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The Prospects and Implications of Non-nuclear Means for Strategic Conflict

by Carl H. Builder

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The Prospects and Implications of Non-nuclear Means for Strategic Conflict

INTRODUCTION

During the next decade, the proliferation of a new generation of precision strike systems - air- and surface-launched cruise missiles and remotely piloted vehicles - could usher in a new era of strategic conventional warfare. Armed with fuel-air explosives or advanced point munitions, these weapons would enable states to threaten intolerable damage against soft and even hard targets of an adversary without resort to nuclear blackmail. . . . While most of these missiles are not being produced for strategic missions, the guidance systems, the motors, and the airframes of many of them could be exploited for such roles.¹

Since August 1945 strategic conflict has increasingly come to mean nuclear war. That connection is evident even in the efforts to control long-range nuclear weapons: strategic arms limitation talks (SALT) and strategic arms reduction talks (START). Today, strategic conflict is seldom taken to mean anything other than a nuclear war fought with long-range nuclear weapons - weapons that are now more often referred to as central strategic systems or strategic rocket forces. The words, 'strategic' and 'nuclear', may have become so intertwined in their meaning as to impair breadth and clarity of thought about either strategic or nuclear war.

Is it possible that strategic conflicts could be fought without resort to nuclear weapons? Upon a little reflection, the answer is 'yes, of course'. Except for the two nuclear weapons used by the United States against Hiroshima and Nagasaki in 1945, the entire human experience with strategic conflict has been non-nuclear.² Furthermore, military operations for 'strategic' objectives have been con-

ducted without resort to nuclear weapons since 1945.³

This Paper explores the possibility that future strategic conflicts - even between the super-powers - could be fought without nuclear weapons. The discussion is necessarily based mostly on speculation and argument, for the evidence is at present neither complete nor unambiguous. But the implications of that possibility are sufficiently important to warrant their consideration now, well before the pattern of evidence has resolved itself into a clear picture.

Definitions

Separating the ideas of strategic and nuclear conflict may at first appear to be only a semantic distinction. Nuclear war would almost certainly be perceived as a strategic conflict, at least for the nations experiencing the direct effects of nuclear explosions.⁴ But the reverse does not necessarily follow. The use of nuclear weapons in a strategic conflict between nuclear-armed states is not certain, even if that conflict is carried to their homelands - unless one also makes the assumption that *any* conflict between nuclear-armed states is *certain* to escalate to the use of nuclear weapons. The assumption that even limited use of nuclear weapons will inevitably escalate to general nuclear war is not uncommon (and the *risk* of escalation to nuclear war in any direct conflict between nuclear-armed states is widely perceived), but the *certainty* of nuclear war arising from any conflict between nuclear-armed states is not a common assumption. In fact, it is the possibility of non-nuclear conflict between the super-powers in Europe that drives most Western military planning and resource allocation.

What, then, is 'strategic conflict'? For some, strategic conflict is defined by its scope: it means general nuclear war - a war fought without limits on geography or targets or the means for their destruction. For others, it is defined by its potential consequences - a war that could destroy entire societies. Still others associate strategic conflict with the use of particular weapons - those carrying nuclear explosives and having intercontinental range. Unfortunately, none of these concepts say very much about the purposes or objectives of strategic conflict. More helpful here may be Webster's definition of strategic conflict as warfare 'designed . . . to strike an enemy at the sources of his military, economic, or political power'.⁵

Nuclear weapons can certainly do that. They are the most efficient means currently available for striking at many targets associated with those objectives. But they have never been the *only* means available; and the relative efficiency of alternatives may be increasing rapidly. The prevailing assumption - that strategic conflict between nuclear-armed states will necessarily be a nuclear war - needs to be carefully re-examined in light of new developments in both the disincentives and alternatives to the use of nuclear weapons. Nuclear weapons are (and are likely to remain for some time) the most efficient (i.e., cost-effective) instruments for threatening the destruction of entire cities and societies. But it is no longer clearly evident that cities and industries will remain the principal sources of military, political or economic power in modern conflicts, nor that nuclear weapons will remain the most militarily useful means for striking at the relevant sources of power in future conflicts.

Rowen and Wohlstratter have suggested that the availability of thermo-nuclear weapons, with their enormous power for destruction, may have encouraged laziness in thinking about strategic targets and their vulnerabilities:

The invention of the H-bomb effectively ended detailed examination of the vulnerability of many types of targets, and, much more important, discouraged fundamental thinking about targeting selection and the

purposes of target destruction. It is high time to rethink this problem.⁶

Thesis

The thesis developed here is that nuclear-armed states in conflict will increasingly have the incentives and the means to attack the enemy's sources of power without resorting to nuclear weapons.

That thesis does not rest upon some peculiar interpretation of words or some restrictive concept of conflict - for example, it does not mean that other means of mass destruction (chemical or biological warfare) or dramatic new super-weapons (lasers or particle-beam weapons) would simply be substituted for nuclear weapons. Nor does it rest on novel targeting schemes (the discovery of critical or 'panacea' targets'), unconventional operations (commando raids or sabotage), or restricted combat arenas (war at sea or in space). Rather, it rests on several steady and apparent trends in the nature of modern societies, technology and conflict. These trends suggest that fundamental strategic objectives could be pursued with non-nuclear strikes against familiar strategic targets, using technical means which, while not yet assembled, have already been revealed in all their components.

Some would refer to these emerging capabilities for non-nuclear strategic conflict as being 'conventional strategic' or 'advanced conventional' means for warfare. Those may be apt descriptions; but it is probably better to avoid the term, 'conventional' here, because some of the systems and operations might be quite *unconventional* by today's standards. For example, the concept of precision-guided munitions (PGM) carried to the other side of the globe by long-range delivery vehicles and controlled through space satellites is not a 'conventional' concept, nor would their use in war take on the character of conventional, or familiar, operations.

Five years ago, Richard Burt observed the emergence of these non-nuclear capabilities:

The growing availability of a new generation of conventional weapons has raised the possibility . . . that new conventional

weapons might be substituted in roles that were previously thought to require nuclear weapons . . .⁷

A specialized class of the more advanced systems could come to function as surrogates for nuclear weapons, providing states with credible conventional deterrent capabilities.⁸

This Paper explores the possibility that most of the objectives considered for strategic conflicts - even between the super-powers and even for counterforce strikes - may increasingly be attainable without resort to nuclear weapons. In exploring this possibility, several urgent questions arise at the outset and must be dealt with at once, lest they overshadow every point and argument:

- Is the possibility of these non-nuclear strategic capabilities desirable? Are they to be eagerly sought?
- Does the use of non-nuclear weapons make the destruction of vital strategic targets any less provocative? Are not such non-nuclear capabilities likely to evoke a nuclear response?
- Can the dangers and consequences of nuclear war really be escaped by such technological cleverness? Will not the threat of the use of nuclear weapons remain?

First, the desirability and the possibility of non-nuclear strategic weapons are two different things. There is much both to fear and to admire about such capabilities. This Paper does not advocate them; it explores their possibility and implications. Second, non-nuclear strategic capabilities, if they come about, will never be a certain means of avoiding nuclear war or the threat of nuclear war - just as conventional tactical capabilities can no longer provide insurance against nuclear responses or escalation. But, like conventional forces, they may come to represent an important level of conflict short of nuclear violence. Third, non-nuclear strategic capabilities will not be forgone merely because they *could* be countered with (or provoke) a nuclear response, for the extension of that logic would deny much of the utility of conventional forces in the presence of

nuclear arms. Rather, they may be sought precisely because they hold open the prospects of adding a rung - an additional degree of flexibility - to the escalation ladder and of providing a firebreak between the conventional and the nuclear, even at the strategic level of conflict.

If non-nuclear strategic capabilities are developed and deployed, nuclear weapons are not likely to go away, but their expected use in strategic conflicts may be sharply circumscribed. Although the nuclear genie may never be forced back into the bottle, it might be restricted to a much smaller and better defined role, which would have many profound implications for arms policies and for arms control. The incentive and potential to exploit technology to that end were eloquently described by Fred Ikle nearly a decade ago:

By taking advantage of modern technology, we should be able to escape the evil dilemma that the strategic forces on both sides must either be designed to kill people or else jeopardize the opponent's confidence in his deterrent. The potential accuracy of 'smart' bombs and missiles and current choices in weapon effects could enable both sides to avoid the killing of vast millions and yet to inflict assured destruction on military, industrial and transportation assets - the sinews and muscles of the regime initiating war.¹⁰

Non-nuclear capabilities for strategic conflict could emerge rapidly because, although they have yet to be demonstrated, no technological breakthroughs are required; the capabilities are inherent in current military and space systems. When the possibilities dawn upon enough people to make them credible and fashionable to entertain, there may be a sudden and significant revolution in military technology, and that suggests rapid and painful adjustments in policies and forces. A good example of this phenomenon can be seen in the history of modern cruise missile technology. The emergence of this technology in propulsion (small turbofans) and guidance systems (terrain matching) was fully evident in working - even flying -

prototypes more than fifteen years ago, and to a few military planners its significance was immediately apparent. Yet it took many years for that initial circle of reluctance to spread and to overcome the reluctance of established institutions to embrace completely different approaches to their missions. The cruise missile was an institutional orphan; it was neither an aircraft nor a ballistic missile. But the US defence laboratories and development activities had been institutionally divided according to that distinction, and the cruise missile was seen by both institutional camps as a threat to the traditional systems around which they had been organized. When modern cruise-missile technology finally did become widely enough appreciated outside those institutions, it was generally seen as a revolution in military capabilities - but, by that time, the real revolution was not in the technology but in people's minds, as the potential of existing technology finally 'dawned' upon them.

Even if this analysis has misjudged the likelihood of non-nuclear strategic capabilities for the near future the prospect nevertheless offers an intellectual opportunity. It invites a re-examination of existing arms and alliance

policies. In that exercise many hidden assumptions come into focus, inherent tensions are exacerbated, and comfortable ambiguities must finally be confronted. Thus, even as a means to gain a fresh perspective on existing policies, there is much to commend the entertainment of a hypothetical world in which *all* strategic objectives - short of the destruction of entire societies - can be achieved without resort to nuclear weapons.

Chapter I of this Paper outlines four trends leading to the possibility that nuclear weapons will be neither necessary nor desirable for waging future strategic conflicts. Extrapolating those trends raises some fundamental questions about the feasibility, significance, utility and implications of non-nuclear strategic weapons. Chapter II takes up the first of these questions, the technical feasibility of such non-nuclear weapons, while Chapter III addresses their military significance. Chapter IV explores possible rationales for the development, possession and use of non-nuclear strategic forces. Finally, Chapter V concludes with some of the policy implications for such forces as they emerge and become a part of the future.

I. TRENDS

There is a hopeful sign that the trend of the first part of this century, towards the inclusion of non-military target systems and civilian populations in military campaigns, will be reversed. Precision delivery means that military targets can be destroyed with less total explosive power and less collateral damage to non-military targets. The faster pace [of war] means that tactical forces-in-being, as well as strategic forces, count for more, and the general economy for less, in achieving a favourable outcome.¹¹

Despite the lateral and vertical proliferation of nuclear arms, there are at least four trends favouring the development of alternate means for prosecuting strategic conflicts:

- The use of nuclear weapons as a military or political option for the highly developed

four trends could represent an inexorable force towards the development of revolutionary capabilities for non-nuclear strategic conflict. In this Chapter, each of these four trends is developed in more detail, and some of the fundamental questions they pose are raised.

Reluctance to Use Nuclear Weapons

The first trend is one of growing disinclines. It is now widely perceived that even limited use of thermonuclear weapons against highly developed and densely populated areas would be an unprecedented human calamity - a disaster of such proportions that it would not justify any conceivable political or ideological goals.¹² While analysts continue to raise and answer theoretical questions about strategic nuclear war - the ability to win or lose missile duels, or the survivability of urban populations under civil defence programmes - the abilities of the modern nuclear-armed states¹³ to destroy each other's societies is not really in doubt. The sheer number of nuclear weapons,¹⁴ the diversity of means to deliver them,¹⁵ and the growing fragility of highly developed and urbanized societies¹⁶ are realities that lie outside and overshadow the theoretical analyses of missile duels and assured destruction.

The use of nuclear weapons - whether battlefield, theatre, tactical or strategic - in the face of secure retaliatory forces is likely to be more an act of political and societal resignation than one of military utility. Not everybody accepts this view today, but the number who do appears to be growing rather than declining. The military *advantage* of using nuclear weapons when they are available to both sides in a conflict has yet to be demonstrated convincingly, and the limited advantages that might be conceived for them could be offset by the great uncertainties¹⁷ and awesome considerations that would attend the contemplation of even limited use of nuclear weapons. At the very least, there are the uncertainties of unintended collateral damage, particularly that due to fallout,¹⁸ and the risk of escalation. Those making the decision to initiate the use of nuclear weapons must consider not only the reactions of their opponents but also those of their own publics

and of the world community at large. The decision to use nuclear weapons - now even more than in 1945 - means entering upon unfamiliar and unpredictable moral ground.¹⁹

Thus, the threatened use of nuclear weapons for many provocations is becoming less credible, and the reluctance to use them - as with the historical reluctance to use chemical and biological weapons - seems likely only to increase, at least for conflicts between nations with the means to retaliate in kind.

Having said that, however, it is important to distinguish between the *reluctance* of some people to use nuclear weapons and the *likelihood* that their use will be avoided. While reluctance to use them may increase within the developed nations, so might the likelihood of their use by others who have little or no nation at stake. Although the developed nations may not be able to afford the consequences of using nuclear weapons against a similarly armed opponent, that could be less true for subnational groups, who, without a society at hostage and thus not equally vulnerable, may have little to lose in using nuclear weapons. Perhaps undeveloped nations, too, may see themselves less vulnerable than the developed nations, and therefore less reluctant to use nuclear weapons to punctuate their demands. And, even if everyone were increasingly reluctant to use nuclear weapons, there is an intuitive increase in risk of their accidental use commensurate with their horizontal and vertical proliferation.

While it remains generally the case that political leaders will continue to posture and threaten the use of nuclear weapons for the purposes of deterrence, their willingness to commit those forces in combat has probably never been great, and should only decrease in the future as the consequences of their use become less acceptable. Consequently, those nuclear forces designed for strategic objectives in conflict will become less usable, and therefore less relevant instruments for fighting wars. Ultimately, it may be found that nuclear weapons were the instruments of seduction - of the military institutions, by the political elites. As long as there have been nuclear weapons, political leaderships have kept tight control over them, despite repeated

pleas by the military for some control to be relinquished to local military commanders - ostensibly because political decisions for release would not be timely for certain uses. The result may be that the politicians have finally gained control of the military by encouraging them to acquire and even demand weapons too powerful for them to control or use. While efforts to make nuclear weapons better for military purposes (by making them smaller and delivering them more precisely) will probably continue, those efforts are not likely to alter greatly the political reluctance to use nuclear weapons - a reluctance rooted more in an appreciation of their societal risks than their military utility.²⁰

Pace of Conflict

The character of strategic targets is changing because of the quickening pace of modern warfare. When the destructive pace of conflict is sufficiently slow, wars can be sustained over a period of years, providing sufficient time for the economic and political resources of a nation to be converted into military power which is then brought to bear in the conflict. Industrial plants can be changed over to military production, and the civilian population can be mobilized and trained to produce war materiel or to fight, given months or years to do so. Under these circumstances, which prevailed during the first half of this century, industry and civilian morale have been taken to be fundamental sources of military power in a conflict and in consequence have become strategic targets. World War II was such a conflict, and the experience of that war has had a pervasive influence on Western thinking about the nature of strategic nuclear warfare and targeting. That influence is evident in the continued heavy emphasis on the destruction of urban societies and their industrial capacity as the sources of war-making potential. Soviet thinking seems to have been little different and Soviet fear of Western potential even more pronounced.

Since 1945, however, the world has seen a substantial acceleration in the tempo of destruction in conflict - and without the use of nuclear weapons. Wars have been fought and won or lost in weeks, days or even hours. In

fact, the perception of the 'short war' is so prevalent today as to cause some concern about the lack of preparation to mobilize societal resources in the event of a conflict turning out to be protracted. To say that a modern conflict is likely to be too short to mobilize societal resources is not the same as being certain that it will not be protracted - just as the likelihood of nuclear war escalating to societal destruction does not rule out the important possibility of its remaining limited.

With this change has come a significant shift in the sources of war-making potential in any given conflict, and therein lies the paradox of World War II strategic bombing theories. If the destructive pace of a conflict, is sufficiently slow to allow time for industry and civilian morale to become the basic sources of military power, then it is also likely to be sufficiently slow to permit industry and civilian morale to adapt, recover and become hardened against attacks upon them. Only with the first atomic bombs did the destructive pace of strategic bombing reach levels that could truly shatter both industry and civilian morale - a pace that could effectively prohibit adaptation and recovery. But that destructive pace could also shorten wars to the point where industry and civilian mobilization were no longer the sources of military power - at least for the conflict at hand. The industry and population of a nation are no longer so important to the conduct of a war, once it has begun: they are increasingly less likely to be mobilized and brought to bear before a conflict is terminated. This is true at least for conflicts between states, where the pace of destruction can be imposed by the stronger of the adversaries, in contrast with conflicts within states (guerrilla, internal, or civil wars), where the pace can be set by the weaker of the two. Since 1945, the only conflicts between states that have continued long enough to permit societal mobilization are the Korean and Iraq-Iran wars. The rapid pace of modern conflict between states has been most clearly evident in the several India-Pakistan and Arab-Israeli wars and in the recent Falkland Islands conflict.

Proportionately more important, therefore, are the military forces-in-being (and equip-

ment and munitions in the stockpile), since these are the only resources that can influence the outcome of a short-lived war. The war over the Falkland Islands may be more representative than World War II of what the future holds. That war spanned little more than ten weeks, insufficient time to train new manpower for fighting. New equipment could not be produced; it could only be acquired from existing stocks, on hand or provided by allies. Argentina apparently sought additional *Exocet* missiles in the world arms market and fighter-bomber aircraft from Peru. Britain sought additional *Sidewinder* missiles and KC-135 tanker aircraft from the United States. The pace of that conflict, whether imposed by technology or politics, was simply not compatible with the pace of industrial and manpower mobilization. Indeed, given the pace of modern warfare and the threat of nuclear weapons, the industry and people of a nation are more likely to be the hostages rather than the means for waging a conflict in progress.

Thus, today, the relevant strategic targets are to be found mostly in the military assets of a nation, and possibly in its political leadership, but to a very small extent in its industry, and even less in its urban society. To attack urban and industrial areas in modern warfare is not to fight the present conflict but to wage war on the future; and threatening to wage war on the future may be precisely what nuclear weapons are best suited to do.

Vulnerability of Targets

Despite costly efforts to protect long-range nuclear delivery vehicles through hardening, proliferation and dispersal, the sources of strategic power are probably becoming more, rather than less, vulnerable. Because of the enormous capabilities, cost and complexity - even fragility - of modern military forces, their principal elements or components are becoming fewer in number and more uncertain in their operations. Where once thousands of aircraft were required, only hundreds are now needed; hundreds of ships have been replaced by tens. Two or three bases or facilities may now constitute the entire logistic support for major weapon sys-

tems. For example, the C-5A fleet of aircraft that comprises the heavy, outsized-cargo airlift capability for the US (and is a critical element in plans for the early reinforcement of NATO) has been based in peacetime on only two airbases, in Delaware and California. The *Trident* missile system will also be supported by two port facilities, one each on the Atlantic and Pacific coasts of the US. The cost of maintaining complex weapon systems, such as ballistic missiles and combat aircraft, has encouraged the peacetime concentration of repair and servicing facilities for everything from strategic weapons to conventional forces.

The sophisticated materials and structures used in modern weapons makes many of them susceptible to destruction by a single hit from a projectile. For example, the highly stressed propellant cases of ballistic missiles have been described as being vulnerable to a small-calibre rifle bullet. At high speeds, aircraft and the turbines that power them are susceptible to rapid self-destruction from vibrations induced by damage to small components. Bird strike is a major problem for modern jet aircraft. The special materials and shapes necessary to produce highly accurate re-entry vehicles for ballistic missiles are so sensitive that possible encounters with dust and even rain have been of great concern. In general, the tolerance to damage of complex modern systems seems to be declining rather than increasing.

The increasing sensitivity of modern weapons and the systems that support them raises the spectre of their being crippled by subtle or selective attacks on components. Electronic systems can be jammed, critical control nodes can be destroyed, and essential logistics links can be broken. The loss of certain supplies, spares, support equipment - within a complex system untested by the circumstances of war - can result in unexpected and widespread losses in military capability. These complexities make the threat of 'horse shoe nail' failures the justifiable nightmare of combat operations near the limits of current military capabilities. Such fragility is of greatest concern to the West where strategic capabilities are already considered marginal.

such as those for the reinforcement of Europe, the projection of forces into the Persian Gulf, and counterforce attacks on hardened targets. It is of significantly less concern where strategic capabilities are robust - e.g., the super-powers' capabilities for societal destruction - or where conflict is expected to be protracted.

This growing concentration and fragility of modern weapons, which has either accompanied or resulted from their increasing capabilities for destruction, suggests that the weapons of today are not so numerous nor so dispersed as they were in World War II - the war that is so often the paradigm for strategic conflict. The number of targets that may have to be attacked to destroy the relevant military assets of modern nations may in fact have been declining rather than increasing over the past three decades.²¹ The efforts to conceal modern weapons and to harden them in protective shelters are not due solely to the advent of nuclear weapons; they have become so few, fragile and expensive that dispersal and replacement are no longer sufficient to assure their survival even against attacks with conventional weapons. The extensive efforts over the past twenty years to provide hardened protective shelters for tactical aircraft in Europe is a good example of this. Those costly efforts have been undertaken not just because the effectiveness of means for destroying aircraft on the ground has improved dramatically since 1945, but also because there are fewer aircraft to be destroyed. If the number of aircraft available for a future European conflict were the same as in World War II (i.e., tens of thousands), it is doubtful whether efforts to provide hardened shelters would be either necessary or economically feasible.

conventional munitions for penetration, fragmentation and concussion;

- Space systems are providing the global information necessary for precision navigation and high-capacity communication, reconnaissance and surveillance;
- Strategic delivery vehicles have proved their ability to transport substantial payloads rapidly and reliably over intercontinental distances.

These technologies have not emerged recently. The capabilities they offer are no longer highly speculative. They are all mature enough to have produced second- and third-generation systems.

Whether they now provide sufficient technical capabilities to displace nuclear weapons for strategic conflict is one of the central issues to be explored in this Paper. At this point it is sufficient to note that these technologies do not have to be extrapolated to evaluate the thesis. It will be shown that, if combined only within their currently demonstrated capabilities, they offer some prospect of non-nuclear means for striking at a variety of strategic military targets. Together, they already provide the capabilities for transportation, intelligence and destructiveness necessary to enable contemplation of the prospect of waging future strategic conflicts at intercontinental ranges without resort to nuclear weapons.

None of these four trends is without its ambiguities or counter-examples, but the basic premise of the first - the reluctance of highly-developed, nuclear armed nations to use nuclear weapons against comparably armed opponents - is essential to the thesis of this Paper. Clearly, if there is no reluctance to use nuclear weapons, there will be no great incentive to develop or support the technical means of non-nuclear strategic conflict described here. Yet it is upon that very same premise that the present theories of nuclear deterrence and conventional defence also hang. In the arguments developed in the following chapters, the importance of that premise will surface several times.

The four trends already outlined pose some basic questions, each of which is taken up in the following chapters:

- Tactical weapons are demonstrating techniques for both controlled dispersal and precise delivery of some extremely efficient

By what rationales can non-nuclear strategic forces evolve in the presence of nuclear weapons?

What incentives will drive their development and what concepts will guide their deployment and use? What kind of new world will they create? The path from here to there is neither obvious nor pleasant to contemplate.

What might such capabilities imply for arms policies?

It seems particularly important to probe how they might affect the current concepts for deterrence and arms control. These are the policy areas where it is most valuable to be ahead rather than behind the trends or developments that will force changes.

These questions are taken up sequentially in the four chapters that follow.

Is it possible or technically feasible to attack any strategic target without using nuclear weapons?

Strategic conflicts require the ability to destroy a variety of targets. It is not enough to find only a few strategic targets that may be peculiarly susceptible to non-nuclear attack.

Is it technically or economically possible to build a militarily significant non-nuclear force - capable of striking a broad spectrum of military targets in a strategic conflict?

It is not enough to say that non-nuclear weapons can be used effectively for some tasks, even in a nuclear war. If the possibility of strategic conflict without nuclear weapons are important, it will be because most or all of the strategic objectives in war can be achieved without resort to nuclear means.

Political will, social climate, resource availability, military doctrine and 'breadth of vision' are as important determinants of 'where technology is going'... as are the dramatic breakthroughs achieved by research and development.²²

Is it feasible to destroy important strategic targets without using nuclear weapons? In developing arguments supporting the feasibility of waging strategic conflict with non-nuclear weapons, it will be useful to separate the questions of technical and military feasibility. Technical feasibility, addressed in this chapter, is taken to mean whether, under the most favourable circumstances, technical means can be devised to destroy representative strategic targets without using nuclear weapons. The answer is to be found in the laws of physics and in the state of technology. The more difficult question of military feasibility, addressed in Chapter III, is whether those technical means could find practical military application in the prosecution of a strategic conflict. The answer to that question involves considerations of their cost and the possible countermeasures.

From a strictly technical standpoint, accurately delivered modern conventional munitions are competitive with nuclear munitions for some applications and superior for others. This means that some operations, which in the past were thought of as requiring nuclear munitions, can, with modern technology, be conducted with non-nuclear munitions.²³

This technology has proved itself competitive for most strategic defence applications. Strategic air defence missiles, whether surface- or air-launched, are increasingly fitted with non-nuclear warheads, even though some earlier models were nuclear-tipped. The same trend can be seen for anti-satellite systems: the initial capabilities were achieved with nuclear weapons, but the most modern means (US and Soviet) are non-nuclear, partly because nuclear weapons can

II. TECHNICAL FEASIBILITY

Current Status

Non-nuclear weapons technology for some tactical applications has already reached the point where it can provide capabilities competitive with nuclear weapons:

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Technologies

New technologies are eroding the monopoly of nuclear weapons for the confident destruction of strategic military targets. At least three maturing technologies are contributing to this erosion:

- Tactical weapons are demonstrating techniques for both controlled dispersal and precise delivery of some extremely efficient

destroy the space environment in which friendly satellites must operate. Anti-submarine warfare (ASW) for strategic defence also favours non-nuclear means. Although both nuclear and non-nuclear ASW weapons are available, the latter are generally preferred, because the use of nuclear weapons temporarily destroys the ocean environment for acoustic sensors - the most effective technical means for detecting and tracking submarines. The only aspect of strategic defence which continues to rely heavily on the use of nuclear weapons is ballistic missile defence. Even here, however, non-nuclear means are attractive for avoiding undesired side effects, such as the blinding of radars, and - as President Reagan's Strategic Defense Initiative (SDI) demonstrates - the main interest is now in non-nuclear mechanisms of destruction.

Non-nuclear weapons for strategic conflict are thus already widely accepted - and even preferred for many, perhaps most, defensive operations. Note that these non-nuclear means have been favoured even for defence against nuclear attacks: situations where the stakes are extremely high and political inhibitions on nuclear use can be presumed to be at their lowest. This is an early indication that non-nuclear weapons can be militarily more effective than their nuclear counter-parts, particularly when considerations of collateral damage to military operations are included.

Whether these same considerations also apply to the choice of weapons for strategic offensive operations is less evident. The technical feasibility of non-nuclear means for such operations rests on the answers to two questions:

- Which strategic offensive targets, if any, are susceptible to destruction without using nuclear weapons?
- Can suitable non-nuclear weapons successfully strike those targets?

This Paper is not the place to attempt a comprehensive analysis of either strategic targets or the design of non-nuclear weapon systems for their destruction. Such efforts would be as premature as attempts to design today's

strategic nuclear forces when thermonuclear weapons first emerged in the mid-1950s. Although the basic technical means - supersonic aircraft, ballistic missiles, nuclear-powered submarines, etc. - were all evident even then, the employment concepts and the most effective approaches still required considerable evolution. Some of the current affection for ballistic missiles on nuclear submarines and for cruise missiles (as well as some of the current disaffection with fixed land-based ballistic missiles) was not then apparent but evolved subsequently with experience of both designs and operations. The same evolution is to be expected with non-nuclear strategic weapons.

Moreover, much of the technical data - on the accuracy and lethality of precision-guided munitions (PGM) against various targets, on the space information systems that might help to acquire those targets and guide weapons to them, and on the various delivery vehicles that might carry such weapons - is restricted to governmental use. Likewise, the structural details of strategic targets - the basis for analysing their vulnerability to non-nuclear attack - are generally withheld from the public.

Here, therefore, it is more appropriate to review some of the arguments and available evidence that important classes of strategic targets can be made vulnerable through non-nuclear means of attack, without pretending that the means suggested are the most efficient or that the entire array of strategic targets has been systematically considered.

Target Destruction

Most man-made objects are susceptible to destruction with a properly placed projectile or explosive charge. It is only when the destructive device cannot be properly placed that massing their effects by means of rapid-fire guns or large warheads, including atomic warheads, becomes attractive. It could be argued that massing the effects of weapons is necessary when the size or number of targets is very large. Machine guns deal with hundreds of advancing men; atomic bombs deal with thousands of buildings in a single city. But it can also be argued that the ability to place every bullet or every high-explosive

bomb precisely where it was desired would make both machine guns and atomic bombs less important as means for stopping a human charge or destroying a city. Their importance lies in their effectiveness, in comparison with alternative means currently available. If a specific target can be designated and a non-nuclear projectile or explosive charge can be placed wherever one chooses, it becomes difficult to visualize anything that cannot be destroyed or made unusable.

From the work of demolition experts, it is obvious that a few carefully placed charges can drop bridges and large buildings, but to do it efficiently requires knowledge of the target, its weak points and the effects of explosives upon structural members. There is also evidence that tanks or ships can be destroyed by a single well-aimed (or lucky) hit. Indeed, ships provide some of the most dramatic examples, some having survived incredible punishment in battle, others succumbing to a single hit. The World War II losses of the battle cruiser *Hood* and the battleship *Arizona* have been attributed to the explosion of their magazines as a result of single, fortuitous hits. More recent, and perhaps more to the point of this Paper, are the losses of several ships to single, less fortuitous hits by *Exocet* missiles in the Falklands war. These results probably say as much about the intentional placement of the hits as they do about the vulnerability of modern ships. Furthermore, we also know that 1-kg shaped charge can easily defeat a tank if properly placed.²⁴

But are there some objects that can resist even the perfectly placed non-nuclear device? Large reinforced-concrete structures come to mind, such as dams and the containment buildings for nuclear reactors; but these, too, have been breached in air attacks with high explosives. While reinforced concrete is highly resistant to large distributed loads, such as the air pressures created by a nearby explosion, it is quite susceptible to penetration by devices which concentrate and direct their energy into the concrete, such as hypervelocity projectiles and shaped-charge explosives. An 800-kg shaped charge may be sufficient to penetrate ten metres of concrete.²⁵

Other targets, including missile silos, deep underground command bunkers and aircraft runways, may be difficult to destroy, even with nuclear weapons because of their physical hardness or configuration. Here, however, one must be strict about defining the target. Destroying a missile silo without (or even with) a nuclear weapon may indeed be difficult, but destroying its contents with a shaped charge that pierces its door and sprays the interior with shrapnel or molten metal might be relatively more simple. Which, then, is the target: the silo or its contents? The brute force, so readily available in nuclear weapons, encourages one to think that it is the silo, rather than the missile inside.

Similarly, personnel in command bunkers must communicate with those they command in order to be effective. Preventing those communications (by severing lines or destroying antennae) may be just as effective as destroying the bunker itself - and either approach may only temporarily disrupt the functioning of command. Whether it is more difficult to prevent the communications or destroy the bunker is a matter of perspective. If nuclear weapons are used, it makes little difference; a weapon with sufficient yield can do both at the same time. If they are not, however, it may be necessary to attack the weakest links in the communications chain - the power supplies, transmission line nodes or antennae. Again, conceptual familiarity and confidence with nuclear weapons for use against strategic targets may have channelled most thinking toward brute force approaches. But, if there is great reluctance to use nuclear weapons, then there is a need to be increasingly sensitive to alternative and, perhaps, less confident approaches to strategic objectives.

Runways are another example of a difficult target that can be approached several ways. Non-nuclear munitions specifically designed for the destruction of runways are now becoming available,²⁶ but runways need not be the only target. They are important only when there are enemy aircraft that might use them, and it is conceivable that an attacker would not want to destroy enemy runways - for example, if they could be of future use in

landing his supplies or assault forces. (If Britain could have controlled the airspace around the Falkland Islands, she might have been better served by preserving the runway at Port Stanley for her own use. Her inability to do so, however, made runway closure the only means available to prevent its use by Argentine aircraft, and even then the (lightly) damaged runway was used for clandestine resupply flights by Argentina.) The aircraft themselves, even in hardened protective shelters, may be much more susceptible to damage by precisely placed projectiles or explosive charges than the runways they use.

Other area targets, such as depots and storage areas, can be attacked either by selectively and precisely striking elements within the area or by exposing all elements to damage with evenly distributed weapons effects. Fuel-air explosives can produce a given level of overpressure (blast shock) over a larger area than high explosives, and with significantly less mass.²⁷ Indeed, such weapons may be able to create pressure waves approaching those produced by nuclear weapons.²⁸ Cluster munitions could be designed to damage more than three times the area of industrial buildings that conventional bombs of the same weight could affect.²⁹

Given latitude in target definition, therefore, it is hard to imagine any strategic objective - military, economic or political - that absolutely requires the use of a nuclear weapon. However, the corollary of this is that the technical feasibility of non-nuclear strategic weapons now comes to depend on the successful positioning of suitable destructive devices in relation to their targets, however they may be defined and wherever they may be located.

Weapon Placement

The precise delivery of munitions against specific targets has become the new reality of the modern battlefield. Whatever the actual limitations of the first generation of laser-guided bombs or wire-guided anti-tank missiles, the prevailing expectation is that the forces on a future battlefield will have increasingly numerous and dependable means to hit a selected target at the first attempt. The

technical feasibility of guiding a weapon to within a few feet (or even inches) of the aiming point, using lasers or other means for terminal homing, is no longer seriously questioned. Navigation over semi-global ranges may soon be measured in terms of feet:

The high accuracy of precision-guided munitions at short ranges is well known. But impressive improvements in accuracy are also taking place at long range. For example, the accuracy of inertially guided intercontinental missile systems has improved by an order of magnitude in roughly a decade. With ballistic or aerodynamic vehicles, another order of magnitude improvement may be expected without terminal guidance, or even more with it. It is clear from public information that the area of the median circle of error for strategic rockets has long been measured in tenths of a square mile: it appears that it will soon be measured in hundredths and in the long run in thousandths of a square mile or less.³⁰

The questions about PGM and precision navigation systems no longer centre on their accuracy but on their combat effectiveness because of environmental conditions, training requirements, availability, counter-measures, etc. Thus, whatever the present reservations about the expanding arrays of PGM, or about the increasing reliance upon them on the battlefield, they concern military suitability and cost and not the technical ability to deliver a weapon precisely to a specific target.

It should be noted that nations are increasingly forced to rely upon untried technologies and weapons. There is, however, a natural reluctance in military institutions to rely on the untried, and many of the reservations about battlefield PGM probably have their source in the fact that these weapons have not been truly tested in large-scale use on the battlefield. But this is also true of nuclear weapons and ballistic missiles of all types, yet the major military powers now have little choice but to rely upon them to deter the most severe threats to their national security. Fred Ikle has observed that:

Military services cling to the type of weapons to which they have become accustomed, seeking marginal improvements rather than radical innovations³¹

However, technology will not wait. Radical innovation is occurring in military technology, despite the absence of wars that would serve to validate that technology in battle. This has been a problem for most of the twentieth century. But, while it makes for uneasiness about the future performance of weapons, it is not likely either to go away or to improve in the foreseeable future.

Properly positioning a suitable munition involves more than precision in its delivery. It requires information about where the munition should be delivered, and that means information about the target - its existence, location and vulnerabilities to the munition used. Upon reflection, however, it would seem that the knowledge about the current existence and location of strategic targets now required for nuclear strikes is probably quite adequate for non-nuclear strikes as well. If a nuclear weapon can be confidently delivered within a fraction of a mile from a known strategic target - as we know it can - that same delivery accuracy is well within the battlefield range for existing PGM. If a precision-guided battlefield weapon, along with its kit of required sensors, can be delivered to within the lethal range of a nuclear weapon, then those sensors ought to enable it to acquire the target and complete its precision delivery to the desired point. This also applies to targets of limited mobility, such as ships and mobile ground equipment, which may move from their last observed position. These can be attacked either with a nuclear weapon whose destructive effects are large enough to compensate for positional uncertainties, or by intelligent PGM which have the sensors and computing ability to find the target within the area of uncertainty and attack it precisely. For example, modern acoustic torpedoes can actively search for a submarine target by spiralling down within a cylindrical volume of water. Thus, a submarine detected and tracked - say, by space satellite sensors - could conceivably be quickly attacked using a pattern of acoustic

torpedoes delivered to the target area by ballistic missiles. While a nuclear weapon would probably be more efficient for that purpose (in terms of weapon weight required to produce a given probability of target destruction), it might be less effective militarily because of adverse collateral effects on the acoustic environment. Generally speaking, with modern microelectronics it is no longer difficult or expensive to provide powerful computers capable of recognizing a specific target within an instantaneous picture of the target area.

Another way to look at the problem is to observe that probably more is known about the existence, design and location of most strategic targets today than will ever be known more than a few minutes in advance about the tanks, aircraft and ships to be engaged on some future battlefield, and the sensors, computers and even the human 'presence' available on the battlefield can now be projected halfway round the world.

Knowledge of Weapons Effects

Non-nuclear weapons, depending more upon precise placement than brute force to destroy their targets, would seem to be at greater risk from uncertainties in weapons effects. The desired non-nuclear device might be positioned at precisely the right place, but how certain is it that it will produce the desired effect?

That question seldom arises with nuclear weapons, given proper positioning. Their effects are generally perceived to be known and adequate, and their enormous, almost limitless, power makes the vulnerability of targets seem obvious and certain. But the responses of targets to nuclear effects are not really all that well known, and our knowledge is severely circumscribed by the evident political, ecological and economic difficulties of nuclear weapons testing. The test experience and weapons effects data for non-nuclear weapons, on the other hand, are enormous and well documented for a wide array of targets. (In fact, the effects of a shaped-charge explosive delivered directly against a reinforced concrete structure may be much better known and more demonstrable than the effect of a nearby nuclear detonation.) Thus, knowledge of the vul-

required for strategic targets should no longer be in question.

nerability of strategic targets to precisely executed non-nuclear strikes might turn out to be more robust than the knowledge of their vulnerability to nuclear weapons effects, because of the relative ease of validation through operational testing. Hudson and Hass acknowledged the difference in their comparisons of nuclear and conventional munitions:

The target damage capability of conventional weapons can be determined by conducting large numbers of tests. This has led to a proliferation of data describing the effectiveness of a given weapon when used in a given mode against a given target. The amount of nuclear weapons testing, on the other hand, has been very limited, making it necessary to use a different approach. The free field environments have been measured, calculated or estimated, and the target response to these various environments has been separately calculated or estimated from the somewhat sparse test data base. The environments and target responses are then coupled to estimate the degree of target damage.³²

The application of nuclear weapons to strategic targets may be the more familiar concept. But familiarity with an idea or notion is not necessarily the same as either knowledge or confidence.³³

Weapons Delivery
Finally, the technical ability to deliver and control a PGM at the semi-global ranges

III. MILITARY SIGNIFICANCE

Now the strategy of the United States is focused even more sharply on counterforce – the use of some fraction of the US strategic nuclear force to attack a portion of the enemy's target system consisting of military installations, logistical complexes, command bunkers, and – to put the most important matter last – missiles in their silos.³⁵

Accepting, at least in theory, that it is technically feasible to destroy almost any type of

cal and military value, and they must be able to pursue those objectives in the face of such countermeasures as might be reasonably expected.

Implicit in the notion of pursuing rational objectives within a strategic conflict is the possibility that such wars may be fought in stages, as a series of escalating phases, and not necessarily as a single, uncontrollable spasm of attacks on all targets simultaneously. Not everyone will accept the possibility of controlled strategic conflict, but neither can the possibility be ruled out. If the only way that strategic conflicts will be fought is as a single spasm, then non-nuclear capabilities will have little military significance until they can replace all strategic nuclear weapons. The advent of non-nuclear strategic capabilities may very well increase the prospects for controlled strategic conflicts, but such capabilities will not even be entertained in minds whose only concept of strategic conflict is that of a single all-out exchange of arsenals.

Given the technical feasibility of non-nuclear strategic weapons, their military significance depends on which objectives are to be pursued with them, the economic feasibility of the forces required to pursue those objectives, and the prospects for successful countermeasures to thwart the objectives or forces.

Objectives

The strategic objectives that should be considered for the possible application of non-nuclear forces are the same ones for which the use of nuclear weapons is now contemplated. The possibilities can be framed by first considering the two extremes in destructiveness currently associated with the application of nuclear weapons – what have come to be known as 'assured destruction' and 'limited strategic' operations.

Can non-nuclear strategic forces be configured to destroy an entire society by destroying most of its cities? Probably not. The weight of non-nuclear munitions required to destroy a large city, even if the munitions are sophisticated and precisely placed, is still very large indeed; at least hundreds of tons, and more probably thousands of tons, per

city would be required. The cost of destroying tens or hundreds of cities would be prohibitive, just in terms of transporting the munitions to the targets, unless the task could be spread out over a long period of time, as it was in the city bombings of World War II. Then, however, the pace of destruction is likely to be so slow (e.g., one or two cities destroyed per day in World War II) that the damage to society can be isolated and repaired sufficiently to permit that society to continue to function. While the total damage done to German cities and industry by strategic bombing in World War II was tremendous, it was accomplished at a pace insufficient to destroy the German society or its war production.

But the destruction of cities would be a poor choice of strategic objective to pursue by means of non-nuclear weapons – even if they were adequate to the task. First, while cities will remain the most important political hostages in a strategic conflict, they are also less and less able to contribute as the sources of power – military, economic, or political – for waging that conflict, so that cities are likely to be the last, rather than the first, targets in any strategic conflict. City destruction, therefore, would apply non-nuclear strategic forces at exactly the wrong end of the escalation ladder.

Second, flattening or burning entire cities is something that nuclear weapons do very efficiently – in fact that is the only capability that they have so far demonstrated in conflict. In this role they are perceived to be so efficient that only a few hundred, and certainly not thousands, are required to credibly threaten the destruction of a society, and non-nuclear weapons would find it hard to do something which nuclear weapons do very easily. On the other hand, although assured destruction figures prominently in the Western rationale for strategic nuclear forces, urban and industrial targeting may in fact account for only 10–15% of the total US requirements for strategic nuclear weapons.³⁶

At the other extreme of destructiveness, limited strategic operations (small, spoiling attacks on critical assets), the possibility of non-nuclear forces competing with nuclear weapons seems more favourable. Many of the

specialized facilities for military command and control, space operations, early warning, and long-range communications are vulnerable to a relatively few, precisely-delivered munitions. Similar opportunities exist within complex civil systems, such as at the nodes in power grids, communications networks and transportation links and there are some critical industries that might be severely disrupted by attacks on just a few targets - the 'panacea' targets.³⁷ Even large industrial facilities can be disrupted by a few hits at their power sources, rail links or fuel supplies.

These sensitive assets, like cities, number only in the hundreds and thus make only modest demands on the total strategic force requirements.³⁸ While some 'panacea' targets may be excellent candidates for non-nuclear strikes, the forces required - whether nuclear or non-nuclear - will continue to be relatively small. What makes limited strategic operations an attractive application for non-nuclear forces is the perception that such operations are the lowest rungs of the strategic escalation ladder and, therefore, the most desirable place for non-nuclear options.

However, the most interesting and challenging objective for non-nuclear weapons are to be found in the destruction of the military facilities and equipment that comprise the arms of modern conflict - what are now often called the counterforce and counter-military targets. These include the nuclear and conventional forces and the bases that support them, and they consist of ships, aircraft, missiles, ground vehicles, runways, barracks, bunkers and depots - all the artefacts associated with a modern military establishment.

Because these targets represent the military forces-in-being, they increasingly constitute the critical source of power in possible fast-paced strategic conflicts. And, because they are numerous and so many are distributed and hardened against attack, they generate most of the present nuclear force requirements. There are nearly 6,000 such targets in the Soviet Union, half of which are considered sufficiently hardened to require two nuclear weapons to ensure their destruction. (The need for two weapons is derived largely

from current ballistic missile delivery accuracies, which in turn reflect the use of all-inertial guidance systems. The resulting yield/accuracy combinations frequently make the probability of destroying a hardened target closer to one half than to unity, so that two nuclear weapons per target are needed if high confidence of destruction is demanded.) Counterforce targets may account for 85-90% of the current US requirements for nuclear weapons.³⁹ Some of them may be the strategic targets most susceptible or vulnerable to non-nuclear strikes.

It is these targets - numbering in the thousands and lying at the very centre of strategic power - that are crucial to the future of non-nuclear strategic weapons. If they can be attacked with economically feasible non-nuclear forces, then the prospect for these new weapons will not be limited to feats of technological virtuosity at the threshold of nuclear war. Rather, they will be destined to replace the bulk of nuclear weapons and become the pivotal military forces of the future.

Forces

For the application of nuclear weapons, military targets are conveniently divided into two categories:

- 'Hard' targets - such as missile silos, weapons storage sites, command bunkers, etc. - most of which are treated as point targets for nuclear weapons effects.⁴⁰
- 'Soft' targets - such as barracks, depots, air defences, etc. - some of which are treated as area targets for nuclear weapons effects.⁴¹

Because most of the former are compact, they make attractive targets for precision attacks. For example, it may be technically feasible to destroy a missile inside its hardened silo by directing a shaped-charge explosive or hypervelocity projectile against the silo door. Precise non-nuclear attacks against the doors of weapons storage or command bunkers may be more effective than a near miss by a nuclear weapon.

Theoretically, of course, several thousand hardened targets, such as missile silos, can be

attacked with a reasonably-sized force of nuclear strategic delivery vehicles - at least, that is the assumption which underlies the classical analyses of missile duels. Several hundred large ballistic missiles with multiple, independently-targeted warheads have been proposed as adequate, even if several warheads are required for each target because of unreliabilities and inaccuracies.⁴² If each missile carries sufficient nuclear weapons to attack three or more targets, then hundreds of missiles can strike thousands of targets. The same is true of bomber forces using stand-off missiles to deliver nuclear weapons on ballistic or cruise trajectories. Bomber loads of up to 20 such missiles can be carried.⁴³ Enough for a few hundred bombers to attack several thousand targets - twice over, if necessary.

If those same several thousand hard targets had to be attacked effectively without nuclear weapons, would a very much larger number of delivery vehicles be required? The answer is crucial but not obvious. If the non-nuclear forces needed were ten or a hundred times larger than the requisite nuclear forces, they would be prohibitively expensive. But if they were only two or four times larger, they might be affordable - and might therefore offer an attractive alternative to initiating escalation to the use of nuclear weapons. Short of designing the required forces, what can be inferred about the relative size of a non-nuclear force to attack several thousand hard targets?

Tactical PGM designed to penetrate armoured targets vary in weight from a few kilograms for the tube-launched to a few hundred kilograms for the air-launched.⁴⁴ Such weights would seem to be generally quite comparable to those of nuclear weapons.⁴⁵ Of course, the major difference between the two lies not in their weights, but in their destructive power or explosive yield. A non-nuclear PGM must be delivered precisely to its target in order to destroy while a nuclear weapon need only be delivered within a few hundred metres of its target to produce the desired result. Delivering a non-nuclear munition by means of a cruise missile or a ballistic missile re-entry vehicle equipped with the additional sensors and communications needed to effect its precision

delivery might add considerable weight, but an increase of much more than a factor of two or three would seem excessive. Certainly an increase by a factor of ten should not be required.⁴⁶

Is building a force of strategic delivery vehicles with two or three times more payload technically and economically feasible? Doubling or tripling the delivery capabilities of ICBM or bomber forces sounds like an awe-inspiring prospect. It is surprising for some to learn that the delivery capabilities of the two super-powers' ICBM and long-range bomber forces differ by multiples of more than four (see Tables 1 and 2 on the following page).

Increasing the capacity of an ICBM or bomber force two, three or even four times in order to carry non-nuclear weapons against a significant strategic objective would therefore not lie outside recent experience of force build-ups or asymmetries in force compositions. The additional delivery capability required to execute a comprehensive non-nuclear attack upon the hardened targets of the super-powers is probably only several times larger than the existing strategic nuclear forces - measured in terms of their total throw-weight or payload.

As for the softer area targets, such as military depots, barracks and air defences, it may well turn out that these are more difficult to destroy with non-nuclear systems than hardened point targets. The weapon selection and design for the attack of area targets is, for some reason, less obvious than putting a shaped-charge explosive at the centre of a silo door, and the design of suitable systems is necessarily beyond the scope of this Paper. However, it is at least conceivable that such targets could be attacked without nuclear weapons. Much of the current developmental efforts for improved non-nuclear tactical weapons, such as the *Assault Breaker* concept, are specifically oriented towards this goal. Moreover, many of these targets - such as armoured vehicles and ships - can be attacked without great time-urgency in a strategic conflict. Given prior suppression of air defences, perhaps with non-nuclear wea-

Table 1: Comparison of ICBM Throw-weights

Nation	Missile type	Throw-weight per missile (000 lb)		Total throw-weight (000 lb)
		Number	Weight	
United States	Titan II	52	7.5	390
	Minuteman II	450	1.5	675
	Minuteman III	550	2.0	1,100
Soviet Union	SS-11	580	2.0	1,160
	SS-13	60	1.0	60
	SS-17	150	6.0	900
	SS-18	308	16.7	5,144
	SS-19	300	7.5	2,250
Ratio of Soviet/US ICBM throw-weights:				9,514
				9,514/2,165 = 4.39

Table 2: Comparison of Long-range Bomber Payloads

Nation	Bomber type	Number	Payload per aircraft (000 lb)	
			Number	Total payload (000 lb)
United States	B-52D	75	60	4,500
	B-52G	151	70	10,570
	B052H	90	70	6,300
				21,370
Soviet Union	Tu-95 Bear	105	40	4,200
	Mya-4 Bison	45	20	900
				5,100
Ratio of US/Soviet bomber payloads:				21,370/5,100 = 4.19

SOURCE: *The Military Balance 1981-1982* (London: IISS, 1981, pp. 104-5. Where a range of throw-weights is given, the highest figure has been used.

pons delivered by ballistic missiles, the less time-urgent military targets might be subjected to repeated attacks by conventionally-armed aircraft or cruise missiles.

If the several thousand hardened targets on each side could be attacked successfully without nuclear weapons, by using forces about two or three times larger than the US bomber force or the Soviet heavy ICBM force, then it does not seem unreasonable to suppose that the several thousand other, softer military targets might also be threatened with comparable additional forces. The cost of such additions might be reckoned as a substantial fraction of the cost of current strategic forces, but it should be remembered that current strategic forces represent only quite a small fraction of the cost (around 10%) of the total military forces maintained by both super-powers.

Moreover, there may be some savings from non-nuclear strategic forces as compared to their nuclear counterparts. For example, non-nuclear weapons, like PGM, should be less expensive, even with their sophisticated guidance and communications systems, than nuclear warheads. And the security required to protect non-nuclear weapons should be

Should a President, in the event of a nuclear attack, be left with the single option of ordering the mass destruction of enemy civilians, in the face of the certainty that it would be followed by the mass slaughter of Americans?⁷⁷

This became the principal public rationale for the US development of capabilities for limited nuclear options in the 1970s.

Countermeasures

If such non-nuclear forces could be afforded, might they not be easily countered by a variety of defensive measures? Non-nuclear weapons, unlike their nuclear counterparts, will depend upon precision delivery and terminal homing to ensure that their much more modest destructive power is brought fully to bear on the target. Such precision delivery will necessarily rely upon sensors which are subject to familiar countermeasures, including jamming, decoying and masking. Moreover, focused weapons can be defeated by equally focused defences. (For example, shaped charges can be defeated by forcing them to be activated prematurely by an extra layer of sacrificial armour placed on the outside of the intended target.) If non-nuclear weapons require precise placement at some critical point or aspect of a target, then only that point or aspect needs such additional protection to defeat the attack. If communications are required between elements of the weapon system - to enable remote designation of individual targets for example - then those, too, are subject to jamming or signal exploitation.

All of these features of non-nuclear weapon systems would seem to make them more vulnerable to countermeasures than the blind brute force of nuclear weapons. Defences which seem near-hopeless against nuclear weapons, such as ballistic missile defences for soft targets, would take on a new life against non-nuclear strategic weapons. Could any reliance be placed upon strategic forces which are more vulnerable to a much broader array of countermeasures?

There are two issues here. How vulnerable, relatively, are non-nuclear strategic weapons to countermeasures? And is that degree of

vulnerability tolerable? The first issue cannot be resolved precisely, if ever, in advance of the design of such weapons. Non-nuclear strategic weapons will almost certainly be more susceptible to countermeasures, and perhaps also more vulnerable to pre-emptive counterforce strikes, but there is no reason to suppose that countermeasures against non-nuclear weapons must simply be accepted without responses.

Communications links can be made very difficult to jam by the choice of frequencies, frequency hopping, multiplex techniques and the design of antennae. Multiple sensors can look simultaneously in various parts of the electromagnetic spectrum, and their information can be processed with 'smart' algorithms to see through efforts at concealment and deception. Building microchip 'intelligence' into even the smallest of weapons or projectiles, so that they may respond actively and instantaneously to changing circumstances, is no longer either technically difficult or expensive.

Multi-staged charges can be designed to defeat layered armour. Non-nuclear defence suppression and saturation weapons, for use against both air and ballistic missile defences, might enjoy renewed attention. All this is the familiar game of measure and countermeasure - a game played at a cost in money, confidence and continued vigilance for both attacker and defender. Whether the cost ratio favour the attacker or defender is not clear at this point, but they will probably change to and fro with time, targets and technology.

Some reflection on the endless interaction of countermeasures suggests that, whether the weapons are nuclear or not, there is no fundamental difference in the nature of the interaction. The tremendous force of nuclear weapons changes the scale but not the nature of the interaction. It is almost certain to become more subtle and dynamic without nuclear weapons, but countermeasures and responses to those countermeasures will continue for all forms of combat. Thus, while non-nuclear strategic weapons seem destined to be more vulnerable to countermeasures than their nuclear predecessors, it is not apparent that they will always be significantly or unacceptably so. Erik Klippenberg,

Erik Klippenberg

in discussing the prospects for new weapons technologies, observed:

The threat of countermeasures in the broadest sense of the word, however, should not lead us to believe that the effectiveness of new and very accurate weapons will be completely nullified. Under special circumstances and for a short period this may happen to a small number of weapon systems. But there is no reason why we should let it happen to the majority of our systems.⁴⁸

In sum, there would appear to be the increasing possibility that the entire spectrum of

military targets in a strategic conflict could be attacked without resort to nuclear weapons. The technical means are available even now, and the economic demands of the requisite forces, while substantial (and certainly higher than for nuclear weapons), do not appear to be prohibitive. While the advance in related technologies can only improve upon this possibility with time, it is still not clear that the appearance of such capabilities will be actively sought or actively limited, nor how or why they will ultimately be presented for choice. For a better grasp of these issues, it is important to examine the possible rationales for the development, possession and use of these non-nuclear strategic weapons.

IV. RATIONALES

During the next decade, then, highly accurate delivery vehicles armed with specialized warheads are likely to be used to supplant nuclear weapons in many tactical roles and, more importantly, might be deployed to perform 'strategic' missions against military command centers, vulnerable economic assets, and high-value civilian targets.⁴⁹

If non-nuclear strategic weapons are increasingly likely to be technically feasible and militarily significant, what do they portend for the future? How will they emerge? And how will they change the world into which they emerge? To understand the impact of non-nuclear strategic weapons upon the future - whether or not they are ever used in that future - it is necessary to have concepts for how they might be used in conflict and how they might evolve, and these concepts must be consistent with several important realities about the existence, present and future, of nuclear weapons.

First, nuclear weapons are, and will remain, unique in their credibility as a threat to destroy entire cities and societies in a single attack. Because of that unique quality, they will also remain the most potent political instruments and national symbols of power. The advent of non-nuclear strategic weapons will not, therefore, eliminate the

apons being used separately and together in various phases or for various purposes. For example, NATO has traditionally assumed an 'initial conventional defence' phase for a war in Europe. For that same war, the Soviet Union is frequently assumed to have the forces and plans for conventional strikes against NATO theatre nuclear forces. Is it, therefore, any less rational to contemplate initial strategic strikes with non-nuclear weapons, even against strategic nuclear forces?

However, the rationality of initial strategic strikes with non-nuclear weapons is more likely to be challenged because of what appears, on the surface, to be a very simple and sufficient response to them. A nuclear-armed opponent could simply refuse to cooperate in a contest of technological surgery on each other's sources of power. Since the side confronted with sophisticated non-nuclear weapons could decline to play by the same rules, the non-nuclear capabilities suggested here could always be countered with a nuclear response.

Obviously, it takes the co-operation of both sides to a conflict to avoid resort to nuclear weapons. It may not be immediately obvious why the Soviet Union should feel threatened by, or even respond to, the Western development of non-nuclear strategic capabilities. It would not be uncharacteristic for her to take the position that any such schemes to wage aggressive war against the Soviet homeland - no matter how technically sophisticated - would be countered immediately by a massive nuclear strike. The Soviet Union could certainly threaten that the use of even a single non-nuclear weapon against her strategic forces would evoke a nuclear response. What, then, would such sophisticated non-nuclear capabilities have accomplished?

In a world with nuclear weapons, nothing can insure against a nuclear response to any provocation, and the threat of nuclear attack has been a constant feature of the security relationship since 1945. It is important to remember that even a successful conventional defence of Europe could invoke a nuclear response; so could any other conflict directly or indirectly involving the interests

of the nuclear-armed states. The use of non-nuclear strategic strike capabilities may or may not be more likely to invoke a nuclear response than other non-nuclear forms of conflict; but it would certainly be more likely to invoke this response than a strategic strike with nuclear weapons.

[The advent of non-nuclear strategic weapons] doesn't mean, of course, that there's any way of being certain an adversary will not start a nuclear war, including a suicidal one. We can, however, choose our wartime as well as our pre-war strategies so as to keep his stake in avoiding a nuclear response large, and so as to make as plain as possible [both] the limits that we intend to observe and are observing, and our ability to deal at a non-nuclear level with a wide variety of military and industrial targets.⁵⁰

The most important incentive for the development of non-nuclear strategic weapons springs from the presumption (stated in Chapter I) of a growing reluctance to use nuclear weapons. If that presumption is incorrect, then not only are non-nuclear weapons easily countered by a nuclear response, but the principal incentive for their development also disappears. On the other hand, if the presumption is correct, then the incentive for their development will exist and a nuclear response to their use will be an awesome and uncomfortable step.

Granted, then, a reluctance to respond with nuclear weapons, how would the side being attacked know that an incoming strategic attack was non-nuclear? It may not be possible to distinguish between an initial strategic attack with nuclear and one with non-nuclear weapons until after it is over. Would the defender wait to find out? Could he afford to wait? There can be no certain answers. But these may be the wrong questions.

Today, in the absence of any significant non-nuclear strategic offensive capabilities, there is not much doubt that any strategic attack would be nuclear. Yet there remains considerable doubt whether the defender would elect to launch a nuclear counter-

attack without waiting for the incoming attack to arrive. Launching a nuclear retaliatory strike on the basis of perceived warning rather than sustained injury has always been a disputed and problematical choice. In a future world where an adversary was known to have considerable non-nuclear strategic capabilities, that doubt can only increase. If the attack *might* be non-nuclear, then in the face of that doubt the defender would be no more likely than he is today to initiate nuclear war.

The question is not whether non-nuclear strategic capabilities could be countered by nuclear capabilities. Of course they could. Rather, the question is: would their use be less escalatory or conducive to a nuclear response than the use of nuclear strategic capabilities? The value of non-nuclear strategic capabilities would not be the certain avoidance of nuclear war, but the enhanced prospect of not having to be the first to use nuclear weapons. If both sides in a potential conflict pursued such capabilities for that reason, then the prospects for avoiding nuclear war might be substantially better than they are today.

Concepts of Strategic Conflict

Even after the initial use of nuclear weapons, it is still possible and rational to consider the use of non-nuclear weapons, depending upon the objectives and the concerns that attend them. Concepts of theatre conflict in Europe do not ignore the role of conventional forces after the first use of nuclear weapons. Perceptions of Soviet strategy for a European war have long included the notion of nuclear strikes for shock, and conventional forces for exploitation. Strategic defensive operations – for air defence or anti-submarine warfare – are expected to continue to use non-nuclear weapons even after nuclear war has commenced, simply because they are more effective than their nuclear counterparts where collateral effects are of concern.

Are non-nuclear weapons for strategic offensive operations possible or rational once nuclear weapons have been used? It would seem so, wherever collateral damage is of concern. That collateral damage *should* always be of concern, there is little doubt.⁵¹

but whether it *will* be of concern, once the first nuclear weapon has been used, is obviously disputable, judging from the current debates about nuclear weapons. If one is *certain* that the initial use of nuclear weapons will result in rapid escalation to the destruction of entire societies, then concerns for collateral damage in the pursuit of military targets are, curiously, both the least and most of one's worries.

On the other hand, if one conceives that the initial use of nuclear weapons is just as likely to trigger desperate efforts on both sides of a conflict to prevent further escalation, then concerns for collateral damage could become paramount. At that hypothetical juncture, the continued pursuit of essential strategic objectives without unnecessary damage could very well lead to non-nuclear weapons being used at the same time as, or even after, nuclear weapons. A remote military installation might be struck with a nuclear weapon, while another inside a city might be attacked with some kind of non-nuclear device. After a frightening initial exchange of nuclear weapons, the continuing use of non-nuclear strategic forces might signal a willingness to de-escalate the conflict, but not to abandon the ability to pursue vital strategic objectives.

Thus it would seem both possible and rational to think of non-nuclear strategic offensive weapons existing alongside nuclear weapons. Whether they would be usable only before the initial use of nuclear weapons, or could be employed during and after nuclear exchanges, depends upon how one views the certainty of escalation, and hence the outcome of all nuclear wars. The greater the uncertainty of escalation and outcomes, the more rational the co-existence of nuclear and non-nuclear strategic weapons would seem to be.

Effects on Nuclear Arsenals

If nuclear and non-nuclear strategic weapons were to coexist, what changes should be expected in the nuclear arsenals? The answer depends upon how much of the spectrum of strategic objectives can be pursued effectively with non-nuclear weapons. If they are restricted to a few specialized targets among those now con-

sidered suitable for limited strategic operations, then the effect upon present strategic nuclear forces would be minimal – perhaps no more than a relaxing of some of the current efforts to adapt nuclear weapons to such targets by making them more flexible in their targeting and the collateral damage they inflict more controllable.

It is more challenging to speculate what might happen if strategic conventional weapons were to prove themselves capable of a much larger role in strategic conflict. If it became possible to strike effectively at the full range of strategic military targets without using nuclear weapons, the effect upon strategic nuclear arsenals might be profound. First, it could become evident to many, and not just to those pressing the current debates about nuclear arms, that strategic nuclear weapons are really needed *only* to threaten the destruction of cities and societies. At the limit, nuclear weapons would no longer be required for military purposes in a strategic conflict. The enormous arsenals of strategic nuclear weapons now possessed by the two super-powers could no longer be justified by the ambiguities of some military purposes, such as counterforce or countermilitary campaigns or flexible or limited responses. They would finally be revealed for what many have always held them to be – destroyers of societies and national symbols of political power.⁵²

In that event, one could expect increasing public pressure for substantial reductions in the super-power arsenals of strategic nuclear weapons. There might then be a much stronger tendency for one or both super-powers to move towards the so-called minimum deterrence postures in which their nuclear weapons could be numbered in hundreds rather than thousands. Redundant, high-confidence capability to threaten the destruction of any modern society probably does not require much more than a few hundred modern ballistic missiles, diversely based for concealment and protection. That suggests the possibility of a world markedly different from the one that exists today. Yet while some, perhaps many, might welcome such a world of greatly reduced nuclear arsenals, caution is clearly warranted.

First, the effort to supplant most strategic nuclear arms by non-nuclear replacements, like the similar substitution now being proposed for theatre nuclear forces, is almost certain to involve higher costs.⁵³ If this were to double or treble the costs of strategic forces, there might be great anguish among those who desire both, but have not been forced to choose between, reducing nuclear armaments and reducing arms expenditures.

Second, nuclear arms have become premier symbols of national power. The super-powers are distinguished in the eyes of many by their enormous arsenals of nuclear weapons. Would these symbols be easily relinquished, even if they were no longer absolutely required for attacks on military targets? If the so-called minimum deterrence postures were adequate even for the super-powers, how different would their nuclear arsenals then be from those of Britain or France, which have been forced by economic necessity to adopt what amount to minimum deterrence postures for their strategic forces?⁵⁴

Third, the transition to a world of significantly reduced nuclear arsenals for the super-powers, could be a very unstable process. Getting from here to there might be so obviously dangerous that the shift might never be sought by – only forced upon – one or both of the super-powers. These dangers – and how they might be brought about or avoided – can be perceived by contemplating some of the ways in which non-nuclear strategic weapons could evolve in the decades ahead.

Concepts for Development

If non-nuclear strategic offensive forces are technically feasible today and hold some potential for being militarily effective, why is their development not being pursued now? Several reasons have already been suggested:

- Their technical feasibility and significance are not yet widely appreciated;
- Their military utility or desirability are not yet clearly established;
- They will threaten the existing order of things ranging from bureaucratic organizations to the symbols of national power; and

- They will probably cost more, initially and significantly, than their nuclear counter-parts.

These impediments may not be overcome quickly or easily but two opposing aspects bear watching. First, the current development of non-nuclear theatre and battlefield weapons, not at all unlike those suggested here, continues apace. New 'smart' munitions for delivery with ballistic and cruise missiles will demonstrate the integration of the required technologies and broaden the appreciation of the targets that can be attacked effectively without resort to nuclear weapons. When it becomes evident that hardened and dispersed targets can be attacked remotely - from tens or hundreds of kilometres away - with 'conventional' weapons, then doing the same thing over thousands of kilometres will quickly become obvious.

Second, the weapons and aerospace industries will be alert to the technical capabilities and the economic opportunities embodied in the development of non-nuclear strategic forces. If the role of such forces is seen as being limited, say, to a few critical targets at the initial stages of a strategic conflict, then the economic opportunities for these industries will be small and will attract little attention. But if such forces could be large, as large or larger than current strategic nuclear forces, then the size of the market will invite intense interest, competition and even promotion by these industries, and such efforts have resulted historically in the generation of political advocacy for the development of weapons systems.

Given these opposing aspects, how might the development of non-nuclear strategic offensive forces occur? Scenario writing is always a risky enterprise but the following path seems reasonable. Over the next decade, the development and deployment of new non-nuclear battlefield and theatre weapons will continue, and perhaps accelerate, wherever they are fortuitously successful or attractive. As a broader set of targets beyond the battlefield is brought under the shadow of these weapons, extensions in weapon system ranges will be sought to expand their target coverage.

At that point the possibility of extending their range to intercontinental distances will become apparent. Initially the force ambitions might be modest - just enough to attack certain critical targets in a limited strategic operation, or perhaps to strike time-urgent targets while projecting forces into a third area.⁵⁵ However, the critical juncture in the development of non-nuclear strategic weapons will come when ambitions reach out to encompass the numerous hard targets currently associated with strategic nuclear forces. The required non-nuclear forces will be large and will have profound implications for existing nuclear arsenals.

As noted in Chapter III, the lion's share of the US requirements for strategic nuclear weapons lies with the hardened targets. Even though the numbers of hard and soft military targets are comparable, the number of nuclear weapons required for hard targets is currently about double that needed for soft targets, because the weapon accuracy and yield combinations available to the US do not yet provide for target destruction with high confidence.⁵⁶ Thus more than half of US strategic nuclear weapons might be most easily or obviously supplanted by non-nuclear capabilities for hardened point targets. If so, the remainder of the requirements for soft military and other critical targets might appear as a challenging residual nuclear mission, to be eliminated as quickly as technology and ingenuity will permit.

However, the attainment of hard target kill capabilities is likely to be resisted, because they are widely viewed as destabilizing - they constitute a threat to disarm or gain significant advantage over an opponent, if used first. Non-nuclear weapons with hard target kill capabilities could be used first to attack their nuclear counterparts and thereby gain an advantage for subsequent attacks upon other military targets. In that sense, they would indeed be destabilizing.

Yet they will not really threaten the capability of the super-powers to destroy each other's societies with nuclear weapons. The presumptions here are that the super-powers' capabilities for societal destruction are now assured well beyond any hard target kill or counterforce threats that might be posed -

nuclear or non-nuclear. Hence, the great - and growing - reluctance to use nuclear weapons against a comparably armed opponent. These premises may not be correct, but they are essential to this forecast of the increasing importance of non-nuclear strategic capabilities. If those premises are wrong, so is the thesis of the Paper. Today, a strategic campaign against hard targets can be a threat to super-power fighting capabilities, but not to their capabilities for assured destruction. The threat of a splendid disarming first strike is long past for the super-powers.

Moreover, the non-nuclear threat to nuclear weapons may only be temporary. At the same time that many nuclear weapons will become vulnerable to non-nuclear attack, they will also become increasingly redundant, as non-nuclear equivalents are introduced. While the transition in dependency from nuclear to non-nuclear weapons for strategic conflicts seems likely to be fraught with instabilities, the first strike stability for nuclear weapons may ultimately improve. There may not be any choice as to whether there will or will not be hard target kill or counterforce capabilities in the world, but there may be a choice as to whether they take the form of nuclear or non-nuclear weapons.

Unfortunately, the development of non-nuclear means for strategic conflict is not likely to be balanced between the super-powers; such evolutions are seldom symmetrical. If one side possesses growing capabilities to fight a strategic conflict without nuclear weapons, the other will be forced to rely upon the threat of a nuclear response to any use of those capabilities. Furthermore, if one side must retain a large arsenal of nuclear weapons to offset the emergence of non-nuclear capabilities in the hands of the other, might not both sides just as well retain their nuclear arsenals? Hence there may be

great reluctance to reduce the inventories of strategic nuclear forces until both sides have acquired, and feel secure with, their non-nuclear capabilities.

Yet the side which first acquires a secure capability to fight a strategic conflict without nuclear weapons may find itself in a superior political position to make proposals or take unilateral actions for major reductions in strategic nuclear forces.⁵⁷ The development of non-nuclear strategic weapons may therefore be seen by some as a technological avenue for political leadership in arms control and nuclear disarmament.

These arguments and concerns about the development, possession and use of non-nuclear strategic weapons indicate that they are certainly possible and possibly rational. But the arguments are not sufficiently one-sided to prove whether or not the weapons are desirable. It is likely that the question of desirability will not be resolved, just as the desirability of nuclear weapons has never been resolved. The desirability of nuclear arms will always be difficult to judge so long as nuclear arms are seen by so many as fulfilling different purposes. Nuclear arms are sought for political and military reasons, for deterrence and warfighting aims, for civil and military targets, for offensive and defensive operations, for countervalue and counterforce missions. Given so many different functions for nuclear weapons, it is not surprising to find in the current debates so many different prescriptions for the kinds and amounts of nuclear weapons desired or required. It seems likely that these new weapons, like those they are destined to supplant, will simply come to exist. As they emerge, their good and evil properties will be debated, with most of the arguments, like those over nuclear weapons, being rooted in fundamentally different perceptions of mankind and the roles of social institutions.

V. POLICY IMPLICATIONS

family of multipurpose systems which may not only be non-nuclear, capitalizing on new force technologies, but also non-exotic, using old weaponry ideas in newer

Weapons soon available will no longer fall into the 'old' categories - strategic offensive, conventional defensive, and the like. We can expect the emergence of a whole

indirect effects upon the nuclear arsenals of the super-powers. To the extent that non-nuclear weapons can undermine the rationale for very large numbers of nuclear weapons, the former can be used as instruments to control the latter, although those instruments may very well be a nightmare within the current forms or processes of arms control. Thus, a logical starting point is to look for the effects of non-nuclear strategic capabilities on the overall objectives or purposes of nuclear arms control.

For the control of nuclear arms, there are three fundamental policy questions:

- How can the likelihood of nuclear war be reduced?
- How can the consequences of nuclear war, if it should occur, be reduced?
- How can the economic burdens of nuclear arms be reduced?

There is a tension between the first two questions in modern deterrence theory. Efforts to reduce the consequences of horror of nuclear war can make nuclear war appear more tolerable and therefore can reduce the inhibitions against starting such a war. One way to reduce the likelihood of nuclear war (i.e., to deter it) is to increase its consequences by making it more horrible to contemplate.

That same tension exists between the risks and consequences of conflicts if non-nuclear means are substituted for nuclear means.

In one instance, the worry is about the risk of precipitating war, while in the other it is the worry of excessive consequences in the event of war. Both of these concerns - risks and consequences - are reflected in US efforts at strategic arms control: by controlling both the size and the kinds of forces, we hope to reduce both the risks and consequences of nuclear war. Unfortunately, the risks and consequences of nuclear war may be inversely (or perversely) related to the risks and consequences of conventional wars...

It can be argued that the relatively higher risks of conventional conflict are, to some

degree, kept in check by the shadow of very much higher consequences at the nuclear end of the conflict spectrum. By reducing the perceived risks or consequences of nuclear conflict, we may be unintentionally increasing the risk of conventional conflicts. Trading nuclear war for conventional war would be a tempting bargain except for escalation. If we allow the risks of conventional conflicts to increase by making nuclear conflict less credible, then through the backdoor of escalation, the net effect may be perverse: it may ultimately increase the risks of nuclear conflict.⁵⁹

Two questions are posed here. Will the advent of non-nuclear strategic capabilities reduce the consequences of nuclear conflict? And will it increase the risks of non-nuclear conflict, thereby increasing the risks of nuclear conflict via escalation?

If a few hundred nuclear weapons are sufficient to destroy a modern society, then the worst or most awesome consequences of nuclear war cannot be significantly reduced unless nuclear weapons are virtually eliminated. As argued here, the advent of non-nuclear capabilities would offer no prospects for the elimination of nuclear weapons, nor even their replacement in the ultimate threat to destroy cities. Thus, the consequences of full-scale nuclear war, at least in the contemplation of societal destruction, are not likely to change because of emerging capabilities for non-nuclear strategic conflict.

However, if non-nuclear strategic capabilities permit significant reductions in the large numbers of nuclear weapons which are now justified by and aimed at military targets, the global consequences of nuclear war may be much reduced. Several hundred nuclear weapons may indeed be sufficient to destroy a modern society, but if several thousand are used against the military targets within that same society, the difference in the global damage to the environment could be significant.⁶⁰

Nonetheless, even if the advent of non-nuclear strategic capabilities might make the consequences of strategic conflict appear less awesome, they might greatly increase the

risks of such conflict - perhaps starting with non-nuclear weapons, but escalating to the use of nuclear weapons. An opposing view holds that the clearer the escalatory path to nuclear warfare, the more nuclear deterrence extends down that path.

The risk of nuclear war can only be emphasized credibly when one can demonstrate how the initial stages of the escalatory process might take place. . . . One cannot have the ostensible benefit of a nuclear threat [or deterrence] without running its risks.⁶¹

The use of non-nuclear strategic weapons could - perhaps should - mark a stage much closer to the initiation of strategic nuclear warfare than the use of conventional battlefield or theatre weapons. Their use could signify - more clearly than any other form of conflict below nuclear war - the escalatory path to the credible use of nuclear weapons. The targets and the delivery vehicles involved in non-nuclear weapons use might very well be the same as those for nuclear weapons, and the last remaining escalatory step would simply be to increase by several orders of magnitude the scale and the indiscriminate nature of the destruction.

This additional step in the escalation ladder would have two effects. First, it would lower or fill in the so-called nuclear threshold - bridging or closing the large chasms that now exist between conventional and nuclear warfare and between theatre and strategic conflicts. Second, it would extend strategic nuclear deterrence farther down the escalation ladder - making the escalation to strategic nuclear warfare from lesser levels of conflict much more apparent. The attractiveness or otherwise of these two effects depends upon whether one is more concerned about deterring nuclear war or about deterring lesser wars that might or might not escalate to the nuclear level. Both views are evident in the current debates about nuclear arms and their control.

The advent of non-nuclear strategic weapons might make lower ceilings on nuclear strategic weapons less difficult to achieve, but they are likely to make a

multipurpose, imaginative ways with fairly exotic delivery modes. These new weapons, difficult to characterize as to purpose, will have difficulty 'fitting in' with the traditional political constraints of arms control dialogues and will suggest whole new political and conceptual frameworks with which the international community must come to grips.⁵⁸

Some judgments about the desirability of possessing or developing non-nuclear weapons will be based upon their implications for international security policies. At least three important international policy areas may be affected by the advent of significant capabilities for non-nuclear strategic conflict:

- Negotiations and agreements for the control of strategic arms;
- Alliance agreements for the deployment and planned use of theatre and strategic forces, both nuclear and non-nuclear; and
- Policies or agreements to limit or control the proliferation of weapons or their technology.

While inevitably inter-related, each of these three is addressed separately below. Together, they represent those areas of international security policy-making which will be most directly affected and facilitated by early decisions about new weapons developments or deployments. Some examples of successful early (pre-emptive) decisions might include the SALT I agreement to control anti-ballistic missile (ABM) defences, the NATO agreement to deploy cruise missiles, and the Nuclear Non-Proliferation Treaty (NPT). The failures might perhaps include the lost chance to control multiple independently-targeted re-entry vehicles (MIRV), the breakdown of agreements to deploy enhanced-radiation or reduced-blast nuclear weapons (neutron warheads), and the loss of control over weapons in space.

Strategic Arms-control Policies

The most important arms-control implications of non-nuclear strategic weapons will probably be found not so much in direct efforts to control or limit them as in their

of US or Soviet strategic nuclear forces be any greater than those of France or Britain, whose forces have been designed primarily for the threat of societal destruction? If non-nuclear strategic capabilities are sufficient to displace some, or even most, strategic nuclear forces of the super-powers, they will proportionately reduce the weight and influence of the super-powers in their alliances, at least insofar as that weight and influence depends upon their very large strategic nuclear forces deter to a regional conflict.

Thus, if non-nuclear strategic capabilities would increase the probability of earlier US strategic involvement in a European conflict - i.e. before Europe is turned into a nuclear battlefield - one of the principal values of that involvement would no longer rest, as it does now, on invoking US strategic nuclear capabilities. Rather, if early US strategic involvement were to have any value, it would then rest on non-nuclear strategic capabilities, which might be used earlier than nuclear capabilities - and which might be much more widely shared (or shareable) within the Alliance than nuclear weapons. That, in turn, would give West Europeans much more control over escalation and their destinies.⁶² The net effect might be to weaken the Alliance, or at least those ties to the United States motivated by the concept of extended nuclear deterrence.

Some of the inherent tensions built into the NATO Alliance and its concepts of deterrence may become much more apparent and painful if such non-nuclear strategic capabilities should materialize. For example, the concept of extended nuclear deterrence for NATO by the coupling of US strategic nuclear forces to any European war has always contained a tension between declaratory policies and actual capabilities. The credibility of the threat to use US strategic nuclear forces in the event depends, at least to some extent, upon the development of evident capabilities for the use of nuclear weapons. In the past, that has involved capabilities for limited nuclear operations and escalation linkages with theatre and battlefield nuclear weapons. Understandably, such capabilities and the discussion of their use has been frightening to some West Europeans, among others, as signs

objectives in strategic conflict, then there would be a new, critical step below the nuclear threshold on the conceptual escalation ladder. Until now, scenarios involving strategic nuclear war between the super-powers have often been associated with the possible escalation of a conflict in Europe - from the use of conventional weapons to battlefield nuclear weapons, to theatre (intercontinental) nuclear weapons.

The existence of non-nuclear strategic capabilities would raise some interesting alternatives. Might not a conventional conflict in Europe draw the super-powers first into a non-nuclear strategic exchange, *before* escalation to the use of nuclear weapons in Europe? Or might not nuclear escalation in Europe be bypassed entirely, if the super-powers were already engaged in strategic strikes, albeit non-nuclear, upon their respective homelands? If, as seems likely, non-nuclear strategic weapons are preceded in their evolution by the appearance of non-nuclear theatre weapons, such abridgements of the escalation ladder are even more logical.

The prospect of avoiding nuclear conflict in Europe, while still coupling the strategic forces of the super-powers to any conflict in Europe, might at first seem attractive to some members of NATO. But for those members concerned more with deterrence of *any* conflict in Europe, the threat of non-nuclear strategic conflict may be less awesome, and thus less comforting, than the threat of all-out nuclear war between the super-powers. This is the same dilemma discussed earlier. What kind of conflict is of greatest concern and, therefore, most to be deterred? The answer depends not just on the perceived consequences of a conflict, but also on the relative likelihood of those consequences and who would suffer them.

The advent of non-nuclear strategic capabilities could sharpen some other tensions that now exist within the NATO Alliance. Suppose that non-nuclear strategic capabilities became adequate for *all* military targets, leaving societal destruction as the only justifiable role for strategic nuclear forces. Why then should the deterrent value

of saving money, reducing the probabilities of nuclear war, or reducing the consequences of nuclear war? The advent of non-nuclear strategic capabilities will cut across the grain of these objectives by reducing the probabilities and consequences of *nuclear* war, but at the risk of increasing the costs and opportunities for *strategic* conflicts (which might escalate to nuclear war). Some hard choices for arms control would appear to lie ahead in any case. These choices can be posed as devil's alternatives for arms control. Is it better to be faced with one chance in ten of killing ten million or one chance in a hundred of killing a hundred million? And, having chosen, what if the other choice is half as costly in terms of the burden of arms? These are the kind of unpleasant questions which become harder to avoid with the emergence of non-nuclear strategic capabilities.

Given these complexities, it seems likely that the introduction of non-nuclear strategic weapons will be both resisted and advocated by those concerned with the control of strategic arms. But if these new weapons include control through formal agreements - which seems quite possible - their introduction will probably be used as leverage in the public clamour for reductions in nuclear strategic arms. Perhaps that will be seen by some to be their greatest virtue during what could be a stormy and dangerous time ahead.

Alliance Policies

The regional alliances involving the super-powers are, of course, ultimately underwritten by their strategic nuclear forces. The concepts of extended deterrence and coupling, so evident in the dialogue among the members of the NATO Alliance, reflect concerns about the role of US strategic nuclear forces in deterring a conflict in Europe. To the extent that non-nuclear strategic capabilities could affect the acquisition and control of strategic nuclear arms, Alliance policies could also be affected.

How might the advent of non-nuclear strategic capabilities change the concepts or paradigms of war escalation and, therefore, Alliance policies? If nuclear weapons were no longer required for any (or most) military

mockery of current arms-control conventions for counting and verification. It is not at all apparent how one could ever be certain whether a missile or aircraft of intercontinental range was designed to carry nuclear or non-nuclear weapons. Of course, that sort of problem exists today for battlefield and theatre weapons - with respect to artillery pieces and fighter-bombers, for example - except that, for political more than military reasons, these weapons have not until now been of such great concern to Western arms controllers. That provides a clue to the eventual answer. Ultimately, nuclear weapons will have no utility beyond city destruction, and the small, secure forces required for that will not be of great concern for arms-control counting or verification. Of course, the path to that utopian day is neither straight nor smooth.

The introduction of non-nuclear strategic weapons could induce great instability in the quest for the newly-discovered capabilities for non-nuclear strategic conflict. As the role for nuclear arms shrinks, there could be a vigorous race to fill the vacuum with non-nuclear means for strategic conflict, in an effort to dominate any conflict at that critical stage just below the nuclear threshold. Would that race, if uncontrolled, go to the side possessing the advantage in technology, as the United States tends to see herself? Or might it go to the side capable of producing and fielding more military equipment, as the Soviet Union has demonstrated in her recent military build-up? Is it in our interests to control that race or to encourage it? Is the possibility of replacing some - even most, but not all - nuclear weapons worth the price of a costly conventional arms race?

In any event, there would seem to be little prospect for the advent of non-nuclear strategic capabilities to reduce the economic burden of arms. Rather the opposite. Being less efficient than nuclear weapons in the destruction of many targets, they are likely to be more numerous, complex and costly than their nuclear counterparts. Yet some of the inherent tensions in the several stated purposes of current nuclear arms-control efforts may become more starkly evident. Is nuclear arms control motivated more by the prospect

- only newly relevant. Perhaps the best way to prepare for the eventuality of non-nuclear strategic capabilities would be to ensure that current policies for nuclear arms are shifted on to much more explicit and rational foundations for today's realities, let alone tomorrow's possibilities.

A revolution in weapons is on the way. It is not unfolding as dramatically as nuclear weapons did in 1945. The PGM of the late 1960 - anti-armour missiles and laser-guided bombs signalled its dawn. The morning of this revolution is coming in the 1980s with a new generation of non-nuclear theatre weapons capable of both mass and precision strikes. The turn of the century will see the revolution reach its noonday with the emergence of capabilities for intercontinental strategic conflict without nuclear weapons.

The political taboo against the use of nuclear weapons is very real, and exists for convincing reasons. Therefore the ability to destroy vital target systems efficiently and cheaply and with a modest force, without much by-product damage, and without nuclear weapons, is a capability of potentially revolutionary importance: probably the most important development since the A-bomb.⁶⁶

While this Paper has not attempted to answer all the questions raised by this revolution in prospect, it is important to recognise that strategic non-nuclear war is again a proper subject for debate after some thirty years of inattention. It is not too early to begin thinking about the implications of technological developments which will once again make it possible to attack important military targets deep inside the homelands of the super-powers with non-nuclear weapons. It has not been the primary purpose of this Paper to make value judgements about whether such developments are desirable or undesirable. It has been, more simply, to alert those who think about such things to the fact that a revolution is on the way.

tion while discouraging vertical nuclear proliferation. Again, non-nuclear strategic weapons will pose new choices in terms of old dilemmas.

At the same time, capabilities for non-nuclear strategic conflict may be even more difficult to acquire technically than nuclear weapons. The intercontinental capabilities which are the principal focus of this Paper appear to be inherently dependent upon large space programmes for global information.⁶⁵ Their acquisition may depend upon an even broader base of technology and economic resources than nuclear weapons acquisition, which now rests primarily on the availability of nuclear materials, the knowledge to assemble them, and the acquisition of relatively unsophisticated delivery systems.

The non-nuclear strategic weapons of the kind addressed here will probably remain, technically and economically, available only to the super-powers for several decades after their introduction. The super-powers might be more willing to share these new weapons or their control with allies than they have been for nuclear weapons, but that sharing will probably involve giving access to space-borne assets and underwriting development costs. In any event, one would expect to see the prior development and proliferation of shorter-range non-nuclear weapons for theatre or regional use to show both the way and the pitfalls that may lie ahead for the future of non-nuclear strategic weapons.

Concluding Remarks

There is a common thread in all these implications for international policy-making: the advent of capabilities for non-nuclear strategic conflict will exacerbate many of the tensions, ambiguities and contradictions in existing Western policies for nuclear arms. Issues that exist today but need not be confronted, because of the pervasive, even suffocating, influence of nuclear weapons, will emerge in an uncomfortable glare and with some considerable dissonance. The questions that will have to be answered will not be new

'city busting' operations, the discrimination offered by precision-guided, specialized warheads may not be viewed as violating existing norms of warfare. This means that while [such] technologies will not come to possess the psychological or the status value of nuclear arms, the lower stigma attached to their acquisition is likely to lead to their widespread proliferation.⁶³

Such non-nuclear capabilities may take on special importance in situations where nations are about to acquire nuclear capabilities:

It is even possible to imagine that these weapons could enable non-nuclear states to obtain some form of conventional counter-force capability. In this role, strategic conventional forces might be used by a regional or outside power to destroy, in a pre-emptive strike, the nuclear weapons fabrication and launch centres of an incipient nuclear state . . .

On the regional level, the introduction of conventional preemption capabilities could arouse a host of uncertainties, particularly during a period when the task of distinguishing civilian nuclear programs from weapons production activities is likely to become more difficult.⁶⁴

Paradoxically, the availability of capabilities for non-nuclear strategic conflict could *increase* the incentives for nuclear proliferation. Today, the size of nuclear arsenals possessed by the super-powers makes competition in nuclear weapons look hopeless to most non-nuclear states. If such large arsenals are seen as being what are really required to compete, and if anything less is just political posturing, then the price of competition appears prohibitive.

But the advent of non-nuclear strategic capabilities, by reducing the role of strategic nuclear arms to the threat of societal destruction, could reduce the size of competing nuclear weapons arsenals to the point where many more nations might perceive them as being within their resources. That would seem to invite horizontal nuclear prolifera-

of American nuclear adventurism or as attempts to limit a nuclear conflict to Europe, or both.

The more credible the threat for the purposes of deterring a conflict, the more plausible the prospects for initiating or inviting such a conflict. That dilemma may be sharpened by non-nuclear strategic capabilities which can simultaneously improve super-power coupling and lower the threshold for strategic conflict. Yet the risks of decoupling are severe as things stand, because of the existing balance of strategic nuclear capabilities between the super-powers and their mutual possession of secure retaliatory forces. Given these long-standing tensions within NATO, the advent of non-nuclear strategic capabilities seems more likely to loosen alliance bonds than strengthen them. It is not that these new weapons will be intrinsically unfavourable for the West or for European security. Rather, they will make all too evident the logical cracks that have been papered over for decades by the enormous potential of nuclear weapons for both destruction and ambiguity.

Strategic Arms Proliferation

The prospect of non-nuclear means for waging intercontinental strategic conflict invites speculation about the abilities of other technologically advanced states to develop and deploy non-nuclear strategic capabilities. Richard Burt has suggested that the stigma attached to nuclear arms may not apply to the proliferation of non-nuclear strategic weapons:

In the past, other avenues of mass destruction, such as biological weapons, have been open to non-nuclear states, but these alternatives have generally not been exploited. This general taboo against the acquisition and use of weapons of mass destruction remains relatively strong (and perhaps is even increasing), despite the growing systemic incentives to acquire nuclear weapons. This taboo could have a paradoxical effect on the introduction of conventional weapons capable of attacking strategic assets: while it is unlikely that states will obtain conventional weapons for

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¹Richard Burt, *Nuclear Proliferation and Conventional Arms Transfers: The Missing Link*, The California Seminar on Arms Control and Policy, Discussion Paper No. 76, September 1977, p. 17.

²Even the experience of the use of those two nuclear weapons leaves much uncertainty as to their strategic necessity or effectiveness. For a summary of differing views on the necessity and effect of using the first atomic bombs against Japan, see Len Giovannitti and Fred Freed, *The Decision To Drop The Bomb* (London: Methuen, 1967), pp. 320-35. While those two bombs may have been *efficient*, compared to alternative means then available, they were no more *effective* in destroying cities or killing people than the conventional methods used against Dresden and Tokyo (*Ibid.*, p. 269).

³More recent experience with conflicts involving strategic operations suggests understandable reluctance to employ nuclear instruments, even when they are available and efficient instruments for strategic strikes. Two examples from the last decade come to mind:

⁴In 1972 the bombing of Hanoi was undertaken for strategic objectives and against targets that would have been most efficiently destroyed with nuclear weapons. Yet the US elected, for very good reasons, to restrict her attacks to the use of high-explosive bombs, even though they were dropped from B-52 aircraft designed principally for nuclear weapons delivery.

⁵The 1981 Israeli strike on the Iraqi nuclear reactor near Baghdad was clearly for strategic objectives (see Amos Perlmutter, 'The Israeli Raid on Iraq: A New Proliferation Landscape', *Strategic Review*, vol. X, no. 1, Winter 1982, pp. 34-43). The target's value and hardness made it an obvious candidate for nuclear attack; and Israel is generally believed to have nuclear weapons available for use. Although there are different appreciations of Israel's nuclear capabilities, the latest CIA reports estimate that the number of operational nuclear warheads it owns is around 200'. (See Amos Perlmutter, Michael Handel and Uri Bar-Joseph, *Two Minutes Over Baghdad*, (London: Valentine, Mitchell, 1982, p. 51)). Yet Israel accepted the greater operational complexities and risks of failure in mounting a conventional air attack.

⁶This is a point made frequently by those nations who see themselves as being the prospective battlefield for a nuclear war between the super-powers. While to the super-powers the use of 'tactical' or 'battlefield' nuclear weapons in a European war may appear qualitatively different from the use of strategic nuclear weapons, the differences do not seem all that great to the prospective victims.

⁷*Wehner's New Colleague Dictionary*, (Springfield, MA: Merriam, 1981), p. 1141.

⁸Henry S. Rowen and Albert Wohlstetter, 'Varying Response with Circumstance', in Johan J. Holst and Uwe Nerlich (eds), *Beyond Nuclear Deterrence* (New York: Crane, Russak, 1977), p. 238.

⁹'Panacea' targets refers to a hypothetical class of targets which have historically fascinated the proponents of strategic bombing. They are those few, critical targets the successful destruction of which would theoretically bring

a nation to its knees or its war machinery to a halt. During World War II, the Allied 'panacea' targets included the Ruhr dams and the German ball-bearing production plants.

¹⁰Air Marshal Arthur T. ('Bomber') Harris termed a 'panacea target', single targets that everyone - except the Germans - would assume might end the war in a single blow (Edward Jablonski, *Airwar. Tragic Victories* (New York: Doubleday, 1971), p. 136). 'Harris . . . had long opposed precision bombing because it dealt with what he dismissed as mere "panacea" targets' (Ronald H. Bailey, *The Air War in Europe*, (Chicago: Time-Life Books, 1979), p. 54).

¹¹The relative effectiveness of allocating strategic bombing efforts against various target classes - military targets, civilian morale, the economy, or panacea targets - has stimulated considerable debate. That debate includes questions of whether attacks on panacea targets have demonstrated the value attributed to them, whether such targets have been given adequate priority in bombing campaigns, and whether the theory underlying the concept of panacea targets is valid.

¹²Burt (*op. cit.* in note 1), p. 3.

¹³*Ibid.*, p. 5.

¹⁴Fred Charles Ikle, *Can Nuclear Deterrence Last out the Century?*, California Arms Control and Foreign Policy Seminar, January 1973, p. 15.

¹⁵James Digby, *Precision-Guided Weapons*, Adelphi Paper no. 118 (London: IISS, 1975), p. 12.

¹⁶It is almost impossible for any rational person to consider the consequences of a thermonuclear exchange - square miles of radioactive rubble where great cities once stood, deaths in the tens or hundreds of millions - and see war as "an act of policy carried on by other means". (Francis T. Underhill, 'Modernized Societies and the Uses of War', in Capt. John J. McIntyre USN (ed.), *The Future of Conflict* (Washington DC: The National Security Affairs Institute, 1979), p. 9.

¹⁷Modern nuclear-armed states may be defied here as those that possess the technology and economic resources to build and deploy the most modern forms of nuclear weapons, such as ballistic missiles deployed in nuclear-powered submarines. Today, these would include: (doubtfully) Britain; France; the USSR; the US; and (again doubtfully) China. Britain does not build ballistic missiles; China's submarine programme is hesitant.

¹⁸It has been estimated that there are about 50,000 nuclear weapons of all kinds in the world today. See Sidney Drell, 'L + RV: A Formula for Arms Control', *The Bulletin of the Atomic Scientists*, vol. 38, no. 4, April 1982, p. 28.

¹⁹The means for delivering nuclear weapons to strategic targets are very much larger than the much counted and much discussed strategic nuclear delivery vehicles, or SNDV. They also include numerous tactical weapon systems, such as fighter-bombers, that could be pressed into service at their extreme ranges or on one-way trips to their targets. In the degraded defence environment which is likely to exist after major nuclear exchanges, even civilian or commercial aircraft could be adapted for transporting nuclear weapons over intercontinental dis-

tances to their targets. As long as any of the tens of thousands of nuclear weapons survive, men can devise ways, perhaps clandestine or suicidal ways, of transporting the relatively few nuclear weapons required to devastate a modern society.

¹⁶The fragility of modern societies is described by Underhill: 'As society moves toward greater and greater use of inanimate power, the units in it become progressively more specialized and less self-sufficient. Complex patterns of interdependency develop, patterns that are extraordinarily sensitive to disruptions in any part of the fabric. Every individual in a modernized society depends on hundreds of others, the vast majority of whom are strangers, to provide goods and services for his daily existence and well-being (*op. cit.* in note 12, p. 12).

¹⁷The Office of Technology Assessment (OTA) for the US Congress has put it thus: 'the uncertainties are such that no government could predict with any confidence what the results of a limited attack or counter-attack would be even if there was no further escalation' (*The Effects of Nuclear War*, OTA, Congress of the United States, (Montclair: Allanheld, Osmun, 1980), p. 4).

¹⁸An excellent discussion of these uncertainties is given in Bruce W. Bennett, *Fatality Uncertainties in Limited Nuclear War* (Santa Monica, Ca: Rand Corporation, R-2218-AF, November 1977), pp. 6-7. Bennett goes on to illustrate the consequences of these uncertainties for a limited attack on US ICBM sites (p. 10) where the collateral fatalities could range from 300,000 to 3.3 million (a factor of more than ten) for 95% confidence.

¹⁹Sidney Drell has expressed the awesome chasm as follows: 'Nuclear weapons are fundamentally different from non-nuclear ones. They have a long and deadly radioactive memory. They are weapons of mass destruction, and the possibility of using them raises for all of us fundamental ethical and moral issues. Nuclear war would be so great a disaster for humanity and a physical catastrophe for our environment and ecosystem that the unknowns of a nuclear conflict dwarf the known and the predictable (*op. cit.* in note 14).

²⁰Efforts to make nuclear weapons more suitable for military purposes - by making them more discriminating and controlled in their effects - pose a dilemma. The most common fear is that efforts to make them more suitable for fighting wars will invite their use and, hence, the risks of societal destruction. But there is also the fear that nuclear weapons have been made more destructive than is necessary for their military purposes, and that foregoing opportunities to make them less destructive will cause unnecessary damage to societies if nuclear deterrence should somehow fail. These fears represent the two edges of the deterrence sword which are seldom contemplated at the same time in the same mind. For more discussion of these considerations, see Carl H. Builder and Mortie H. Graubard, *The International Law of Armed Conflict: the Implications for the Concept of Assured Destruction*, (Santa Monica, Ca: Rand Corporation, R-2804, January 1982).

²¹Trends here are difficult to sort out. New kinds of target have been added (e.g., ballistic missiles, air defence, nuclear weapons storage sites, etc.) but the numbers of some major, existing types of weapon (e.g., aircraft and ships) have been reduced. Numbers of mili-

tary ground vehicles (i.e., tanks, armoured personnel carriers, trucks, etc.) have increased, but the number of military personnel (especially combatants) has decreased. With respect to the number of *separate* strategic targets that must be attacked, perhaps one of the most troubling long-term trends is the apparent reduction and consolidation of military bases, installations and depots, at least in the United States and Britain, since 1945.

²²McIntyre (*op. cit.* in note 12), p. 122.

²³Cecil I. Hudson, Jr. and Peter H. Hass, 'New Technologies: The Prospects', in Holst and Nerlich (*op. cit.* in note 6), p. 108 (emphasis added).

²⁴*Ibid.*, p. 127.

²⁵*Ibid.*, p. 128.

²⁶Runways are difficult targets for both nuclear and non-nuclear weapons because of their configuration and hardness (i.e., a linear target, flush with the ground), but non-nuclear munitions designed specifically for runway destruction are emerging from the laboratories. A 45-lb submunition has been developed by USAF at Eglin AFB, FL, and is considered off-the-shelf hardware. It was developed under the name of clustered airfield defeat munition'. One concept for delivering such submunitions, called *Axe*, would use the first stage of the Lockheed C-4 submarine-launched ballistic missile for propulsion giving the weapon a range of 350 naut. mi. carrying a payload of 14,000 lb. The warhead would contain 384 kinetic energy penetrating submunitions . . . and each of the submunitions . . . would penetrate a runway before detonation to cause an upheaval to repair . . . A single *Axe* missile can completely close 2.5 mi. of highway, as an example. *Axe* is believed capable of closing all hardened airfields in Warsaw Pact nations within 10 min . . . (See *Aviation Week & Space Technology*, 7 June 1982, pp. 64-7).

²⁷Hudson and Hass (*op. cit.* in note 23), p. 129.

²⁸*Jane's Weapon Systems 1980-1981* (London: Jane's, 1980), p. 405.

²⁹Hudson and Hass (*op. cit.* in note 23), pp. 130-1. Fred Charles Ikle (*op. cit.* in note 6), p. 230.

³⁰Hudson and Hass (*op. cit.* in note 23), p. 143.

³¹The uncertainties attending the effectiveness of nuclear weapons against strategic targets is graphically illustrated by Bruce W. Bennett in *Uncertainty in ICBM Survivability* (Santa Monica, Ca: Rand Corporation, P-6394, October 1979).

³²Hudson and Hass (*op. cit.* in note 23), pp. 108-9.

³³Earl C. Ravenal, 'Counterforce and Alliance: The Ultimate Connection', *International Security*, Spring 1982 (vol. 6, no. 4), p. 28.

³⁴Ravenal estimates that the US targets about 6,700 separate aim points in the USSR. Of these, about 2,700 are hardened targets requiring two reliable weapons each, for a total of 9,400 reliably delivered weapons. But only about 1,000 aim points or weapons are associated with urban and industrial targets. Moreover, the number of cities involved is probably only several hundred. *Ibid.*, pp. 28-9.

³⁵For example, a significant fraction of the oil refining capacity for either the US or the USSR could be

tional strike systems, capable of attacking high-value targets deep in Eastern Europe or in the Soviet homeland itself, could provide Western European governments with a new means of "escalation autonomy" – the ability to raise independently the stakes attached to Warsaw Pact aggression. But these new conventional operations are better understood as deterrent "links" rather than as military ends in themselves, for even the most fully developed "conventional strategic" capability would be incapable, by itself, of deterring a nuclear-armed USSR. Instead, surrogate technologies could provide some European states with a mechanism for threatening escalation, which could come to encompass a strategic exchange between the super-powers. Long-range conventional strike systems could thus assume a role similar to the one commonly ascribed to the *force de frappe* – that of a potential trigger mechanism for ensuring that, in the event of a war in Europe, the super-powers would not remain as sanctuaries, safe from the ravages of war. Viewed in these terms, the non-nuclear technologies would work not so much to offer Europeans escalation autonomy, for deterrence would ultimately reside with the US strategic arsenal, as to enable the Alliance to "parcel out" control of the escalation process' (*op. cit.* in note 1, p. 15).

Such strategic forces could be used to strike airfields, air defences, radars, communications, and other time-urgent targets, to prepare the way for the subsequent projection of airborne or seaborne forces ashore. Homeland basing, halfway around the globe, might be preferred as being more reliable than dependency upon regional host nations for basing rights and freedom of use.

Richard Burt has suggested one such initiative that might result from non-nuclear strategic capabilities: 'some observers have speculated that the introduction of new conventional weapons technologies could enable existing nuclear powers to adopt nuclear "no first use" policies' (*op. cit.* in note 1, pp. 7-8).

McIntyre (*op. cit.* in note 12), p. 119.
 Carl H. Builder, 'Why Not First-Strike Counterforce 1979', pp. 33-4, *Strategic Review*, vol. VII, no. 2, Spring 1979.

For an analysis of these global environmental effects, see the report prepared by the National Academy of Sciences, *Effects of Multiple Nuclear Explosions Worldwide* (Washington DC: 1975). A short summary and update of these effects can be found in *The Effects of Nuclear War* (*op. cit.* in note 17), pp. 109-15.

Barry M. Blechman and Douglas M. Hart, 'The Political Utility of Nuclear Weapons: The 1973 Middle East Crisis', *International Security*, vol. 7, no. 1, Summer 1982, pp. 154-5.

Burt has suggested that the availability of non-nuclear strategic capabilities in the hands of the members of the Alliance should afford them enhanced control over the escalation of a European conflict: 'At the same time, the availability of a new generation of long-range conven-

vehicle, including its nuclear weapon. The same source indicates that three 200-KT nuclear weapons can be carried in the 1,000-lb throw-weight of the *Polaris* A-3, for a single re-entry vehicle weight of about 150 kg, for the following non-nuclear front-end for an ICBM: three *Maverick* missiles at 210 kg each. Add as much again (630 kg) for launch rails, acquisition sensors (TV and IR), and command communications relays. Then add the same again (another 630 kg) for a re-entry vehicle and drogue parachutes to get the whole through the atmosphere and slowed to a reasonable speed and position for target viewing and missile launching. The total package comes to about 1,900 kg, or a little over 4,000 lbs. That front end is lighter than that of the Soviet SS-N-18 slaw which carries three nuclear weapons (*Ibid.*, p. 105).

Richard M. Nixon, 'First Annual Report to the Congress on United States Foreign Policy for the 1970s', p. 105.
 Erik Klippenberg, 'New Technologies: Some Requirements', in Rowen and Wohlsteiner (*op. cit.* in note 6), p. 152.

Burt (*op. cit.* in note 1), p. 12, (emphasis added).
 Thomas Brown, Steve Head, David McCarvey, Arthur Steiner and Albert Wohlsteiner, *Political Military Significance of Continuous Terminal Homing*, Background paper dated 31 March 1976, distributed at the European-American Institute for Security Research Workshop on 'Improved Technologies in a Changing NATO Strategy', in St Paul de Vence, France, 17-18 September 1982, p. 42.

For the legal and moral arguments, see Builder and Graubard (*op. cit.* in note 20).

This prospect once again evokes Robert Oppenheimer's frequently-quoted recollection from the Bhagavad Gita, immediately after the first atomic (*Trinity*) explosion: 'Now I am become death, destroyer of worlds'.

The anticipation of higher costs to replace nuclear weapons with high-technology non-nuclear weapons is reflected in the following quotation: 'NATO could dispense with most of its 6,000 short-range nuclear arms for battlefield use if allied governments would raise their defence spending by 4% a year for the rest of the 1980s. The extra spending would allow NATO to invest in the new strategy, which is based on US-made weapons, mainly precision-guided long-range missiles that can home on targets deep behind Soviet lines' ('NATO Debates Shift to Conventional Weapons', *International Herald Tribune*, 6 October 1982, p. 1).

The quotation is based upon statements attributed to Gen. Bernard Rogers, SACEUR. For a more deliberate statement of his views, see Gen. Bernard W. Rogers, 'The Atlantic Alliance: Prescriptions for a Difficult Decade', in *Foreign Affairs*, vol. 60, no. 5, Summer 1982, p. 1155.

However, Gregory Treverton has pointed out that: '... the French force will by 1990 constitute more than the present "minimum massive retaliation" capability it now has' (*Nuclear Weapons in Europe*, Adelphi Paper no. 168 (London: ISS, 1981), p. 4).

The author is indebted to Bruce Nardulli for pointing out the potential for non-nuclear strategic weapons to support the projection of military power into third

destroyed with less than 100 nuclear weapons. See *The Effects of Nuclear War* (*op. cit.* in note 17), pp. 64-80. This points an attack with ten Soviet ICBM carrying 80 re-entry vehicles that could destroy about 64% of US oil refining capacity. Conversely, an attack with ten US missiles carrying 73 re-entry vehicles could destroy 73% of Soviet capacity. These targets might be difficult to destroy without nuclear weapons, but the point here is that they are few in number and therefore do not create large requirements for nuclear weapons.

Ravensall suggests that the 'ideal' requirement for warheads in the US intercontinental strategic nuclear force is 15,000 to 20,000 (*op. cit.* in note 35, p. 29).

With hard (more correctly, point) targets, the question is whether or not a large enough bomb is likely to be tossed close enough to the target to produce the desired destructive effect. Lethal radius of the weapon and vehicle delivery accuracy are the parameters of concern for comparison.

With soft (more correctly, area) targets, the question is whether or not the bomb to be used is large enough to produce the desired destructive effect over an area large enough to include all portions of an extended target. As a first approximation, the lethal area of the weapon is the only parameter of concern. The vehicle delivery accuracy is typically well within that lethal area for soft targets. If the weapon is so small, or it is delivered so inaccurately, that such is not the case, then it may be more properly treated as a hard or point target.

There are now some 308 SS-18 in service, mostly with 8 x 2MT warheads' according to *The Military Balance 1981-1982* (London: ISS, 1981), p. 3. That implies over 2,000 warheads on the Soviet heavy ICBM alone, enough for a theoretical two-for-one attack on the 1,052 US ICBM silos.

B-52G aircraft have been equipped to carry up to 20 SRAM (AGM-69), eight internally on a rotary rack and 12 externally on wing pylons. A similar configuration is also possible for ALCM (AGM-86), although the first operational aircraft to carry these cruise missiles will carry only the exterior loadings. See *Jane's All The World's Aircraft 1979-80*, (London: Jane's, 1979), pp. 302, 651.

For typical examples, the tube-launched *TOW* missile weighs 19 kg, while the air-launched *Maverick* weighs 210 kg. Both are intended primarily for anti-tank or anti-armour applications (*Ibid.*, p. 659).

The weights of nuclear weapons are generally not available, but they can be inferred with some uncertainty. Nuclear weapons can be fired from 155mm and 203mm howitzers. The 155mm howitzer fires a high-explosive shell weighing about 43 kg (*Jane's Weapon Systems 1970-1980* (London: Jane's, 1979), p. 400). Both the internal and external ballistics of guns are quite sensitive to projectile weight, so drastic differences in shell weights for nuclear weapons seem unlikely. Ten nuclear weapons of 50-KT yield, including their ballistic re-entry vehicles, can be packed into the 2,000-lb throw-weight of the *Poseidon* C-3 missile (*The Military Balance*, *op. cit.* in note 42, p. 104). This suggests something less than 100 kg for each re-entry