in power whether by going for multi-stage or for clustered engines is a demanding task. Smooth stage separation can be critically important, especially that between the final stage and the missile bus or RV.

Aerospace, An East Asian Value?

The impression thus conveyed of how difficult long-range ballistic missile development is even for China and North Korea (in the absence of Russian involvement) is borne out by the recent record. Consideration has already been given to North Korea. In China, we have a country generally aware of her traditional prestige but also particularly aware of the contrast between her ancient scientific prowess and her twentieth-century technological backwardness. From that background has stemmed a dour confidence that things can and will be put right in due course.

That psychology is not to be discounted. What was evident to ourselves, during twinned lecture tours of China in 1987, was how much the economic boom then incipient was being informed by the preparedness of those in authority to assess candidly their current capabilities and the improvements most urgently required. No doubt it was that same firmness of purpose that had enabled Beijing to achieve thermonuclear status by 1967 in spite of the cessation of Soviet aid in 1960, already a time of acute economic crisis across China as the Great Leap Forward experiment in social reconstruction turned to bitter ashes. Evidently, too, the replication of Soviet aircraft (up to and including the Mig-23) has been tackled with flair, which is good reason why the Pakistani Air Force continues to fly these machines in half its tactical squadrons. Nor should one ignore how Chinese artillery development was praised for its precision, honesty and thoroughness by the late Dr G.V. Bull[49], never mind for the moment how amorally fanatic his own approach to gun design was.

Yet in spite of everything, China is not finding it at all easy to sustain a viable Space programme. True to the Lin Piao strategy identified in Chapter 2, Chairman Mao endorsed the independent development of orbital satellites at the very time he was launching the Great Leap Forward at village and precinct level in 1958. Between 1970 and 1989, some 21 launches were carried out, all but three of them successfully. In 1986, a telecommunications satellite was placed in geostationary orbit by a Long March 3, a modified ICBM that burns hydrogen with oxygen in its third stage. By 1988, the first two commercial payloads had been placed in orbit; and soon China seemed *en route* to a special place in that exotic service industry, combining uniquely low cost with good reliability.[50] But of the six commercial Long March launches conducted these last two years, three have failed.[51]

The point is, though, that progress with strategic offensive rocketry has been even more unsteady. China's forlorn endeavours to create a flotilla of strategic missile-firing submarines were alluded to in Chapter 4. Her land-based force comprises 90 to 100 missiles on static sites. All but 17 are liquid-fuelled CSS-2s (DF-3s) adjudged able to fire single warheads of one or two megatons across 2750 km. The rest are two types of ICBM with single warheads of several megatons yield apiece. Both first entered service around 15 years ago. The bigger model, the DF-5, may have one solid-fuelled stage; and has been tested with multiple warheads. While little evidence has been released on site hardening, one must presume this to be constrained by the operational complications associated with liquid-fuelled rockets. Yet China successfully tested a thermonuclear device nearly thirty years ago. This seems to confirm the point that warheads of mass destruction are a sight easier to develop than the means of their long-distance delivery.

None the less, aerospace (like nuclear energy) is emerging as something of an East Asian value, including on the manufacturing side. Japan is addressed in Chapter 6. Indonesia, too, is striving to create a 'regionally dominant civil and military aircraft industry'. Its national company, IPTN, was established twenty years ago. Sustained by heavy subsidies and by offset/licensing agreements with several European countries, it already provides 15,000 jobs. However, neither surface-to-air systems nor BMD appear to be on its immediate agenda.

In that field, the way ahead has appeared more evident to Taiwan. Work on a Tien Kung-1 (TK-1) or Sky Bow-1 air defence missile began at the Chung Shan Institute of Science and Technology in Taipei in 1981, as did work on a TK-2 around 1986. Essentially speaking, the TK-1 is a combination of a Patriot launcher and Improved Hawk electronics. Reportedly, it successfully intercepted a Hawk missile

some years back. With both the TK-1 and TK-2, the phased-array radar as well as the launch platforms are truck-mounted. In addition to an extra rocket stage, improved in-flight guidance and adaptation to vertical launch, the TK-2 missile incorporates an active terminal seeker. The TK-2 has a slant range of 80 km and the TK-1 of 50. In 1989, it was announced that 900 TK-1 missiles were to be produced over the next eight years.[52] Now it is said TK-2 production will start at the turn of the century. The General Staff are understood to accept that TK-2 is unlikely fully to match performance-wise the on-going Patriot series (also on order as an interim measure) but believe it will proffer some leverage in the negotiation of overseas purchases. Beijing's warning shots this Spring revived an interest in Taipeh in surface-to-surface ballistic missiles, including a Sky Bow adaptation. However, this seems unlikely to be persevered with, if only for fear of its being labelled 'provocative'. If, as now seems more likely, Taiwan moves towards a very high-technology professional army, BMD could assume some prominence within it.

To what end? Presumably to try and deny Beijing the option of selective or demonstrative missile strikes, an option that could badly damage international business confidence in Taiwan. Meanwhile, the Taiwanese themselves are proving hard to panic. A survey published in *The China Times*, a leading Taipei newspaper, this January showed them taking a very measured view of the overall threat.[53] My impression when there this April, in the immediate aftermath of those admonitory missile shoots, was very similar.

Within the Arab-Iranian zone, the capability for aerospace production is as yet minimal. What there is will be very largely concerned with assembly (e.g. Scud missiles in Iran and Syria?) as opposed to manufacture or, still less, development. In his recent world survey of aerospace manufacture, Keith Hayward found no occasion to mention the region at all. Compare that with his extended treatment of South and East Asia.[54] Certainly, Iraq did not progress with missile development as smoothly as it did with warheads of mass destruction. Whatever the regional or national level of technical development, however, the potentialities of a particular regime will depend considerably on organisational factors. Israel and North Korea have well been cited as two countries which, despite huge differences in political culture, share a talent for gearing their aerospace industry to an appropriate number of defined goals.[55] Saddam Hussein's Iraq has never had that attribute in sufficient measure. Perhaps even China has lacked it to date. By 1988, she had in service in her maritime arms alone (navy, coastal and navy air) no fewer than 24 types of guided missiles and unguided rockets, from man-held weapons upwards. All or nearly all these designs were being manufactured in China itself.[56]

MTCR

The *modus operandi* of the Missile Technology Control Regime (MTCR) as the leading institutional constraint on missile proliferation was outlined in Chapter 2. How it can contribute to checking the spread of rockets, in particular, is shown by the case of the Condor 2. Iraq took the lead, with Egypt and Argentina in support, in the attempted development from 1984 of this system with its specified range of 900 km. Among the reasons for the termination of the multi-billion dollar programme without fruition in 1990-1 were general pressure from the MTCR membership, particular pressure by the United States on Egypt and maybe industrial sabotage.[57]

Imposing adequate constraint the MCTR way is far from easy, even in the not too disordered world we now enjoy. The setting of a lower range limit as high as 300 km

for the systems covered may be inevitable but has excluded a wide panoply from purview. A 1994 estimate was that 37 countries were operating ballistic missiles in the 40 to 300 km range bracket.[58] A desire not to impede the development of civil Space launchers can create further loopholes even though these may be less extensive than those between cruise missilry and civil aviation. A factor more broadly in play is the interest various dubious parties have in making the international trade in weapons components even more labyrinthine than it might inherently be.

Recent discussion has highlighted the added complication that Surface-to-Air Missiles (SAM) may be convertible into tolerably efficient surface-to-surface missiles. Sky Bow was mentioned above in this connection. In 1987, South Korea caused diplomatic ructions by stating it was prepared to divert Nike Hercules SAM to this end.[59] Serbs fired the SA-2, the original Soviet home air defence model, against Bosnian cities in the autumn of 1994.[60] Earlier the SA-2 had been adapted by the Chinese. Upgraded with solid propellant motors, it became the M-7, designated by NATO the CSS-8.[61] Some 25 launchers and 200 missiles were exported to Iran (see above).[62]

Yet in spite of everything, the spread of the longer-range missiles, ballistic and also cruise, is now subject to heavy brake action, more so than several years ago. How heavy it can continue to be, this next quarter of a century and beyond, is the moot point. How secure the whole arms control process is long-term, in this realm and more generally, is no less problematic. These last 200 years the advances that have been made in subjecting war to formalised constraints have stemmed largely from the paramountcy of the Anglo-Americans and from their regard for the rule of law. As Russia and China grow stronger, they are going to challenge the current American ascendancy. Even if they do not wax outright bellicose, we are bound to see some pretty negative politics. We shall almost certainly see a more rough-and-ready approach to arms control.

At this stage, it is important to recognise how fragile is that cornerstone of the arms control edifice, the ABM treaty of 1972. For the United States to cast it aside cavalierly would be the height of folly, a gratuitous affront to world opinion. Granted, the timing of any dialogue with Russia about the treaty's replacement would have to be judged most carefully, not least with reference to the impact on her internal politics. The fact remains there is an ever-widening discordance in spirit and substance between the 1972 formulation and what has been going on around the world, with the connivance or involvement of the White House and the Kremlin.

It is not just that the first sentence of Article V commits both signatories 'not to develop, test or deploy ABM systems or components which are sea-based, air-based, Space-based or mobile land-based'. Various other articles or appended agreed statements are mocked by what is currently happening. The preamble states that the treaty's prime aim is to curb the strategic arms race. In the interim, however, technical dexterity has blurred more and more the difference between 'strategic' and 'tactical' weapons, be they offensive or defensive. So, too, has the strategic revolution. Meanwhile, the neat distinction between anti-missile and anti-aircraft has been fading. That between ABM and Anti-Satellite (ASAT) began to years ago.

All in all, it looks unlikely that one can preserve far into the next century the 1972 accord. This is regardless of any nuances of 'broad' interpretation that may be allowable or of attempts to 'clarify its terms', the sort of revisionary exercise some American liberals have hoped may suffice. The crux 'is that this text deals with a category of weapons that has since lost its singularity. You might as well try and

construct an arms pact around the light bomber or the battle cruiser or the siege gun. A no less obvious anachronism is that the treaty is between just two States whereas various others are now acquiring a range of relevant capabilities'.[63] With this backward-looking character, it is redolent of other arms control accords: the Washington Naval Conference, the Montreux Convention, ... It has been said time out of mind that generals are always preparing to fight the last war. It can be said with equal justification that arms controllers are always seeking to prevent it.

6 - The New Geopolitics

Evidently a prime aim of our external policy, nationally and across the alliance, must be to back the strong forces at work within the developing world in favour of moderation, those that seek peaceful progress towards pluralist democracy. Equally apparent is that supporting the moderate involves being tough with the despotic.

As and when our forces are again committed in coalition campaigns out of area, the weapons they face will be likely to include battlefield missiles, ballistic and cruise. Hostile action more directly against Europe or North America might include strategic missile strikes. Additionally or alternatively, it could assume other forms. Currency manipulations and export embargoes may be less things of the past than we might wish. After all, OPEC still exists; and its members still control three-quarters of the world's commercially-viable oil reserves.[1] Non-collaboration in the management of the environment may emerge as yet another stratagem for confrontation with the West.

None the less, the kind of aggression dictators may find easiest to set in train is terrorism. Cultural confusion and underemployment may generate extremism among the urban young more strongly as time goes by. Pertinent, too, is the reality that it is easier for a backward regime to fabricate certain kinds of mass destruction warheads than the aerospace vehicles that deliver them. With or without these warheads, the projection of terrorism can be global. Another advantage of this mode of aggression may be unclear attribution. In the summer of 1914, the Entente powers accepted the denial by the government in Belgrade of Austrian claims that it was implicated in the assassination in Sarajevo of Archduke Ferdinand. We now know several members of the Serbian cabinet were privy to the conspiracy.

The weak link in terrorism as an instrument of conflict is the obverse of what has just been said. It is a government's inability to control the terrorists as firmly as it can normally expect to its regular forces, including whatever bombers or missile crews it may command. This will make even the Libyas of this world more reluctant to entrust mass destruction devices to terrorist hands than is sometimes assumed.[2] That will certainly apply if by 'mass destruction' one means nuclear and biological as opposed to chemical. 'Rogue nation' possession will not automatically connote terrorist access.

So one does well to identify the purposes to which a developing nation might put strategic missiles. A long-range warning shot is the first option. A somewhat tougher one is pre-emptive attack on the troops a nation like Britain, France, Germany or the United States might deploy against the regime in question, perhaps in response to economic warfare or a terror campaign. The ultimate stratagem is using warheads of mass destruction against those troops or their homelands. This last option, in the sense, is the most basic. After all, it would involve recourse to not many missiles used without much finesse.

However, a small strategic force dedicated solely to so simple an end could be vulnerable to pre-emptive destruction on site. Everything would depend on numbers and technology set in the context of the geography and geometry of the particular strategic situation. Let us take the forty CSS-2 (together with 10 launchers) China has supplied to Saudi Arabia. Being liquid-fuelled and immobile, they must be inherently susceptible to pre-emptive attack. If so, they might only be usable pre-emptively themselves. Even as things are, that proposition could bear on the Saudi relationship with Iran and with Israel. Were a more radical regime to assume power in Riyadh, those CSS-2s might be a strategic factor throughout the Middle East and Eastern Mediterranean. The proneness of revolutionary polities drastically to misjudge a

strategic situation, every now and again, would also have to be allowed for in such an eventuality.

Considerations of this kind do make a *prima facie* case for a thin screen deployment of strategic BMD. To acknowledge as much is to concede no questions about deployment patterns or schedules in given circumstances. But speaking still in general terms, the case is strengthened by the risk of unauthorised release. Much attention has been given in the literature to psychotic illness on the part of a key operative, the 'Caine Mutiny' syndrome. But that hazard has always to be set in the wider political and strategic context. Most worrisome is the possibility of polities possessed of strategic weapons actually disintegrating.[3] During that nationwide Maoist upsurge of orchestrated hooliganism known as the Cultural Revolution (1966-9), much interest was shown in the West in which of the latter-day Chinese warlords that episode was spawning might locally gain control of nuclear triggers. With the break-up of the USSR, the United States felt obliged to launch a multipronged campaign to assist the regrouping of all such assets within the Russian Federation, along with much actual dismantling.

Weakened central control can pose acutely the problem of apportioning responsibility for warlike acts, externally directed. Whose writ actually ran on a given occasion? Amidst the post-war chaos of 1920, Polish troops seized from Lithuania the historic town of Vilna. The Pilsudski government in Warsaw speciously insisted that local commanders had taken matters into their own hands. In the resultant confusion, the infant League of Nations was reduced to humiliating passivity. In 1931, Japan's Kwantung army precipitated the fighting in Manchuria that led to its taking the whole province over. A democratically-elected government in Tokyo rightfully pleaded that these militarists were out of control. Again, the League was first confused and then humiliated.

Firm command-and-control is needed for any strategic deterrent, in order to minimise the risk of wildcat release and to help the outside world read aright the circumstances in which any untoward event has taken place. Unfortunately, there is little hard evidence in the open literature as to what arrangements have been, or may be, made within the newer nuclear nations: that is to say, within India, Israel, North Korea or Pakistan. Particularly relevant is the Permissive Action Link (PAL), an American invention designed to preclude the use of a nuclear weapon without the prior insertion of a numerical code only to be obtained once an unlock (probably two-key) has been duly authorised. This routine, originally proposed by Fred Iklé and taken up by President Kennedy, is sound and, one could say, basic. But it seems never to have been adopted by China.[4] Nor may any nuclear power have applied it comprehensively as yet. So it would not be surprising if none of the new members of the nuclear club has taken it properly on board.

The Russian Malaise

What then of the risk of an accidental or unauthorised release from Russia, one of the possibilities addressed in PFS? On this subject the Pentagon has declared itself sanguine. It has thereby aligned with a view prevalent among arms control liberals since Soviet days. Witness a commentary crafted in the middle of 1991: 'This issue has been discussed frequently over the past two decades with Soviet officials and scientists who are fully aware of US procedures and have reported that the Soviet Union has similar procedures. The Chairman of the Joint Chiefs, Colin Powell, has stated that his knowledge of Soviet safeguards leaves him comfortable that nuclear

weapons will not get into improper hands and would be *unusable* if they did... . The new leadership, both military and civilian, has offered repeated assurances that nuclear weapons will remain under central control and has indicated that safeguards are to be reviewed and, if necessary, strengthened'. (my italics)[5]

This view is backed by a very elaborated study from that bastion of American arms control liberalism, the Brookings Institution. Carrying the story through to the 1991 crisis, it tells how institutional command chains underpinned by electronic links kept the control of Soviet nuclear weapons firmly in the hands of several people at the centre. Under normal circumstances, this could allow of a low alert status - e.g. keeping warheads and missiles separate. In the abnormal circumstance of an American surprise attack, it could even involve centralised release by automation, the missile crews being by-passed. There was said to be no way the leaders of the failed coup of 1991 could have suborned this network, had they dared try.[6] One could see that the continued deployment around Moscow of BMD (to the level of 100 launchers allowed by the 1972 and 1974 accords) as a token of this emphasis on tight central control.

On this reckoning, the wildcat release of missiles from Soviet or now Russian soil could never occur, whatever the ambient circumstances. On a wider interpretation, however, anxieties remain. Does Moscow's record in regard to the management of civil nuclear power or the disposal of nuclear waste engender confidence in her always keeping proper control of nuclear weapons? What of the difficulty she has lately had ascertaining the size of her own plutonium stockpile? What of her rough-and-ready arrangements for the storage of decommissioned fissile material? And is not there a contradiction between the Kremlin's oft-stated precept of tight centralisation by the military of nuclear control and the way Soviet doctrine manuals depicted the nuclear land battle as just another form of open mobile warfare? Is there not a further contradiction in the USSR's possessing no fewer than 54,000 nuclear warheads in the peak year of 1985?[7] Concern is not assuaged by intimations that, during the 1962 Cuba crisis, discretionary control over the release of nuclear warheads then in place on the island was devolved more or less unconditionally to the hardline Soviet commander there. Nor is it by the USSR's having built up a capability for biological warfare that does not enter into this Brookings' reckoning. All in all, Moscow actually looks less reliable as a nuclear custodian than do Islamabad, Jerusalem or New Delhi, save perhaps for the Kremlin's extensive recourse to electronic locks. But we might find the next generation of proliferators more hair-raising than any of them.

But as regards post-Soviet Moscow, concern lest things one day get out of hand should probably relate less to the possibility of some incidental irregularity within the *status quo* than to that of a disintegrative crisis at national level. Before his fall in 1991, Mikhail Gorbachev was warning that, should *glasnost* and *perestroika* (openness and restructuring) fail to achieve a political and economic alchemy, the USSR could become 'another Lebanon'. A year earlier, Eduard Shevardnadze had warned that failure would mean a return to dictatorship.[8] Those admonitions were alternate sides of the same coin. The danger that the USSR might fragment has been removed by the removal of the USSR itself. But the possibility that the Russian Federation will face a disintegration crisis, sometime in the next two or three decades, still has to be reckoned with. A chauvinist authoritarianism imposed to curb fissiparous tendencies could have proved more repressive than a straight continuation of the Brezhnev era might have.

Clearly, the risk is exacerbated by the mess Russia has slid into as a society. It was bad enough to find, two or three years back, public figures in Moscow and St Petersburg comparing their situation with that of Weimar Germany. It is worse to have to concede today that in some behavioural aspects (e.g. the ramification of syndicated violence and of corruption), Russia may be sicker than Weimar was on the eve of its lurch into Nazism. A morbid sense of national humiliation may be more obsessive, too.

The extent of the syndrome was trenchantly depicted by Lady Thatcher in her John Findley Green Foundation lecture in Fulton, Missouri, this March: 'the Soviet empire in its collapse released all the ills of ethnic, social and political backwardness which it had frozen in suspended animation for so long. ... The absence of the legal and customary foundations of a free economy led to a distorted "robber capitalism", one dominated by the combined forces of the mafia and the old Communist nomenklatura, with little appeal to ordinary people. The moral vacuum created by communism in everyday life was filled for some by a revived Orthodox Church but for others by the rise in crime, corruption, gambling and drug addiction - all contributing to a spreading ethic of luck, a belief that economic life is a zero-sum game, and an irrational nostalgia for a totalitarian order without totalitarian methods. .... whoever wins the forthcoming Russian elections will almost certainly institute a more assertive foreign policy, one less friendly to the US'.[9] It is an overview that has all too strong a ring of truth; and which offers no assured peace in the years or even the decades ahead. For as long as this malaise persists, it will be hard for any government in Moscow not to view negatively those tendencies towards regional devolution that might otherwise do much to promote the whole process of economic and political liberalisation.[10,11,12]

In the absence of proper devolution, outright secession would still be improbable, even in the North Caucasus.[13] Much more likely would be the further spread of mafia archipelagos which the Kremlin then had to act forcefully against. At present, the military appears reluctant to get deeper into routine internal security.[14] But that attitude could change with a transition to all-volunteer enlistment and some restoration of morale. Securing the national borders has historically been a major preoccupation of Moscow. It could become the theme that links the external and internal roles.

The outside world would have nothing to gain from Russia's becoming progressively more anarchic. Take one prominent issue, that of the stockpiles created by the decommissioning of nuclear weapons in accordance with arms control agreements. Moscow is legatee to 'over 45 tonnes of highly enriched uranium and 15 tonnes of plutonium as well as countless components emerging annually into a storage system that, by the Russians' own admission, is 20 to 30 years out of date and underfunded; and thus vulnerable to scavenging by countries or terrorist groups that are after nuclear materials and hardware'.[15] That annual throughput would be enough to make over 10,000 Hiroshima and Nagasaki bombs. Given a state of anarchy, some of this could find its way into rogue hands, at home or abroad. That may not be the same as saying terrorist nuclear arsenals will spring up everywhere. But it is still a disconcerting prospect.

Nevertheless, the greater likelihood may be that corruption and disorderliness induce a backlash that elevates into the Kremlin a regime of authoritarian chauvinists. Nor should this be seen as a possibility only in the short term. Historical analogies suggest that, even on best-case assumptions, it could be several decades before Russia

becomes so akin to the West that hostilities between her and ourselves are no more conceivable than between, say, Britain and Norway.

A further factor to reckon with will be the always convoluted interplay between Moscow and Beijing. The spectacular nature of the 'economic miracle' now unfolding in China cannot gainsay the contradictions this is generating in terms of ecological stress, demographic expansion, inter-regional imbalances in production, lack of personal freedom and sheer corruption. She is entering upon what may be a very drawn out crisis of political adjustment. Meanwhile she is improving her military panoply, most notably through the indigenous production of a perhaps undue diversity of tactical missiles. She is still enough of an LDC to find such missilry a sight easier to develop than strike aircraft truly adapted to this electronic age.

The worst near-term outcome would be that hardliners inherit the Deng Xiaoping succession in Beijing and make common cause with people of similar ilk who by then have triumphed in Moscow, either displacing Boris Yeltsin or else incorporating him. The two regimes might still be considerably at variance, nationally and in terms of stated ideology. Nevertheless, they would share a detestation of what (in the aftermath of the Tiananmen Square showdown) Deng spoke of as 'bourgeois liberalism and cultural pollution'. The career of Lin Piao (1908-1971) is again salutary, illustrating this time the ambiguities of affiliation that can arise. On successive occasions from 1927 onwards, this revolutionary veteran put himself at the head of anti-Muscovite radicals. Yet in 1971 he died in a plane crash in Mongolia *en route* to exile in Moscow. He was fleeing from the backlash within China against a Cultural Revolution that he himself had helped Chairman Mao unleash, this in defiance of Kremlin advice.

If ever a Moscow-Beijing axis is forged anew, the BMD question could prove a lot more fulcral than it is usually admitted to be in the West's relations with China. In SDI days, China took far more interest than any other developing country in the pros and cons. In several statements made in the second half of 1985, Deng warned that Space-based defence would destabilise the military balance.[16] As regards missile defence in the round, however, the disposition in Beijing then was to place the onus not on the Americans alone but on the interaction between two opportunistic states. Witness the insistence that Soviet BMD research 'actually started long before the US launching of SDI'.[17] At a press conference in February last year, however, an official from China's Foreign Ministry took a firmly anti-Washington line. He indicated his country's opposition to 'any modified form of the Strategic Defense Initiative because it will touch off another round in the arms race in Outer Space' and thereby 'increase the danger of nuclear war'.[18] Perhaps this heavily loaded reference to Outer Space was intended to leave Beijing's own options open in respect of surface-based BMD.

A Resurgent Threat?

Suppose that, with or without encouragement from Beijing, Moscow does revert to martial chauvinism. How might this lead to aggressive action? Perhaps the first notion to dispel is that her military establishment is now too much of a shambles for this ever to happen. The evidence of history is that Russia's military might can sometimes recuperate dramatically. Take the purge of his armed forces Stalin began in 1937 (see Chapter 2). The effects thereof became dreadfully apparent during the Winter War against Finland, 1939-40, when the Red Army lost 273,000 dead, nine times as many as the Finns had troops in the field.[19] In 1941 and 1942, it was to

endure further terrible reverses at the hands of the Wehrmacht. But then it relentlessly drove the Germans back, all the way from Stalingrad to Berlin.

Granted, the social discipline this recovery depended on would be hard to impose anywhere in the world today. Relevant, too, is that it is becoming harder to make up leeway in basic technology, especially electronics. Lead times for weapons development and for training tend to be longer too. Even so, it would be wise to assume that Moscow's panoply could be reconstituted within fifteen years by a regime bent on achieving this. In the particular case of long-range ballistic missiles, restitution could be that bit easier, technically and managerially. The outlook is also influenced by (a) the evolution of arms control, (b) Moscow's withdrawal from Eastern Europe and (c) her historical preoccupation with a counter-European strategy.

Rarely has that strategy been made more manifest than at the start of the missile era. By late 1962, five years after Sputnik 1, the USSR's ICBM echelon had expanded to only 75, the state of affairs that had left it so desperately exposed to a Counterforce first strike (see Chapter 1). Yet between 1961 and 1963, no fewer than 700 Medium and Intermediate-Range Ballistic Missiles (MRBMs and IRBMs) were deployed inside the USSR's western borders, targetted on NATO Europe. According to the American definitions then in currency across the alliance, the range of an MRBM was between 800 and 2500 km; and of an IRBM, between 2500 and 5500.

Hardly less remarkable than the 1962 situation is that well under a third of the MRBMs/IRBMs were to be diverted East of the Urals during the build-up opposite China that began as soon as Mao Tse-Tung launched the Cultural Revolution in 1966. Even in mid-1988, some 305 out of a total of 467 deployed launchers were still inside those western borders and only 162 opposite China.[20] But by then the USSR was implementing its side of the Intermediate Nuclear Forces (INF) agreement of December 1987. This committed each superpower to the worldwide elimination, inside three years, of all ground-launched missiles, ballistic and cruise, within the range spectrum of 500 to 5500 km. As much duly happened. The Strategic Arms Reduction Talks (START) are likewise important. If the USA and Russia proceed as planned and fully implement both the START I and START II agreements by 2003, their inventories of strategic nuclear weapons will then have shrunk by two-thirds since their peak. In this particular context, 'strategic' is still taken only to mean being able to hit the heartland of North America or Eurasia respectively. However, such weapons could be directed almost instantly against theatres like Europe. But the lower the inventories are, the less likely will this be.

Interaction with Moscow

Granted, all of this presupposes the continuation of arms control. Granted, too, that this in turn is going to depend heavily on the tolerably smooth continuation of liberalisation and modernisation in Russia. Whether this happens will be governed, first and foremost, by internal factors. At certain junctures, however, the impact of Western strategy and diplomacy may be crucial as was the case with SDI in 1986-7. This could apply with NATO enlargement or civil space collaboration or strategic arms control. The timing and substance of any revision of the ABM treaty could be a matter of particular sensitivity.

The acid test of any overtures to Russia that bear on international security has to be this. Would her concurrence with whatever is proposed strengthen within her body politic the forces of constitutional progress, not those of authoritarian reaction? When the former are not merely in power but retain the initiative, then forging such links with

the outside world may further bolster their position. When instead their grip is weak, a backlash against them may be further encouraged by undue suasion by the West.

Take the saga of Global Protection System Against Limited Strikes (GPALS). One commitment Presidents Bush and Yeltsin entered into at their summit in Washington in June 1992 was to explore urgently the scope for (a) establishing a ballistic missile early warning centre, (b) co-operation with other states in developing capabilities for BMD and (c) a legal basis for co-operation that could include new treaties and agreements or changes in existing ones in order to implement GPALS. In July, high level delegations met in Moscow for what they termed 'good and fruitful discussions on all relevant issues'. Three working groups were established.

It had all started with the visit of Boris Yeltsin to the West that January. Addressing the United Nations, he averred, 'the time has come to consider creating a global system for protection of the world community. It could be based on a reorientation of the US Strategic Defense Initiative to make use of technologies developed in Russia's defence complex'. *En route* through London he told the BBC that Russia would adhere to the ABM treaty but stood 'ready to continue impartial discussion ... on the limitation of non-nuclear anti-ballistic missile systems'. He also proclaimed his country's desire to become a 'full-blooded member of the European Community'. That quixotic departure must have helped convince his critics at home that the whole foray was 'hasty and premature'.[21]

A week after the Washington summit, *Izvestiya* printed an interview on strategic arms cuts with General Pavel Grachev, the Russian Defence Minister. In the course of it, he said that if 'the United States tries to step outside the bounds of the ABM treaty' the existing accords (the draft START treaty and some further cuts agreed in Washington) would immediately lapse. He thus put himself squarely at the head of the opposition to everything the summit had connoted. No doubt his stance is a major reason why GPALS has been stalled these last three years. Some collaboration on TMD does continue between Washington and Moscow. Witness the simulation being conducted this summer on the joint battle management of the SA-12 and the Patriot. But that is in part tokenism and in part a natural outgrowth of the dialectic about TMD/NMD demarcation.

Interpreted more widely, the general's remarks bespoke a concurrence between Russian conservatives and American liberals in that both were committing themselves to the preservation of the ABM treaty, very much in its pristine form. Hopefully, however, these two schools of thought may eventually come tacitly together in support of the rather more coherent principle of the non-weaponisation of Space. Understanding Moscow's philosophy of BMD was extremely difficult in the Soviet era because (a) any techniques that had attracted military interest were *ipso facto* subject to the most immutable censorship, and (b) Soviet commentators on scientific progress were prone to wax lyrical about ultimate possibilities, as opposed to immediate ones, whether for war or peace. Nevertheless, one could discern an authentic distinction being made between terrestrial BMD and 'Space-strike weapons', the former being acceptable but not the latter.[22]

The 1985 statements by Deng Xiaoping alluded to above were cast along similar lines. In the Chinese case, the gist of the argument against Space weapons was as follows. Whereas the USA might have a tolerably adequate canopy in place soon after the turn of the century, the USSR would be unable to follow suit for another 15 years or so. In the interim, her behaviour could become erratic, with a disposition towards pre-emptive attack. Afterwards, a duopoly in Space-based strategic defence could

tempt Washington and Moscow to work towards an oppressive condominium affecting a whole range of world issues. All of which indicates that any future move by the United States to deploy weapons in Space would invoke a fiercely hostile reaction in Beijing as well as Moscow.

So there is much that could undermine the regime of multi-pronged arms control, presently seen as so vital to curbing the spread of mass destruction warheads and offensive missiles. On the other hand, the longer this regime continues intact the more secure it should be. Even so, no state should rest its defence policy on the presumption that, beyond some ill-determined point, reversion is inconceivable. Arms accords have been flouted too flagrantly too often in the course of this century to warrant that. What the West can allow is that it would take an aggressive Russia a decade at least to disentangle itself from arms control and build anew an MRBM/IRBM echelon tantamount to the *status quo ante* of 1987. With China, the analysis would proceed differently but might well lead to a similar conclusion as regards the warning time for a strategic missile threat.

As always with defence policy, one must work from cautious pessimism. So how far might a more belligerent Moscow be prepared, with or without Beijing's support, to strengthen militarily anti-Western tendencies in the developing world? There are two ways in which this might be done with more efficacy (financial, logistic and operational) than by shipping out the full panoply of blitzkrieg after the fashion of the Cold War years. The one way would be the supply of light weapons to guerrilla movements; the other the supply to governments of offensive missiles though not, one presumes, warheads of mass destruction.

Against this, it could be argued that Moscow would be unlikely ever to encourage weapons proliferation in the 'South' that involved (a) supplying missiles that could bring her own territory within range, and (b) lending support to regimes she was not akin to philosophically. Nor could one deny that each reservation must carry some weight. In the 1980s, Moscow was exercised about Israel's development of the Jericho ballistic missile, the second variant of which has a range of 1500 km and so would have been able to reach Soviet territory.[23] Then again, recent events in Afghanistan, Bosnia and the Caucasus have done something to revive historic grounds for regarding Islam as a perennial enemy of the Russian Orthodox faith.

In modern times, however, battle lines have rarely been drawn that unequivocally for long. Friends and foes are categories that overlap and alter, perhaps even more than in the past. For several years up to 1958, the Soviets did assist their Chinese neighbours towards military nuclear status, even though relations between the two Communist giants had been ambivalent ever since 1927. Then again, one has only to look at the close strategic partnership between pre-Gorbachev Moscow and Gadafi's Tripoli to appreciate the sublime indifference of each to their lack of philosophical affinity. Likewise in the future, a Moscow or Beijing upholding an authoritarian form of consumerism might make common cause with LDC autocracies of different complexion. Closed minds have a lot in common, regardless of how they are furnished.

Things in the Balance

Broadly speaking, Moscow's future strategy will be determined in one of two ways. The one is for external concerns to redound upon internal politics. The other is for an internal dialectic to determine attitudes to the wider world. The latter mechanism is dominant at the present time.

Yet if there is, in spite of everything, steady progress towards an open society and pluralist democracy, we are still unlikely to see a revival of GPALS 1992-style. More likely is a fairly positive interpretation of the 1994 Moscow-Washington declaration of a common desire to develop and deploy theatre BMD on a co-operative basis; and, more specifically, to conduct joint TMD exercises, early warning included.

If the internal balance does pitch towards authoritarianism once again (under Yeltsin, Lebed, Zyuganov or whoever) attitudes to defence as a whole, and BMD in particular, will become more autarkic. Something of the flavour then to be anticipated can be gleaned from a statement Pavel Grachev made on 23 May this year, shortly before his dismissal as defence minister. He said home air defence had to remain an independent service, one always at 90 per cent of its wartime manning levels. He went on to make particular reference to the S-300, the theatre anti-aircraft and anti-missile weapon NATO knows as the SA-12. He declared that 'air defense troops equipped with S-300 missile defense systems located all along the perimeter of the border of the Russian Federation guarantee a rebuff to a considerable large number of potential enemy targets which might carry nuclear weapons, at the approach to the Russian border'. What this exposition shows us is that, in practice, the 'theatre' versus 'strategic' distinction in BMD blurs even more easily for Russia than it does for the West. At the same time, the symbolism is very much that of the garrison state, solid around its periphery.

However things go, it will be important to predict how Russian BMD technology may compare with Western, after all the chaos of the last few years and the downgrading of military priorities. If, as is probable, Moscow feels Space-based BMD still to be far beyond her competence, she is likely to be all the more righteous in her opposition to any American forays in that direction. Her practical responses could include more reliance on mobile ICBMs, weapons able so to concentrate as to 'punch holes' in any SBL canopy. Her BMD response, in particular, could include a revival of Anti-Satellite (ASAT) weapons.

What has to be admitted is that, in the past, the West has been even worse at gauging the progress Moscow has made with BMD than it has her military technology as a whole.[24] Thus in 1985, a thorough scan of Soviet technical literature in the public domain uncovered hardly any interest in EMP: 'Only three articles ... all old, discuss the problem in detail; and they deal with ground-based rather than Space-borne communications. The discussions also do not touch on the intentional use of nuclear weapons for jamming communications'.[25] For all its rigour, however, this was a most inapposite case of negative proof, against the background of Soviet censorship. As much become clear when, in 1986, a synoptic review of the Space-weapon 'dilemma' was published in Moscow. In it, EMP was discussed at some length.[26]

It is improbable, whatever happens, that the Russian Federation will ever become as opaque as the USSR very generally was. But scope for error will remain. One needs, for instance, to be wary of suggestions (e.g. from BMDO) that the SA-12 is clearly superior to the PAC-2 if not the PAC-3.[27] That seems to be belied by indications that in its early variants at least, the SA-12 has retained the ultimate option of nuclear warheads. That is hardly a sign of assured operational dexterity.[28]

The Middle East

Strategically, the Middle East is today further away from both Moscow and Beijing than it was at the height of the Cold War. As acknowledged above, however, that does not exclude adventurism in that region, particularly by a Moscow prepared

once again to challenge the hegemony of the West. Temptation thus to become involved would be increased by the endemic instability of the Middle East and North Africa. No other region is so stressed by the tension between traditionalism and modernisation. High population growth is driving a rapid urban implosion. In many areas a deepening water crisis is driving people out of agriculture.

This much is well recognised. What even the economic/hydrological commentaries very regularly overlook, however, is the likelihood that some of most critical water crises within the region will be accentuated by climate change.[29] Even on a moderate prediction of the pace of global warming these next several decades, North Africa and much of the Middle East is very exposed to the poleward encroachments of desert margins that global warming will induce.

There are historical parallels. From about the seventh century AD, there was half a millennium of slow but quite insistent warming across Europe and the Mediterranean basin. During the first three or four centuries of this trend there was a visible shift of economic and geopolitical strength from the Mediterranean to North-West Europe; and this does correlate closely with declining rainfall around much of the Mediterranean and the Middle East.[30] Conversely, during the climax of the last big glaciation (some 17 to 20 thousand years ago) the Gulf Stream drift was curving its way past Portugal instead of between Scotland and Iceland. Much of the Sahara was correspondingly moist.[31]

A more immediate danger is a collapse of the Oslo peace process as between Israel and her neighbours: a collapse that would *inter alia* defer, perhaps forever, an equitable and stable solution of the Palestinian question. Here one has to confront the success in the Israeli premiership election this year of Likud, the legatee of the Irgun and of the Stern Gang. What worries one most about Likud is not its ideological fanaticism apropos such questions as Jewish settlements on the West Bank. It is its thuggish disregard for democratic norms. The two terrorist movements just referred to played the major part in the Arab expulsions of 1948, not to mention atrocities against British troops. The Israeli army historical division confirmed last year that, in the 1956 campaign, 273 Egyptian POWs were shot in cold blood by a paratroop battalion under the overall command of Ariel Sharon and Rafael Eytan, now members of the Likud government.[32] Likud resorted to orchestrated and sustained hooliganism to secure for itself victory in the critical Israeli election of 1981. The then Defence Minister Sharon and Eytan, as his Chief of Staff, bear heavy responsibility for the massacre of 1000 Palestinians by Lebanese Christian militia in the Sabra and Chatila refugee camps in 1982.

All this might be regarded as 'water under the bridge' but for one further blemish. The Likud-led campaign of vitriolic slander and innuendo against Yitzhak Rabin last year engendered the atmosphere that led to his murder.[33] The implication is that Britain will need to be very careful in its dealings with the Netanyahu administration especially as regards anything that might smack of a strategic relationship. The proper implementation, in spite of everything, of the Oslo peace accords has to be one test. But another ought to be how Israel is fitting into the general structure of counter-proliferation within the region. Here, BMD is a salient issue.

The history of Israeli BMD effectively dates from May 1986 with the signature of an SDI Memorandum of Understanding. That November, architecture studies were begun on the Arrow 1. This system first flew in August 1990; and achieved a test

interception some four years later. Its interceptor bears a large proximity-activated high-explosive warhead; and is credited with a slant range of 90 km.

Until the Gulf War of 1991, however, the Israel Defence Force was less than enthusiastic for BMD *per se*. It ran counter to the accepted philosophy of deterrence through pre-emption or heavy retaliation. Also the cost of each Scud kill was predicted at between 7.5 and 25 times the cost of a Scud: this on the basis of two Arrows (priced at $1.25 to 2.5 million apiece) being directed at each Scud with a sliced cost for infrastructure also being allowed for. Moreover, the estimate was that, in 20 years' time, an Arab coalition might be able to direct 300 missiles a day against Israel.[34] Yet in a seminal visit to the country in August 1985, none other than Dr Edward Teller had talked in terms of current BMD technologies merely warding off several missiles at a time from Gadafi or whoever. He freely conceded that not even SDI could ever be upgraded in any 'human way' to cope with 1000 missiles plus many decoys.[35] Not surprisingly then, many informed Israelis were little enamoured of BMD.

The 1991 experience changed all that. The Scud offensive showed that strategic deterrence did not always deter. Defense Minister Moshe Arens was already quite keen on Arrow but reluctant to issue anti-gas kits nationwide which he felt would engender panic. On that score he had to back down.[36] The minimal losses inflicted on the echelons of Scuds launchers in the course of several thousand aerial sorties were noted, as were the Iraqi experiments with dummy launchers. The failure of the Patriot PAC-1 and PAC-2 properly to intercept RVs was soon learned of, too, but tended to be put down to these weapons being, in essence, improvisations.

Now Israel is heavily into BMD, strongly encouraged by concessionary agreements made by the Clinton administration earlier this year as part of its desperate endeavour to keep Shimon Peres in power. The Arrow 1 is now being succeeded by the Arrow 2, formally given the go-ahead in April 1995. It has a more compact missile with a more sophisticated proximity-fused warhead; and is reportedly reduced in weight from 2000 to 1300 kg. But being steered only by vanes as opposed to thruster rockets, the Arrow's altitude ceiling remains well within the atmosphere.[37] Nor is its overland mobility at all impressive. It is seen by the Pentagon as a useful technology demonstrator, not a subject for joint procurement.

A year ago, it looked as if the American involvement with Arrow 2 would be a much less than with Arrow 1, if only because the latter had occasioned a lot of ill-feeling between the Israelis and Lockheed. But that is not how things have panned out. Thus only a few doubts are expressed on Capitol Hill about Arrow 1's having failed several interception flight tests or about the White House being happy to fund NMD for Israel but not for its own country.[38] As Senate Republican leader, Bob Dole backed the Arrow nexus zealously, as part of what he hoped would become a more 'full-fledged alliance'.[39]

The aim is to deploy the Arrow 2 in two main sites, in association with PAC-2, between 1999 and 2002. Rather over half the billion dollars the programme is forecast to cost over the next ten years is expected to come from the United States. Also included in an agreement signed between Shimon Peres and William Perry this April is an American pledge to continue to support the Nautilus programme for the ground-based engagement with infra-red laser of Katyusha rockets. Collaboration is also incipient on the IBIS concept for deep interception boost-phase by means of an Unmanned Aerial Vehicle launching and/or guiding mini-missiles.[40] Meanwhile, the United States does not demur at Israel's remaining outside the IAEA and NPT regimes.

Nor at her building up a nuclear stockpile that *Jane's Intelligence Review* surmises is close to 200 warheads.[41] The counter-proliferation strategy is not applied to Jerusalem.

Elsewhere in the Middle East, Britain and France appear willing to back, and quite possibly to join in, action to preclude a Libyan 'bomb' though alliance unity is less assured apropos Iran. Meanwhile, Iraq would find it more or less impossible to break out of the UN monitoring regime. Syria does not have much scope for posing a strategic threat to anywhere in the West nor a lot to gain from so doing. Most relevant is that economic crisis and diplomatic isolation have obliged North Korea resentfully to accept a form of détente with South Korea and the United States that has her own nuclear disarmament as its focus. If, as is quite possible, Pyongyang tries to twist or bludgeon her way out of this, it will be disposed to do so by picking a quarrel with Seoul rather than by confronting the Americans with shipments of advanced missiles to the Middle East.

Geopolitics Revisited

The state of affairs just depicted cannot last indefinitely. The United States will be stranded morally if Netanyahu exploits the strategic nexus with her to reduce the Palestinians to bantustan status in the manner apprehended by a distinguished professor at the Hebrew University.[42] Wider trends will also have an effect. The materials for biological war will be hard to track. So may cruise missile deployment. Meanwhile, the Arabian peninsula may gradually become unstable; and the West's military involvement therefore more contentious. Any distancing of themselves from the West on the part of Russia and China will both make any pre-emptive actions more risky and weaken the rest of the counter-proliferation regime.

Nor may pre-emption ever be feasible against any of the world's larger states. Nor might any such aspiration be helpful. Take India and Pakistan. It has well been argued that the best hope of peace on the subcontinent lies in the nuclear stability that already obtains. Each side has a small stockpile of nuclear bombs and/or fissile material; and strike aircraft suitable for retaliation but not for pre-emption.[43] Counter-proliferation should never be treated as an end in itself, an absolute to be pursued regardless of the circumstances of a given region or the totality of policy towards it.

These next several years, however, the spread within the Middle East (Israel perhaps still excepted) of ballistic missiles and of the means of mass destruction does show every sign of being tightly constrained. If so, this implies that no such threat could build up from that quarter against the heart of Europe in less than a decade. A corollary may be that European participation in a Gulf War-style expeditionary coalition looks similarly improbable in the region within that time frame. Even any action against Iran is likely to be confined to air and missile strikes. We shall not be marching on Tehran.

Yet if not in the Middle East, then where else will the West undertake expeditionary warfare on the grand scale against well-accoutred opposition? Latin America? Southern Africa? Southern Asia? Hardly. As we get deeper into a tension-ridden 21st century the parameters of strategy may change drastically, geographically as in other respects. But not these next ten years. The Korean peninsula is the one place that presents itself within that time frame for what would be, in any case, a rather constrictive version of the Gulf War scenario.

The implication is that we have to embark on a fundamental reassessment of the threat, geopolitically speaking. These last four years or so, the BMD debate has been conditioned by a world view akin to that enunciated in BMDO's 1994 report:

'Intelligence assessments have placed an extremely low probability on a deliberate attack on the United States by the states of the former Soviet Union or China. Accidental or unauthorised launches of former Soviet or Chinese nuclear missiles are also considered unlikely. However, the possibility of a limited long-range ballistic threat from the Third World sometime in the first decade of the next century cannot be excluded'.[44] This view BMDO was bound to find appealing. The missile threat as depicted is too tangible to ignore yet not so awesome in scale and quality as to make active defence futile. North Korea apart, the rather dated term 'Third World' is almost synonymous with the 'Middle East', as employed in this context.

What can be anticipated, however, is that it will come generally to be appreciated that, for the next five to ten years at any rate, the counter-proliferation strategy will take much of the BMD pressure off both the USA and Europe by addressing the 'Third World' threats more at source. But in the meantime, awareness is spreading that, in neither Russia nor China, does rapid economic change any longer promise to generate a political and social culture so akin to that of a stable democracy that conflict between them and the West is inconceivable. On the contrary, each remains imbued with a rather authoritarian chauvinism; and this may well make both of them determined to challenge the hegemony of the West and of the United States in particular. What measure of outright belligerency that might lead to is impossible to predict. It will depend so much on their internal tensions.

One thing does seem certain. It is that, in both cases again, long-range missiles will figure in any warlike confrontations. Granted, one is envisaging circumstances unlikely to develop that drastically for a decade at the earliest. But the span envisaged is relevant enough to British BMD policy.

One country that has sustained, for nearly half a century, a remarkably stable democracy based on a strong economy is Japan. Now she is seeking to gain, notably via permanent membership of the UN Security Council, a comparable voice in world diplomacy. Thus far she has been more than a little inhibited by her extreme geopolitical exposure. Nor are things changing very fast in this regard. The Cold War still seems less far away in Japan than it does today in Europe. This is bound to condition her deliberations about BMD.

Michael Portillo has recently called for closer defence co-operation between Britain and Japan. This call mainly relates to the two countries being destined to become closer colleagues in international peacekeeping and in non-proliferation. But their respective attitudes towards BMD will be of interest to each as well, even though the two offshore archipelagos are actually very different in their strategic situations and outlooks.

Japan in Context

The current Japanese review of BMD policy effectively stems from top-level discussions between Tokyo and Washington in the summer of 1993. That December, a Japan-US TMD Working Group held the first of what have so far been five meetings; and in January 1995, a Japan-US Bilateral Study Group held the first of what have also been to date (i.e. as of this April) five meetings. The latter body reports to the former. It also interacts with a Ballistic Missile Defense Study Team within the Japan Defense Agency's BMD Study Office. A new Memorandum of Understanding on BMD has been signed with Washington. It focusses much more specifically on providing BMD for Japan than did the one signed in 1986.

It is painfully apparent that, since knowledge is power in this sphere, the chips in the dialogue are stacked heavily in the Americans' favour. The Japanese are insistent, none the less, that they will make their own minds up, this in about two years' time. In the interim, they are not committed to anything regarding whether to go for advanced BMD and, if so, in what form. But from 1995 through 1999, the Air Self-Defense Force is acquiring 24 batteries of an early variant of the PAC-2, this through domestic production under licence from Raytheon. Production of the Patriot commenced under a similar arrangement in 1985.

Estimates of what BMD procurement might cost Japan after PAC-2 range from some three billion dollars to something in excess of ten, depending on how ambitious the concept. The most basic solution would be to upgrade the Patriot/PAC-2 procurement so as to have some PAC-3 in each site; and to assign the four Aegis destroyers Japan is already bringing into service to the provision of upper tier TMD coverage in home waters. That solution could be effective, so BMDO claims, against the Nodong 1. To counter Russian and Chinese threats, it would be necessary to look towards more Aegis destroyers and/or enhanced land-based radar coverage plus five or six THAAD installations.[45]

These deliberations are taking place within several conceptual contexts, either specific or broad. Perhaps the most specific is the National Defense Programme Outline officially adopted last November, the first statement of its kind since 1976. Not that Japanese strategy has been frozen completely solid in the interim. One milestone in its progress came in 1981 when Tokyo accepted primary responsibility for sea control up to 1000 miles south and east from the Japanese coast. This outward orientation is developed little further in the 1995 outline, however. Witness the vagueness of references to 'international peace co-operation activities'.[46] Meanwhile, the associated Mid-Term Defense Build-Up Plan (1996-2000) makes only cursory reference to BMD. It says simply that 'a conclusion shall be reached after conducting from a comprehensive point of view a sufficient study on such aspects as its usefulness, cost-effectiveness'.[47]

Sensitive to Japanese expressions of resentment (e.g. over Okinawa; and the financing of the Gulf War), the Americans are currently disposed to claim that the Tokyo-Washington relationship is entering a new and more equal phase. To an extent, this may be true. None the less, the basic framework of reference remains. Japan still much prefers the American nuclear umbrella to enduring the social divisiveness that going military nuclear herself would engender. She is also acutely aware of her economic dependence on the American trading connection. For her part, the United States is interested in technology transfers hardly less than she was before the waning of the Japanese supercomputer programme.

At the same time, Washington is as committed as ever to being able to intervene in strength in the Western Pacific and beyond; and sees Tokyo as absolutely fulcral to that. Eighty per cent of the fuel and ammunition used by the Americans in the Gulf War was shipped from Japan.[48] One might add that some in Washington extol TMD deployed in and around the Japanese islands as tantamount to NMD, a helpful precedent from their point of view. Reportedly, a study submitted to Congress last November by the Defense Task Force of the National Research Council is explicit about the correlation.[49]

Tokyo's burgeoning conviction that her great economic progress, however insecurely based, entitles her to a permanent seat on the Security Council is a big factor to reckon with. It receives, may one note, solid British endorsement. But how does it

relate to the renunciation, in Article 9 of the post-war constitution, of 'the threat or use of force as a means of settling international disputes'? How does it relate to anti-militarism, a sentiment by no means confined to the Left? Witness the opposition evinced of late to fitting fighter aircraft with in-flight refuelling probes.

Even if the above questions could easily be answered, this still would not tell us what Japan's BMD policy is going to be. One could surmise she will seek to complement a more sophisticated American presence: maybe American THAADs and Japanese PAC-3s. But a lot may depend on what BMD capability attaches to the Medium-Range Surface-to-Air Missile that Japan herself has started to develop. From what little we yet know of it, this weapon promises to be a potent expression of the national drive for technological self-sufficiency.[50] It might even emerge as a market rival to Corps SAM, assuming the national proscription on arms exports is relaxed in the meantime.

There is at the moment some domestic pressure on the Clinton Administration to create a BMD ring of containment around China and North Korea, perhaps as part of the global BMD canopy advocated by Henry Cooper and Margaret Thatcher. Thus in a foreign policy address on 9 May, Bob Dole called for multilateral Asian collaboration with the United States on BMD development and deployment, this within the context of a Pacific Democracy Defense network. Surely, however, its military geometry would be altogether too extended. The politics would also be all wrong. South Korea and Japan still do not want to draw that close. Taipeh would be concerned not to offend Beijing gratuitously through such an affiliation. Remote Australia will be for some time undecided whether to acquire PAC-2 or PAC-3 to protect an expeditionary force or whether to go for nothing.

None the less, the Clinton administration has felt obliged to demonstrate that its bilateral BMD linkages with South Korea, Japan and Taiwan will be tantamount to an oceanic pact, especially with American naval BMD acting as the cement for this matrix. The President himself argued as much when addressing the Pacific Basin Economic Council in Washington on 21 May. The danger now is that Washington will be a bit too keen to make things more tangible. In April, William Perry asked the Japanese to advance their target decision date from March 1998 to December 1996. In no sense is Tokyo ready too.

7 - Our Interaction With Washington

However one may reason abstractedly about the singularity or otherwise of BMD, there is no denying that a peculiar importance attaches to British policy in this regard. An immediate reason is that no other country has launched so thoroughgoing a BMD review. Its Japanese counterpart most readily invites comparison with PFS. However, it is (a) completing later, (b) faced with a simpler mix of threat scenarios and hence of policy choices, (c) binational in formal structure, and (d) lacks as deep and diverse a back-up from Defence-minded scientific and industrial communities. Moreover, the background to the British PFS is a strategic dialogue with Washington sustained since 1940. With no other country, except perhaps Russia, does the United States maintain even today as global a discourse as she does with Britain; and that with Russia still retains much of the ambivalence of an adversary partnership.

Not that the 'special relationship' between London and Washington has ever been one of untrammelled bliss. The 1944 Bretton Woods strategy of financing world trade on the basis of exchange rate parity between two great reserve currencies, the dollar and the pound sterling, played an invaluable part in sustaining world economic recovery in the first 15 to 20 years after World War Two. But the extent to which it inhibited Britain from devaluation has to figure in any explanation of why Britain's economic performance was so sluggish in what for some of our industrial rivals were the 'economic miracle' decades of the 1950s and the 1960s. Britain was among those who felt badly let down by the abrupt termination of Lend Lease in 1945; and she veritably felt betrayed by the unilateral reneging on military nuclear collaboration in 1946, a reneging in the name of counter-proliferation. Ten years later, the Anglo-French amphibious task force bearing down on Suez was repeatedly 'buzzed' by the US Sixth Fleet in what had become the bitterest dispute of them all. Among other bones of often sharp geopolitical contention have been Mediterranean Grand Strategy, 1940-3; Poland, 1943-5; China from 1949; the Persian oil settlement in 1954; the cancellation of the Skybolt missile in 1962; Israel recurrently from 1967; and the American-led invasion of Grenada in 1983. There was also a vigorous though, at governmental level, always empathetic dialectic over Vietnam from 1965.

What has been so remarkable, however, is the resilience of the relationship, its ability to survive and rebound from particular difficulties. Barely 18 months after 'Suez', the United States and Britain were co-ordinating military interventions in the Lebanon and Jordan respectively, their joint aim being to check an upsurge of radical pan-Arab nationalism orchestrated from Cairo. This erstwhile young naval officer (then serving a while in the Fleet Operations Centre at Lascaris, Malta) well recalls his amazement at how close and unruffled the collaboration between the two navies once more appeared.

This precept of joint military intervention has lately loomed strong again. It has done so in the aftermath of the Gulf War but also of a Cold War in which we 'constantly thickened our political, military and intelligence co-operation as we together pursued far-flung goals. Even though our roles were progressively less equal, America saw Britain as its strategic forward post; and Britain regarded America as its own strategic hinterland'.[1] Whether coincidentally or by design, that ambassadorial statement was made at Chatham House on the tenth anniversary of President Reagan's keynote speech inaugurating what we were soon to know as SDI.

But the express recognition in the passage just cited of 'progressively less equal' roles does pose the critical question. Must we accept that, in the 1990s, the special

relationship is in graceful but inexorable decline? Certainly there is structural change. Bretton Woods looks as remote from the modern world as does 'Empire Free Trade' or the 'Gold Standard'. Not unconnected with that reality is how, in the summer of 1994, President Clinton explicitly identified Germany as America's most important partner in Europe (see Chapter 8). Even the English language is a less exclusive bond now that, across the world at large, the number of people who speak it with 'reasonable competence' is three times those who claim it as their native tongue.[2] Something rather similar will apply to permanent membership of the Security Council, once Germany and Japan have acceded. Again, if one looks back 30 years, say, one could list perhaps 20 territories around the world about which London and Washington talked more bilaterally than did either with any other party. My reckoning was that, by 1985 or thereabouts, this number had reduced to six: Cyprus, the Falklands, Gibraltar, Hong Kong, Southern Africa and Northern Ireland.[3]

Today the second and third on that list give little cause for active diplomacy. But any of the others could feature prominently into the next century. Besides which, the continuing tradition of very extensive intergovernmental contact (e.g. 16000 US officials visit Britain every year[4]) may increasingly be directed to wider aspects of global security, ranging from climate change to BMD.

Indications that things could trend in this direction are various. Take the two themes just identified. British scientists have been making throughout a big contribution to the Intergovernmental Panel on Climate Change, as betokened by our providing one of the three co-chairmen (the others being from the United States and Russia) of its seminal 1990 report. That is naturally conducive to much direct dialogue, academic and official, with colleagues in the States. No doubt it could be with those in Russia, too, except that Russian climatology tends still to operate very much within the confines of its own national scientific culture.

SDI and After

As regards BMD, the philosophic fundamentals of a new and hopefully more positive relationship with Moscow in the field of strategic deterrence were explored early in the SDI era. Witness testimony to the the Senate Foreign Relations Committee in February 1985 by Ambassador Paul Nitze, the senior Presidential aide on arms control throughout Ronald Reagan's term of office. Nitze looked forward to a well-judged SDI playing a link role in a regime not of Mutual Assured Destruction but of Mutual Assured Survival. The latter would be one in which nuclear retaliation played a progressive smaller part in peace preservation partly because 'retaliation' did.[5] On several occasions during this phase either Reagan or Nitze averred that this new relationship could involve exchanges of technology, as appropriate, with Moscow.

Meanwhile, in his policy directive of 24 April 1984 creating the Strategic Defense Initiative Organisation (SDIO), the Secretary of Defense had ruled that, as SDIO explored a 'layered defense system' with the main emphasis on 'non-nuclear technologies', there had to be 'full consultation with our allies'. The Pentagon was thus reiterating what the President himself had stressed in that keynote speech of 23 March the previous year. He had averred that the 'vital interests' of the USA and its allies remained 'inextricably linked. Their safety and ours are one'. So all concerned would proceed 'consistent with our obligations under the Anti-Ballistic Missile (ABM) treaty and recognizing the need for closer consultation with our Allies'.

Soon, consultation phased into active collaboration as far as the technological dimension was concerned. When the NATO Nuclear Planning Group met in

Luxembourg in March 1985, Secretary of Defense Caspar Weinberger invited his European allies to join in SDI research. His concept was that each participant negotiate bilaterally with Washington a Memorandum Of Understanding (MOU) that would facilitate the involvement in SDI of its firms and research institutes. Similar overtures were made to Australia, France, Israel and Japan. Only Australia declined outright. Her Labor government under Bob Hawke was already embroiled deeply with the far Left about the modalities of the ANZUS pact.[6]

In December 1985, Britain became the first country to sign a MOU, covering 'intellectual property rights' and related matters. Within two years, MOUs had similarly been crafted and signed with the governments of West Germany, Israel, Italy and Japan. France sought no MOU but allowed, nay encouraged, its firms to collaborate. Also, in July 1987, what was called a 'Memorandum of Agreement' was signed between SDIO and the Netherlands Organisation for Applied Scientific Research. A prime reason why The Hague did not sign a full MOU, government-to-government, was that its electronics giant, Philips of Eindhoven expressed misgivings. In the words of one of its board members: 'We are not in the business of selling research results but products and systems'.[7] Nor were concerns on this score absent within those countries that did go on to sign with Washington fully-fledged MOUs.

A significant aspect of international collaboration in 1986 was the launching of studies of the architectures requisite for SDI. The celebrated *UK Architecture Study* was launched that September; and an Israeli-American bilateral study was to be agreed in December. That month, too, seven consortia of American and European firms were awarded the first contracts in a programme of Theatre Missile Defense Architecture Studies.

Such patterns of collaboration have well survived the transition from SDIO to BMDO. Thus the Anglo-American MOU has simply been transferred across. Lately the Pentagon has claimed, in fact, that the involvement of 'allies and friends in the US ballistic missile defense programs gained increased impetus when' in 1993, the 'then Secretary of Defense Aspin restructured and renamed the program, giving priority to Theatre Missile Defense (TMD)'.[8] What certainly has followed from these and other linkages is that the more prominent of the allies and friends of the United States - Canada, France, Germany, Israel, Italy, Japan and the United Kingdom - can in no way avoid having a policy on BMD. To ignore the subject altogether would still be to adopt a policy, one of implicit rejection. The upshot could be to persuade the Americans to modify or abandon BMD. Alternatively, it could incline them more to 'go it alone' in this and other aspects of national strategy.

For Britain, this impacting on American opinion whichever way we turn is liable to be the more acute because of the way, through the middle 1980s, the dialogue between London and Washington about the strategy of SDI became a singularly strong expression of what may or may not have been the 'golden evening' of the old special relationship. Very early on in the SDI saga the Thatcher administration moved to stake out a joint policy. In December 1984, the Prime Minister and the President agreed, at Camp David, on 'four points' that would be the criteria by which any decision to deploy would eventually be taken. Any such departure should follow upon discussions with allies and also adversaries; preserve parity; consolidate deterrence; and allow for cuts in the strategic missile echelons of both West and East.

Speaking to the Royal United Services Institute for Defence Studies in March 1985, Sir Geoffrey Howe was to spell out, as Foreign Secretary, a gamut of reservations about SDI:

'There would be no advantage in creating a new Maginot Line of the twenty-first century, liable to be outflanked by relatively simple and demonstrably cheaper countermeasures. If the technology does work, what will be its psychological impact on the other side?... . And, if the ballistic missile showed signs of becoming, in President Reagan's words, impotent and obsolete, how would protection be extended against the non-ballistic nuclear threat, the threat posed by aircraft or cruise missiles, battlefield nuclear weapons or, in the final analysis, by covert action?... . Leaving aside the threat to civilian populations, would active defences provide the only feasible way of protecting key military installations? Might we be better advised to employ other methods of protection such as more mobile and undersea forces?'.[9]

At another Camp David meeting, held after the 1986 Reykjavik summit, the Prime Minister and the President reaffirmed that, within the constraints of the 1972 treaty, the US should pursue SDI. Sir Geoffrey later saw this Camp David accord and the previous one as having together 'become the basis of NATO's policy posture in this sphere'.[10] Meanwhile, the Arms Control Association in Washington was praising the British Embassy to the hilt for the way it was making its presence felt on SDI, this very much along lines that the Association approved of. Yet at the same time, informal access to the Strategic Defense Initiative Organisation (SDIO) was visibly easier for British nationals than for other non-Americans. My own *entrées* (one fortnight of quite privileged access in 1985; and a second one in 1987) were said by my American hosts to be singular. Moreover they had arisen out of fundamental criticisms of SDI, not out of some fulsome endorsement of it.

The mutual confidence that has sustained so rich an Anglo-American dialogue stems most specifically from the 50 years and more of collaboration in strategic aerospace and military nuclear development, the nuclear nexus being reformed by an Act passed by Congress in 1958. This collaboration had involved the United States' supplying the United Kingdom with first the Polaris and then the Trident strategic missiles. Collateral with it has been the establishment, again by binational agreement, of the RAF-manned Ballistic Missile Early Warning System (BMEWS) at Fylingdales, operational since 1964. The other two stations in the BMEWS chain, Clear in Alaska and Thule in Greenland, have always been American-operated. Other inputs, on the British side, have regularly come from the defence science centres (notably Farnborough, Malvern and Porton Down) and also from our centres for geophysical and astronomical research. It is roughly 40 years since our then chief adversary, the USSR, began to develop Anti-Ballistic Missiles. This means that we have had, for at least that span, experience of interacting with the Americans about missile offence and defence. Perennially close links between the respective intelligence communities are part of the same pattern.

What is so noteworthy about the inputs from the British government in the 1984-7 period is the degree to which they stemmed from precepts that belong to the realm of strategic doctrine: precepts about strategic stability, arms control and so on. As the whole debate died down after 1987, that perspective tended to get lost within the Anglo-American dialogue as well as more widely. With public interest in BMD declining almost to vanishing point in Britain, as it was everywhere outside the United States, exchanges on the subject between the professional communities became less intensive and more exclusively confined to the technological aspects.

Yet herein lies a paradox. It may be traced back to the *Strategic Defense Initiative, Defensive Technologies Study* produced in 1984 by the Fletcher panel, the ad hoc review body established in April 1983 under the chairmanship of Dr James

Fletcher, the head of NASA.[11] This Fletcher report called for a broad though goal-oriented programme of research and basic development, with a view to deciding early in the 1990s whether one should begin systems development in readiness for deployment soon after the year 2000. Virtually from the outset, this call was interpreted as one for a comprehensive (i.e. strategic as well as technical) debate about the merits of proceeding, a debate in which the allies would be much involved. As a fervent Atlanticist, James Abrahamson, the USAF officer who directed SDIO from 1984 to 1989, much favoured this interpretation of Fletcher. But he told me himself in 1987 that he was still quite unclear what form the inter-allied consultations might take. In the event, there seems to have been neither form nor substance.

Since 1991, with the general upsurge of professional interest in BMD at theatre level, dialogue has become more vigorous once more, the more so since the launch of our PFS. But the heavy preoccupation with technology has considerably persisted thus far.

Nor is there any denying the potential importance of inputs from the Allies (and, above all, from ourselves) into the technological judgements due to be made. Not least may this apply to the stringent assessment of field and simulation testing. As things stand, it is disconcerting to find plans for TMD deployment currently being drawn up which take for granted the satisfactory performance of systems that are still years away from the completion of what one hopes will have been adequate validation.

Crucial, on the American side, is the role of BMDO. Its antecedent, SDIO, was deeply distrusted by arms control liberals. It was seen, at best, as a front organisation for what William Broad dubbed the 'high tech Gulags', groups of scientists in secluded National Laboratories working with maniacal energy and in all too deadly secrecy.[12] Undeniably, too, certain strands in the SDI conspectus (e.g. nuclear-pumped X-ray lasers) did owe too much to single-minded zeal. All the same, General Abrahamson sought to preserve within the Washington organisation an open debate on many issues. Let me recount one episode. Early in 1988, I requested SDIO read through in draft the chapter of the *New Strategy Through Space* book which examined all the military technologies of SDI. The SDIO people knew full well this study would oppose the weaponisation of Space, something they themselves still saw as centrally important. Nevertheless, O'Dean Judd as Chief Scientist and Dick Gullickson, his deputy, did a thorough technical review of this script, much enhancing the quality of a text that, viewed in partisan terms, was going to do little for their cause.

In its remit, structure and ethos, BMDO is more of a procurement agency and less of an exploratory one. The post of Chief Scientist has been replaced by that of Architecture Integrator, a position currently combined with that of Deputy Director. There has now to be more of a commitment to stick strictly to development deadlines. Take THAAD again. Though Lockheed Martin, as its lead developer, sometimes suggests the contrary, this system does seem bound to rely quite heavily on the Space and Missile Tracking System (SMTS), the collateral programme not due to begin orbital flight tests until 1998-9. At the very least, there would have to be this reliance in the face of any resurgent Russian threat, replete with MIRVs and sophisticated decoys. This alone ought to preclude any THAAD procurement decision until 2001 or thereabouts. But this point gets no mention in the doubts currently being aired about THAAD, nor in the Clinton administration's proposal to stretch its agreed level of procurement across another four years.

Lockheed Martin is playing very much an upfront role in the American advocacy of BMD abroad, not least as subcontractors to British Aerospace within the PFS. They

are doing so as a corporation with an exceptionally heavy involvement in, and dependence on, military aerospace. Structurally, they are the product of a merger these last few months of Lockheed and Martin Marietta; and soon, it is said, of Loral as well. Twenty years ago, the repute of Lockheed was low as regards overseas dealings, not least in Europe. In 1976, the then Chairman and Vice-Chairman resigned after Senate revelations about $24 million being paid as bribes to foreigners since 1970 alone. This, as well as a mint of money in the 1960s, had been dispensed to promote the Starfighter, an overstretched design procured in especially large numbers by the Luftwaffe only to crash in large numbers as well. By 'large', one has to mean hundreds of major accidents. What the Japanese called 'the Lockheed bomber affair' precipitated major crises in Bonn, the Hague and Tokyo.

My own recent contacts with Lockheed Martin (at Farnborough and in Geneva, London and Washington) have not left me with the impression that anything remotely resembling that episode is currently extant. THAAD is accorded a lot of prominence but the presentations about it have been scrupulous enough. They have probably been more objective than one might find with the great majority of interest groups of whatever kind. Nevertheless, the Starfighter saga does highlight how readily an undue partiality can enter into deliberations as and when either a programme or its parent corporation are under market strain. Room for its so doing must be considerable with BMD in that this whole weapons genre is geared to tight performance parameters projected into a very uncertain future. Bias can creep in without wilful venality, not least as regards threat prediction.

The influence of national culture in the round has also to be reckoned with. It is not a factor that is going to affect much the testing of systems actually being developed. But it may affect considerably perceptions of future possibilities. As the Americans often observe themselves, their history long ago instilled in them a zest to exploit technology to the full, this through application of 'the overall principle that organises all the technical elements - what used to be called scientific management and what is still called the managerial function'.[13] In World Wars One and Two, we had good cause to be grateful for this visionary approach as US government and industry responded mightily each time round to a sudden plunge into full-scale hostilities. The Apollo and SDI endeavours that so daunted the Soviets were manifestations of the same spirit.

Other Contentious Issues

The downside has sometimes been an overweaning optimism about the benefits exotic technology can bring, especially as regards the flow of exact and objective information. Not least has this been so in the military domain. Since 1940, there have been a whole succession of differences between the Americans and the British about the management of military operations, with the former very consistently being the technological optimists. To review some of these differences may be to glean some useful insights as to the future course of BMD, not least in its more exotic manifestations.

At the beginning of 1943, the United States Army Air Force (USAAF), then building up in the UK, was committed to precision attacks on German targets being delivered in broad daylight by means of unescorted bombers. RAF Bomber Command saw this as suicidally optimistic. Events soon proved that it was. Mercifully, in the course of the next two years, the two air arms managed to achieve a partial

convergence of doctrine and a complementality of function that became, in the view of many of us, crucial to the Allied victory in Europe.

Another subject for wartime disagreement was strategy for the Second Front. The Americans maintained that mass and technique would allow of a decisive descent early on (they initially said as early as 1942!), always provided their British cousins did not allow themselves to be distracted by Mediterranean 'sideshows'. The British, led very much by Churchill himself, advanced a whole complex of arguments as to why an active Mediterranean strategy was a necessary precursor to a Second Front in France that could not, in any case, be launched before 1944. It is hard not to see the British as 90 per cent right on this score.

To which one might add, though, that a striking instance of a highly constructive reciprocity in respect of this Operation Overlord was the telephonic conferencing whereby an agreed position was thrashed out between the meteorological services about the forecasts for the actual landings in Normandy. British pessimism as to what weather could be assured brought about a postponement of D-Day from 5 to 6 June. That avoided an immediate disaster. But then American optimism was to prevail with the confirmation of the 6th, rather than a further delay until the next tidal opportunity a fortnight thence. Had the sanguine Americans not carried the day on the second occasion our assault forces would have been lambasted (on 19 to 22 June) by what very suddenly became the worst midsummer Channel gales in 40 years.[14] Anything more catastrophic for unconsolidated beach-heads is hard to imagine.

Anglo-American differences along remarkably analogous lines were to recur quite regularly after 1945. For five years or so from about 1957, the American defence community nurtured the hope that battlefield nuclear weapons could proffer economy to overstretched forces; and even that the Western world, being educated and democratic, was best fitted to exercise this option. As Edward Teller and a colleague were to put it in 1958: 'Any unit fighting in a nuclear war will have to be small, mobile, inconspicuous and capable of independent action.

There will be no possibility, and no need, to occupy territory nor to fight at fixed and definite fronts. If a war should be fought for military reasons and for military advantage, it will consist of short and sharp local engagements, involving skill and advanced techniques and not involving masses that slaughter and are being slaughtered'.[15]

Already, however, sharp differences were emerging among American military scientists as to what the connotations might be for force structure, or in BMD parlance, for the choice of 'architecture'. Some accepted the Teller logic that an atomic battle would be so fluid that frontal warfare would disintegrate into a *melée* in depth. But from it they inferred that this transition would overstretch further the numerically weaker side. The conversion of the US Army to a 'five-fingered' or 'pentomic' divisional structure (as opposed to the customary three brigades) was, in the main, a response to this apprehension.

Yet there were, too, American analysts who discounted any notion of collapse into a *melée*. They simply argued instead that the extra firepower of its battlefield nuclear weapons would enable a division to cover wider frontages than before. They felt it would typically be able to hold firmly a sector 20 miles across, a divisional front by no means without precedent in recent war but well over twice what had been feasible in the hills of Korea.[16] Their optimism waxed the stronger with the introduction of the Davy Crockett mortar, a lightweight crew-served weapon that could throw across one or two miles a fission warhead of a quarter to half a kiloton

explosive yield. Late in 1960, the Pentagon placed a provisional order for 6250, many being earmarked for routine deployment well forward.

That particular debate has been dwelt on a little because it anticipates quite remarkably the previsions of the land battle in the impending missile era variously being generated the other side of the Atlantic at the present time. It may therefore be highly germane that, during the early 1960s, all these notions about a very open though coherent nuclear land battle were discarded. The Davy Crockett programme was cut back hard; and was soon to be abandoned altogether. There was a reversion to triadic divisions - the three brigades apiece. Overall, less finesse was being looked for in battlefield nuclear exchanges. This conceptual pull-back owed something to more extensive discussion with highly sceptical European Allies, with ourselves but also the continentals.

Nevertheless, a utopian attitude towards technological possibilities continued to characterise other aspects of the American military domain. Thus the USN regularly waxed more optimistic than did the Royal Navy (RN) about the usefulness of deploying a mix of defensive systems along the Greenland-Iceland-Faroes-United Kingdom arc (alias 'the GIUK gap') in order to block Soviet air and sea transits during warlike maritime crises.[17] By the 'eighties, the USN was evincing no less confidence about the integrity within naval task forces of large fleet carriers even if deployed well forward strategically - e.g. in the higher latitudes of the Norwegian Sea or the North Pacific.

Before that, of course, had come 'Vietnam'. My own experience of that campaign was confined to one short visit, as a journalist, in April 1966. Yet that was enough to convince me that the overriding disposition of the US analysts (albeit not of the field troops or the aircrews) was to look always for neat enumeration, regardless of the character of a problem or of the information to hand about it. Economic and social statistics were relied on far more than was sensible, given their narrow scope, dubious quality and patchy availability. Other aberrant inclinations were to (a) highlight military progress more than political, and (b) gauge the former too much in terms of outlays - e.g. the tonnages dropped of bombs, leaflets and so on. All these criticisms were being regularly levelled, empathetically but quite explicitly, by the excellent advisory mission Britain then maintained in Saigon, under the leadership of Sir Robert Thompson.

Later on, an undue preoccupation with this tropic scene unhelpfully influenced the evolution of USAF tactical doctrine. Exploiting an electronic virtuosity much superior to their opponents', US strike aircraft on missions over North Vietnam used often to battle their way in at medium altitudes, thereby gaining both range and co-ordination while forfeiting the protection afforded by low altitude and narrow horizons. This stratagem involved the dispatch of aerial armadas comprising a mix of ground-attack, escort and EW planes. Having proved viable enough in this South-East Asian context, it was persevered with for a while even in Central Europe. However, around the time of the final withdrawal from Vietnam in 1975, it was abruptly demoted throughout the USAF in favour of egress in small groups, flying very fast and low. For some time, the latter remedy had been preferred (whenever tough opposition was to be expected) by the NATO Europeans and, of course, the Israelis.

Most of the issues here identified embrace a dimension that properly belongs to grand strategy. But all of them do much involve operational philosophy. It does seem abundantly clear that our American allies extol very readily the benefits that may accrue militarily from recourse to the highest technologies. Indeed, it is this quality

that spurs them to advance the frontiers of technology and to reap its benefits, a disposition that in many ways still resounds to the advantage of all of us. What all the instances cited also show very consistently, however, is that this faith can prove overweaning, not least as regards the scope for exactitude in command and control.

What is often to be observed is not just an Anglo-American divide but a Euro-American one. In other words, the Europeans come across as instinctually more cautious about technical change: about its pace, its nature and its consequences. As regards command and control, in particular, one is tempted to suggest that more people in the Pentagon and the think-tanks might usefully read Karl von Clausewitz as assiduously as those great Atlanticist captains of World War Two, Dwight Eisenhower and George Marshall, are known to have done.[18] Clausewitz as viewed in the round is not acclaimed without reserve in Europe, certainly not in Britain or France. But his central perception of war as a crude and basic process that does not lend itself to great finesse is widely endorsed, out as far as Moscow to say the least.[19] As for ourselves, we and the Americans may still be closer in many institutional and cultural respects than we and our continental neighbours are. As the above examples indicate, however, our outlook in respect of military operational management has tended to be more European.

All of which is poised to assume a new relevance, in respect of BMD but also more generally. The Americans have suddenly become almost obsessively aware of how firmly they have resumed military technological leadership not just as against Russia but in regard to all other countries. This they persuasively depict as a function of their lead in the information revolution overall: 'US investment in ISR[20] - particularly the high leverage Space-based aspects of this set of systems - exceeds that of all other nations combined, and America leads by a considerable margin in C4I[21] and precision force as well. It has already begun, systematically, to assemble the new system of systems and is well down the revolutionary path, while most nations have not yet even realized a revolution in military affairs is under way'.[22]

That is a trenchant statement that well and truly throws a mighty challenge down. In another part of the same presentation, however, this trenchancy could be said to hyperinflate and become mere hubris. At that stage, the argument runs thus. Throughout the realms of ISR and C4I the American 'rate of improvement will increase dramatically over the next decade. Sensors, for example, will give real-time continuous surveillance in all types of weather over large geographical areas. Fusing and processing information - making sense of the vast amount of data that can be gathered - will give US forces what is called dominant battlespace knowledge, a wide asymmetry between what Americans and opponents know. With that, the United States will be able to prevail militarily, whether the arena is a triple-canopy jungle, an urban area, or similar to Desert Storm'.[23] But it is hard to believe that all geographical environments will be equally accessible under the new dispensation. Surely, too, some threats will be harder to track than the deployment of a mechanised army. What of biological proliferation? What of a submarine offensive? What of terrorist infiltration? What of popular insurgency or a revolutionary putsch? What of a pre-emptive strike with strategic missiles? What of Hezbollah katyushas? And how does all this relate to the disinclination now so strongly evident across the West (not least in the United States and Israel) to accept casualties in foreign wars? What if, as in the Lebanon in 1982, the enemy can induce a precipitate withdrawal by killing just one or two hundred allied troops? What if, as in the Lebanon in 1996, an army can be so disinclined to

accept any casualties that it wrong-foots itself badly over the question of collateral damage?

There will be plenty to debate these next few years. Clearly, the debate will not simply take the form of transAtlantic disputations between teams of officials, be the setting binational or NATO. There are sure to be cross-currents. There will, in any case, be open discussion involving journalists, strategic analysts, military historians, scientists, retired officers and politicians. All the same, it will be surprising if something of a transAtlantic dichotomy does not persist. Not least may it over the notion now modish in the Pentagon that, in the course of the next quarter of a century, the manned aircraft will be displaced very comprehensively in theatre war by Unmanned Aerial Vehicles (UAVs). Cautious Europe may not be quite that categoric.

In these early formulations of what one may characterise as the American radical view of future theatre war, TMD has figured little. It gets no mention in the Nye and Owens analysis here cited. Nor does it in a collateral study, focussed mainly on military structures, by the Professor of Strategic Studies at the Paul H. Nitze School at John Hopkins.[24] Nor in a recent feature along similar lines in *Scientific American*.[25] Nor does it get more than a perfunctory mention in the latest rendering of Field Manual 100-5 *Operations*: the text that has been for decades past, in successive editions, a basic exposition of the US Army's concept of operations.[26]

The likelihood remains, none the less, that TMD will assume some prominence as the debate ramifies. It will do so not least because of an emergent conviction in the United States that the advent of submunitions in this realm will mean that, from the second half of the coming decade, BPI will have to assume centre stage if active TMD is to stay in business at all. Meanwhile, interest burgeons in the US Republican Party in the NMD it committed itself to in principle in its 'Contract with America' statement in 1994. The Republicans will probably fail to regain the White House this November; and are also likely to lose control of the House of Representatives. But their chances of retaining a majority in the all-important Senate look somewhat less bleak. Besides which, they may well catch the voters' mood across the board in the year 2000.

The American experience this past decade has been that the Vice-President plays a fulcral part in the formulation of BMD policy - George Bush, Dan Quayle and Al Gore. At this moment in time, it is quite unclear, to me at least, how Jack Kemp would play this issue. Still more to the point, nobody has the faintest idea who might be sworn in as Republican Vice-President in 2001. In lieu of this knowledge, we do well not to ignore the recent evolution of Republican thinking about NMD. But it has to be judged within the setting of the BMD professional debate, including that about BPI.

BPI and NMD

The ABL apart, these interweaving issues are being shaped within the United States by the conceptual ascendancy of the unmanned platform either in the air or in Near Space. Its genesis can be traced back to the period 1958 to 1970 and to the Space race so vividly in progress then. Initially it was presumed within the USAF that manned platforms would have a role to play militarily within that domain: that is to say, one over and beyond the servicing, repair or modification of unmanned military platforms. This presumption spawned two lead programmes, the X-20 Dyna-Soar and the Manned Orbital Laboratory (MOL). The latter was a two-man Spacecraft designed to orbit 500 miles up; and the former a single-seat rocket plane intended to zoom to an altitude of 60 miles. The cancellation of each in turn, essentially because there was

nothing for either to do, curtailed this whole line of development. All through the SDI saga, every 'man-in-the-loop' was to be set firmly on the Earth's surface. Edward Teller will have made sure of that.

Now the debate is again turning Earthwards as the Pentagon air staff review most stringently the future of 'the man-in-the-cockpit' throughout the tactical air environment. While one may applaud the moral courage they have shown in breasting this issue, one must here urge that the implications for BPI are no less searchingly addressed. These relate to the feasibility or otherwise of interception before an ascent release of submunitions. So do they to the relative merits of attempting this as opposed to making pre-emptive attacks on the missile sites or, of course, reliance on passive defence. One complication is that neither pre-emption nor passive defence come within the remit of BMDO as strictly defined. Another is that the holistic problem of battle management also looms large in the BPI context. All in all, there seems to be plenty of scope for an Anglo-European input to the debate and, indeed, to systems development.

With NMD the political focus thus far has been less on the operational aspect and more on grand strategy, on geopolitics coupled with deterrence philosophy and arms control. None the less, controversy about deployment patterns is already in the air. In Washington this February, I made appointments with quite a representative spread of people who were (a) what one may term the second echelon of the Republican Party leadership or (b) serving as senior staffers for committees on a Capitol Hill at present dominated by the Republicans. Every meeting proceeded cordially and ended with reciprocal commitments to keep in contact. None the less, much of the thinking imparted was disconcerting, not least as regards too cavalier a preparedness to cast out the ABM treaty without putting any other arms control provision in its place.

Perhaps the most revealing encounter was with Ambassador David Smith, national security adviser to Senator Dole and formerly head of the Bush administration's team at the Disarmament and Space talks at Geneva. Very confident of Dole's getting the nomination and not too unhopeful of his beating Clinton, he said they would proceed thus on assuming office. A 'top-down' defence review would be conducted with expedition. Then the Russians would be asked to renegotiate the ABM treaty in order to allow an American deployment of Ground Based Interceptors (GBI) as follows: up to 200 at each of six sites, four within the continental United States and the other two in Hawaii and Alaska respectively. In the event of the Russians being unwilling to effect such a renegotiation within what would be a stipulated six-month deadline, they - the Americans - would proceed regardless. Presumably, he meant they would exercise the right each party to the treaty has (under Article XV) to withdraw at six months' notice 'if it decides that extraordinary events related to the subject matter of this Treaty have jeopardised its supreme interests'.

My first response to this presentation was to express concern at the absence of any reference within it to consultation with Allies. My next comment was simply that I could imagine no better way of wrecking relations with Russia and the Atlantic Alliance at one and the same time. To which I might have added that so drastic a departure would also instantly set in motion an unravelling of the whole interwoven fabric of arms control provisions with disastrous results for counterproliferation and, indeed, any semblance of a new world order. Allowance has to be made for Dole's initial campaign stratagem of reaching out to his Far Right, an inclination that some commentators were soon to caution him against. But it would be foolish casually to

assume that none of this rendering of NMD would survive the early weeks in office or, if you like, that none will survive come 2001.

A further subject of disagreement as our conversation progressed was whether any break with Moscow on an issue such as this could adversely affect the internal development of the new Russia. Speaking, it is only fair to note, as a Russian linguist and scholar, Ambassador Smith saw this as most unlikely. Yet with respect it still seems to me that, if the evolution of SDI could impact so strongly in 1985-7, then a new-style BMD might likewise impact (positively or otherwise) in the years ahead. Everything might depend on how close to some parting of the ways the Kremlin was for other reasons at a given point in time.

A closely-related question is whether Moscow might once again become actively belligerent towards the West. Some on the geopolitical Right within the United States would endorse BMDO's 1984 perception that both Moscow and Beijing have been neutralised in those terms. This means, they say, that rogue states have lost their bedrock of support: 'In the 1950s our adversaries had strategic depth. They had the whole Communist world behind them. That is why we were not able to prevail in Vietnam and Korea. In 1991, with the cold war won, our great adversaries are in retreat. The enemies we do encounter today, like Saddam Hussein, have to face us on their own. Because of that, they don't stand a chance'.[27]

Against that, you have the views of Frank Gaffney, the former Reagan defence aide. He is now the co-ordinator of the Coalition for America, a body that exists to argue that 'the development and deployment of anti-missile defences must be made an immediate national priority'. The Coalition's main concern corporately-speaking is with the threat from the four identified rogue states: Iraq, Iran, North Korea and Libya. But it also seizes avidly on indications that China may even now be minded to exploit the United States' lack of NMD to force its hand on Taiwan.[28]

For Gaffney himself, however, the Muscovite dimension is still there. He suspects that appreciable numbers of SS-20s, withdrawn ostensibly to be dismantled under the terms of the INF, have in fact been stored away. He believes that, in any case, Moscow could present anew the threat from its general purpose forces in under ten years or that from its strategic rockets in much shorter order. It is a pitch consonant with the consternation he expressed about Ronald Reagan himself after his own resignation as Acting Assistant Secretary of Defense in 1987. One particularly acerbic comment was that the 'fact that the same man could have enunciated the arms control policy of the early Reagan years and presided over its undoing late in his administration may prove fertile ground for future historians and psychoanalysts'.[29]

Frank Gaffney lends his solid support to Henry Cooper's view (noted in Chapter 4) that a fleet of BMD-Aegis cruisers could provide cover worldwide against limited numbers of ballistic missiles launched from anywhere. Likewise a study team from the Heritage Foundation (the leading conservative think-tank) has argued that, for gross incremental expenditure of two to three billion dollars, 650 Upper Tier interceptors could be installed on twenty-two Aegis cruisers in the period 1998-2001, this in order to counter near-term threats from North Korea as well as from the Middle East and North Africa. Concurrent deployment on Great Lakes barges would proffer some protection against Russian ICBMs.[30]

All that still leaves room enough, within the Republican Right, for differences of opinion about BMD and especially over NMD. In the early SDI days, the advocates of comprehensive NMD polarised quite sharply into those who sought the early and widespread deployment of a Space canopy based on KEW in the form of mini-missiles;

and those keen to progress straight to platforms bearing DEW, probably in the form of laser beams. The former school of thought was spearheaded by General Daniel Graham and the High Frontier lobby he was the founder father of. The rumbustious Danny Graham is, alas, no longer with us though even before his demise, his High Frontier was welcoming on board people like Ambassador Cooper, zealous for Space-Based Lasers.

Henry Cooper's formulation may serve as a benchmark, given his standing as a former SDIO director. He wants no truck in the NMD context with Ground-Based Interceptors, an attitude that helps explain his visceral abomination of THAAD. He advocates Aegis deployment from 1999, this being complemented shortly afterwards by a thin screen of Space-based KEW. In the second half of the next decade, the deployment of SBL might commence. Arms control he sees as largely otiose, as do all his colleagues on the Republican Right.

However, the wishes become too obviously the parents of the thought. Cooper goes as far as to suggest that an SBL (of unspecified lasing wavelength) could intercept in boost phase any missile destined to go than 120 km or more.[31] Yet that implies interceptions at altitudes as low as 20 to 25 km, even against missiles on minimum energy flight paths. Even were that just possible when an SBL platform happened to be transiting neatly overhead to the launching site, it would surely be ruled out in more oblique encounters. Beam absorption and scattering would be altogether too pronounced.

The fact of the matter is that both the Coalition to Defend America and the High Frontier have their judgement coloured by a quest for absolute national security of a kind virtually every other student of these matters throughout the free world accepts is anachronistic. But castigating something as an anachronism does not *ipso facto* remove its primordial appeal. Nor does it necessarily deprive it of political authority. Take the 90 or so prominent people who have attached their names to a statement of aims by the Coalition. They happen to include neither Bob Dole nor Dave Smith. But they do include Jack Kemp. They also include James Abrahamson, William Clark, Henry Cooper, John Lehman, Merrill McPeak, Thomas Moorer, Richard Perle, John Poindexter and Caspar Weinberger. Most of these names, and others could be cited, are of people who, these past dozen years or so, have been associated with an Atlanticist approach to BMD, considerably in interaction with ourselves. Yet the more hardline stance they have here identified with derives its impetus from the neo-isolationism Pat Buchanan is so fervently articulating. Protect 'native' America against international free trade, immigrants, cultural pollution, and multilateral crime cartels. His horizons have their domestic setting within that 11 per cent of American adults identified in a 1987 Times Mirror in-depth opinion survey as Moral Republicans or Moralists, one of the ten groupings into which the population was separated therein. The Moralists' attitudes were not that emphatic on everything. But their group did tie for first place in the balance of opinion favourable to SDI development: 63 per cent for and 23 against.[32]

What we may be witnessing is something of a revival of the Pacific First isolationism that last flourished for a short while in Republican circles in the stressful Cold War years of the early 1950s. The Pacific Firsters 'tended to resent what they saw as the control of their party and country by the Ivy League and Wall Street. Their natural conservatism found ... expression not so much in domestic "bread-and-butter" issues as in international and ideological ones. They placed more emphasis than the Democrats and the Eastern Republicans on the importance of the Pacific and on the

deterrent and punitive effect of air and seapower; they placed less on the need to keep wars limited and on the value of multilateral alliances and on the commitment of American ground troops to Europe'.[33] Shades of all this can presently be seen in (a) the economic and social philosophy of Pat Buchanan, (b) the advocacy of sea-based NMD, (c) the disdain for arms control and, indeed, the counter-proliferation strategy, (d) generalised impatience with the UN, (e) extreme concern about Taiwan and (f) a disposition to put the blame for 'Bosnia' squarely on a collective European lapse. Robert Dole can align with this school of thought in so far as he is a Senator for the high plains state of Kansas but not in that his long career has been rooted firmly inside the Washington beltway, home of the liberal establishment..

So what we need to recognise is the pressure that has built up in the United States for a radical initiative on NMD. It could be one quite different from anything successive British administrations have thus far endorsed, going back through the Thatcher years and as far as the McNamara-Healey era of the middle 'sixties. In the final analysis, technical difficulties (especially as related to the introduction by adversaries of submunitions) might preclude certain remedies. What we should not do, however, is shrug off this challenge on the grounds that no NMD thick screen would ever be affordable. Henry Cooper's claim that his proposals could be adopted in full for little more than $25 billion is probably much underpitched [34], as similarly personalised reckonings tended to be in SDI days. But let us take the Dave Smith conspectus as rendered to myself. Some years ago, Lockheed estimated that 100 GBI could be installed at Grand Forks, North Dakota, for $4.7 billion.[35] Do a linear scaling up; and feed in a large extra fraction for support systems. The conclusion one arrives at is that a Smith-style deployment might be effected for not more than $100 billion.

On current projections, the US Department of Defense annual budget will shrink from $295 billion in Fiscal 1989 to $244 in Fiscal 1998; and this steady downward trend will then continue through 2003. The fraction of the total devoted to procurement is some 18 per cent as of 1995, but has started to rise once more.[36] A Republican administration is thought likely to put several billion dollars a year back into the defence budget overall, maybe incrementally for several years in a row. On balance, the Smith objective might just be attainable in full across a span of maybe a decade or so, at least if theatre commitments overseas were being further curtailed.

The British Stance

Past experience, not least from the Churchill-Attlee era (1940-1955), confirms that British leverage in Washington is greatest when American opinion is divided. Today Ambassador Cooper fairly makes the point that thinking on BMD in his country is 'very polarised between the theologians of deterrence and those of arms control'. We and all America's friends and allies clearly have an interest in the constructive resolution of this divide and others liable soon to develop in regard to BMD strategy. Helping to resolve them could afford much scope for customary British diplomacy.

However, there may be two prerequisites to our contributing thus. The one is the generation of BMD doctrine. It will have to be at a level above that of a military concept of operations, at a level where we start to embrace deterrence philosophy, arms control, the geopolitical parameters, pre-emption and environmental impact. Such a doctrine may make it easier to address such questions as whether, in North America and elsewhere, a strictly thin-screen NMD may serve certain valid purposes without compromising the pursuit of arms control or generating an evanescent cult of total security.

The other prerequisite is working closely with our European neighbours, not least so as to redress the geopolitical imbalance that must otherwise be so evident. In discussions within the Ministry of Defence one has encountered some apprehension that our acceding to a European 'partnership of nations' would destroy the old special relationship. The next chapter will explore a little further how this outcome might be avoided. In the meantime, we do well to remember that, since 1960 at any rate, the Americans have recurrently stressed that an enduring special relationship will be one with a 'Britain in Europe'. Kennedy's 'New Frontiersmen' were expounding this view with a veritable excess of fervour in 1962. Ambassador Seitz underlined it in the speech cited above.

Now this concept is assuming a new relevance with Germany poised to move well ahead of France as the most powerful nation on the continent. It may no longer be realistic for anyone to talk of building a new Europe around a Paris-Berlin dumb-bell, even supposing that were somehow desirable. A London-Paris-Berlin triad could hold out much more promise.

8 - European Security

When PFS was launched, there was concern not to duplicate studies in NATO or the United States. One was most immediately aware of the AAS-38 study being conducted through 1993 by the Advisory Group for Aeronautical Research and Development (AGARD), the agency set up in 1952 as accountable to NATO's Military Committee and which has produced across the years a diversity of reports on broad trends and problems. It is about to merge with the Defence Research Group which has concerned itself more with particular service requirements near term. The BMD debate will need always to be suffused with something of the AGARD philosophy.

AAS-38 took cognizance of a variety of other studies or working groups on missile/air defence, set up under alliance auspices. Among them were the NATO Industrial Advisory Group (NIAG) SG 37 Technology Forecast 2000 which addressed the ballistic and cruise threat at both ends of the spectrum: high sophistication in limited numbers as against low-unit-cost saturation. AAS-38 itself looked at defence against ballistic missiles in the 300 to 3000 km range bracket, focussing perhaps unduly on unitary warheads, either high explosive or mass destruction. Working from the presumption that any 'large scale attack will be countered by NATO deterrence policy', the attack scenarios it mainly considered were (a) by a salvo of six to eight 'Scud-like' missiles from a stockpile of the order of 100 and (b) by one of three or four modern ICBMs. Stress was laid on the defence of the whole NATO area - even of Turkey in the face of a Syrian strike. The out-of-area responsibility (say, to Cyprus or to the Gulf sheikdoms) was also recognised. Space-based sensing was assumed throughout but Space-based weaponry deemed unlikely till after 2005.

A disinclination to duplicate AAS-38 or anything similar must have been reinforced by the exceptionally great uncertainties that beset NATO in the middle of 1993. After all, not even the Partnership For Peace formula for exploratory collaboration with the Eastern Europeans was to be enunciated until that autumn.

However, the PFS was cast very much in British national terms. Seven of the 16 original scenarios are concerned with attacks on British sovereign territory. Eight of the remainder are concerned with situations in continental Europe but even these are within the context of protecting British forces (a brigade?, a division?, a deployed fighter wing?) in the field. That is in line, as far as it goes, with the formula of building alliance interdependence from the premisses of identified national interests.[1] But if not followed through aright, this approach could generate two dangers. The one is that the holistic flexibility essential to any kind of aerospace defence in depth will not be pursued alliance-wide. The other is seeming to undermine the principle, enshrined in Article 5 of the North Atlantic Treaty of 1949, that 'an armed attack against one or more of them in Europe or North America shall be considered an attack against them all.'[2]

These points of principle are pertinent on two counts. The one is that a degree of preferential protection may, in any case, be bestowed on certain areas in due course because of a legitimate concern to safeguard certain nodal military assets. The other is that both NATO and the EU may already be a deal more fragile than tends to be recognised in official circles anywhere. They may be so because each is enlarging at a time when millions of voters-cum-taxpayers are uncertain (a) about NATO's continuing relevance and (b) whether the EU can achieve a collective identity firm enough to compensate for the substantial surrender of national sovereignty that membership involves, even as things are. As already implied, the strength of NATO, in

particular, has in the past rested very much on continual demonstration that Finnmark or Thrace are safeguarded just as solidly as are, let us say, the valleys of the Rhine, the Thames and the Mississippi. Soon that principle may extend to the Pripet Marshes, regardless of the added complications logistically and in terms of sectoral cover.

Public Opinion

The evident reality that BMD figures nowhere in the European political agenda at present does not mean we need not prepare for a battle for public opinion on this subject. The SDI debate at its height is well worth reviewing.

Deep cleavages in American opinion were a central feature throughout. But let us now concentrate on the scene elsewhere, starting with the polar flank. Reference was made in Chapter 4 to the Canadian White Paper of June 1987.[3] It endorsed continued collaboration with Washington, through NORAD, against the airbreathing threat but suggested that, starting in perhaps 15 years time, the ground-based radars of the North Warning System ought to be replaced with ones based in Space, the only mode that could 'provide a detection capability adequate against the bomber and cruise missile forces of the future' (p.58). That judgement would have taken cognisance of the long winter nights; and of the sheets of stratocumulus (typically at 1000 metres) that cause mean annual cloud cover to exceed 60 per cent across Arctic Canada. Neither darkness nor sheet cloud are impenetrable to radar.

The Space-based systems could be developed jointly with the Americans or else on a national basis. 'Failure to meet this challenge could mean forfeiting the responsibility for surveillance of Canadian airspace to the United States' (p.59). Meanwhile, involvement in ballistic missile defence would be shaped by 'our own independent analysis of the strategic environment' (p.19) in relation to the preservation of 'stable deterrence' (p.19) and the 'prevention of an arms race in outer Space' (p.27).

At this time, SDI and all other matters as between Ottawa and Washington were being complicated by two ecology-related disputes. The one was Canada's claim to sovereignty over all the waters around her Arctic archipelago; and the other the contribution being made by American hydrocarbon efflux to acidity within her matchless array of rivers and lakes. None the less, her distinctive pitch on SDI had more general significance in view of (a) Ottawa's perennial ambition to act as interlocutor between America and Europe and (b) the extent to which any Canadian response had resonance in Scandinavia. In 1987, too, the Siumit-Inuit governing coalition in Greenland collapsed but was reformed on the understanding that a commission be established to monitor the conversion to phased-array of the BMEWS site at Thule.

The question of Thule upgrading likewise became a cause of parliamentary controversy in Copenhagen. It was so between the ruling conservative coalition and the 'alternative majority' : a loose amalgam of Social Democrats, Socialists and anti-NATO centrists. In a debate in March 1987, however, the Social Democrats unexpectedly dissociated themselves from Socialist demands for an investigative commission. Instead they put forward a motion requiring the government (in liaison with the parliamentary standing committee on defence) to ensure the Thule radar never be used for offensive purposes nor linked to SDI systems; that Denmark and Greenland be kept informed about changes related to this facility; and that NATO and the United States strictly adhere to the ABM treaty. That compromise of a sort was passed with

the support of a grateful government. One may note little shift in the political balance in the Danish election held that September.

In Federal Germany, opinion on defence questions tended to polarise more acutely than in other allied countries. But in the early 'sixties, most West Germans became aware of how much the build-up of 700 strategic ballistic missiles inside the western borders of the USSR had been posited as against themselves. From 1965, deterring thus the 'revanchist' aspirations of the 'bellicose' Federal Republic lost its prominence in the Kremlin's litany. Nevertheless, it was Chancellor Helmut Schmidt who, in the late 'seventies, alerted the alliance to the threat posed by the SS-20s being installed to replace those missiles introduced 15 years earlier.[4] No inkling was there then of the furore that would be invoked within two or three years by NATO's response, the Ground-Launched Cruise Missile (GLCM) and the Pershing 2.

As Federal Minister of Defence before becoming Secretary-General of NATO in mid-1988, the late Manfred Woerner was a leading advocate of TMD, particularly to shield military targets against non-nuclear strikes launched as the first stage in a blitzkrieg offensive. His interest in this probably became less urgent with the signing of the INF accord. But it did not evaporate. In Federal Germany as throughout NATO Europe, the bitterest opposition to SDI had come from the ultra-Left and the least querulous support from the centre Right.

France

One might have expected France to be a great exception to this rule. After all, a key Gaullist theme had been that the advent of a lasting nuclear stalemate as between the Superpowers had enhanced the role of the French deterrent as a protector of Europe. This thesis was neatly encapsulated by Georges Pompidou in 1963 when he averred that the defence of Europe is 'physically and geographically inseparable from that of France which is not the case with forces outside the European continent even if allied'.[5]

Yet two months after becoming Prime Minister in March 1986, the neo-Gaullist conservative Jacques Chirac indicated that his government would be 'much more positive' about SDI than its socialist predecessors bad been. He spoke of it as 'inevitable, irreversible and justified', both technologically and politically. He depicted the nuclear arms race not as stalemated but as endlessly dynamic. He averred that France must 'associate itself with this great research' in order to stay 'the third country in the world in Space technology'.[6] At the same time, French officialdom was making clear how well it understood the potential significance for Europe of TMD.[7] You could say that the one concession made to classical Gaullism was not capping industrial collaboration by the signing of an MOU.

So it is only to be expected that France under President Chirac will be attuned to TMD. Even under President Mitterand, indeed, concern about the new threats burgeoned. The seminal Defence White Paper of 1994 recognised that the 'proliferation of nuclear, biological and chemical mass destruction weapons, *whether or not connected with ballistic vectors*[8], sets new problems for our defence system, both for the protection of the territory and for that of the French forces deployed abroad. This challenge moreover concerns most European countries of the Atlantic Alliance'.[9] Also emphasised was how diverse must be the elements in a counter-missile strategy. Urgency attached to achieving a capability for missile early warning. So did it to inhibiting the development of adversary capabilities, maybe through international sanctions or pre-emptive military action. European collaboration in

defence was extolled with more zeal than Paris had been wont to display. That autumn France became a founder member of the Medium Extended Air Defence System (MEADS)..

Illumination of the evolving French position was regularly afforded by Henri Conze during his tenure (1993-96) as head of the *Délégation Générale pour l'Armament* (DGA), a government agency of central importance in defence development and procurement. Cautious, in view of 'so many failures in the recent past', of binational endeavours with the United States within the weapons ambience[10], he said at least two major pan-European companies ought soon to be formed.[11]

Referring to anti-missile defence in the presentation that June cited above, Conze freely conceded that 'France alone cannot protect its territory. We have to take into account a threat coming from the south-east. Italy and the US would also have an interest to share warning information and active defenses.

So two key spheres for military co-operation are Space and counter-proliferation in general. We are sharing totally the analysis of the threat and the necessity to develop the same policy, and also to determine what the different aspects of that policy are. This is triggering a lot of discussion and working groups between France and the US, and also with some other countries, to explore what should be done'.[12] What was not here revealed, one may note, is anything about the talks that were reported to have taken place between Matra and Antey, the French and Russian aerospace firms, about the possible co-operative development of an anti-ballistic system derived from the Russian SA-12.[13] Maybe those talks never came to much.

Allowing that strategic philosophy and pragmatic behaviour sometimes starkly contrast, the impression one still gleans is of a France committed to European/Atlantic collaboration more solidly than in the past. Witness last December's announcement that thenceforth she would attend NATO defence ministers' meetings, and rejoin the Military Committee as well as certain staffs. What has also been coming over is the message that she will soon re-enlist in the alliance more comprehensively, subject perhaps to some Euro-centric reform of its structures.

Something that has abruptly supervened of late, however, is the concurrence of fiscal stringency and structural overcapacity in a French aerospace industry heavily dependent on military sales, not least overseas. By last autumn, the number of people directly employed was 100,000, down over a quarter in barely five years.[14] One response last year was the merger of the missile-Space divisions of Aerospatiale and Germany's DASA; and this May came the decision of Matra Defense and British Aerospace to merge their missile capabilities. In February, the Chirac administration revived an endeavour, previously launched in December 1992, to merge Aerospatiale and Dassault. The latter is (a) the smaller, (b) mainly privately-owned and (c) imbued with a thick streak of Gaullist wilfulness. Accordingly, it is fiercely resentful of merging. So the Paris government may be consumed with this objective for some time. How stultifying an effect all this could have, at just the wrong moment, on European collaborative ventures has already been shown by two unilateral withdrawals, each said to have been undertaken for budgetary reasons. Several months ago, the French left the Future Large Aircraft (FLA) transport project; and then pulled out of MEADS.

The Shape of Europe

France is very conscious of her Mediterranean identity, it being one facet of her 'God-given' natural frontiers. More generally, a common Mediterranean perspective, absent apropos SDI, could emerge in respect of TMD. But it would be wrong to

assume that this would be bound to involve firm endorsement of TMD to counter an emergent threat from the South and East. The respective political situations may not allow of that. The traditional political parties of both Right and Left have been losing support drastically. Greece has not yet emerged from a decade and more of economic stagnation. In Turkey, we are witnessing a strong rise, among the deprived and disenchanted, of fervent though non-fanatic Islam.[15] That must make it all the more improbable that Ankara would be prepared to play a fulcral role in the provision of an alliance BMD screen.

Granted, there is an awareness in Southern Europe of how easy it is to traverse the Mediterranean, from south to north, with Scud Cs. Relevant, too, is a wish to see the indigenous aerospace industries thrive against the background of a swing towards professional armed forces. On the other hand, a disposition has lately been evident to address Mediterranean security issues through collaboration with all littoral states. Last November, for instance, the EU sponsored a ministerial Euro-Mediterranean Conference in Barcelona. Libya apart, every Mediterranean nation was represented including the Palestinians. The agenda included political rights, the peaceful resolution of territorial disputes, terrorism, and the NPT. Terrorism has, of course, been endemic of late around much of the Mediterranean. Marine ecology is another unifying theme.

In so far as Southern European electorates are today geared up to get tough with North Africa, it is over immigration control rather than missile proliferation. But with economic and social questions, too, the main governmental emphasis has lately been on conciliation and cooperation. The Mediterranean members of the EU have been pressing Brussels, with a modicum of success, not to aid too exclusively the former 'bloc' countries and to help more the Levant and North Africa.

If this overview be valid, there has to be a danger that any debate over BMD will show just how ricketty the whole EU/WEU/NATO structure is becoming on account of our self-inflicted crisis of undue enlargement. Until 1994 or thereabouts, expansion of the European Economic Community (EEC) was very generally viewed as an alternative to tighter integration in whatever mode, with successive British governments preferring the former tendency to the latter. But at the Corfu and Essen summits of that year, most members went along with the view retiring Commission President Jacques Delors had arrived at, this being that 'Europe' could expand to 25 or 30 constituent states yet still move inexorably towards federalism. That January, NATO had launched its Partnership For Peace programme, in part so as to pave the way for its own expansion eastwards. In Warsaw that July, President Clinton proclaimed that NATO's enlargement was 'no longer a question of whether but when or how'. In the confused debate that ensued, it came generally to be presumed that any state joining NATO will also join the EU, shortly before or after.[16] Yet soon even Delors was coming to admit that a 'Europe of the thirty' might well fractionate into regional cliques.[17]

It is much to be hoped that BMD never serves as a catalyst for this. Whether or not it does will depend on a number of factors. What BMD policy is proposed and why? How much harmony prevails throughout Europe at the time? What are relations with the USA like? How does the world scene appear? Institutional and doctrinal factors will also figure.

Arguably, indeed, the Western European Union (WEU) should become a forum in which NATO Europe (led by Britain, Germany and now, presumably, France) thrashes out a BMD doctrine. After all, it has taken an interest in ballistic missiles and related questions these last few years. In June 1993, WEU sponsored a symposium in

Rome to identify and broadly cost Europe's TMD options. The proposal that emerged was for a theatre-wide system comprising (a) several satellites for launch detection, (b) ground-based fire-control complete with long-range radar and (c) ground-based ABM. It foresaw a need for systems mobility to facilitate force projection especially overseas. In February 1994, a working group on BMD produced a threat appreciation. However, it did warn against focussing overmuch on the ballistic threat as opposed to the 'particularly worrying' possibility of cruise missile proliferation. Cruise missiles were recognised as being a most efficacious means of CBW.

A report that November by WEU's Technological and Aerospace Committee identified several distinct areas in which transAtlantic collaboration was desirable as, too, was a common European front on BMD policy.[18] For instance, early-warning sytems might be implemented through WEU albeit as interoperable with American assets. One ought to define, however, what here can be meant by early warning. Surely not alerting and cueing from geostationary orbit?

At all events, this activity has been in keeping with the consultative traditions of the WEU. So has it with the provisions in the 1991 Maastricht treaty for having WEU evolve as the 'defence component' of the EU and as, subject to existing NATO obligations, a means of strengthening the European pillar of the alliance through the formulation of a common defence policy. The same has applied to the active endeavours by Britain in recent months to extend the role of the WEU. Unfortunately, these have run up against quite a bloc of opposition, consolidating around Paris and Berlin. The nub of the counter-argument is that, Maastricht notwithstanding, the EU must generate its own security policy. This is because a grand strategy for peace in Europe and abroad must rest very considerably on civilian power. That must be true to the point of banality. But it still does not mean that the military side of things does not need to be addressed definitively. Nor does it gainsay the argument that, from everyone's point of view, the best body to do this in terms of fundamental issues is WEU since it excludes from full membership of itself those EU members that are not also members of NATO.

WEU could not begin to rival NATO/SACEUR *vis-à-vis* staff work in depth nor in C4I structures adequate for the vast and complex European theatre. But it does now possess (as is discussed below) an emergent capability for strategic Space reconnaissance. It is also to make contingency plans for joint task forces operating (most likely alongside the Americans) out-of-area. President Chirac is said to be among those who welcome this.[19] All in all, it is not unreasonable to suppose that WEU might usefully elevate to a doctrinal level European perspectives on BMD-related issues. From that one might progress towards an Atlantic doctrine on this subject, a formulation conspicuously lacking at the present time.

Deployment Options

Suffice for now to explore the deployment options open to NATO Europe. One that has to be weighed is the protection of forces projected overseas, their protection while moving through beach-heads or airheads but also when duly deployed, maybe in a coalition order of battle across an extended front. Studies of missilry and the land battle, done in the Cold War setting of the Warsaw Pact versus NATO on the North German plain, may have some relevance out of area in the next century.

What then of deeper strikes by ballistic missiles, perhaps supported by airbreathing platforms? Acknowledging a heavy strike (e.g. 200 RVs bearing warheads of mass destruction) to be unbeatable except on the basis of deterrence through

massive retaliation, how might one prepare against, say, five or ten RVs fired in each of just a few well separated salvos? Is there scope for inclusion in the ladder of escalation a rung that relates to the distinction Glenn Snyder made many years ago: deterrence through denial as opposed to deterrence through retaliation?[20] Everything would hinge on how the threat was expected to evolve. But, in principle, such a rung could have value as (a) betokening resolve, (b) keeping in tune with a moderate interpretation of the American Republican aspiration for NMD, (c) limiting an adversary's scope for graduated escalation, and (d) dealing in a restrained fashion with aberrant releases. It could be seen, indeed, as a latter-day manifestation of NATO's long-standing doctrine of 'the pause'.

If this be accepted, three operational philosophies suggest themselves for BMD in NATO Europe, in combination or as alternatives. The first is the close-in defence (against precision attack by high explosives or chemicals) of certain key objectives. Here one should focus on military assets crucial to the defence of the continent or for deployment further afield but not defensible by passive means alone. These might include key naval and air bases. They could well include master radars. In Britain one thinks, first and foremost, of the Trident base at Faslane; the Fylingdales BMEWS; RAF Strike Command main airfields; and RN Devonport. Needless to say, this approach would depend on technical assessments of what degree of protection was potentially feasible; and then, of course, on the development of an appropriate weapons system.

The second philosophy involves 'thin screen' area defence, and has considerably informed PFS. Licit in principle, it could become a vexatious alternative, not least if interpreted too much in British national terms. One has felt tempted, with gentle encouragement from Lockheed Martin, to accept that three THAAD batteries near Faslane, Fylingdales and the Strike Command HQ at High Wycombe respectively would proffer local defence to those nodal British assets but also some measure of wider protection to some 90 per cent of the British people. No doubt the same argument can be advanced in respect of Brussels, SHAPE and the crowded Low Countries. For Europe as a whole, however, the arithmetic becomes absurd. One THAAD battery may screen 50 to 100 thousand square kilometres. The continent of Europe extends across ten million square kilometres.

So a THAAD deployment of the kind here depicted would make Britain an exclusive sanctuary just plausibly enough to undermine goodwill towards us in France and Germany, not to mention the rest of NATO Europe. At the same time, undue insularity on our part would encourage a similar American reaction. And what would be gained in return? We would be lucky if the THAAD batteries kept leak rates down to 15 per cent even against light area attacks. Nobody would rely on an ally prepared to act so unilaterally to afford itself a while so flimsy a measure of protection. It would be seen as simply an endeavour to divert probing strikes from ourselves to our neighbours. So they would lose confidence in our strategic nuclear umbrella ever extending firmly across themselves. An ultimate consequence of that could be a loss of co-operation in the active defence of Faslane, Fylingdales and so on, as and when this does become needful, against high precision missile strikes. Strike Command headquarters ought, in any case, to lend itself to passive defence.

The nub of the argument remains that THAAD is quite simply not a wide area weapons system in pan-European terms. Nor would it be easy to write the specification for anything that would be in the face of threats from both the South and the East. Europe is too large, yet at the same time too close to the likely sources of action. A missile fired from Tripoli against Edinburgh, say, would have a quite

different flight profile to one fired from Tripoli against Naples. All else apart, its re-entry speed would have to be twice as great; and its apogee over twice as high, 550 versus 225 km. The difference between Pyongyang to San Francisco and Pyongyang to New York would be by no means as great: perhaps 10 per cent as regards re-entry speed though rather more as regards apogee.

A similar divergence opens up *vis-à-vis* missiles trained on NATO Europe from within the Western borders of the Russian Federation. However, it would be re-oriented through about ninety degrees. The contrast would be as between Warsaw and Bristol or Budapest and Brest. To write a systems specification to cover this grid of permutations might be close to impossible.

Duly one turns to the third option, the defence of peripheral countries that now are, or soon may be, under the shadow of weapons of the calibre of Scud and Nodong. What this could connote in Eastern Europe, and how best to respond, is impossible even to speculate about at this stage. About the Southern flank, one can talk with some coherence. One tends to say that a cordon along the Mediterranean could essentially be either land-based or sea-based. In the south-east quarter, however, the alignment would be more problematic. How far Turkey wished to include herself would have to be tested. Without her, the line would be forced back to the NATO/EU frontier in the Balkans. But that may be even more shifting the next 10 to 15 years than is currently envisaged. Through the winter of 1990/1, Germany was brutal in her insistence on the immediate recognition by the EU of Croatia and Slovenia,[21] regardless of the implications for stability across former Yugoslavia. It is easy to imagine she will press before long for their inclusion in the big institutions as well.

MEADS

On the procurement side, Britain could have been brought nearer a time of decision by France's withdrawal this May from MEADS, a programme that has become central to visions of evolving BMD on the basis of cross-border industrial collaboration. Its origins go back to early this decade. In April 1991, the US Army/Marine Corps harmonized their notions of Corps SAM, the replacement for Hawk in middle-tier air defence. Moves were also afoot to blend this requirement with the corresponding German one, Taktisches Luft Verteidigungs System (TLVS). From late 1991, too, British Aerospace was in dialogue with the Americans about project definition and competitive tendering for Corps SAM.

Prominent among the other programmes bearing on this project was and is *Famille de Systèmes Anti-aériens Futurs (FSAF)*. This was spawned in France between 1982 and 1984 with feasibility studies on theatre surface-to-air defence against both ballistic and aerodynamic attack. In 1989, the EUROSAM consortium was formed to manage this programme. Its parent firms are Aerospatiale and Thomson-CSF of France; and Alenia of Italy. Several FSAF members have been under development with some emphasis on the naval side of things. On the non-naval side, a lead item has been the Hawk replacement known as SAMP-T, a lower-tier system built around the ASTER 30, a French interceptor missile with some anti-ballistic capability. There has been some schedule slippage. But signature of a binational production contract is confidently expected by the end of this year. It will provide for the operational deployment of SAMP-T from 2006 onwards

Anxious about the Pentagon's ability to fund Corps SAM as well as all the other BMD programmes, John Deutsch, then US Deputy Secretary of Defense, suddenly arranged meetings with German and French colleagues in August 1994, the British

being surprisingly excluded. A month or so later, Berlin, Paris and Washington signed an initial agreement for corps-level Theatre Missile Defence, their declared hope being that this would prove to be the genesis of a NATO programme. Towards the end of the year, Italy began to express interest. In February 1995, Rome joined with the other three in signing a statement of intent for the development of the Medium Extended Air Defence System (MEADS), a statement that subsumed the trilateral accord.

Cost and workshare were formally divided on the basis of 50 per cent for the USA, 20 per cent each for France and Germany and 10 per cent for Italy. US Under Secretary of Defense for Acquisition and Technology, Paul Kaminski, insisted, none the less, that 'there is a path for other countries also to join in the future'.[22] Before the crisis of French withdrawal, however, the programme had begun to gel around the existing members. Two Euro-American industrial teams had formed to compete throughout the Project Definition and Validation Stage (1996-8) for the privilege of leading the programme through the next stage, that of Design and Development. This is due to last from 1998 through to first entry into service in 2005.

Even so, support at national level has nowhere been unequivocal. American industrialists have been more than a little resentful. They recognise MEADS to be a conduit to large markets ($50 billion altogether?) in Europe and beyond. But they also know that, if the uniquely seamless integration of technological development being promised is achieved in practice, there will *ipso facto* be much transAtlantic pooling of technological know-how, they fear to their net detriment.[23] Correspondingly, MEADS had its ups-and-downs during last summer's fraught review on Capitol Hill of the defence budget. At one point, the Senate Armed Services Committee deleted all the $30 million MEADS request though, thanks largely to the interventions of Senator Sam Nunn, two-thirds of this was restored in conference. This summer, too, the administration's proposals for MEADS funding have had a rough time in Congress. But they seem to have survived intact, thanks to repeated assurances that the United States share in the development programme will not be raised above the 50 per cent set in 1995.[24]

My impression in Washington this February was that, within the Clinton administration, support for MEADS had firmed up. Democrats in general were more disposed to the view, expounded by Senator Nunn for some years, that this burden-sharing is good for alliance solidarity as well as for American tax levels. If firming up there has been, however, it is very much on the basis of MEADS being seen as synonymous with Corps SAM. In this the Americans have been considerably encouraged by the Germans, resistant for both political and military reasons to even considering ASTER as an alternative.[25] Obversely, this Corps SAM interpretation will have been a factor behind the French decision to pull out. Italy's position was thus placed in some doubt as well even though Alenia was known to attach singular importance to the industrial benefits of MEADS participation.

At least the identification with Corps SAM has made it easier to comprehend what MEADS is about. It is intended to cope with all forms of theatre aerospace attack from advanced cruise missiles to ballistic RVs. Its slant range is 25 km. Modularity and low manning levels would help make it much more mobile, both in-theatre and strategically, than is the Patriot PAC-3. Vertical launchers and a dual function (search and acquisition) rotating radar should give it 360° coverage, another big improvement on Patriot. If one has any immediate doubt, in principle as one might say, it concerns the engagement of low-flying and jinking cruise missiles. Doppler radars borne in UAV rotorcraft or beneath tethered balloons might well solve the problem of acquisition and

tracking but would still not ensure actual interceptions so close to the surface. The main, perhaps the only, MEADS warhead mode would be a hittile, not as satisfactory against cruise attack as fragmentation. Once again the question of actual interception emerges as a critically uncertain one in anti-missile development.

None the less, one may anticipate that MEADS will exploit its general dexterity to push back the lower and upper tier limits of its mission profile. The judgement this country may have soon to make is whether to seek a share of the action, in place of or alongside France, from 1998. The circumstances surrounding our exclusion in 1994 are still far from clear. It may be that we remained too undecided about our requirements. Perhaps, too, American reactions were influenced directly by President Clinton's averration that July of the 'truly unique relationship' which existed in the 'new Europe' between the United States and Germany because 'so many of our challenges are just to Germany's East'. Britain he dismissed as but 'the mother country'. At all events, many of the friends of MEADS would likely welcome Britain's joining at the Design and Development stage and not only as a guarantee of the programme's survival. Indeed, some prominent Americans would deny there was ever a time they did not favour our accession.

Assuming MEADS does survive, it will constitute something of a return to the halcyon era of transAtlantic collaboration in military aerospace production, the era that culminated in the Hawk and F-16 programmes. If so, it may set a fresh precedent for other bilateral ventures - e.g. a civil hypersonic transport, unless the Americans turn instead to Russia in this regard. But the alternative possibility is that competition in the aerospace sector from over the ocean will become savage as military markets level outworldwide.

Our Industrial Base

Objectively it is hard not to believe savagery will be prominent these next few years, almost regardless of what happens to MEADS. This likelihood may underscore the principle that MOD procurement policy must take due account of our defence industrial needs. Already all sides seem more aware than some years ago that, when not manufacturing our own defence equipment, we (a) have little influence over decisions to cancel during development, (b) may not get the most advanced versions of any finished product, (c) will be poorly placed to generate in-service modifications, and (d) may lapse too much into dependency in regard to resupply. Recognised, too, is the reality that our important role as 'expert customers' of the Americans or whoever is set against a background of on-going experience in development work across a broad front.

This stronger awareness is apparent in the recent dialectic between (a) the Defence Committee and the Trade and Industry Committee of the House of Commons and (b) the Ministry of Defence and the Department of Trade and Industry. A joint committee report last November endorsed 'mutually advantageous' collaboration with the USA but described 'greater European collaboration as crucial to the survival of the defence industries of the UK and other European countries' ; and it called on the government to assume 'a more prominent role in creating a European defence market involving greater collaboration at government and company levels'. It further asked that the MOD 'take more account in procurement of the value to the armed forces of industrial back-up'; and, indeed, that it 'be given a more formal responsibility to take account of the future of the UK's defence industries'.[26] The reply from the two ministries acknowledged that collaborative projects, 'usually within Europe', are likely

to become increasingly important; and indicated some initiatives that may proactively shape policy in this area. It rejected any outright commitment to a 'European preference' policy or to widespread mergers but acknowledged the need for a progressive consolidation of the European scene.[27] Last autumn, a Labour Party working group, headed by Dr David Clark, on the British defence industry said that while 'collaboration in Europe shows more scope for genuine partnership, this should not preclude the continuation of UK-US collaborative projects. The United States is Britain's oldest ally in terms of defence technology innovation and transfer ... and the loss of this transatlantic corridor of technological information sharing would be sorely felt'.[28] The debate continues.

The structural crisis we have to get to grips with industrially is fundamentally a global and post-Cold War one. Defence spending around the world is estimated to have fallen from $1.2 trillion in 1987 to $850 billion in 1994 (both figures at 1994 dollar prices). The procurement fraction of that will have contracted proportionately more. Aerospace analysts now 'expect the world's air forces to buy approximately 3,500 new fighters over the next 20 years while civil airlines will buy some 15,500 commercial airliners'.[29] In some respects, of course, a dynamic civil capacity can underwrite a more constrained military one. But that principle cannot usually extend to the direct subsidisation of individual programmes. Nor can it well extend in any form to sectors like guided weapons that have only a very partial overlay, technologically speaking, with the civil side.

The Society of British Aerospace Companies is particularly concerned about the shrinking and impoverishment of our national industrial base for guided weapons (GW). It estimates the manpower level in the defence industry as a whole to have fallen 45 per cent since 1988 but that in the major GW divisions to have fallen 80 per cent. The production capabilities we no longer possess include those for long-range rocket motors and ramjet/ramrocket propulsion. Among a number of GW technologies considered 'endangered' within the UK are thrust-vector controls and high-g thrusters; active radar seekers and anti-radar homing devices; and infra-red seekers, sensors and fuses. Yet, globally speaking, all those sectors have a comparatively buoyant future in prospect, industrially and militarily.

As to the remedy, the British aerospace community is somewhat divided on the question of pan-European mergers. British Aerospace itself now explicitly sees its own best future as down that road whereas the aero-engine, sub-system and component manufacturers tend to be apprehensive of thereby excluding themselves from opportunities in North America or, indeed, further afield. But the least that ought to be said is that a strong European nexus is a remedy that *ipso facto* enhances our bargaining position *vis-à-vis* other options. Significance attaches to the fact that Britain and others will now be joining the European Procurement Agency that was founded as a Franco-German venture in 1993. Through last year, there was speculation in the aeronautical press as to whether Paris and Berlin would welcome accessions at all.

Further convergence towards collaboration/integration is likely to be a *sine qua non* for European aerospace manufacturing especially on the military side. Since 1989, manpower in the United States aerospace industry has fallen from c.1,400,000 to c.950,000, a drop of a third. That in the EU has thus far fallen less proportionally, by about a quarter from c.450,000.[30] If Europe now lies singularly exposed, this is basically due to two structural factors. The one is that the American domestic market

is typically three times larger. The other is that the American industry is less fragmented.

Yet the American firms have continued to come under official pressure (most notably at a senior executives' 'last supper' with Secretary of Defense Perry) to merge further. True to American business and constitutional philosophy, the federal government is likely to encourage the survival of but two corporations in each major military sector. So in ten years' time, just McDonnell-Douglas and Lockheed-Martin-Loral for warplanes; and Hughes versus Raytheon in missilry? Even as things stand, American aerospace producers tend to be twice as large (judged on manning levels) as their European counterparts.[31]

The economies of scale that come with size connote an ability to spend more on "overheads". These may include well-heeled sales drives. They may also include the free-ranging exploration of novel concepts, most famously through the Lockheed 'skunk' works (the progenitors of the SR-71 and the F-117) and the McDonnell-Douglas 'phantom works'. This latter benefit may again be looming in importance against the background of the accelerating revolution in information technology. So far, the Europeans have held their own remarkably well on the applications side of computer hardware and software. But that virtuosity may not be easy to sustain from now on. UAVs is one very important field in which Europe is in real danger of being completely outclassed. It is very germane to BMD.

A further point to make is that, notwithstanding the striking success of Airbus Industrie, *ad hoc* holding companies are not necessarily a good way to pool European resources multinationally. All else apart, reaching working agreements tends to be so difficult as only to be achievable by playing things too safe in terms either of basic concept or of technology application. Concorde was hamstrung at a critical juncture by strong American playing of the environmental card *vis-à-vis* landing rights and overflying. In addition, however, those who had defined that binational programme had failed properly to anticipate the upsurge of fuel costs and the advent of the jumbo jet. Lately there has been quite a lot of pressure both sides of the Atlantic for Airbus Industrie to be transformed into an autonomous European multinational operating strictly in accordance with normal commercial principles. That transformation is now being actively explored even though it may mean the end of the governmental guarantees of commercial loans that have been one of the keys to the progress of Airbus Industrie to date.

Nobody is going to be so foolish as to suggest that our military procurement should be distorted merely to keep European or, indeed, British aerospace firms in business. Least of all would this be permissible in a sphere like BMD where performance parameters and cost-exchange ratios are liable to be tight at the best of times. As suggested above, however, it is reasonable to recognise that BMD choices have implications on the industrial side of grand strategy. Such recognition may make taxpayers more ready to fund. Also, the Americans may be more ready to seek collaboration with Europe, rather than cut-throat competition, if they perceive European governments as resolved that aerospace manufacture shall flourish within their Union. Besides, collaboration implies commonality, always an important attribute in any military alliance.

A domain where the Americans are easily irked by any threat to their hegemony is Space. McDonnell-Douglas (with its Delta 3) and Lockheed-Martin (with the Atlas-Proton project) are each limbering up to challenge the primacy the European Space Agency's Ariane series of rockets established in the wake of the shuttle Challenger

disaster in 1986. Lately, Ariane 4 has commanded some 60 per cent of the world's commercial launcher market. Correspondingly, Ariane 5 has been expected to affirm European leadership in the commercial market and especially in the provision of enhanced lift capability for large infrastructure/manned Space missions.[32] But in the aftermath of its disastrous first launch this June, Ariane's management culture is the subject of much astringent comment.[33]

Overhead Surveillance

Lockheed Martin indicates that it will also be competing against Helios and what has been called Osiris, military satellite programmes that, though outside ESA, are thoroughly European. The Pentagon's declaration in 1995 of a willingness regularly to share with NATO or with individual allies missile early-warning data from its Defense Support Program (DSP) geostationary satellites may owe something to this throwing down of a gauntlet.

It is sometimes said that some hesitancy in Washington at the start of the 1982 Falklands crisis confirmed that a free flow of information from there to London cannot be assured when there is a conflict of interest between the two capitals. That may be a misreading of that particular situation. The backing of ourselves by the Reagan administration soon proved amazingly solid, bearing in mind (a) Washington's hegemonic responsibility to seek a peaceful solution as long as there was still the faintest chance of this and (b) the uncertain regional consequences of a collapse of the Galtieri dictatorship in the throes of defeat. This solidarity was manifest in sanctions against Buenos Aires and, most importantly, in logistic and intelligence support to our task force. The intelligence included much gleaned from Space.

What we may come to see as more sobering is the record in respect of monitoring the warfare in former Yugoslavia. Washington has been able throughout to generate much hard data by means of orbital satellites, aircraft and UAVs. But until the massacres hard upon the fall of the Srebrenica 'safe area' last summer, there was a disinclination to publish or otherwise probe further *prima facie* evidence of ethnic cleansing via prison compounds and mass executions. The reason seems to have been that Presidents Bush and Clinton in turn were anxious not to fire up opinion in favour of the dispatch of American ground troops.[34] Also Washington has been implicated in evasions (in respect of the Bosnian Moslems and Croatia) of the general arms embargo the Security Council imposed in 1991. It would be interesting to know how far this, too, has involved (e.g. in respect of Iranian arms shipments to Bosnia) selectivity in the dissemination of data to the UN and to allies. At all events, the Baconian principle that 'knowledge itself is power' applies with great force in modern strategy, not least as regards overhead reconnaissance. This is why Israel and maybe China already has a military observation satellite; and a reason why a number of other countries have civil surveillance.

So what may now be on offer in terms of Space-derived information from the European side? What certainly is not is anything remotely approaching what the United States is attaining in terms of military operational support, be this for active TMD or anything else. Europe, however defined, is a good two decades away from a counterpart to DSP, even assuming it may aspire to that. It is a sight further away from anything to match what we trust SMTS will achieve. All that is seriously in prospect at present is a measure of strategic reconnaissance from Space. Still, that in itself is not insignificant in the context of TMD and more generally.

In 1995, the Helios 1 was launched via an Ariane rocket. It is a French-led military programme with Italy contributing 14 per cent of the cost and Spain seven. In terms of its basic platform design and much of its electronics, it derives rather directly from Spot, a French civilian resources satellite with a resolution of ten metres in its optical mode and 20 in the infra-red. A matter of some remark, during the closing years of the Cold War, was that (even with these rather coarse resolutions) this duality yielded results of real military value. A celebrated example was the panoramic view of Gremikha, the large base for Soviet nuclear ballistic missile submarines (SSBNs) dug out of the forbidding Kola peninsula.[35]

Since then, things have moved on. Spot 5, due in service at the turn of the century, is expected to have an optical resolution of five metres. Helios 1, which is similarly optical and infra-red, is generally understood to have an optical resolution of one metre.[36] It is due to be succeeded in several years time or so by Helios 2 which Germany is financing to the tune of 20 per cent with Italy and Spain probably joining in again as well. Then will follow Osiris, a radar-surveillance satellite. It now being renamed Horus as France hands the lead role over to Germany. With that handover comes an obligation to fund to the tune of perhaps 60 per cent.

Horus is not a clearly defined concept at the moment, certainly not as far as its public profile is concerned. But among the particulars available about Helios is that each subscribing country has an image reception and a processing centre, a spread which could make pre-emptive interdiction that much more difficult. In addition, there is now a special WEU data processing centre at Torrejon in Spain. Its creation was foreshadowed by the April 1990 meeting of the WEU Council of Ministers. The official communiqué stated that 'Ministers also noted the progress which had been made in studying the possibilities for European co-operation in the field of Space-based observation systems for the purposes of arms control verification, and also for crisis and environmental monitoring. They called for concrete proposals to be submitted to them at their next meeting, *inter alia* with a view to examining the possibility of establishing a satellite verification agency'.[37]

The Helios 2 and Horus programmes are expected to cost a good two billion dollars apiece.[38] But the impression one gets, in the aftermath of their endorsement at the Chirac-Kohl summit last November, is that the thrust they represent will be less readily curtailed by budgetary constraints or whatever than some other endeavours have been of late. Overall, the proportion of French military procurement expenditure devoted to Space is due to rise from one to four per cent between 1997 and 2002.[39] What then should Britain's attitude be? We are already involved in staffing the Torrejon facility. But our direct participation in Helios or Horus seems not to be on anybody's agenda. So our next step might simply be greater involvement in ESA, bearing in mind that in this age of information the diffusion of technology takes place as readily from civil to military as *vice versa*. Being more involved could be contributive in the round as well as beneficial, industrially and politically, to ourselves.

At present, Britain ranks fourth among the 16 member nations of ESA as regards financial contribution. Part of the background to this relatively modest commitment is the decision by Kenneth Clarke, as Minister responsible for Space policy in the middle 1980s, to rein back on our participation in ESA because its plans seemed too extravagant or irrelevant, particularly with the emphasis on manned Spaceflight. What can now be said, however, is that ESA is applying a variety of techniques and achieving a wide coverage of the electromagnetic spectrum to conduct a diverse and distinctive programme of pure and applied science. There is also the launcher

programme. We have been expected, in fact, to be more involved in Ariane 5 than we have been in Ariane 4. But perhaps that will now depend on a successful launch the next twelve months or so.

A question always in the background whenever one contemplates moving closer to our WEU partners in respect of strategic monitoring or contingency planning is whether this will fatally impair the special intelligence relationship with the United States, a relationship that became singularly strong under the auspices of the Combined Chiefs of Staff in the Second World War. A clear-cut answer would be hard to provide, even if one were better qualified than one is. But a few general comments may here be in order. Though the said relationship finds expression through a number of channels, it is probably fair to say that there are two which give it a unique character. The one is the nexus, formalised as long ago as 1946, between the Government Communication Headquarters (GCHQ) at Cheltenham and the National Security Agency at the Pentagon. Both bodies are world watchers; and each has a prime responsibility for code-breaking. The other is interaction by the Joint Intelligence Committee (JIC) of the Cabinet Office. The JIC has sometimes been the more able to present a circumspect view (e.g. over the post-Sputnik 'missile gap'?) in that, unlike some American counterparts, it has not been comprised entirely of intelligence specialists.[40]

As just implied, however, the various linkages are pretty much separate one from another. There is no reason to assume flows of raw data or the analysis thereof between, say, Cheltenham and Torrejon. Quite the contrary, in fact. It is probably fair to say that there will be some trend towards pooling in the longer term because intelligence work everywhere is moving more towards synoptic appreciations. Indeed, the impending establishment of a WEU situation centre will be a step in this direction. But in the meantime, other things will or may happen. The British ability to influence the American intelligence community must have derived in part from the institutionalised pluralism that has characterised it across the years. That may change. The organisation of intelligence is currently the subject of a big rethink in the United States, not least by a Presidential Commission that has been due to report this Spring. Britain's retreat from Empire is relevant here as well. We are just about to relinquish another 'listening post', Hong Kong. Then to revert to Bosnia, there is no reason to believe that the transmission of general intelligence by the Americans to the other contingents in the NATO Rapid Reaction Force has differed essentially this last year from that to our own troops. Nor is there any good reason to expect it to.

9 - Conclusion

Notwithstanding the best efforts of Lady Thatcher in Fulton this March, popular awareness of BMD throughout the West (but especially this side of the Atlantic) still lags far behind the subject's intrinsic importance. Herein lies a danger. It is that when public opinion does catch up, it will do so very abruptly with a sharp polarisation of attitudes as the consequence. That would be part and parcel of a pattern only too well established in Europe since 1945 in regard to military-related subjects. Sudden upsurges of protest, led by the militant Left, have peaked with remarkable regularity every 15 years. This happened in 1953 over German rearmament; 1968 over Vietnam; and 1983 over cruise missiles.

Lately, the far Left has been itself much deflated by the collapse from within of Communism, a credo that school of thought had long depicted as a robust philosophical challenge though not a source of military threat. Therefore its next peak of militancy may be deferred a while. But that is not to say it will never arrive. It is easy to conjure an assortment of issues that could induce it: structural unemployment, environment, anti-Americanism, corruption. Also endemic among youth in modern Western society is frustration with the educational process as seen in relation to the prospects for sustained and fulfilling employment. That reaction phases into a feeling on the part of many that their whole ambience is lacking in noble ideals. That feeling makes them susceptible.

So were BMD policy to be badly cast or presented by governments either side of the Atlantic, it could become the next arms race theme to galvanise a wave of protest by the European Left. The only thing is that, this next time round, the radical Right might be on the streets as well. Meanwhile, in the United States, NMD might have become a primary driver for the nativist isolationism of the Pat Buchanan school. Gyrations to these extremes could all too easily cause alliance fragmentation, both within Europe and as between there and North America. Even if the situation did not deteriorate to that extent, it might still be far from conducive to a judicious solution of the BMD question. Many options present themselves on BMD policy. Good choices could hardly be made against the background of a crude dichotomy between technological opportunism on the one hand and know-nothing rejectionism on the other.

Qualified Singularity

One thing Britain cannot do at this juncture is stand aside from the BMD debate. That option now looks more otiose than ever, given the airing the issue has already had within NATO and elsewhere, with ourselves well to the fore as discussants. So an affectation of disinterest might simply be read as outright rejection.

Besides, the long-range ballistic missile does have singularity in enough respects to claim special attention. It is well suited to the delivery of warheads of whatever kind across distances up to and including the intercontinental. It will in due course be able to do this with pinpoint accuracy over whatever range, whether with multiple RVs or a unitary one. It will thereby shatter an axiom enunciated by Clausewitz in the wake of his Napoleonic war experience He cautioned that, while geometry had lately 'attained anew a great importance' in tactics, it was 'not decisive' in strategy. He then gave vent to what must then have seemed the crowning platitude that, in strategy, 'We do not fire from one theatre of war to another'[1]. The geometry of ballistic missile

flight has changed that perspective more abruptly than has any other development in contemporary military science.

What underlines this new truism is those several respects in which the missile, and perhaps especially the ballistic missile is a weapon for the relatively 'poor men' of this world. Though far from easy to make or operate, it is easier than is a strike aircraft or a frigate. It is also easier to make than an advanced cruise missile. Its quality does not have to equal that of similar weapons on the other side. It is one of those instruments of war (others archetypically being the terrorist suitcase or the attack submarine) that are eligible for use in small numbers or even singly. It is further a poor man's remedy because it should have quite a long 'shelf life' (twenty years?) and because old and new versions may be employed together to compounded effect. Moreover, it could prove a reasonably effective mode of delivery for certain types of biological bomb.

By a 'poor man', one will usually mean either the Libyas or the North Koreas of this world, nations denied by size and backwardness a truly large and diverse industrial base. But the term as here used is considerably applicable to China or, if you like, India or Pakistan this next quarter of a century. It could well apply, indeed, to a Russia moving back from a rather dependent friendship with the West towards an attitude once again ambivalent or hostile. The strategic missile (ballistic or cruise) cannot match insurgent terrorism as a threat to deploy covertly over whatever distances by regimes or communities that feel excluded from the new world order. But there are circumstances in which it might serve as an umbrella from beneath which terrorism may be supported. Nor should we ignore how rocket technology may eventually imperil surface fleets, particularly in combination with cruise technologies via hybrid forms or else in simple mixes. Nor that scores or hundreds of missiles, ballistic and cruise, may one day rain down on our forces engaged in land warfare out of area. Nor that some are already available for dispatch against the home territories of our Mediterranean allies.

The End of Absolutes

Absolute security will not be achievable by any state in the world of the twenty-first century whether via BMD or anything else. A seminal paper on the philosophy of Space-related warfare by the SDIO official historian concluded that the Clausewitzian factors of uncertainty, luck, chance and psychology would probably make 'combat-outcomes ... as unpredictable as they have been in other arenas of war'.[2]

Therefore missile defence must never again be commended to its electorate by any democratic government after the fashion of that 1980s advertisement which showed children gambolling safe beneath an inviolable SDI 'peace shield'. Nor must any army be sent to war with the promise that it will gain victory without taking casualties from ballistic missiles or anything else. That illusion was what skewed disastrously Israel's strategy in the Lebanon this Spring.

The Harmel philosophy of twinning defence with detente (and arms control) applies very much to certain modes of BMD. It is no less important that BMD be pursued through alliance co-ordination, a point Lady Thatcher stressed at Fulton.[3] It, too, needs to be underscored at this juncture. For if one puts too geopolitical a construction on the 1993 PFS scenarios, one could infer that the unilateral national approach is the valid one. Nor is that reading in any wise discouraged by a BMDO and a Lockheed Martin now anxious to create the precedent of a binational deal for a

THAAD system now in some difficulty. But it is not in line with Britain's interests nor her obligations.

Alliance Under Strain

At the operational level, it is imperative that any European TMD be handled through NATO; and it would be desirable for American NMD also to be co-ordinated with NATO, ideally via NORAD. Lady Thatcher hit the first nail firmly at Fulton with her insistence that the EU ought not to seek its own defence identity, putatively as a step on the federalist road. Where she may be seriously in error, none the less, is in arguing that (partly to keep Washington committed to multilateral BMD) the future basis of the Atlantic Alliance must be that the United States is 'the dominant power surrounded by allies that generally follow its lead' not merely on the defence of the area encompassed by an enlarged NATO but on global issues of security and trade as well. This arrangement would, as she sees it, be underpinned by a North Atlantic Free Trade Area and capped by 'an annual summit of the heads of government of all the North Atlantic countries, under the chairmanship of the President of the United States'.

Such a formula might well turn out to be one for the alliance withering to nothingness within ten years. It would lend fresh credibility, and not only in France, to the old Gaullist objection to a NATO divided as between 'the integrator and the integrated'. It would revivify neutralist sentiment, on the northern and the southern flanks of Europe if not elsewhere. It would bitterly frustrate those many millions of Europeans (not to mention quite a few North Americans) who look for continuing interdependence but more on the basis of transAtlantic parity. The impact on moderate opinion across the world at large would probably be negative.

More specifically, it would not be a suitable milieu for the articulation of European perspectives on foreign policy matters. Yet it is not hard to imagine these being in the future significantly different from American in respect of Russia or China or both. They have long been so in regard to the Middle East. The EEC's Venice Declaration of 1981 was a clear manifestation of that apropos the Israeli-Palestinian question. One difference at the present time is more of a disposition in Europe to keep lines to Tehran open.

More scope may also be needed for giving vent to what could well be some distinctively European perspectives on the revolution in military science now under way. Not least could these apply to BMD. How far ahead, and in what circumstances, may strategic pre-emption be viable as a first layer in BMD? What of the prospect, in due course, of high-precision strategic missiles? What part can active BMD play on the battlefield? What about naval TMD? How should BMD relate to arms control? What would be the BMD implications of Poland, Czechoslovakia and Hungary acceding to NATO? What if NATO or the EU is extended to include the Baltic States? Is it important to intercept mass destruction RVs only above the ozone layer? What rules of engagement should obtain in this regard? It is *vis-à-vis* doctrinal issues like these, all of which reside somewhere in the grey area between operational technique and grand strategy that a singular link role might be performed by the WEU, an institution Lady Thatcher omitted to mention at Fulton.

Counter-Proliferation

So how should one enunciate a BMD policy? Much as with the United States itself, Europe is unlikely to come under ballistic missile attack these next 10 years.

With due allowance for political and institutional uncertainties, it is hard to see Russia regenerating a serious threat in less than a decade. It might well not happen for considerably longer. Making due allowance for her uncertain pace of technical development, it is hard to see China threatening Europe directly within a decadal span.

Likewise, the Middle Eastern threat would be unlikely to develop faster even if other things were equal. Nor are they equal. The United States has been making it quite plain that, in accordance with her counter-proliferation doctrine, she will use naval blockade or aerial interdiction or even covert action to prevent Iran or Libya achieving strategic status in this realm. Moreover, Israel would be very inclined to act alone, should Washington back off come the crunch. My guess is that Britain would be prepared, as in 1986, to collaborate with the United States in a pre-emptive strike against Libya. Continental Europe would be unlikely to object at all fervently, not if things really had come to a dangerous pass. Indeed, the France of President Chirac might participate, particularly in view of his country's Mediterranean identity and its continued military presence around the Gulf and elsewhere east of Suez. Many Europeans might prefer overt coalition action against Tripoli or even Tehran rather than covert action by the United States, Israel or anybody else. They might prefer it as well to BMD deployment. They might also feel that, as in 1991, collaboration could be a means of gaining leverage on American policy towards the 'peace process' in the Middle East.

Little mentioned in this connection at present are Iraq and Syria. The former is still subject to overarching constraint. The latter is deeply involved in insurgency in the Lebanon and has a track record for the wider support of terrorism. On the other hand, she is conscious of the need to avoid all-out war with a better-prepared Israel and of being hemmed in by the closer relationship of late between Israel and Turkey[4], a relationship formally underpinned by a security agreement. Syria's participation in the Gulf war was part of a quest to bolster her legitimacy in the eyes of the West, this to avoid general war and to secure favourable deals on the Lebanon and the Golan. To all of which one has to add that North Korea may find meddling in the Middle East less advantageous than before. If Pyongyang does decide to break right out of her new and constraining relationship with Washington and Seoul, she may well decide that the only way to do so is by blitzkrieg action against the South.

Unfortunately, a culture lag is becoming evident in the commentaries on counterproliferation. It is that of blatantly ignoring how the newly proactive approach, in America but also among her allies, is limiting the options our adversaries possess. Take a presentation made this April by Robert Joseph, in the Bush years a member of the Standing Consultative Commission on the ABM treaty. Speaking of Medium Range Ballistic Missiles 'capable of striking Europe', he said that 'Given North Korea's record of selling ballistic missiles to countries such as Iran and Syria, I think one has to plan for these missiles being deployed to other vital regions such as the Gulf'.[5] But that presupposes a continuity that quite simply will not be allowed unless the West executes a complete *volte face*. Likewise the statement by Rolf Ekens, head of the UN commission in charge of Iraqi disarmament, that Baghdad had designed a missile intended to dispatch a mass destruction warhead across 3000 km, proves nothing about her future possibilities.

To all of which there may be this corollary. However serious tensions may become across the Middle East and North Africa in the longer term, there will not be another Gulf-style 'mother of battles' there this next decade. Nor will anywhere else, except perhaps Korea, necessitate the West's involvement in overland warfare in such

a fashion and on such a scale. However, there are still many states in the developing world that are not merely small but 'soft' in the Gunnar Myrdal sense of not being firmly in control of their own borders and territory. This may make them susceptible to 'indirect aggression', the aggravation by external forces of their internal conflicts. Accordingly, a theme supplementary to that of major regional war has to be intervention to deal with armed conflict that is more localised and comparatively unsophisticated. But that, too, could involve exposure to missile attack. So ought the British contingent in any interventionary force to have BMD cover? May this, in fact, be needful these next ten years?

At first sight, the answer on both counts has to be affirmative. Intervention may be called for at any time. Our troops must be shielded, particularly if the Americans or other allies are thus accoutred. Yet things are not that simple. To start with, there are the difficulties inherent in trying to intercept short-range (and depressed trajectory?) rockets especially if they bear submunitions. Often in such operations geography is an added complication. Allied troops will be guarding an airfield or government complex, say, with insurgents in the shanty towns or the surrounding hills. So once again one has to judge whether to depend instead on passive defence, counter-attack or pre-emption. A disposition to do this may be strengthened by the tactical and logistical problems presented by the introduction of surface BMD into such a situation as part of a spearhead force. So may it by the low probability that mass destruction warheads would figure in such a scenario. It is not so much that the Pol Pots of this world would eschew chemical warheads, say, just because their own people would be endangered. They are not as solicitous as that. It is simply that they would be most unlikely to have access to such devices, at any rate not this next decade. It is worth remembering that, even at the height of the Cold War, those supplying Leftist guerrilla movements were consistently reluctant to let them have the sort of heavy and advanced weapons that would have given them real freedom of action.

Smuggled materials are, of course, a threat. But even in the unlikely event of a complete break up of the Russian Federation or its descent much deeper into the grip of the mafia archipelagos, the risk must be fairly low of the transference to a terrorist organisation of a nuclear warhead designed for (and in a ready state for) operational installation in a battlefield rocket. One should mainly be concerned with the toxic properties of radioactive, chemical or biological material. Yet lethality in this more insidious form may be transmitted as well by rucksack as by rocket. If some menacing package has already been spirited across thousands of miles, it may be no insuperable challenge to infiltrate it an extra mile or two down urban alleyways. Almost the same applies to a nuclear warhead, in any case.[6]

Without mass destruction warheads, however, rockets could still be acutely threatening to *une force d'intervention* during initial entry, assuming adequate cover was not forthcoming from friendly indigenous forces. At that time, too, passive defence would be hard to organise. Nor may pre-emption be politically appropriate. Yet for the reasons indicated, it is far from clear that the answer lies in a strategically mobile unit of surface-based BMD. Nor that ballistic missile interception from the air will be an option available these next few years, if indeed it is ever to be. So the remedy may have to lie in very swift and accurate counterattack, this presumably from the air.

A Decade For Revision

But suppose we can look to a decadal period of grace in respect of large-scale expeditionary warfare as well as of strategic missile assault. We still cannot afford to procrastinate. If BMD and related aims require new systems development, there is no time to lose. There is not much in any case. Stress has been laid above on alliance negotiation. Closer to home, it is surely needful to involve the British Army fully in the PFS deliberations or whatever may follow on from them. For one thing, the Army would probably play a part in TMD surface-to-air. The presumption among European armed forces would be that, while the air arms would assume responsibility for area defence at divisional level and above, coverage at what ourselves and certain other countries call brigade level would be provided by elements organic to the ground troops. The two rather contrary caveats to enter are that (a) the RAF Regiment has a strong tradition of forward airfield defence and (b) American practice is to give the US Army weapons like Patriot which extend organic protection back through divisional to corps level.

A more basic point is that armies stand to be prime beneficiaries from TMD. It is therefore important to get their holistic perspectives on the land-air battle and where active BMD may fit in. A study done in the 1980s showed that, whether one took ranges up to 500 km or between 500 and 1000 km, a single sortie by the Soviet strike aircraft available to the Warsaw Pact could dispatch an order of magnitude (factor of 10) more warload than could be borne by all the Tactical Ballistic Missiles in service with it.[7] Granted, the balance would be different in a 'poorer man's' part of the world tomorrow. Even so, this stark comparison does make one ask whether the aim of armies in dispersed beach-heads or extended orders of battle ought not to be to seek ride out missile attack, aided by mobility, hardening and other measures of passive defence. Soldiers do tend to prefer passive defence with its reasonably assured and enduring performance. This preference may be well-founded though it will be important to assess how well passive BMD may cope with smart submunitions. Some aspects of passive defence are always least applicable to confined beach-heads and other loci of debarkation.

At all events, uncertainty is visibly growing in the world of surface-based BMD. It is not clear to me at this point in time what the import is of the decision by the Clinton administration to stretch the production schedule planned for THAAD to 2006 instead of 2002. Malcolm O'Neill testified, as Director of BMDO, that 'no technical issues' factored in this delay[8]. But the three interception flight tests carried out thus far have failed; and test failures are habitually a source of cost-escalation. In fact, a schedule stretch was the economy measure least favoured by Lockheed Martin themselves. So what now happens to their own proposal for reducing costs by trimming the specification; and is the intention still to proceed with the fly-off in 2002 between the marinised THAAD and Standard Leap? It also remains important to know how SMTS fares in flight testing from 1998, certainly if THAAD and so on have eventually to face sophisticated threats.

Meantime, those THAAD test failures increase one's concern that just one successful interception will clear Lockheed Martin to progress from the Demonstration/Validation phase to Engineering Manufacturing. One is also apprehensive about the danger that any field tests of the synergy between THAAD and our Mesar radar technology demonstrator will commit us to THAAD procurement, either contractually or morally, years too early. The notion is that the Mesar 2 should

be the radar in any THAAD batteries this country procures, though not in any purchased elsewhere.

The Submunitions Crisis

The travails of THAAD, MEADS and so on may prove but the prelude to an era of deepening difficulty for surface BMD, especially in relation to the prospective introduction into offensive rocketry of submunitions intended for release during ascent. One has encountered, both in MOD and in our Defence Staff in Washington, some disposition to discount either ascent release or the submunition in general. With respect, that is not how the tide of American opinion now runs. Furthermore, submunition release pre-apogee is a prime consideration in the Statement of Work for our own Ascent Phase Kill Associated Study. It has similarly been accorded prominence in some analytical work at Alliance level.[9]

On 4 January 1993, a letter was sent to me by Richard Garwin, the IBM Research Fellow who has throughout assumed a high profile in the American BMD debate, this from a liberal standpoint. In this letter, he does express optimism about the interception from the ground of a standard RV. But he immediately qualifies that by admitting the near impossibility of intercepting thus 'forty' bomblets dispersed from a single rocket during ascent, a spread that would often enhance, too, the lethal efficiency of the biological, chemical or high explosive materials such a 'terror' strike might deliver. One is bound to say that if Richard Garwin can thus align with Henry Cooper, that axis has to have much strength. It gains the more from the progress being made in various countries (including Russia) with smart submunitions for use in artillery, mortars and tactical aircraft.[10] Translated into the world of rocketry, this points towards a convergence of the concept of the submunition and that of the MIRV.

Nor should one be too diverted by arguments about what particular intelligence appreciations say about near-term prospects. Often 'near-term' means very short-term. Besides, the evolution of the payload of rockets is harder to track or predict than is the development of the rockets *per se*. One recalls the confused debate that raged in the United States between 1966 and 1973 about when the USSR would be introducing MIRV-ed warheads in ICBMs. Month by month, the evidence or lack thereof was conflicting. But in the summer of 1973, Moscow tested multiple warheads that did seem authentically to be targetted independently, a consummation very much on time in relation to median forecasts made in 1967-8.[11] Now Moscow seems certain to develop the SS-X-6 towards a range of 500 km, the bottom end of the INF exclusion bracket. It is surely prudent to anticipate, too, that ascent stage release of submunitions will be resorted to with some variant of this weapon. Policy towards the export of this and similar systems will be shaped by the general state of international relations.

What will be needed, in any event, are continual revaluations (via intelligence analysis and operational research) of the efficacy of submunitions against high value targets, at whatever stage in flight those munitions may be dispersed. In the 1988 study quoted earlier of TMD on the then central front in Europe, some probabilities were worked out which may be illustrative. Suppose a Tactical Ballistic Missile (TBM), bearing 100 submunitions set to disperse to a radius of 70 metres by the time of impact, is launched against a radar hardened to five pounds per square inch; and that, with an explosive charge of 10 kg, any one submunition may 'lethally' damage such a radar up to eight metres from it. If the CEP is 35 metres, the likelihood of an incapacitating hit by at least one of the submunitions within such a cone of dispersion is 90 per cent. If instead the CEP is 350 metres (the value generally allowed to the SS-

23s, the missile cited in one of the airfield attack scenarios depicted in Chapter 4[12]), the probability of incapacitation by just one rocket is only 21 per cent. Double the radar hardness, and those percentages drop to 68 and 18 respectively.[13]

No doubt ascent release would make it less easy to keep the cone of dispersion as tight as here stipulated. Across a range of 350 km, for instance, that would imply a divergence as low as 20 microradians; and such finesse is not easy to believe in. Indeed, an opinion given to me by one of our aerospace industrialists was that a milliradian spread would not be easy to keep down to. But let us suppose the divergence were just three times greater than the 20 parts in a million just cited? With a TBM only achieving a CEP in the several hundred metres bracket, that extra spread might make little difference. It could even be beneficial. With a TBM able to register a very small CEP, however, an otherwise high probability of kill could well be diminished by something like four-fifths. All the same, submunitions released during ascent should regularly be effective with high explosive or pre-1940 chemical warheads against wide and soft targets (e.g. logistic parks and ports) in theatre war. With biological or nerve gas charges, they will obviously be so more generally. The US Army's Training and Doctrine Command has suggested wide bomblet release patterns as one criteria for tactical alert against a biological and chemical threat.[14]

In principle, beam weapons might do the rapid target switching BMD would require in such a situation. But even for them switching between dozens of submunitions per round looks an impossibly tall order. None the less, the more modest expectation that laser beams may be effective against certain unitary warheads in localised encounters finds expression in Nautilus, a collaborative programme consolidated last year as between the US Army and the Israel Defence Force. Reportedly a deuterium-fluoride[15] infra-red laser weapon below the megawatt range, it has already effected trial interceptions of two katusha rockets, exploding the unitary warhead fitted in one of them. Yet it remains highly probable that, with a modicum of extra shielding, such warheads can be made immune.

Experience with hydrogen fluoride lasers in the SDI context may not be neatly translatable. But it tends to suggest that such devices would be too cumbersome and susceptible for other than a low intensity and immobile environment, suitable perhaps for the Lebanon border but not Desert Storm. A caveat to enter, though, is that laser defence may ultimately be applicable at sea for the protection of ships against sensor-fused attack. Here one is talking about close-in defence. Also about the electrical power a warship can abundantly provide. Also about the tautology that sensors, fusing or whatever, are sensitive.

Otherwise the big area of development or contention for TMD will be BPI. Always the cardinal question will be whether worthwhile dividends can be gained from engagement boost phase as opposed to attacking the launch site, pre-emptively or re-actively? A site will contain one launcher and perhaps 10 missiles, by definition of more interest than one ascending missile. Nor is it helpful overly to stress how few Scuds were actually destroyed on the ground during the Gulf War. Harassment by air attack and overland by special forces will have been a major reason why Saddam Hussein fired off less than 20 per cent of the Scuds at his disposal. That happens to compare favourably with the results of the allied air offensive against German V-1 sites through the summer of 1944. About a third of the huge allied bombing effort was diverted to this end but the result was to reduce the mean monthly release of V-1s against England only from the target 3000 intended to 2667.[16]

That comparison may not in itself indicate a long-term trend. What is certain is that the relevant technologies and operational routines have moved on apace since 1991. Two consequences are of special import. The one is that target acquisition data may flow much more quickly and voluminously to where it is needed in the forward areas. The other is that Common Grid intermeshing of locational information will improve weapons accuracy dramatically. According to one review of the tactical air scene, the 15-metre CEP achievable by GPS or the 20-metre by inertial guidance alone or the 40-metre using just a Mark 84 'smart' bomb can be reduced to three metres through this integration. If so, the number of strikes averagely needed to achieve a 90 per cent kill probability against an aircraft in a revetment falls from nine to less than one.[17] The implications for TBM batteries targetted in situ immediately upon a missile release could be grim.

The logic of focussing on BPI is made the more questionable by the technical uncertainties that surround this approach in whatever mode. None the less, we ought now to monitor as closely as possible the progress of the ABL (see Chapter 4). After all, the ubiquitous flexibility that solution appears to connote could be of singular importance. It might, for instance, contribute crucially to any longer term requirement to protect naval task forces. Then there is the question of how an expeditionary force can best be covered during initial debarkation. On 18 April a memorandum was sent to the head of BMDO by Lt. Gen. Jay Garner, head of the US Army Space And Strategic Defense Command. This reportedly challenged the notion that USN warships could extend BMD protection overland, bearing in mind the observed limitations of the LEAP projectile and the Aegis SPY-1 radar. The remedy might lie with the ABL, perhaps for allied forces as well as US.

The ABL Revisited

But before presuming that, some basic questions do have to be addressed. One is how well and how consistently an ABL might perform, how far down into the atmosphere and across what slant ranges. Can the algorithms now written for atmospheric turbulence correct, with due consistency, against beam refraction? One is concerned, first and foremost, with a broad zone of altitude around the tropopause, a zone characterised by innumerable discontinuities in air currents and temperatures. Algorithms do not resolve, in any case, the problems of beam divergence or, especially within the lower atmosphere, absorption.

One senses that, even these last few weeks, a more sober appreciation of these realities has permeated the American ABL debate. USAF Secretary Sheila Widnall still suggests that, given total air superiority, the parent 747 could even fly into enemy airspace; and that this system could contribute vitally to, say, a new Korean war. But she summates the prospect thus: 'I've never minimised the risks but I do think it's time to do this. Basically what we've got now are ground modules that work. And so the question is integrating the modules into the airplanes and scaling up'.[18] Unfortunately, with lasing, the results of scaling up are notoriously uncertain because the relationship between power and performance is decidedly non-linear. The chances that the 747 ABL could actually enter service as early as 2006 cannot be high.

Throughout one must ask, too, how recourse to such a weapon might relate to the emergence across the West of a public and governmental taboo against beam warfare intended to blind. Witness Protocol IV of the UN Weaponry Convention. The iodine-oxygen laser is not being developed for the ABL with any such intention in mind. Nevertheless, its wavelength is within the spectral sector (400 to 1400 nm) that

the human cornea is particularly transparent to.[19] It is also just on the edge of a spectral window of very low atmospheric absorption.[20] Subject to what the more definitive advice of the atmospheric scientists may be about the absorption question, there may be a need for special command and control procedures.

A third issue is what interest the Americans might have in some kind of commonality apropos the ABL, if not joint development then maybe joint NATO operation in a manner akin to the AWACS force. Some such special arrangement might serve as an overt guarantee against indiscriminate use. At all events, the American inclination, at theatre level, has been moving towards BPI coupled with anti-surface action. Further encouragement of this trend is afforded by Israeli advocacy of BPI by UAV. Witness the current proposal for a Moab missile that may dispense with shrouding and cryogenic cooling by (a) being mounted in a high-altitude UAV, (b) limiting fly-out speed to 2 km/sec, and (c) squeezing state-of-art technology 'to the limit'. Its intercept range is given as 100 km from release at 50,000 feet; and 80 km from 30,000.[21] Those range estimates look somewhat optimistic in relation to fly-out speed; and there is no reason to assume effectiveness against shorter range TBMs. But Moab is a further reminder of how active the UAV dimension has become.

What has to be reckoned with throughout is that, in the near future, this trend towards theatre BMD at boost phase or earlier may surge to an attitude a good deal more categoric. Switches of this sort are by no means unknown in aerospace defence. Thirty years ago, a sea change occurred the other way about with regard to continental defence against the manned bomber. In 1957, the USAF annual outlay on research, development and procurement in that sector peaked at nearly ten billion dollars (1986 prices). Then came Sputnik I with its connotation of a drastic downgrading of the threat from the manned bomber in favour of that from the ICBM. By 1962, the said outlay was down to two billion; and by 1972 to one.[22] A most unsatisfactory outcome of Britain's quest for BMD coverage out of area would be for her to go for PAC-3 and/or THAAD, only then to be told by the Americans themselves that such surface-based weapons were now but ancillary.

Defended Peace In Europe

Though quite a lot of analytical work has already been done within the Atlantic Alliance on the conceptual parameters for BMD cover of the European theatre, there is still some way to go to provide a firm foundation for policy decisions. The reason for this resides in the uncertainties that surround the underlying judgements. While there may be a large measure of agreement that the most active missile threats nearer-term are presented from the 'south and south-east' not a few analysts feel unable as yet to discount the 'East' as a source, given the instabilities that plague the area encompassed by the former Soviet Union. Opinions vary as to whether the preservation of a buffer zone between NATO and the Russian Federation would be conducive to European Security, in the BMD context as in others. Meanwhile few feel able to exclude once and for all the revival of a missile threat from the North Atlantic.

At the operational level, too, uncertainties inevitably persist. How large may the threat overall be from ballistic and/or cruise missiles? How many such weapons may be fired in one salvo? And what of decoys, manoeuvring warheads and 'end-game' guidance? Moscow, at least, has long utilised the first two of these technologies; and she may soon, if not already, possess the third, starting with missile sensors designed to home on master radars, including ones geared to BMD.

What does seem generally to be agreed is that any network for wide-area coverage would need two active tiers, the lower probably being left under single-nation control but the upper one not. For the latter, one should probably be thinking of an interceptor speed of at least three kilometres a second. After all, one would be looking for several chances to intercept from good angles RVs travelling at several kilometres a second several hundred kilometres above the surface.

The contradictory requirements for BMD radar coverage on the exposed peripheries of NATO might be resolved by complementing a Fylingdales-style BMEWS with mobile UHF phased-array units for BMD missions. Early warning cover by the latter might not be a third of the 3000 km a Fylingdales facility might register in whatever direction. On the other hand, deployment well forward would confer big geodetic advantages. An RV at a height of 100 km, say, would be out of sight to a radar at MSL more than about 400 km away. Besides which, mobile UHF deployed well forward might incorporate discrimination and fire control functions. Good intra-theatre strategic mobility for any such system could be important for the modulation of warlike crises.

To which one can add that Britain's S-band MESAR might be a most suitable technology basis for a network development along these lines, particularly in view of its anti-jamming agility. In particular, such a network, deployable to eastwards and to southwards within NATO's established boundaries, could do something to resolve the contradictions created by the exigencies of geography and by graduated deterrence on these exposed peripheries of Europe.

Similar considerations obtain as regards the basing of air and maritime assets well forward, hopefully to intercept boost-phase enemy missiles launched from not more than a couple of hundred kilometres inland. That scenario is not implausible so long as one envisages an adversary state on the southern shores of the Mediterranean obtaining its missiles from a Moscow that was still adhering to its obligations under the INF. Otherwise there is everywhere deep desert hinterland in which missiles can be sited out of range of interception from the sea that soon after launch. In fact, it is this state of affairs that vitiates the notion sometimes aired that, by virtue of its high velocity, Standard Leap could shield much of Western Europe. Take an incoming RV with a range of 2500 km on a 'minimum energy' trajectory. Standard Leap could well match its burn-out velocity of 4.5 km/sec. But it could not engage the RV once it had climbed to anywhere near its apogee of 425 km. Standard Leap is barely exoatmospheric.

The purely aerial modes of TMD have so far attracted little comment except that BPI interception by air-to-air missiles can be expected eventually to give way to that by ABL. But there has been some imaginative discussion of naval innovation. For instance, co-operative engagement for BPI is envisaged as between wide-aperture land-based radars and fast (i.e.at least 4 km/sec.) interceptors on board ship. Among other futuristic ideas that have been explored is one from the USN. A 'slingshot' aircraft 'would be launched into the threat area ... . On the pilot's command, the interceptors would be launched from the carrier for the subsequent intercepts'.

At least two of the smaller European countries with illustrious naval traditions, Greece and the Netherlands, have lately expressed positive interest in TMD. At the turn of this year, Admiral Stagas, Chief of the Hellenic Navy General Staff, cited the maintenance of a 'credible nuclear deterrent' and contributing to 'theatre missile defence' as the 'two particular missions' for allied naval forces in the new world situation. Then in February, the keel was laid for a new air defence frigate for the

Royal Netherlands Navy. This vessel (a collaborative venture with Germany and Spain) will initially bear the Standard Block IVA and be structured to evolve to full TMD, presumably with Standard Leap.

Save that the tortuous political geography of the Balkan-Turkish sector may pose near to insuperable difficulties for any sectoral defence well forward, the precept of a sea-air-land continuum is philosophically sound for TMD within the Mediterranean theatre as a whole. But quite apart from the maritime dimension not being translatable to defence against Russia, actual application would require a raft of subtle judgements. Account would have to be taken of how decisively the counter-proliferation strategy was slowing down missile and warhead procurement across the Middle East, by all countries other than Israel. So would it of the need not to discourage or discredit the forces of moderation in the Arab/Iranian world, this by building too quickly against their region too conspicuous a BMD/Extended Air Defence cordon. The best way to subject the extremists to discouragement instead might be to have BMD assets in preparation or in reserve rather than fully and constantly in place. The SDI precedent supports that view. Staying not too far ahead of a prospective military challenge can be a risky game to play. But it could be easier in this situation as long as counter-proliferation underwritten by pre-emption remains as firmly in place as it shows every sign of doing this next decade.

A gradualist approach would also be important in (a) preserving a consensus within Western public opinion and (b) making sound choices on the technical/operational side. The most fundamental thing would be to have a network of early warning radar to hand, ready for crisis definition and damage limitation. The next priority might be an ability to defend those assets and also key points of debarkation, perhaps by means of batteries flown in as war threatens. Could there be a requirement here for another NATO multinational specialist force?

So is this a philosophy of BMD deployment that could help to square the contradictions liable to be generated by the enlargement of the EU and NATO into Eastern Europe? Alas, the answer may have to be negative. As in many previous situations, mere averration that weaponry was defensive would not preclude its being provocative and destabilising in certain circumstances. Under the 1994 Partnership for Peace programme, joint planning and exercising may take place between the partners and NATO 'in such fields as peace-keeping, search and rescue and humanitarian operations, and others as may arise'. These provisions were not directly aimed at Russia who has since become a member of the Partnership for Peace. But supposing the smaller states of Eastern Europe moved from the Partnership into NATO, perhaps via the EU. What if a BMD screen had eventually to be provided from the Black Sea to the Gulf of Finland? Nobody could deny that such assets in the Baltic States, for instance, would be counter-Moscow. Yet while that posture might infuriate or even, indeed, alarm the Russians, it might also be thoroughly unsound operationally. It would, after all, cover a sector three times as wide as the old inter-German border; and might locally be swamped, at any time, by probing actions. Yet for the leading nations of NATO to be unwilling ever to proffer such cover to fellow members would be for them to renege on the precept that an attack on one is an attack on all.

Naturally, enlargement enthusiasts will protest that none of this would apply with much force if the new NATO membership is limited to Poland, the Czech Republic, Slovakia and Hungary. But ensuring that indefinitely would not be easy. Throughout Eastern Europe, too, there is always the argument that membership of

Western institutions is needful to underpin democracy. Nor is the widely canvassed principle that no part of the former Soviet Union might be admitted in itself enough of a barrier. The Baltic States deny they ever were licitly part of the USSR; and in this they have vocal support, certainly in the United States and Scandinavia. That may not automatically gain them NATO membership but their entry into EU, in due course, seems assured.

Assessment Revision

Deeper into the heartland of Western Europe, the prospects for the provision of 'thin-screen' area defence (against five or ten RVs?) are clouded by there being no appropriate weapons system in sight. Besides, this whole requirement may be subject to searching revision if, as is not unlikely, there is a disposition to stress less the urgency of the threat from 'the South' and to re-emphasise that which could be posed by an unfriendly Moscow and/or Beijing.

A strategic scenario that has alternatively been canvassed is one that rests on two distinct premises. The core is that the whole of the Former Soviet Union (FSU) will remain entirely non-bellicose as far as its direct relations with the West are concerned. But the other is that the relevant technologies will migrate freely to the 'rest of the world' from the West but particularly from the FSU. On these assumptions, the rest of the world (meaning North Africa and the Middle East for the purposes of NATO Europe) could in due course present a threat panoply that included ballistic missiles able to deliver warloads several thousand kilometres to re-enter at five kilometres a second. These warloads could consist of multiple RVs, maybe of high manoeuvrability and supported by penetration aids. Each RV might bear either a high explosive or chemical warhead or else a truly mass destruction one, nuclear or biological. Nor might self-homing RVs be excluded indefinitely.

As of the present time, few students of these matters would dissent from the view that the second premise just cited was too pessimistic yet the first too sanguine. The balance, in respect of the evolution of the threat profile within a given time frame, might not be so very different. Either way, one arrives at an attack profile that could be coped with only by a combination of a sophisticated surface-to-air system and a proven SMTS. Even then, one could not ward off decisively enough an area attack launched in strength with nuclear unitary warheads and or biological submunitions.

What both the requirement and the capability may ultimately boil down to is the close-in defence of certain nodal assets against precision strikes by means of high explosive or chemical warheads borne in smart submunitions/RVs released either after re-entry or maybe during ascent. In Britain, several military facilities suggest themselves for inclusion early on, as was noted in Chapter 8. In particular, an attack of this kind on our Trident support base at Faslane could compromise our strategic deterrent without constituting a compelling *casus belli* at the level of a counter-city nuclear riposte. So the answer would have to lie in local defence, active and passive.

Overview Needed

But such precautions should only be taken through the application of proven technologies, as and when there are indications of an emergent threat. Also they should be undertaken only within the context of NATO. The importance of Britain's doing nothing that is unilateral and premature is underlined by how the debate about NATO's future is trending. Against the background of proposed enlargement, there is abroad a disposition to discuss alliance membership in terms of cultural and economic

symbolism rather than of accession to a solid military pact.[23] Some people seem careless of the implications for military morale and motivation

If the above assessment be correct, one is talking about no move to deploy BMD within the UK for another five years at the earliest. Nor may it be either necessary or desirable to go firm any earlier on BMD provision for our expeditionary forces. But, as has been suggested throughout, such a period of grace may be invaluable for everything from technical evaluation to doctrinal evolution. As regards doctrine, some emphasis has been placed on the need to thrash out a politico-military BMD strategy, not least under the auspices of the WEU. But Her Majesty's Forces may also need to adapt their respective operational doctrines to the era of 'the ascent of the missile'. The Royal Navy allows it may be required to provide TMD as part of a general extension of naval air cover to 'lodgement areas' ashore during combined operations out of area.[24] However, the point is not developed in its 1995 exposition of British maritime doctrine.[25] Neither do doctrinal statements by the other two services address BMD much as yet. What each of them does do, however, is accord some prominence to Offensive Counter-Air (OCA) operations. As a former Director of Defence Studies, RAF, has put it: 'Simple analysis suggests that the return from OCA can be great: destruction of numbers of aircraft on the ground before they have had the chance to attack, and disruption to further operations'.[26] Translated to the BMD realm, Offensive Counter-Air means pre-emptive assaults on launch sites. BPI and later is defensive action.

Arguably, however, what is needed is not an extra strand of doctrine woven around missilry *per se*. Rather it is one woven round the contingent release, in the course of theatre conflict and by whatever means, of warheads of mass destruction of whatever kind. Granted, nuclear (and maybe chemical) escalation had always to be reckoned with in the context of NATO versus the Warsaw Pact. But the parameters may be fundamentally different if related to (a) limited engagements out-of-area, perhaps against irregular forces; and (b) more ready recourse by our opponents to chemical or, indeed, biological devices. All else apart, the actual scenarios will be harder than ever to predict in advance.

What also is probable is that military interest in active TMD will eventually recede if an arms race is continued indefinitely. This will be because missile inventories (ballistic and cruise) will have become so much larger, more diverse and, in part at least, more sophisticated. It is hard to imagine active TMD being at all effective, overland at any rate, against mixed salvos spearheaded by sensor-fused multiple warheads borne by ballistic/hybrid missiles that also dispense a diversity of decoys. Already active defence may be of limited avail against missiles delivering nuclear or CBW warheads. It may also become progressively less effective against those projecting high explosives or incendiaries. In the interim, the salient questions will be (a) how much breathing space any mode of active missile defence might gain; and (b) how far this might facilitate the radical changes in military doctrine and structure demanded by the new era of ultra-dynamic war symbolised today by the ballistic missile, much as the dive-bomber betokened the blitzkrieg in 1940. Judgements about securing worthwhile interludes will stem from an appreciation that is both technical and geopolitical.

A key element in the tactical revolution will have to be enhancement of passive defence: more emphasis on hardening, deception, concealment, mobility and dispersion - usually in that ascending order. Suffusing everything should be a holistic concern with devolution and dexterity. A prime need will be to limit dependence on

nodal facilities: command centres, bridges, runways, ports... . But there must also be offensive development, ensuring that the alliance has enough of the best attack missiles (plus adequate surveillance and direction), particularly to counter overland offensives.[27]

Not least would a premium on offensive missilry be apposite for naval bombardment. Indeed, it could be seen as the culmination of the primacy now given to the projection of naval power into conflict situations ashore. It could especially be so for navies like ours that are strategically mobile but not of the size to operate very large fleet carriers. Nor should we forget that close-in missile defence (via laser beams or some other exotic technology) may have more enduring possibilities on the Open Sea.

It affords us, indeed, an instructive historical parallel. An analogy with the contemporary military revolution can be seen in the impact aviation made on navies after 1918. Perspectives on the Royal Navy's reaction then were afforded in the contributions to a 1967 symposium by two of the successive incumbents of the Chair of History at Royal Naval College, Greenwich. Geoffrey Till showed how manifold were the reasons, as they appeared during the 1920s, for agnosticism in the 'air power versus battleship' controversy. While accepting that, Bryan Ranft expressed regret that 'as with the advent of the torpedo some 50 years earlier, there was no overall study of the possible revolutionary effect which aircraft were to have on every aspect of naval warfare'.[28]

Again, an overview is needed. It ought to be informed by comparative cost-benefit profiles of active defence, passive defence and pro-active offensive action. It certainly ought to look a quarter of a century ahead. More immediately, however, Britain may have to decide whether it wishes to join in MEADS, in lieu of France if not alongside her. How important may it be to (a) our military preparedness and (b) our defence industry? The bottom line is, of course, whether MEADS has an assured future. The French withdrawal this May revived ambivalence on Capitol Hill towards the programme, this in what may turn out to be a rather xenophobic election year. Concurrently American industry, backed by the Commerce Department through the embassy network, is pushing harder to secure for itself alone more aerospace business within Europe. The projects being targetted, infrastructural ones included, are said to be worth 28 billion dollars.[29]

TransAtlantic Collaboration?

None the less, MEADS still has a lot going for it. On 22 April, the United States, Germany and Italy proceeded (after some hesitation on Rome's part) to sign a further Statement of Intent intended to secure the programme through fiscal 1997, this on the overt understanding that French re-enlistment remained on the cards. As of this June, senior officials of the DGA were openly divided about whether to (a) seek re-enlistment in due course in MEADS, (b) promote EUROSAM, with British participation or (c) place little reliance on active BMD.[30]

Meanwhile, some American participants had been suggesting that the project might actually be less burdensome financially in France's absence. Instead, it might be recast along less demanding lines.[31] Just what that might mean is not clear. Nor can one yet know how well MEADS/Corps SAM will perform once built. But one should note that its basic specification represents more or less a generational advance over PAC-3 in the brigade-level role. This especially applies to (a) data handling, (b)

dexterity against the cruise missile and (c) mobility. Corps SAM would most likely have continued as a purely American programme, had MEADS collapsed this summer.

In due course, the MEADS relationship ought to be extended to embrace other weapons programmes, particularly ones pertinent to missile war. INF-compliant offensive missiles, not least for use from the sea, look a good possibility. So does close-in BMD for nodal assets. So, too, does a radical solution (e.g. interception from rotorcraft?) to the vexatious problem of the low-altitude high-performance cruise missile. So does the UAV used for engagement or just surveillance.

Timely in this connection is a recent study by the influential Center for Strategic and International Studies at Georgetown University. Entitled *Making TransAtlantic Defense Co-operation Work: Findings and Recommendations of the CSIS Atlantic Partnership Project*, it reportedly stresses that a shortage of research and development capacity each side of the Atlantic is rendering imperative co-operation at every level from operational requirement onward. It further avers how important such a congruence would be politically at this juncture. A contribution by Daniel Gouré seeks to identify the areas that most lend themselves to collaborative endeavour. Gouré is prominent among the coterie of American analysts writing about the contemporary military revolution. His particular concern, as it has come over to me, has been to stress how radical and comprehensive a force restructuring this revolution will demand.[32]

The gist of his analysis on this occasion has been summed up as follows.[33] Of most value might be a transatlantic 'sharing of intelligence and early warning data. Currently, this would involve sharing of US defense satellite program data'. Other possibilities within the BMD ambit include sea-based TMD, boost-phase interception, and directed energy. Tactical aviation also affords an opportunity to 'collaborate on components such as weapons systems, navigation systems and ground attack'. One thing the Europeans are not thought to see themselves contributing usefully to is NMD. Nor, according to the report here cited, does this study consider the development of any system that might somehow be adapted to provide a European 'NMD'. Still, these are particularities. Overall, this CSIS work endorses well the notion of 'hands across the ocean' in full and equal partnership.

Not that such an industrial strategy could ever be risk-free for any party. Always there is the danger that multilateral agreements will be hard to conclude except by eschewing radical thought about specification and design. At the present time, however, two factors may be working towards more positive ends. The ethos in American military aerospace has lately become exceptionally innovative. Also the current trend towards cross-border mergers in European aerospace ought to favour the creative meeting of minds. Dialogue within one transnational company should normally be less constrained than that between two separate firms in different countries.

Part of the rationale of merging across borders has to be that each national division will then concentrate on what it does best, both at the development stage and at the manufacturing. Yet while that accords well with classic economic notions about opportunity cost, it can also mean that every country thus involved will thereby lose a measure of industrial autonomy. Presumably, however, this kind of reckoning will count for less in Western Europe as both the EU and the WEU memberships evolve towards common security strategies. Moreover, mergers within Europe should usually be more as between comparative equals than ones as between European and American participants. Nor does the American military aerospace community seem much

interested in transAtlantic mergers at this juncture. It is too busy merging domestically.

The NMD Debate

What should be looked towards no less earnestly is a revival of the transAtlantic interaction at the philosophical or doctrinal level. In part, this will be a matter of working out the fundamentals of the dynamic revolution in theatre war. But it may also be one of Europe (and Britain, in particular, in she so wishes) bearing on the American NMD debate in the kind of way this country did so constructively with SDI in the middle 1980s. What one should be talking of in the new situation is encouraging the Americans to build themselves a consensus around the notion of 'thin-screen' defence. Preparatory moves along these lines, as and when the prognosis warranted, would allow of the introduction of valuable 'pauses' into the dangerous business of crisis escalation. At the same time, it would leave the way open for any longer term requirement to protect nodal military targets against the high precision attacks eventually to be reckoned with.

Malcolm O'Neill believed that, at present, three interceptors may be needed per RV to allow of an 85 to 90 per cent interception rate.[34] In which case, it should be possible to defend the continental United States from one treaty-compliant ABM site against up to 35 RVs. Besides which, there have been indications that a Democrat administration might consider, as and when it judged the time to be ripe, seeking to revoke the 1974 protocol whereby Washington and Moscow each confined themselves to just one ABM site rather than the two allowed (subject to stated conditions) under the 1972 treaty. The chief advantage of revocation might be that a thin protective screen could be extended more convincingly over Alaska and Hawaii.

What the Democrats are not likely to budge over is their insistence that any decisions about NMD deployment be taken in the light of evidence about incipient threats. On the contrary, they may soon insist openly, and not unreasonably, that proper account be taken of the 1993 counter-proliferation strategy, particularly in its more forceful aspects.

The Weaponisation of Space?

Here then is the knee of the curve. While room enough remains for debate about structure and timing, the principle of contingent 'thin screen' NMD deployment against potential probing actions is a perfectly rational one. Where irrationality would come in is by going beyond that, driven by Pat Buchanan-style isolationism coupled with an overweaning quest for absolute immunity from casualties in war that no country on Earth can sensibly aspire to these days. Attempting to would lead the United States, sooner rather than later, into the deployment of Space-Based Lasers. But this still would not render her or any allies inviolable by ballistic missiles. Most of the technical problems associated with the ABL would reappear in accentuated form with the SBL. Worst of all, an orbital speed of 8 km/sec. would make beam lock-on to target very hard to sustain long enough and with the required finesse. Nor would an SBL canopy be difficult for any sizeable country to swamp simply by concentrating offensive missiles in certain areas. For a decade now, Moscow has had in service the SS-25, a road-mobile ICBM able to dispatch a megaton-range unitary warhead over 10,000 km.[35]

The downside consequences would be manifold. Arms control would be shattered; and with it, most likely, international co-operation against ecological

disturbance and all the other global ills. Alliance relationships might sunder in all directions. Once the arms race had extended into Space in this fashion it would be liable to do so in other respects as well; and this at a time when the more general utilisation of Space (civil and military) is expanding fast. Already tendencies in this direction can be observed. The US Army has kept its options open with a Kinetic Energy Anti-Satellite (ASAT) weapon due to be flight-tested in Fiscal 1998. It is exploring, too, the ASAT potentialities of high-energy lasing in the mid-infra-red. Meanwhile, a USAF officer responsible for 'Space control architecture' has warned that 'Any nation that has a commercial satellite system transmitter has by definition a satellite jammer'.[36]

Nor would SBL resolve the dilemma of what to do about the hostile submarine in international waters but close enough to allied shores to discharge its missiles, be they ballistic or cruise, point blank at coastal cities. In SDI days, various remedies were proposed. No two of them were consistent one with another. Now as then, the more general threat from cruise missiles would be there too. So would that from terrorist infiltration. Not merely would SBL be irrelevant to these other menaces, operationally speaking. It might positively encourage them by dint of the psychological oppressiveness of having weapons mounted in orbit. In the light of all of which, it was disconcerting to find the Senate Armed Services Committee this May expressing a preference for the SBL as against the ABL.[37] What is extremely important at this juncture is that America's allies (meaning, first and foremost, Britain, Japan and Israel) do nothing that can be construed in Washington as a precedent for comprehensive NMD, most probably in the form of SBL.

Yet even without that gyration to an extreme, the problem of how to stabilise the missile race through arms control will remain. One point at issue ever since the negotiations that produced the ABM treaty has been whether or when sensors in Space have to be seen as integral to weapons systems on the ground. It is a quandary that relates to that proscription in Article V on the development, testing or deployment of ABM 'systems or components' that are Space-based. A convention has become established that orbital sensors that essentially supply background information (cueing included) should not be regarded as 'components'. In particular, the two elements in the current US Space-Based Infra-Red System programme (namely, the DSP and the SMTS) have been adjudged treaty-compliant on these grounds.

A complication is that sensing is becoming ever more definitive and better networked. So according to Robert Bell of the National Security Council, the debate this next decade over the 'demarcation' between an 'adjunct' sensor and one that is part of BMD fire control will make the on-going endeavour to delineate between theatre and strategic defences 'look almost manageable'.[38] Currently, the response of American liberals tends to be to try and exclude from the TMD conspectus everything except PAC-3, this on the rather luddite grounds of its being a lower tier and localised system.[39,40] Alas, contradictions would surface anew as soon as the time came to replace PAC-3 with the more versatile Corps SAM or something equivalent. It is an archetypal example of what one means when one says arms controllers are always seeking to prevent the last war.

Arms Control Recast?

Accepting that the required diplomacy will have to be very carefully judged, it still seems to me that the ABM treaty will have to be superceded in due course by a multinational accord that draws the line at the positioning in Space of actual ordnance.

It is a distinction that is definable and tangible, not least to public opinion around the world. It would constitute a clear refutation of the jibe so often heard from ultra-conservative opinion (e.g. Henry Cooper, Colin Gray, Richard Perle...) that arms control is feasible only when it is unnecessary. The 'non-weaponisation of Space', meaning a proscription on the placing of ordnance there, would be an invaluable dimension in the management of that milieu. It ought to be feasible and would be necessary. Suffice to add that the weaponisation of Space was something Margaret Thatcher cautioned Ronald Reagan about in 1984.[41]

There is one further matter to consider, one outside the defined remits of FIS or PFP but pertinent to both. Should one be working towards a system for what might be called GPACE: Global Protection Against Collisions with Extra-terrestrial objects - with meteorites, comets or asteroids? This subject resides in science fiction far less than do the Unidentified Flying Objects (UFOs) that various Ministries of Defence, including our own, have kept a watching brief on across the years. Of late, there has been a steady confluence of evidence from astronomy, archaeology, history, and historical climatology that these collisions will have compromised our welfare more often and more severely than used to be appreciated. This is not something to pursue further now. The technological parameters are too different from those of any recognised mode of BMD. And here again one would have to judge stringently the timing and political setting of any diplomatic initiative. Witness China's recent intimation that she might make the 'asteroid threat' part of an alibi for not signing a comprehensive nuclear test ban.[42] May one suggest, however, that active GPACE could usefully figure in any PFP follow-on studies.

NOTES

FOREWORD

1. *Britain In NATO*, Fabian Tract 357, Fabian Society, London, November 1964.
2. *Arms Without Empire*, Penguin Books, Harmondsworth, 1967, Chapters 2 and 6.
3. Professor Neville Brown and General Sir Anthony Farrar-Hockley, *Nuclear First Use*, RUSI Military Power Series, Royal United Services Institute for Defence Studies, London, 1985.
4. *The Future Global Challenge*, Crane Russak for the RUSI, London, 1977, Part II.
5. See the author's *Climate Change: A Threat to Peace*, Conflict Studies 272, Research Institute For The Study Of Conflict and Terrorism, London, July 1994, p.25.
6. *New Strategy Through Space*, Leicester University Press, Leicester, 1990, Chapter 13.

EXECUTIVE SUMMARY

1. The cross references are to chapters in which the themes in question receive treatment at some length. Chapter 9 is not generally referred to as most issues come up there.

CHAPTER 1

1. *The Future Global Challenge*, Crane Russak for the RUSI, London, 1977, pp.49-50.
2. Christopher Hartley, 'The Future of Manned Aircraft' in *The Implications of Military Technology in the 1970s*, Adelphi Paper 46, International Institute for Strategic Studies, London, 1968, pp.28-37.
3. *1995 Report to the Congress on Ballistic Missile Defense*, BMDO, Washington DC, September 1995, section 3.2.3.
4. *Defense Week*, vol.17, no.3, 16 January 1996, pp.1 and 16.
5. Donald R. Baucom, *The Origins of SDI, 1944-1983*, University Press of Kansas, Lawrence, 1992, p.4.
6. Herbert York, 'Deterrence by means of mass destruction', *Pacem In Terris*, Conference III, Session V-VI, October 1973, pp.5-6.
7. Now the International Institute for Strategic Studies.
8. Baucom, *op.cit.*, p.113.
9. *Aviation Week and Space Technology*, vol.127, no.21, 23 November 1987, p.49.
10. *Ballistic Missile Defense Technologies*, Office of Technology Assessment, US Government Printing Office, Washington DC, September 1985, Chapter 7.
11. *1992 Report to Congress on the Strategic Defense Initiative*, Strategic Defense Initiative Organisation, Washington DC, 1992, Section 3.35.

CHAPTER 2

1. See the author's *New Strategy Through Space*, Pinter, London, 1989, p.138.
2. See e.g Yevgeni Velikov *et al.*, *Weaponry in Space. The Dilemma of Security*, Mir Publishing House, Moscow, 1986.
3. *The Scientific American*, vol.261, no.6, December 1986, p.64.
4. See the author's *Has SDI A Future?*, Muirhead Paper No. 7, University of Birmingham Birmingham, 1992, p.2.
5. Margaret Thatcher, *The Downing Street Years*, Harper Collins, London, 1993, p.467.
6. The Tanner Lectures, Brasenose College, March 1992.
7. *The Daily Telegraph*, 5 February 1987.
8. *Newsweek*, c.20.10.95. Exact date to be confirmed
9. Dwight D. Eisenhower, *Crusade in Europe*, Doubleday, New York, 1948, p.250.
10. Adolph Galland, *The First And The Last*, Methuen, London, 1955, Chapter 10.
11. 'Arming the IRA. The Libyan connection', *The Economist*, 31 March 1990.
12. Richard Clutterbuck, *Terrorism, Drugs and Crime in Europe after 1992*, Routledge, London, 1990, p.76.
13. 'French flight-test rocket-ramjet missile', *Aviation Week and Space Technology*, vol.142, no.9, 27 February 1995, pp.22-3.
14. *Defense of Japan, 1992*, Defense Agency, Tokyo, 1992, p.75 (English-language edition translated by *Japan Times*).
15. g is the acceleration at MSL due to the Earth's gravity. It is 981cm per sec per sec.
16. 'Cruise Missile Threat Quietly Rises', *Defense News*, vol.10, no.12, 27 March to 2 April 1995, pp.27-8.
17. William R. Graham, chair, *Ballistic Missile Proliferation. An Emerging Threat*, Systems Planning Corporation, Arlington, 1992, p.4.
18. *Defense Daily*, vol.190, no.26, 8 February 1996, p.191.
19. *Defense News*, *op.cit.*
20. *The Military Balance, 1995-96*, The International Institute for Strategic Studies, London, 1995, p.286.
21. Neville Brown, *The Future of Air Power*, Croom Helm, Beckenham, 1986, p.101.
22. Carl H. Builder, *The Prospects and Implications of Non-Nuclear Means for Strategic Conflict*, Adelphi Paper 200, The International Institute for Strategic Studies, London, 1985.
23. Cited in *New Strategy Through Space*, p.7.
24. *Defense News*, vol.9, no.47, 28 November to 4 December 1994, p.24.
25. *The Military Balance, 1994-5*, The International Institute for Strategic Studies, London, 1994, p.19.
26. *Aviation Week and Space Technology*, vol.144, no.2, 8 January 1996, p.132.
27. *The Military Balance, 1995/6*, *op.cit.*, pp.290-2.
28. See e.g. Bill McKibben, *The End of Nature*, Viking Penguin, New York, 1990, Chapter 2.
29. Michel Garder, *A History of the Soviet Army*, Pall Mall Press, London, 1966, Chapter 8.
30. Theodore H. White, *China: The Roots of Madness*, BBC, London, 1968.
31. Daniel Frei, *Risks of Unintentional Nuclear War*, Allanheld and Osmun, Totowa, 1983, Chapter II.

CHAPTER 3

1. Lisbeth Gronlund and David C. Wright, 'Depressed trajectory SLBMs: a technical evaluation and arms control possibilities', *Science and Global Security*, vol.3, 1992, pp.101-59.
2. H.H. Lamb, *Climate: Past, Present and Future*, Methuen, London, 1972, Vol.1, Fig. 2.9.
3. Stephen G. Lambert and William L. Casey, *Laser Communications In Space*, Artech House, Boston, 1995, p.330.
4. Edward Teller, *Better A Shield Than A Sword*, Free Press, New York, 1987, Chapter 12.
5. Paul Davies, *Are We Alone?*, Penguin, Harmondsworth, 1995, pp.13-14.
6. Patricia M. Mische, *Star Wars and the State of our Souls*, TheWinston Press, Minneapolis, 1985, p.2.
7. *The New York Review of Books*, 9 April 1987.
8. See the author's *New Strategy Through Space*, Pinter, London, 1989, pp.82-4.
9. 'Thou Shalt Not Blind', *The Economist*, 15 October 1994.
10. B.H. Liddell Hart (ed.), *The Soviet Army*, Wiedenfeld and Nicolson, London, 1956, Chapter 21.
11. John Duffield, 'The Soviet Military Threat to Western Europe: US Estimates in the 1950s and 1960s', *Journal of Strategic Studies*, vol.15, no.2, June 1992, pp.208-27.
12. Captain James R. Wolf, 'Implications Of Space-based Observation', *Military Review*, vol. LXXIV, no.3, March 1994, pp.75-85.
13. Tara Patel, 'Nuclear treaty flounders as Asia steps up demands', *The New Scientist*, vol.149, no.2020, 9 March 1996, p.6.
14. Gro Harlem Brundtland, Chair, *Our Common Future*, Oxford University Press for World Commission on Environment and Development, Oxford, 1987, pp.18-19.

CHAPTER 4

1. *European Security, 1972-80*, Royal United Services Institute for Defence Studies, London, 1972.
2. *1995 Report to the Congress on Ballistic Missile Defense*, BMDO, Washington DC, September 1995, Fig. 3.2.
3. Edward Teller, *Better a Shield than a Sword*, Free Press, New York, 1987, p.19.
4. Steve Fetter *et alia*, 'Why were Scud casualties so low?', *Nature*, vol.361, 28 January 1993, pp.293-6.
5. Joint Chiefs of Staff, *Dictionary of Military Terms*, Greenhill Books for Department of Defense, New York, 1987, p.8.
6. *Challenge and Commitment*, Federal Government, Ottawa, 1987.
7. United States General Accounting Office, Report to the Chairman, Subcommittee on Defense, Committee on Appropriations, US Senate, Defense Against Nuclear Weapons, Co-ordinated Strategy needed between SDI and the Air Defense Initiative, US GAO, Gaithersburg, September 1991.
8. 'Pilots to leave cockpit in future air force', *Aviation Week and Space Technology*, vol.144, no.6, 5 February 1996, pp.26-7.
9. Neville Brown, *Strategic Mobility*, Chatto and Windus for Institute for Strategic Studies, London, 1963, p.209.
10. *Aviation Week and Space Technology*, vol.143, no.4, 24 July 1995, p.19.
11. *1994 Report to the Congress on Ballistic Missile Defense*, Ballistic Missile Defense Organisation, Washington DC, 1994, Fig. 2-13.
12. *The Military Balance, 1988-1989*, The International Institute for Strategic Studies, London, 1988, Table I.
13. *Jane's Intelligence Review*, vol.8, no.3, March 1996, pp.102-3.
14. S.G. Gorshchov, *The Sea Power of the State*, United States Naval Institute, Annapolis, 1977, pp.100-101.
15. F.W. Lanchester, *Aircraft in Warfare, the Dawn of the Fourth Arm*, Constable, London, 1916, p.26.
16. David C. Wright and Lisbeth Gronlund, 'Underflying *Brilliant Pebbles*', *Nature*, vol.350, 25 April 1991, p.663.
17. Lisbeth Gronlund and David C. Wright, 'Depressed trajectory SLBMs: a technical evaluation and arms control possibilities'. *Science and Global Security*, vol.3, 1992, pp.101-9.
18. *The Military Balance, 1995-1996*, The International Institute for Strategic Studies, London, 1995, p.293.
19. *The Military Balance, 1991-1992*, The International Institute for Strategic Studies, London, 1991, pp.221-26.
20. Ashton B. Carter, *Directed Energy Missile Defense in Space*, US Government Printing Office, Washington DC, April 1984, p.8.
21. R.J. Schlesinger, *Principles of Electronic Warfare*, Prentice Hall, Engelwood Cliffs, 1961, Chapter 6.
22. David Rubenson and James Bonomo, 'The role of ATBM in NATO strategy', *Survival*, vol.XXIX, no.6, November-December 1987, pp.511-27.
23. *Flight International*, vol 120, no.3770, 8 August 1981, p.434.
24. See the author's *European Security, 1972-80*, RUSI, London, 1972, p.124.
25. *Eastport Study Group: A Report to the Director, Strategic Defense Initiative*, Washington DC, 1985 (unpublished), p.48.
26. Gerold Yonas, 'The Strategic Defense Initiative', *Daedalus*, vol.114, no.2, April 1985, pp.73-90.
27. Field Manual 100-5, *Operations*, Department of the Army, Washington DC, 14 June 1993, p.2-24.
28. *1995 Report to Congress, op.cit.*, pp.3-6 to 3-7.
29. *Defense Week*, vol.17, no.5, 29 January 1996
30. Noel A. Thyson *et alia*, 'Booster and Launcher Interceptor Strike System (BLISS) for Theater Missile Defense', *Book of Abstracts, The Eighth Multinational Conference on Theatre Missile Defense*, American Institute of Aeronautics and Astronautics, Washington DC, 1995, p.122.
31. *1994 Report to the Congress on Ballistic Missile Defense*, BMDO, Washington DC, September 1994, Section 4.3.
32. Donald R. Baucom, *The Origins of SDI, 1944-1983*, University Press of Kansas, Lawrence, 1992, p.113.
33. See the author's *New Strategy Through Space*, Leicester University Press, London, 1990, pp.94-5.
34. *Ibid*, pp.82-5.
35. John T. Bosna and Richard-C Whelan, *Guide to the Strategic Defense Initiative*, Arlington, 1986, p.158.
36. Harold Brown, 'Is SDI technically feasible?', *Foreign Affairs*, vol.64, no.3, Fall 1986, pp.436-54.
37. Christian Pochhacker, 'German anti-aircraft laser system', *International Combat Arms*, vol.6, no.1, January 1988, pp.14-5.
38. Ashton B. Carter, *Directed Energy Missile Defense in Space*, US Government Printing Office, Washington DC, April 1984, p.8.
39. *BMD Monitor*, vol.10, no.22, 3 November 1995.
40. *Defense Week*, vol.16, no.43, 30 October 1995.
41. P.H. Borcherds, 'Focussing a coherent beam of light', *American Journal of Physics*, no.3916, June 1971, pp.680-1.
42. *Defense Week*, vol.27, no.28, 8 July 1996.
43. Roger G. Barry and Richard J. Chorley, *Atmosphere, Weather and Climate*, Routledge, London, 1968, Fig.1.8.
44. e.g. *1995 Report to the Congress, op.cit.*, p.2-37.

45. *BMD Monitor*, vol.10, no.19, 22 September 1995.
46. *Jane's Defence Weekly*, vol.24, no.9, 8 September 1995, p.3.
47. *BMD Monitor, op.cit.*
48. *From the Sea* and *Forward ... From the Sea*, Department of the Navy, Washington DC, 1992 and 1994 respectively.
49. *Defense Daily*, vol.189, no.9, 13 December 1995.
50. Wolfgang Plume, 'Guns for Battlefield Air Defense', *International Defense Review Special Report*, no.4, 1995.
51. A.F. Cordesman, *Small Nuclear Forces and US Security Policy*, Centre for Strategic and International Studies (CSIS), Georgetown, 1984, p.213.
52. See the author's *Strategic Mobility*, *op.cit.*, p.15.
53. *The Annual Register. A Record of World Events, 1991*, Longman, Harlow, 1992, pp.148-51.
54. 'In the waiting room' on page 17 of 'The Elusive Golden Apple', A survey of Turkey in *The Economist*, vol.339, no.7969, 8 June 1996.
55. *Aviation Week and Space Technology*, *op.cit.*
56. Henry F. Cooper, 'To Build an Affordable Shield', *Orbis*, vol.39, no.1, Winter 1995, pp.85-99.
57. Edward Teller, *Better a Shield than a Sword*, op.cit.
58. *Arms Control Today*, vol.25, no.10, December 1995/January 1996, p.21.
59. Robert Bell, *Missile Defense and Strategic Deterrence*, George C. Marshall Institute, Washington DC, 1995.

CHAPTER 5

1. *Arms Control and Disarmament Agreements*, Arms Control And Disarmament Agency, Washington DC, 1982, pp.96-8.
2. William Epstein, 'Give More to Get More', *Bulletin of Atomic Scientists*, vol.50, no.6, November/December 1994, pp.15-18.
3. *New Scientist*, vol.142, no.1927, 28 May 1994, p.6.
4. Zachary S. Davis and Mitchell Reiss, *US Counterproliferation Doctrine: Issues for Congress*, Congressional Research Service, Washington, 21 September 1994, p.5.
5. *The Washington Post*, 8 September 1985.
6. State Department text, 4 June 1985.
7. *Los Angeles Times*, 9 July 1985.
8. Davis and Reiss, *op.cit.*, p.12.
9. Uri Dromi, head of Israel government press office, quoted in *The Times*, 19 April 1996.
10. Martin Navias, *Going Ballistic, The Build-Up of Missiles in the Middle East*, Brassey's (UK), London, 1983, p.59.
11. 'Target Gaddafi, Again', *Time*, vol.147, no.14, 1 April 1996, pp.23-4.
12. Official text, p.2.
13. Dromi, *op.cit.*
14. 'Handling Iran', *The Economist*, vol.338, no.7957, 16 March 1996, pp.17-18.
15. Reported in *Kayhan International* 12 October 1974 and quoted in the author's *The Future Global Challenge*, Crane Russak for RUSI, New York, 1977, p.370.
16. Shahram Chubin, 'Does Iran Want Nuclear Weapons?', *Survival*, vol.37, no.1, Spring 1995, pp.86-104.
17. *Ibid.*, p.87.
18. Speech to Atlantic Council, 12 August 1994. European Wireless File text.
19. *The Military Balance, 1995-96*, International Institute for Strategic Studies, London, 1995, p.125.
20. Navias, *op.cit.*, p.14.
21. *Military Balance, 1995-96*, *op.cit.*, p.133.
22. Chubin, *op.cit.*, p.97.
23. Richard K. Betts, 'What will it take to deter the United States?', *Parameters*, vol.XXV, no.4, Winter 1995-6, pp.70-79.
24. Greg Gerardi and Joseph Bermudez, 'An Analysis of North Korean Ballistic Missile Testing', *Jane's Intelligence Review*, vol.7, no.4, April 1995, pp.184-190.
25. *Military Balance, 1995-6*, *op.cit.*, pp.183-4.
26. *Defense White Paper, 1994-5*, The Ministry of National Defense, Seoul, 1994, p.58.
27. *Military Balance, 1993-4*, International Institute for Strategic Studies, London, 1993, p.160.
28. See the author's *The Future of Air Power*, Croom Helm, Beckenham, 1986, pp.146-7.
29. Kongdan Oh and Ralph C. Hassig in Young Wang Kihl (ed.), *Korea and the world: beyond the Cold War*, Westview Press, Boulder, 1994, Chapter 13 'North Korea's Nuclear Program'.
30. Joseph S. Bermudez, 'North Korea's Chemical and Biological Warfare Arsenal', *Jane's Intelligence Review*, vol.6, no.5, May 1993, pp.225-8.
31. Leader 'On Nuclear Allergy', *The Korea Herald*, 3 June 1994.
32. L.L. Bennett, *Nuclear Power in the World. Status and Trends. Economic, Health and Environmental Aspects*, IAEA, Vienna, Autumn 1994, Fig.13.
33. Lisbeth Gronlund and David Wright, *Beyond Safeguards*, Union of Concerned Scientists, Washington DC, May 1994, Chapter 6.
34. L.L. Bennett, *op.cit.*, Table 5.
35. For the Swedish and Swiss debates see Leonard Beaton and John Maddox, *The Spread of Nuclear Weapons*, Chatto and Windus, London, 1962, Chapters 9 and 10.
36. For Turkey and Yugoslavia see the author's *The Future Global Challenge*, Crane Russak for RUSI, London, 1977, pp.370-1.
37. Dr Andreas Rothwell, 'Chemical Weapons in the Middle East, Lessons from Iraq', *Jane's Intelligence Review*, vol.7, no.12, December 1995, pp.556-60.
38. Malcolm Dando, *Biological Warfare in the 21st Century*, Brassey's, London, 1994, p.58.
39. Dando, *op.cit*
40. Graham S. Pearson, 'Why Biological Warfare Matters', *The Arena*, no.3, October 1995.
41. S. Fetter, 'Ballistic missiles and weapons of mass destruction: What is the threat? What should be done?', *International Security*, vol.16, no.1, 1991, pp.5-42.
42. US Arms Control and Disarmament Agency, *Arms Control and Disarmament Agreements*, Washington DC, 1982, pp.120-31.
43. Dando, *op.cit.*
44. 'Russia's Secret Cities', *The Economist*, 25 December 1993.
45. Dando, *op.cit.*, Chapter 8.

46. Aaron Karp, *Ballistic Missile Proliferation. the Politics and Technics*, Oxford University Press for Stockholm International Peace Research Institute, Oxford, 1996, Chapter 5.
47. *Ibid.*, p.117.
48. *Ibid.*
49. *International Defense Review*, vol.20, no.4, 1987, p.420.
50. Keith Hayward, *The World Aerospace Industry*, Duckworth for the RUSI, London, 1994, p.32.
51. 'Long March Failures Bedevil China's Commercial Push', *Aviation Week and Space Technology*, vol.145, no.9, 26 August 1996, p.24-5.
52. Steven Hildreth, *Theatre Missile Defense: Indigenous Programs and Interest among US Friends and Allies*, Congressional Research Service, Washington DC, 5 May 1994, p.4.
53. Reproduced in Andrew N.D. Yang, 'Threats Across The Taiwan Strait: Reaching Out For The Unreachable', *RUSI Journal*, vol. 141, no.2, April 1996, pp.52-6.
54. Keith Hayward, *The World Aerospace Industry*, *op.cit.*, pp.31-7.
55. For a recent account of Pyongyang's centralised intelligence assessments see Desmond Ball, *Jane's Intelligence Review*, vol.8, no.1, January 1996, pp.28-33.
56. Bradley Hahn, 'China's naval tactical missiles', *Navy International*, June 1988, pp.308-12.
57. Martin Navias, *op.cit.*, pp.42-3.
58. Karp, *op.cit.*, Table 4.2
59. P. Hayes, *International Missile Trade and the Two Koreas*, Monterey Institute of International Studies, Monterey, March 1993, p.8.
60. 'Serbs attack Moslem towns with anti-aircraft missiles', *New York Times*, 5 November 1994.
61. Duncan Lennox, *Jane's Defence Weekly*, vol.25, no.16, 17 April 1996, p.40.
62. *The Military Balance, 1995-6*, p.133.
63. The author's *Has SDI A Future?*, Muirhead Paper No.7, University of Birmingham, Birmingham, 1992, p.2.

CHAPTER 6

1. *The Economist*, 7 October 1995, p.17.
2. See e.g. Senator Richard Lugar as quoted in *Aviation Week*, vol.144, no.5, 17 June 1996, p.58.
3. Herbert L. Abrams, 'Human reliability and safety in the handling of nuclear weapons', *Science and Global Security*, vol.2, 1991, pp.325-49.
4. Dan Caldwell, 'Permissive Action Links', *Survival*, vol.XXIX, no.3, May-June 1987, pp.224-38.
5. Spurgeon Kenny, 'Limited ABM Defense: Dangerous and Unnecessary', *Arms Control Today*, vol.21, no.8, October 1991, pp.14 and 16-18.
6. Bruce G. Blair, *The Logic of Accidental Nuclear War*, Brookings Institution, Washington DC, 1993, Chapter 4.
7. Frank van Hippel *et alia*, 'Eliminating Nuclear Warheads', *Scientific American*, vol.269, no.2, August 1993, pp.32-7.
8. 'The Alternative is Dictatorship', *Time*, vol.35, no.16, 16 April 1990, p.28.
9. Text supplied by private office.
10. 'Panel on Siberia: Economic and Territorial Issues', *Soviet Geography*, vol.XXXII, no.6, June 1991, pp.363-422.
11. Jean Radvanyi, 'And What If Russia Breaks Up? Towards New Regional Divisions', *Post-Soviet Geography*, vol.XXXIII, no.1, January 1992, pp.69-77.
12. Ethan B. Kapstein, 'Russia's Future Could Well Be Found In Its Far Flung Provinces', *International Herald Tribune*, 24 November 1995.
13. Robert J. Kaiser, 'Prospects For The Disintegration Of The Russian Federation', *Post-Soviet Geography*, vol.XXXVI, no.7, September 1995, pp.426-35.
14. Deborah Yarsike Ball, 'How reliable are Russia's officers?', *Jane's Intelligence Review*, vol.8, no.5, 1 May 1996.
15. Rose Gottemoeller, *Survival*, vol.38, no.2, Summer 1996, p.171.
16. Bonnie S. Glaser and Banning N. Garrett, 'Chinese perspectives on the Strategic Defense Initiative', *Problems of Communism*, vol.35, no.2, March-April 1986, pp.26-43.
17. Wu Xinguan, 'Striving to safeguard world peace', *International Strategic Studies*, no.2, June 1986, pp.3-6.
18. *The International Herald Tribune*, 18 February 1995.
19. Michel Garder, *A History of the Soviet Army*, Pall Mall Press, London, 1966, p.104.
20. *The Military Balance, 1988-9*, International Institute for Strategic Studies, London, 1988, p.34.
21. Matthew Bunn, 'Star Wars Redux: Limited Defenses, Unlimited Dilemmas', *Arms Control Today*, vol.21, no.4, May 1991, pp.12-18.
22. See the author's *New Strategy Through Space*, Leicester University Press, Leicester, 1990, Chapter 10.
23. Martin Navias, *Going Ballistic. The Build-Up of Missiles in the Middle East*, Brassey's, London, 1993, pp.42-3.
24. See the author's 'A Soviet SDI?', *The World Today*, vol.43, no.12, December 1987, pp.212-15.
25. David C. Chizun, *Soviet Radioelectronic Combat*, Westview Press, Boulder, 1985, p.48.
26. Yevgeni Velikhov *et alia* (ed.), *Weaponry in Space. The Dilemma of Security*, MIR Publishers, Moscow, 1986, pp.51-3.
27. *Aviation Week*, vol.142, no.15, 10 April 1995.
28. Duncan Lennox (ed.), *Jane's Strategic Weapons Systems*, Jane's Information Group, Coulsdon, 1994, Series 15.
29. For a creditable exception see Peter H. Gleick, 'Water and Conflict', *International Security*, vol.18, no.1, Summer 1993, pp.79-112.
30. See the author's OCEES Research Paper No.3, *The Impact of Climate Change: some indications from History, AD 250-1250*, pp.25-30.
31. Hubert Lamb, *Climate, History and the Modern World*, Routledge, London, 1995, Figure 23.
32. 'Israelis tell of massacre', *Daily Telegraph*, 16 August 1995.
33. Shlomo Avineri, 'Murder in Zion', *The World Today*, vol.51, no.12, December 1995, pp.226-7.
34. Reuven Predatur, 'Evolving Ballistic Missile Capabilities and Theatre Missile Defence: the Israeli Predicament', *Security Studies*, vol.3, no.3, Spring 1994, pp.51-70.
35. Stanley A. Blumberg and Louis G. Panos, *Edward Teller. Giant of the Golden Age of Physics*, Charles Scribner, New York, 1990, Chapter 24.
36. Gerald M. Steinberg, 'Israeli responses to the threat of chemical warfare', *Armed Forces and Society*, vol.20, no.1, Fall 1993, pp.85-101.

37. Malcolm O'Neill cited in *BMD Monitor*, vol.11, no.7, 5 April 1996.
38. *Defense Week*, 26 February 1996.
39. *BMD Monitor*, vol.10, no.24, 1 December 1995.
40. *BMD Monitor*, vol.11, no.9, 3 May 1996.
41. *The Times*, 15 November 1994.
42. Avishai Margalit, 'The Chances of Shimon Peres', *The New York Review of Books*, vol. XLIII, no.8, 9 May 1996, pp.18-23.
43. Devin T. Hagerty, 'Nuclear Deterrence In South Asia', *International Security*, vol.20, no.3, Winter 1995/6, pp.79-114.
44. *1994 Report to the Congress on Ballistic Missile Defenses*, Ballistic Missile Defense Organisation, Washington DC, July 1994, pp.1-4.
45. 'Japan weighs up missile defence options', *Jane's Defence Weekly*, 13 August 1994, p.21.
46. III,4,(3),a. English-language translation for press.
47. 3.15.1 English-language translation for press.
48. Kazuhisa Ogawa, 'Japan: the strategic pawn', *NIRA Review*, Winter 1996, pp.3-7.
49. *BMD Monitor*, vol.10, no.23, 17 November 1995.
50. Peter J. Katzenstein and Nobuo Okawara, 'Japan's national security: Structures, Norms and Policies', *International Security*, vol.17, no.4. Spring 1993, pp.84-118.

CHAPTER 7

1. USIS text of a speech on 'The Anglo-American relationship' delivered by Ambassador Raymond Seitz at the Royal Institute of International Affairs on 23 March 1993.
2. Special Survey. 'The New English Empire', *The Economist*, 23 December 1986.
3. See *New Strategy Through Space*, Pinter, London, 1989, p.138.
4. An FCO estimate quoted in B. Vivekanandan, 'Washington Must Rely On London, Not Bonn', *Orbis*, vol.35, no.3, Summer 1991, pp.412-22.
5. Adumbrated in *New Strategy Through Space*, *op.cit.*, p.3.
6. *The Annual Register of World Events, 1985*, Longman, London, , 1986, pp.309-10.
7. 'Taking On Japan Inc.', *Time*, vol.127, no.20, 19 May 1986, pp.52-7.
8. *1994 Report to the Congress on Ballistic Missile Defense*, Ballistic Missile Defense Organisation, Washington DC, July 1994, Chapter 7 Section 2.
9. For a near to full text, see *The Annual Register of World Events, 1984*, Longmans, London, 1985, pp.497-9.
10. 'A crucial role for Britain', *The Guardian*, 30 January 1987.
11. Dr. James C. Fletcher, *Strategic Defense Initiative: Defensive Technologies Study*, SDIO, Washington DC, 1984.
12. William J. Broad, *Star Warriors*, Simon and Shuster, New York, 1985, p.220.
13. Max Lerner, *America As A Civilisation*, New York, 1957, Chapter IV.
14. See the author's 'The Weather for Overlord', *Journal of Meteorology*, vol.19, no.189, May/June, 1994, pp.141-9.
15. Edward Teller, *Our Nuclear Future ... Facts, Dangers and Opportunities*, London, 1958, p.171.
16. T.C. Mataxis and S.L. Goldberg, *Nuclear Tactics*, Stackpole, Harrisburg, 1958, p.131.
17. See the author's *European Security, 1972-80*, Royal United Services Institute for Defence Studies, London, 1972, Chapter 7.
18. Gertram Suide, 'Clausewitz in US and German Doctrine', *Military Review*, vol.LXVI, no.5, June 1986, pp.39-47.
19. See *European Security, 1972-80, op.cit.*, p.85.
20. Intelligence collection; Surveillance; and Reconnaissance.
21. Command; Control; Communications; Computer Processing; and Intelligence.
22. Joseph S. Nye and William A. Owens, 'America's Information Edge', *Foreign Affairs*, vol.75, no.2, March/April, 1996, pp.20-35.
23. *Ibid.*, pp.22-3.
24. Eliot A. Cohen, 'A Revolution in Warfare', *Foreign Affairs*, vol.75, no.2, March/April 1996, pp.37-54.
25. Gary Stix, 'Fighting Future Wars', *Scientific American*, vol. December 1995, pp.74-80.
26. FM 100-5 *Operations*, HQ Department of the Army, Washington DC, 14 June 1993, Section 2-24.
27. Charles Krauthammer, 'The Lonely Superpower', *The New Republic*, 29 July 1991, pp.23-27.
28. See its news release, *Chinese Threat to Destroy Los Angeles Powerfully Reinforces Case for Missile Defense*, 24 January 1996.
29. Frank Gaffney, 'A Policy Abandoned', *The National Interest*, no.11, Spring 1988, pp.43-52.
30. Missile Defense Study Team, *Defending America : A Near- and Long-Term Plan to deploy Missile Defenses*, The Heritage Foundation, Washington DC, 1995, pp.28-9.
31. Henry F. Cooper, 'To Build an Affordable Missile Shield', *Orbis*, vol.39, no.1, Winter 1995, pp.85-99.
32. Gallup, *The People, Press and Politics*, Times Mirror, New York, 1987, Fig.21.
33. D.C. Watt, Frank Spencer and Neville Brown, *A History of the World in the Twentieth Century*, William Morrow, New York, 1968, pp.684-5.
34. *Op.cit.*, pp.96-7.
35. *The Economist*, 30 January 1988.
36. *The Military Balance, 1995-96*, The International Institute for Strategic Studies, London 1995, Tables 4 and 2.

CHAPTER 8

1. Leader 'Palmerston's Duty, Rifkind's realistic exposition of British interests in Europe', *The Times*, 22 September 1995.
2. For a transcript of the *Partnership for Peace* declaration see *The Annual Register of World Events, 1994*, Cartermill, London, 1995, pp.570-2.
3. *Challenge and Commitment*, The Federal Government, Ottawa, 1987.
4. *Annual Register of World Events, 1979*, Longman, London,1980, p.138.
5. Quoted in the author's *European Security, 1972-1980*, RUSI, London 1972, p.59.
6. *The Washington Times*, 23 May 1986.
7. Michael B. Froman *et al.*, *The Naval War College Review*, vol.XXXX, no.2, Spring 1987, pp.37-43.
8. My italics.
9. Government of France *Livre Blanc sur la Défense, 1994*, Paris, 23 February 1994, p.54.

10. 'U.S., France weigh broader co-operation', *Aviation Week and Space Technology*, vol.142, no.25, 19 June 1995, pp.50-51.
11. *Jane's Defence Weekly*, vol.23, no.3, 21 January 1995, p.29.
12. *Aviation Week, op.cit.*, p.51.
13. Steven A. Hildreth and Jason D. Ellis, 'Allied support for Theatre Missile Defense', *Orbis*, vol.40, no.1, Winter 1996, pp.101-21.
14. 'Harsh reality looms for French aerospace', *Aviation Week and Space Technology*, vol.143, no.10, 4 September 1995, pp.38-40.
15. M. Hakan Yavuz, 'Turkey's "Imagined Enemies" : Kurds and Islamists', *The World Today*, vol.52, no.4, April 1996, pp.99-101.
16. Ronald D. Asmus, Richard L. Kugler and F. Stephen Larabee, 'NATO Expansion: the next steps', *Survival*, vol.37, no.1, Spring 1995, pp.7-33.
17. *The Economist*, 28 March 1995.
18. Hildreth and Ellis, *op.cit.*, p.105.
19. 'Burying the General', *The Economist*, 20 April 1996, pp.33-4.
20. Research Monograph No.1, *Deterrence by Denial and Punishment*, Centre of International Studies, Princeton University, Princeton, 2 January 1959.
21. Hanns W. Moull, 'Germany in the Yugoslav crisis', *Survival*, vol.37, no.4, Winter 1995-6, pp.99-130.
22. 'U.S., Allies join on MEADS', *Aviation Week and Space Technology*, vol.142, no.9, 27 February 1995, pp.23-4.
23. *Jane's Defence Weekly*, vol.23, no.25, 25 June 1995, p.37.
24. *Defense Daily*, vol.191, no.64, 28 June 1996.
25. Ezio Bonsignore, 'MEADS: Les jeux sons faits ... or faites vos jeux?', *Military Technology*, no.2, February 1995, pp.32-8.
26. Defence Committee with Trade and Industry Committee, *Aspects of Defence Procurement and Industrial Policy*, HMSO for House of Commons, London, November 1995, pp. XXXIX-XL.
27. 'UK straddles fence on industrial policy', *Aviation Week and Space Technology*, vol.144, no.10, 4 March 1996, pp.43-3.
28. *Strategy for a secure future*, Labour Party, London, 1995, p.15.
29. *Strategic Survey, 1995/6*, Oxford University Press for IISS, Oxford, April 1996, pp.18-19.
30. *A National Aerospace Framework*, The Society of British Aerospace Companies, London, January 1996, p.23.
31. Keith Hayward, *The World Aerospace Industry*, Gerald Duckworth for RUSI, London, 1994, Table 2.1.
32. 'Space: a challenge for Europe', *Space Policy*, vol.11, no.4, November 1995, pp.227-32.
33. Editorial, *Aviation Week and Space Technology*, vol.145, no.6, 5 August 1996, p.74.
34. Charles Lane and Thom Shanker, 'Bosnia: what the CIA did not tell us', *New York Review of Books*, vol.XLIII, no.8, 9 May 1996, pp.10-15.
35. Craig Covault, 'Spot photographs secret base for USSR nuclear submarines, *Aviation Week and Space Technology*, vol.127, no.3, 20 July 1987, pp.18-19.
36. Captain James R. Wolf USAF, 'Implications of Space-based observation', *Military Review*, vol.LXXIV, no.4, April 1994, Fig.1.
37. Text from Office of WEU Secretary-General, London, 23 April 1990, p.5.
38. *Aviation Week and Space Technology*, vol.143, no.22, 27 November 1995, p.22.
39. Pierre Sparaco, 'France Plans More Cuts In Military Procurement', *Aviation Week and Space Technology*, vol.144, no.21, 20 May 1996, pp.68-9.
40. Michael Herman, 'Assessment Machinery: British and American Models', *Intelligence and National Security*, vol.10, no.4, October 1995, pp.13-33.

CHAPTER 9

1. Anatol Rapaport (ed.), *Clauswitz On War*, Penguin, Harmondsworth, 1968, Book 3, Chapter XV.
2. Donald R. Baucom, *Clausewitz on Space War*, Air University Press, Maxwell Air Force Base, June 1992, p.19.
3. John Findley Green Foundation Lecture, 9 March 1996. Text provided by Lady Thatcher's private office.
4. George E. Gruen, 'Dynamic Progress in Turkish-Israeli Relations', *Israel Affairs*, vol.1, no.4, Summer 1995, pp.40-70.
5. *Defense Daily*, vol.191, no.14, 18 April 1996.
6. For a somewhat complacent yet very cogent review of this whole issue see Karl-Heinz Kamp, 'An Overrated Nightmare', *Bulletin of the Atomic Scientists*, vol.52, no.4, July/August 1996, pp.30-4.
7. Benoit Morel and Theodore A. Postol in Chapter 4 of Donald L. Hafner and John Roper (ed.), *ATBMs and Western Security*, Ballinger, Cambridge (Mass), 1988.
8. *Defense Daily*, 18 April 1996. *op.cit.*
9. NATO Industrial Advisory Group. Sub-Group 37, *Multi-layer Defence of Europe. Post-2000*, vol.1, Executive Summary, Brussels, November 1995, p.10.
10. Mark Hewish, 'Smart Munitions, Brains Plus Brawn', *International Defense Review*, vol.29, no.2, 1 February 1996, pp.34-40.
11. Lawrence Freedman, *US Intelligence and the Soviet Strategic Threat*, MacMillan, Basingstoke, 1986, pp.116-7, 140-1, 169-70.
12. *The Military Balance, 1988-9*, The International Institute for Strategic Studies, London, 1988, p.215.
13. Morel and Postol, *op.cit.*, Fig.4.2. Inversion of radar hardening profiles duly corrected.
14. *Defense Week*, vol.17, no.20, 13 May 1996.
15. Deuterium is an isotope of hydrogen.
16. Adolf Galland, *The First and the Last*, Methuen, London, 1955, p.310.
17. Mark Hewish and J.R. Wilson, 'Closing the Loop. New Technologies to counter Mobile Targets', *International Defense Review*, vol.28, no.3, March 1995, pp.69-71.
18. *Defense Daily*, vol.191, no.37, 21 May 1996.
19. M.W. Tovey, 'The Laser Battlefield', *British Army Review*, no.112, April 1996, pp.60-66.
20. John T. Houghton, *The Physics of Atmospheres*, Cambridge University Press, Cambridge, 1977, Fig.A8.1.
21. *International Defense Review*, vol.29, no.7, 1 July 1996, p.5.
22. Herbert York, *1986 Lamont Lecture. Does Strategic Defense Breed Offense?*, CSIA Occasional Paper, Harvard University, Cambridge, 1987.
23. 'The Future of NATO', *The Economist*, vol.339, no.7968, 1 June 1996, pp.21-3.
24. 'British Defence Policy. Labour Approaches A Minefield', *The Economist*, vol.342, no.8002, 1 February 1997, pp.31-3.
25. Directorate of Naval Staff Duties, *The Fundamentals of British Maritime Doctrine*, HMSO, London, 1995, p.86.

26. Tim Garden in A.G.B. Vallance (ed.), *Air Power Doctrine*, HMSO, London, 1990, p.50.
27. See the author's Chapter 21, 'The Ascent of the Missile', *Brassey's Defence Yearbook 1996*, Brassey's, London, 1996.
28. Bryan Ranft (ed.), *Technical Change and British Naval Policy, 1860-1939*, Hodder and Stoughton, London, 1967, Chapter 6.
29. 'US Export Push Challenges Europeans', *Aviation Week and Space Technology*, vol.144, no.22, 27 May 1996, pp.20-23.
30. *Defense Daily*, vol.192, no.1, 1 July 1996.
31. *Defense Daily*, vol.191, no.17, 23 April 1996.
32. Dan Gouré, 'Is there a Military-Technical Revolution in America's Future?', *The Washington Quarterly*, vol.16, no.4, Autumn 1993, pp.175-192.
33. *Defense Daily*, vol.191, no.6, 8 April 1996.
34. 'Outgoing BMDO chief seeks better threat assessment', *Aviation Week and Space Technology*, vol.144, no.23, 3 June 1996, p.32.
35. *The Military Balance, 1996-7*, The International Institute for Strategic Studies, London, 1996, p.113.
36. Major General Robert S. Dickman USAF as quoted in *Aviation Week*, vol.44, no.23, 3 June 1996, p.93.
37. *Defense Daily*, 21 May 1996, *op.cit.*
38. *Defense Week*, vol.17, no.19, 6 May 1996.
39. Spurgeon Kenny, 'The Theater Missile Defense Threat to US Security', *Arms Control Today*, vol.24, no.7, September 1994, pp.3-7.
40. John Pike and Marcus Corbin, 'Taking Aim at the ABM treaty. THAAD and US Security', *Arms Control Today*, vol.25, no.4, May 1995, pp.3-8.
41. Margaret Thatcher, *The Downing Street Years*, Harper Collins, London, 1993, p.467.
42. 'Chinese Seek Atom Option to Fend Off Asteroids', *International Herald Tribune*, 21 April 1996.

ABL	AirBorne Laser
ABM	Anti-Ballistic Missile
ADI	Air Defense Initiative
AIT	Advanced Interceptor Technology
BMD	Ballistic Missile Defence
BMEWS	Ballistic Missile Early Warning System
BMDO	Ballistic Missile Defense Organisation
BPI	Boost Phase Interceptor
BWC	Biological Weapons Convention
CBW	Chemical and Biological Warfare
CEP	Circular Error Probability
CWC	Chemical Weapons Convention
DEW	Directed Energy Weapons
DGA	*Délégation Générale pour l'Armament*
DSP	Defense Support Platform
EMP	Electromagnetic Spectrum
FBM	Fleet Ballistic Missile
FSAF	*Famille de Systèmes Anti-aérien Futurs*
GBI	Ground-Based Interceptor
GPALS	Global Protection Against Limited Strikes
IAEA	International Atomic Energy Authority
ICBM	InterContinental Ballistic Missile
INF	Intermediate Nuclear Forces
IRBM	Intermediate-Range Ballistic Missile
K	Kelvin scale
KEW	Kinetic Energy Weapons
LDC	Less Developed Country
LWIR	Long-Wave Infra-Red
MAD	Mutual Assured Destruction
MAS	Mutual Assured Survival
MEADS	Medium Extended-range Air Defence System
MIRV	Manoeuvrable Independently-targettable Re-Entry Vehicle
MRBM	Medium-Range Ballistic Missile
MSL	Mean Sea Level
MTCR	Missile Technology Control Regime
NMD	National Missile Defense
NPT	Non-Proliferation Treaty
RV	Re-entry Vehicle
SALT	Strategic Arms Limitation Talks
SBIRS	Space-Based Infra-Red System
SBL	Space-Based Laser
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organisation
SFW	Sensor-Fused Weapons
SLBM	Submarine Launched Ballistic Missile
START	Strategic Arms Reduction Talks
SWIR	Short-Wave Infra-Red
UAV	Unmanned Aerial Vehicle