Innovation, Element of Power

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Introduction

According to historian and military analyst Martin van Creveld, military technology and infrastructure, logistics and communications "dictate for the most part the major characteristics of organization, training, strategy, even the concept itself of battle. Without it, one couldn't conduct an armed conflict, and even the existence of conflict would be inconceivable."[1] The vast amount of land held in the rear of the battle sets narrow limits on what could take place along the front: battles, campaigns, and even war. The modern era, since the beginning of the industrial revolution has seen the front line expand to the detriment of the rear flanks. The path dependency described by van Creveld has grown: one fights wars based on and limited by technology.

The acceleration of technological innovation over the 20th century is such that we could describe this era as an age of innovation. Moreover, the speed of this acceleration is rapidly increasing. The striking progress in electronics, information and telecommunication in the last two decades have contributed to the creation of unprecedented economic upheavals: innovative waves have a multiplier effect.

All innovation necessarily disrupts the *status quo ante*. This axiom holds as true for military affairs as for economic ones. For example, the introduction of the steam engine and electricity transformed not only industry but also the realm of military affairs. These new technologies did not impact all nations in the same fashion or way. The resulting imbalance soon benefits one [nation] at the expense of another: those gaining from the breakthrough will be able to dominate those who do not. Innovation is an element of power.

First this paper will analyze the innovative nature of the United States as a society before studying the significant waves of economic, technological and social innovations as experienced by this country.

In the second part, the paper looks at the institutional fluidity valued by Americans and how this has played a role in fostering innovation. In this section, the study will also look at U.S. geopolitics.

Thirdly, the study will then observe the connections between civilian and military evolution and how each has influenced the other, particularly in regards to the fragmentation of economic activity and organizational changes.

The paper will question what is meant by the concept, the "revolution in military affairs," looking closely at promulgators of the concept and at resistance to its acceptance in the fourth section.

The fifth section will sound out the RMA's impact on doctrines, industry and research and development.

The sixth and final part will attempt to put forth some of these notions as they apply to France and Europe.

A bibliography of documents relevant to the current U.S. debate is provided in the Appendix.

[1] Martin van Creveld, *Technology and War, From 2000 BC to the Present,* The Free Press, Macmillan, New York (1991), pp. 311-2.

1: The United States: Innovative Society

An observer of the United States today would have two principal impressions: its renewed sense of power and its bubbling innovation. These are not discrete, but rather are associated phenomena. The facts seem to clearly show that the United States is better at innovation than other countries. First, this report will attempt to grab hold of the rebound effects of this superior innovation, without forgetting the recent decline that affected power and innovation, the nadir of which is symbolized by Carter's presidency.

First this report discusses the sociology of innovation—which is based on U.S. history and its constitutional nature—and then examines the economic character of the American marketplace, and moves to the idea that there is a socio-cultural fluidity within American society.

Second, the study will look at economic innovations, particularly those caused by a wave of technological innovation, the "drought" between the end of the Vietnam War and the end of Jimmy Carter's term of office, and then the benefits from a new type of economy, based on decentralization and the unfolding economic revolution.

In the course of human history, the first experiment demonstrating thermodynamic efficiency was conducted by Benjamin Franklin in 1744. This is one of the first contributions of the American colonies to innovation. Just as Franklin encompassed the scientist, the businessman and the politician, the causes and effects of innovation studied in this paper are parts of a whole.

1.1 Sociology of Innovation

1.1.1 The "Tocqueville" Base

As many historians and analysts have noted, the United States, in contrast to the old nations of Europe and, it could be said today, of Asia, possesses neither a territorial nor an ethnic identity. Rather, the United States has become a new ethno-territorial entity, having been created on the basis of a social contract freely entered into by its citizens. This is what American social scientists call the "American Experiment," in the sense that the nation [United States] is an experiment rather than a country rooted since time immemorial in, according to the ideology of some Europeans, "blood and earth." Thus, the United States is first defined by being established on a contractual, not natural basis, and is itself the very representation of that contract.

The contract is—following the epistomological issues raised by the Declaration of Independence—the Constitution of 1787, itself arising from a long, deliberative process involving not just the Founding Fathers but many other thinkers, intellectuals and political scientists. Completed by the Bill of Rights in 1791, this contract enhances and makes universal the fundamental concept that power originates from the people and so constitutes the state; the state is the representative of the people and the territorial organizations it creates: the federal government and its administration are not fundamental, but secondary; they do not establish, but are established.[2]

Clearly, unlike the European tradition preceding this era, the populace is not beholden to the state, nor are people subjects of the crown, but rather they are subject to a law in which the governing concept is natural law, not divine right. The abolition of an ideology based on roots and ethnicity corresponds to the abandonment of these as criteria for belonging: no longer is sanguinity or caste membership the basis for social hierarchies, but an individual's worth: the American social contract is based on the individual.

[2] Cf: 10th amendment, "The powers not delegated to the United States by the Constitution, nor prohibited by it to the states, are reserved to the states respectively, or to the people."

This notion of a meritocracy, and the absence of identification with a particular region or territory, makes social fluidity normal, not exceptional; the social rigidity that serfdom, guilds, and [medieval] corporations hold as coterminous with the divine order of things, disappears; change becomes the norm. It was not surprising that emigrants settling down in new territory, became inspired by the pioneering spirit, itself arising out of such notions. American history as such fosters the notion of change and pioneering. The apparently endless extension westward, the frontier unfolding before the conquest, the ceaseless contribution of immigration were consolidating unconsciously what was desired by the collective conscience. Despite the melting pot's recurring crises, the pattern continues.

The United States did not escape the desire to consolidate acquired positions and transform them into social monopolies: the blue bloods of Boston and New England wanted to erect an English-style aristocracy. Robber barons believed they could also create another European aristocracy, but all these attempts have remained ephemeral and have been swept aside by the flux of change. The United States remains a nation of pioneers and immigrants who are conscious of these realities. The closing of the frontier, once the Pacific was reached, and the refusal to pursue colonial policies have not tamed the vision, but have redirected it from geography to other spheres such as the New Frontier announced by President Kennedy in 1961.

This said, the American social contract is not that of Jean-Jacques Rousseau. The secret meritocracy of elites. The circulation among elites allows for renewal, but it still assumes a society directed by elites. In the American version, there are functional elites, not feudal or post-feudal ones. Nor are the elites tied as such to the state: they do not derive their force or power from their association with the government, but on the contrary, once established as elites, they then bring their status under the guise of providing the service an elite owes the state. These elites are local, primarily wealth-based, whether it was earned in agriculture, business, industry or banking. The power comes from below.

This power itself is not the monolith of European absolutism. The separation of powers theorized by Montesquieu, John Locke and David Hume has been realized. The executive, legislative and judicial exist and function as equals (whatever may have been the entirely normal historical fluctuations that affected the balance of power among these three branches). The president of the United States can, as his prerogative, propose his budget to both houses of Congress. But it is Congress alone that disposes, to take the most striking example. The Supreme Court could invalidate a law passed by Congress. The powers are separated.

But this "horizontal" separation of powers is not all; there is also a "vertical" separation of power: if the federal government has considerable power, the 50 states also have a fair number of prerogatives: budget, social, internal organization, judicial, etc. There too, power originates from below, before reaching higher levels (this is why weak electoral participation during presidential elections does not necessarily translate into disaffection with politics: "all politics are local" is a well-known adage in American politics). Power is increased and decentralized, thereby preventing an individual from long-term abrogation of power at the expense of the majority.

The double separation of power, reflecting the clear limits to a central government's ability to usurp power, which the Founding Fathers feared like a plague, reinforces the autonomy of an individual and local groups, the "second powers" of which Alexis de Tocqueville spoke; fluidity is the rule, drawn from the Constitution, it is essential to the defining of the United States of America.

The 20th century has seen, since 1916, the [U.S.] federal government reach a size and impact without precedent in American history: the government ordered the economic mobilization for World War I. Fewer than fifteen years later it used war economics more or less successfully to respond to the Great Depression. The federal government became all-powerful with the mobilization for World War II and continued, under the guise of the Cold War, to receive the principal share of political power as the *national security state.* Nonetheless, even during the height of these mobilizations, the federal

government only gained a share of the empire also held by the fifty states. And the 1980s have witnessed the reversion back to historical balances between federal and state power.

The state, in American life, is discrete, often distant, and, with few exceptions, not very intrusive. The American citizen, if compared to a European one or one from developed Asian nations, sees little of government in daily routine. The taxes owed to the federal government are far less onerous than those elsewhere. Public service has a weak share of total employment. The functions fulfilled by the government are fewer and less important.

Still, the federal government as a "Weberian" system of administration is the very example of fixed procedures, of various levels of bureaucracy, of uniform regulation. History has led the European or Asian state to be above most of its citizens and the individual as a distinct entity. American citizens are alone in considering themselves to be the repository of any power that they do not delegate to Washington, [and] that they have the power to change things, whether wrongly or rightly or to what degree is not important, other than to note that this belief is operational and guides Americans behavior.

A society whose social order is defined by hierarchies demands and encourages predictability in behaviors, and necessarily discourages innovation (in all its senses) because the latter could only be a violation of the immutable order assumed by this society. By contrast, a society that rejects rigidity will be one in which innovation, experimentation and novelty flourish.

If American society is individualistic, it is not atomized. Individuals regroup into many associations and other membership groups to work on collective problems. The basic example used by movies is the *posse*, a voluntary and semi-spontaneous detachment of citizens, the clichés of Westerns, around an elected official, the sheriff, to take on an urgent and communal problem. Once the bandits are brought to justice, the posse disbands, and everyone returns to private affairs. At a more sophisticated level, the covered wagon trains which brought together pioneering families represent the highest form of this model of the collective effort. A collegial community is formed *pro tempore* in order to achieve a given end. Once California is reached, each family will go its own way, ready to leave behind former members of the brotherhood.

1.1.2 Trial and Discovery

The individual at liberty to seek out his inalienable rights—as stated in the Declaration of Independence, "life, liberty and the pursuit of happiness"—goes about his business in an economic arena freed of those constraints with which contemporary Europe overburdens its weak entrepreneurial desires.

A contract freely entered into by two autonomous parties embodies the meeting of demand and supply. The contracting parties, as permitted by law, find common ground.

As soon as the number of business dealings exceeds the limits of minimal transactions, the risk may be greater than the personal wealth of the contracting parties. To encourage deals and reduce risk the 19th century saw the formidable development of the company as the [legal] equivalent of a person; one of its principal functions was the separation of risk from the individual. In a joint-stock corporation, whatever its actual form, the stockholder only risked the stock involved, not his or her entire fortune. The risk was transferred from an individual's shoulders to the impersonal structures of a corporation. This limited liability is certainly not an American invention, but it has flourished here: today there are some 13,000 companies listed in the stock market, 63,000 incorporated as large companies, and two to three million corporations. There is also a general societal recognition that these businesses benefit the Republic and serve its ends.

Free risk represents the right to make mistakes and fail. American society does not consider failure a sin, like a vice or trait. Failure does not equate to condemnation to everlasting Hell or a long Purgatory. Henry Ford failed twice before finding a successful formula; taking risks is considered favorably, and failure is not shameful. The United States has never had debtor's prisons; the Puritan's scarlet letter stigmatized moral deviancy, not entrepreneurship.

This "tolerance of failure," to use former CIA director James Woolsey's phrase, "is a basic cultural fact.[3] It is extremely difficult to create, it draws its beginnings from all of history and the culture of a country. In Germany, for instance, if a business is formed and then goes under, it is finished for good; no banker will lend you any more money. What is unique about the United States is the acceptance of failure. This is what distinguishes the United States from other nations. Take for example, a junior Marine Corps officer commanding a destroyer, which was lost during a false maneuver in Subic Bay. He was court-martialed and punished, but this didn't bury his career—this was Chester Nimitz. In this system, you are accountable—you have to take responsibility for your actions—but you aren't destroyed by a mistake or a setback. In Silicon Valley, people list their failures and setbacks on their resumés just as Prussian officers carried dueling scars on their faces: it's a decoration, a medal, something to be proud of."

This is the underlying principle of the venture capital market. J. Woolsey spoke of it in instructive terms: "The venture capitalist knows that of 20 startups, five to seven will fail, five to seven will break even, three to four will be moderately profitable, two to three will be successful, and that he'll hit the jackpot with one of them, a Netscape or Oracle. He plays roulette on the numbers, not the colors."

Silicon Valley's venture capital firms last year raised a third of the venture capital in the United States and a sixth of the world's.[4] Organizations called "gazelles," where business growth tops 20 percent each of the last four years, represent a fifth of Silicon Valley businesses (as opposed to a thirty-fifth of average American firms). Last year, at least $6.5 million was raised by these companies. According to the *Economist,* a middle-of-the-road venture capital company could count on an investment return of 35 percent.

The risk is within limits, the prime [interest rate] could be raised: there are positive indications this might happen. A market organized in such a manner plays an investigative role: it is up to the marketplace to uncover which firms are performing well and which are not, which products are finding buyers and which are not, which product lines are making money, which are not. This process, which Friedrich von Hayek analyzed, insisting not only on its imperfections but also on its irreplaceability, is the invisible hand: "Markets use the knowledge and skills of members of society much more and much better than anything created under a centralized system."[5] This process of selection, even if it does not always choose and promote the best everywhere, on average tends to pick and promote the best. The invisible hand created by markets, explains Hayek, is based on the positive role of ignorance: as we do not know what tomorrow will bring, we must move, decide and risk [today]. Ignorance, thus conceived, pushes us ahead. Market signals are decoded by participants in the marketplace. Their ignorance of tomorrow permits experimentation.

The more experimentation is free of constraints and fostered by institutions, private or public, the better the results are. In this sense, the American economy is very experimental—more experimental than any other.

[3] Author's interview, May 28, 1997.
[4] *Economist*, "Future Perfect? A Survey of Silicon Valley," March 29, 1997.
[5] F. A. Hayek, *Studies in Philosophy, Politics and Economics,* University of Chicago Press (1967), p. 162.

1.1.3. A turbulent society

As was described above, here is a society that is basically characterized by fluidity and mobility. The average American moves seven times during a lifetime, many times greater than the mean in most European countries. This mobility, quite natural in a young country of immigrants, is regional as well as professional. Internal migratory patterns are sometimes incredibly strong. Postwar California and western states experienced a huge wave of immigration (countered slightly by a flow back to interior western states in the early 1990s), as a time when economic difficulties in the traditional industries of the Northeast and the Great Lakes region motivated many of their inhabitants to relocated elsewhere. Since the 1970s, many have gone to the technology-based industries in the "New South." These flows are so continuous as to be considered normal.

Mobility is not only regional but also professional, not just because of the relative ease with which American firms can hire and fire employees as compared to their European counterparts. Just as fads and crazes in fashion, clothing and diet can quickly engage large numbers of fans, regional mobility reflects the attractiveness of new employment opportunities. As soon as an idea has shown its potential, everyone storms after it. The creation of new businesses opens new job opportunities. These, in turn, generate migration patterns.[6]

Consider two recent commercial examples: the surprising success of the megabookstores chains such as Barnes & Nobles and Borders, due to powerful data management tools, or the quick rise of Boston Chicken as a fast food chain—by applying new techniques from the kitchen to the cooking, the chain reduced the cooking time of a chicken to five minutes. It also analyzed the statistical timetable of orders so as to adapt to peak demand times. Everything is computerized, from the store with the best location for attracting a client, preferences, etc. Boston Chicken has made it possible to deliver a meal order (half chicken, coleslaw and rolls) for $7.99 in under 45 minutes, or for little more than what it would cost the customer to buy it in a supermarket. Its success is remarkable. "And it is based on the marriage of cooking and information technologies," explains Gail Fosler, chief economist of the Conference Board.[7]

Fluidity, mobility and movement—these traits, which prove the weakness of rigid compartmentalization, might be compared to a situation in which the number of interactions, the enormous quantity of movement, raises the general "temperature." The number of interactions creates a higher level of social connection. This "interaction effect" has been presented as follows by some mathematicians, economists and sociologists: if we take five people, each one shaking the hand of all the others, the number of handshakes (interactions) will be ten. The formula $n(n-1)/2$ provides the answer. By adding one more handshaker, for six in all, the number of handshakes will go from 10 to 15. Adding one more handshaker to n has a multiplicative effect. With ten handshakers, there are 45 handshakes, with 100, we are already at 5,000, etc.

The increasing social connectivity (number of interactions) that could be referred to as the social mix is a major creative force behind initiatives and innovations. The American economist Michael Rothschild has compared the modern economy to an ecosystem subject to Darwinian evolution—in his words, a "bionomic." The more interactions, the more mutations occur. But, he underlines, while organisms in an ecosystem rarely change, because mutations themselves are relatively infrequent, participants in an economic system are capable of changing themselves through their own efforts. In this fashion, an economic being is Lamarkian, that is, able to transmit the characteristics acquired through evolution.[8]

[6] Blaise Cendrars, *Gold*, a novel that describes the California Gold Rush and provides interesting examples.
[7] Interview with author, May 20, 1997.
[8] Michael Rothschild, *Bioeconomics*

We find in the United States both a high rate of mutation and a friendly terrain for promoting mutations: the experimental society corresponds to the experimental economy. The United States could be considered a truly innovative machine.

Innovation—whether it concerns science, technology, art or culture, political science, social organization, economics, war—is most likely to arise where there are many cross-currents. It is at frontiers, with their elevated rates of mutation, that cross-fertilization easily occurs. Variation and mutation are more easily created and accepted on frontiers as they are zones in which difference is more acceptable and, in fact, encouraged. Behavior is not considered as coming from the self, but rather, to use the famous words of Blaise Pascal, "Truth from here in the Pyrenees, error from there." However, where classical thought sees an untenable contradiction, modern practice has found advantages.

The United States has always shown an ability to rid individuals of their fixed ways (traditions, old customs, regulations, etc.). In place of a narrow band of variation, differences have occurred in larger and expanding ways during the course of the 20th century. The lifting of what is forbidden has given way to a frenzied anarchy of initiatives, most of which disappear, or leave the faintest trace, while others take root and become one of the important innovations in their field. The desire to experiment "in all its meanings" and the accompanying application has opened *ad infinitum* the possibilities for change.

As social inhibition is more or less weak, all sorts of innovations can have their day in the "marketplace." And, the evidence seems to show that the benefits obtained through "good" innovations depend on giving opportunities to all innovations, including "bad" ones. Thus, there is the Internet and gansta rap, Silicon Valley and bizarre cults, biotechnologies and hip-hop. This "open society," to use Karl Popper's term, accepts uncontrolled bursts [of ideas], and it is the entire society that explores which traits are promising. In this sense, the market is a exploratory device in a open society.

The enormous territory settled by Americans allows a multiplicity of inventions to take place; it is on a continental scale, inhabited by over 250 million people. The process of trial and error depends on so many individual experiments that the number of resulting innovations is very high.

So that the cycle of experimentation-innovation takes place, it is still necessary that the social entity tolerate differentiations, eccentricities, divergent points of view and different interests. A society needs to be so set up that it permits, on the one hand, legitimate differences in viewpoints and interests, and so that it creates the institutions for resolving and integrating conflicts. The existence of a unique Constitution over more than 200 years (during which only one conflict threatened to overturn the entire edifice and resulted in a violent upheaval) shows that the process of moderating conflicts has so far been successful.

1.2 Economic Innovation

At this stage of the inquiry, it is convenient to ask more precisely what is meant by innovation. What is technological innovation? How does a society innovate? What is the opposite of innovation?

First,[9] it would appear that technological innovation consists of producing objects or artifacts which have never before been made. In reality, there is a complex chain of events that leads to their creation: they are invented, designed and then produced. For this to occur, there needs to be a manufacturing structure (machines, factories), the necessary factors of production (labor, power, raw materials) and finally, human capital. Innovation, therefore, does not consist of discrete events, it is both a continuous and discontinuous process, that brings together invention, diffusion and, once adopted, innovation.

The history of innovation is basically the history of inventions that have not been innovative, that have been ignored. The time lapse separating an invention from innovation appears to be set at 15-40 years over the last two centuries. It then should be noted that the best innovations were not necessarily the ones that were adopted and gained wide currency: a series of parallel incidents could set events along a particular path, which might have been less than ideal.

Next, it is useful to distinguish among four levels of innovation: (1) incremental improvements (2) radical changes to objects and individual technologies (3) changes in technical systems, that is, combinations of radical transformations altering technology and organizational and administrative changes, and (4) transformations of entire categories, of classifications, of technology, and their corresponding organizational and institutional structures.

A change of the fourth type could be studied as a complex wave, in which each particle (a revolutionary innovation impacted a family of technologies) is essential to the other "particles." The development of the automobile industry needed:

- new materials: sheets of high quality steel
- in the chemical industry, development in gasoline refining and, in particular, cracking
- development of oil exploration and production
- pipeline production, pumping stations
- road network, including garages and service stations
- many other technological innovations (rubber, electricity, etc.)

In order for the industry to prosper, new methods for organizing the work were required, among other factors: Taylorism for the scientific organization of work and Fordism for mass production, which, by lowering production costs, made the car accessible to more and more social classes, which in return altered their patterns of consumption.

There is then a reciprocal multiplier effect among certain groupings of innovations. The cumulative character of technological change allows for the classification of long waves of economic growth founded on the exploitation of a complex "wave": that is, pockets of mutually reinforcing technological innovations. These long waves pave the way for the creation of new products, new markets, new industries and new infrastructures. By the same token, these waves provoke institutional and organizational changes that are essential to the transformation underway.

[9] What follows is largely drawn from Arnulf Grüber, "On the Patterns of Diffusion of Innovation," *Dædalus,* Journal of the American Academy of Arts & Sciences, Summer 1996, Vol. 125, no. 3, pp. 19-42.

In terms of the United States, the historian can discern four major waves, four groupings of technological innovation: around 1820, it involved textiles, major roads, water mills; then to nearly 1870, steam engines, canals and iron mills; to about 1940 it was the era of coal, railroads, steel production, electrification of industry; the next wave, which lasted until recently, featured oil, highways, plastics, electrification of homes. The latest wave seems to involve natural gas, aviation, certain atomic structures, and information.

To synthesize the phenomenon of innovation, it is best to turn to the Austrian economist, Joseph Schumpeter: "The basic impulse to start and keep the capitalist engine running comes from new goods for consumption, new methods of production or transportation, new markets, new forms of industrial organization that create capitalist enterprises… the same process as industrial mutation ... if I could use this biology term … that continuously alters economic structures from the inside out, continuously destroys the old structure, endlessly creates a new one. This process of creative destruction is the essential fact of capitalism."[10]

What fosters or impedes innovation? One could respond, somewhat tautologically, inertia. But the phenomenon relates to or summarizes other [phenomena]. One could speak more precisely of the nondepreciation of historically fixed values. A firm that has little amortization from an old investment is not able to replace it and will refuse to depreciate the worth of the investment. Another firm, through a technical, organizational or marketing advantage, can take the part of a bull in the market place, or a monopoly, which allows it to keep the rent that makes the monopoly profitable while blocking competition. The American sociologist Thorstein Veblen diagnosed that social inertia arose from vested interests, those who would keep an income stream, a monopoly, a privilege and cling to the historic worth of investments that have depreciated thanks to external developments of technology or productivity. This last definition will be used in this monograph.[11]

1.2.2 American innovation sleeps and then arises

Having presented a series of definitions, it is now necessary to pass over a legitimate objection: if the United States is an "innovation machine" as has been argued here, how is this image reconciled with the picture of the American automobile industry in the 1970s and 1980s in which this "innovation machine" was the least flexible?

There is a characteristic cycle to waves of innovation. Without giving too much weight to Kondratiev's cycles, it is necessary to recognize that the diffusion of innovation follows the contours of a logical function (the classic "S" curve). According to the cited study by Arnulf Grüber, the period of time necessary for an innovative process to spread, representing the growth from 10 to 90 percent of usage, is roughly 31 years, whether this time period is for the Cisterian reforms of 1125 to gain acceptance or is for the development of canals in the United States a hundred years ago. It seems to Grüber that for an innovation to become completely dominant (from 1 percent to 99 percent)[12] a double time period of sixty some years is required.

The wave of innovation extends and expands before saturating its destined market. As the market becomes saturated, the earnings from this innovation start to fall. This proto-saturation phase is when problems of inertia and vested interests become most difficult.

Taking once again the example of the American auto industry: enjoying a complete monopoly within the United States in 1945 and an uncontested position during the 1950s, (the era when "Engine Charlie"

[10] J. Schumpeter, *Capitalism, Socialism and Democracy,* Harpers Brothers, New York (1942), p. 43.
[11] Thorstein Veblen, *The Theory of the Leisure Class*, New York (1899).
[12] Translator's note: percentages are not further explained in original.

Wilson of General Motors could exclaim, “What’s good for General Motors is good for America”) Detroit fell asleep at the wheel by relying on factories built in the 1950s and 1960s. Then came the oil crisis, and this very protected monopoly was shocked to discover competitors: there were others, Europeans and Japanese, who had innovated and who had developed models more appropriate for energy shortages. The period of retrenchment in an industry lasts roughly 12 years, about the time Detroit required to reorder its affairs. The same process was also demanded of the American steel industry, which went through serious convulsions before developing the mini-mills for producing specialty steel, and other industries.

The underlying lesson is—contrary to the widespread illusion of power that dominated postwar United States and the notion that America had a manifest destiny—that Americans are not innately better, and their excellence is not automatic. In fact, what was referred to as falling asleep at the wheel in the United States occurred in all fields, developing from the United States’ crushing dominance over the rest of the world in 1945. (Its GNP represented half of the globe’s.) A series of worldwide shocks gradually woke the United States, the effects of which are still with us. First there was the double shock from the Soviet Union, the missile gap and Sputnik, when Americans discovered that they were vulnerable. Then there were repeated monetary shocks, which embroiled the dollar, peaking in the 1971 and 1973 crises and the dollar’s fall against the gold standard. Of course, there was also the Vietnam war, stagflation of the 1970s and injured pride under the humiliations of the Carter era. The wakeup was gradual, but brutal: illusion gave way to reality.

This is the situation in which the U.S. capacity for innovation appears so astonishing, despite the naysayers from all over the world, and even in the United States. From the influential editor of the *Economist* Norman McRae—who forecast in the 1974 special Christmas edition that the United States was henceforth sliding downhill just as the British Empire had—to innumerable books, editorials, conferences and colloquia dedicated to the American crisis or the American decline, even to Paul Kennedy, opinions announced that the United States—reunited with Germany and Japan (yesteryear’s enemies and today’s slyly competing allies) as well as most of Europe, traumatized by Vietnam, and submerged in internal problems of race, poverty, illiteracy, urban decay, industrial weakness, and deficits (budgetary, commercial, balance of trade)—was sinking.

Innovation, at the level of an individual act, group or company, is inserted in a larger setting from which positive and negative feedback can be drawn. If the Iranian hostage crisis represents the nadir, the number and source of rebounds show the U.S. capacity to reinvent itself.

The political rebound, summed up in Ronald Reagan’s favorite phrase, “America is back,” was the first drive. Also near the top of the list would be macro-economic and macro-administrative rebounds: the decision to finally hold down inflation as firmly applied by Paul Volcker, head of the Federal Reserve; fixing the fiscal system by making it less opaque and simpler; reducing taxes and raising thresholds for imposing taxes; abolishing thousands of regulations that were harming businesses—all of this improved the health and vitality of the system in which economic agents act.

While the trend since the New Deal and World War II has been to strengthen the federal government’s prerogatives, functions and offices, along with the requisite revenues, and the mobilization of the Cold War reinforced the process of centralization, Ronald Reagan and his administration privatized and transferred the functions of the federal government to the states or the marketplace—entire areas which had been part of the federal government for several decades.

Innovation on the large scale never ended. But it would henceforth find a setting in which it could flourish.

We should not forget, before describing this flourishing, that a large, young population, fed by strong immigration flows, is an accelerating condition of innovation in modern societies: those under age fifteen make up a bit less than one-third of the population of the United States compared to about one-fifth in

France and 14 percent in Germany. As a result of the Baby Boom, there has been a boomlet, which contrasts to the flattening or declining demographic trends in other developing countries.

1.2.3 Dematerialization of the economy

The growth of productivity and efficiency in an economy are two critical, external features in its evolution. More is produced with less, a principle of least action is at work, more is compressed into a material good, and the amount of energy, primary inputs, and required labor to produce one economic unit (one unit of GNP, or any other measure of choice) has declined historically. A crucial feature of this process is dematerialization: the shift from mass to energy.

The amount of steel used to produce $1,000 (in 1983 dollars) in U.S. GNP has gone from 70 kilograms in 1920 to a third of this mass recently. Inversely, over the course of several decades, new techniques in the metallurgical industry have permitted the cutting in two of input materials. [13] During the 1970s, the invention of the radial tire reduced by a quarter the weight of the tire and the amount of rubber used. The radial technology doubled the life of the tire, which also halved the quantity of inputs required.

Whether through the intermediary of using lighter steel (retaining the best properties per unit of mass) or choosing a substitute, weight is in decline. Wood, steel, copper, lead, all components of economic activity, along with coal, are falling, benefiting from better materials such as aluminum and plastics. In short, the mass needed to create a unit of energy or material efficacy are in a constant relationship. Inversely, for a given mass or weight, the unit of action has significantly increased.

Dematerialization can be measured in terms of energy. In the sense that combustion engines become lighter, to the same extent they are more efficient. In a few hundred years we have gone from charcoal, to oil burning, to gasoline, to nuclear forces; mass has decreased, the absolute and relative thermal productivity has increased. If one imagines this in light of chemistry,[14] one could measure the relative proportion of carbon to hydrogen in combustion, and find that carbon, the element that holds the hydrogen but does not produce energy, is decreasing while the element that truly is combustible is on the rise: the proportion, in effect, is 10:1 for wood, 1-2:1 for coal, 1:2 on average for oil and 1:4 for methane gas. One could discuss the decarbonization of the economy. The shift to nuclear power entirely eliminates carbon and we begin to achieve an economy based on hydrogen-electricity.

Energy usage in the United States has fallen about one percent a year per unit of value produced since the middle of the last century. Since the 1970s it has fallen by two percent per year even though the United States is still in an energy slump. “For the last 200 years, the world has progressively alleviated its energy consumption by preferring hydrogen to carbon,” writes technical historian Jesse Ausubel.[15] Less energy is require to make better products, absolutely and relatively.

The transition from an industrial to a post-industrial economy has amplified this trend. An economy producing more and more services compared to physical goods dematerializes. If energy is a striking example of this dematerialization, electronics provides an even more astonishing case. The famous Moore’s Law, according to which the capacity of microprocessors doubles every 18 months, has been upheld for the last 15 years, and experts expect that this triumphal process will continue for at least another dozen years. The Pentium 200 microprocessor is 300 times faster than the first IBM PC (1981). The standard memory (RAM) in a personal computer has gone from 64 KB to 24 MB. Storage capacity has grown from 10 MB in 1984 to 2 GB in 1996. Modem speeds have risen from 300 to 56,000 bits per second. Fiber optic networks have increased transmission speed by 50 percent a year since 1980. The 8088 circuit board had circuits 3 microns wide in 1984; the IBM–Siemens board’s are .35 microns. Dematerialization in this field has taken the form of miniaturization.

[13] Jesse H. Ausubel, “The Environment for Future Business,” Rockefeller University, 1997, p. 6.
[14] Cf. Nebojsa Nakicenovic, “Freeing Energy from Carbon,” *Dædelus*, op. cit., pp. 95-112.
[15] “The Liberation of the Environment,” op.cit., p. 3.

But dematerialization is also putting the transmission of information into a more powerful position compared to mass production. The telephone directory may be replaceable by a CD-ROM containing 100 million entries; the ton has been supplanted by the gram as a unit of measure. Electrons carrying information create economic value as do material flows, perhaps even more so.

The arrival of tens of millions of computers has shaken the entire realm of economics, production, transport, management, telecommunications, commerce, and society. Once these machines are all connected via modems and the internet, then another revolution will attach itself to the first, and enlarge the latter.

We are enabling the creation of an information world (cyberspace) which is the appropriate location for deploying the interconnected networks that carry information. It will superimpose itself on the economic sphere, that is, on the production of goods (material). But, more and more, cyberspace is the driver.

The growth in calculating power, memory and computer speed has allowed the switch from mainframes to work stations to PCs. This has augmented the number of users and infinitely increased the range of users and of uses. As the number of computers has risen, so has the need to put them into networks. As is frequently the case in the history of technology, one innovation begins to replace an older one by doing the same task before creating new tasks: in the sequence of replacing an old technology with a new one, the goal is to improve and speed up old tasks before doing anything else. "Initially, can a new technology only substitute for an old one? It is only later that the new one will be used for entirely different goals that will necessitate institutional changes in order to maximize their impact."[16]

The technological revolutions in electronics, information and telecommunications were going to recoup the political and economic rebounds of the 1980s to cause an organizational and industrial shock without precedent since the appearance of Fordism and Taylorism.

1.2.4 Institutional Restructuring of the Economy

During the postwar years, the American economy was organized around 500 major corporations, large companies which, circa 1950, alone produced about half of the national product, owned three-quarters of industrial stocks, reaped 40 percent of industry's profits, and employed one out of every eight workers. At the time, General Motors earned three percent of U.S. GNP, or about the GNP of Italy. Each sector was dominated by several giants, which were surrounded by their suppliers, resulting in a second circle of several thousand major companies that, in turn, were supplied by several hundreds of thousands of smaller companies of specialized goods.

Control, precision, exactitude, efficiency, mass production, large production volumes, achieving economies of scale and falling unit costs went hand-in-hand with the close collusion of a cartel and other sizable groups, all of which allowed for reasonable benefits and dividends, all within a firm and durable "social contract," for stockholders, workers and their unions, and for reinvesting.

This model corresponded to the mass production of standardized articles by semi-skilled workers, monitored by supervisors themselves using standardized methods of work and organization. The company's organizational chart closely resembled that of an Army division. Production methods were strongly inspired by *Operation Research* that had flourished during the Second World War to the greater benefit of the allies. Most company presidents and senior managers had been, moreover, officers during the war—the typical example would be Robert McNamara, who imported the *OR* methods and system analysis into Ford before going to do the same at the Pentagon.

[16] Peter K. Pitsch, *The Innovation Age: A New Perspective on the Telecom Revolution,* Hudson Institute, Indianapolis, Indiana, 1996, p. 29.

These huge enterprises were organized into hierarchical pyramids typical of military organizations: on top, the [president] who determined the overall strategy, assisted by a chief of staff who delegated to the senior vice presidents and division heads their operational tasks, the execution of which was carried out by middle managers, etc., with the blue collar worker at the bottom of this industrial army. An entire hierarchy employed military terminology (chain of command, division, division chiefs, standard operating procedures) so that a predetermined plan would be effectively put into action, production goals would be met, goods would be sold at a fixed price. Priorities and objectives were defined strictly at the top, while the bureaucracy was in charge of supervising lower level echelons and giving them orders while gathering information to send upward; as described by economist Robert Reich, "[I]n the Army, the greatest value was placed on maintaining firm control, on the ability of superiors to inspire loyalty through discipline and unconditional obedience and on the ability of subordinates to be inspired."[17]

The type of men wanted by the giants and their emulators were the organization men so finely studied by sociologist William H. Whyte.[18]

The prolonged miasma of the period of stagflation, which lasted from 1965 to 1980, affected this model most. Some of the giants of the postwar era foundered (PanAm, U.S. Steel, railroad firms) or faced ruin (IBM, Chrysler, Ford). From 1975 to 1990, these 500 premier companies did not add one net employee.

The organizational revolution which overturned the internal and external view of American businesses is based on the following principles:

The company is restructured. It eliminates earlier acquisitions from the era of conglomerates (ITT, for instance), if these new companies are outside its main business(es). The firm thus is recentered and reorganized around its core competency: instead of sending all the financial decisions and money flows to a central decision-maker, the company is broken into profit centers which are each responsible for its own operations, but must provide a share of the earnings to the federated entity. The firm becomes a network, allowing for a flattening of the organization and eliminating some of the intermediary levels traditionally devoted to vertical transmission. As the same time they are becoming flatter and less centralized, the resulting "horizontal" companies are separating certain functions from the firm in order to have the work done by contractors, the practice of outsourcing.

The basic units of a business, these profit centers, reorganize themselves in a modular way, through networking. The company, as a result, appears to be a sort of virtual company, with changing coalitions of profit centers that combine forces to handle a shared task, whether the commonality is shared geography or a production goal. There could even be a virtual company in which each of the functions essential to the production cycle, from conception to selling, would have a different responsible unit. This business will gladly adapt some of the ideas and practices developed by Japanese industry, namely, just-in-time delivery for inventory, total quality management—all requiring involved personnel.

The proof is in the decline of mass production of standardized items in favor of individualized or customized items. Mass-produced goods providing small marginal benefits and little value-added have been replaced by high value-added goods or services providing significant benefits at the margin. No longer are armies of semi-skilled laborers working, but instead technicians and specialized engineers. The ratio of blue to white collar jobs has been essentially abandoned, because the educational levels and qualifications of the workforce necessarily require a high degree of autonomy, often correlated to a high level of interest. The work itself has transformed: instead of assembly lines of unskilled or semi-skilled workers, of vast floors of accountants, routinization has given way to more creative and personalized work.

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[17] Robert Reich, *The Work of Nations: Preparing Ourselves for 21st Century Capitalism,* Vintage Book, New York (1992), p. 51.
[18] William H. Whyte, Jr., *The Organization Man*, Simon & Schuster, New York (1956).

This type of business is not interested in forging a strong, centralized bureaucracy that would slow the flow of information and the internal exchange of ideas: the business needs more horizontal coordination. Essential virtues are speed and agility; participating in an unregulated or minimally regulated market; competing against similar companies, even those from other countries; an ability to form coalitions; adapting products and services to swiftly evolving demands; offering specialized services for niche markets and are its trump cards. Above all, the firm needs to experiment, which is something a small team accomplishes better than a large entity.

It is precisely this type of company that has created the most job opportunities in the United States over the last twenty years. According to Robert Reich, former secretary of labor under the Clinton Administration, jobs of this type represent more than 40 percent of American employment.

Silicon Valley symbolizes this type of business. Such a degree of decentralized modularity would be unthinkable without the networking capabilities of a PC connected by modem to the internet: this technology recognizes the social structures that it can exploit and develop; these organizational forms welcome technologies that allow them to spread.

To the extent that Silicon Valley is a representative microcosm of the burgeoning U.S. and world economic "universe," it is interesting to note a British analyst's discernment of its characteristics:

- decentralization and networking
- tolerance of failure
- tolerance of duplicity
- risk-taking tendencies
- high degree of reinvestment
- enthusiasm for change
- merit promotion
- openness
- obsession with the product
- collaborative efforts that mix individualism and communalism
- variety
- acceptance of anyone and everyone as legitimate participants in the "game"
- noninterference and invisibility of government authority[19]

Whether one accepts this vision, the proof of movement in this direction is in the market itself. IBM sold its first PC only 17 years ago; Armonk was forecasting the sale of about 250,000 PCs—the ten million mark was surpassed in 1991. In 1981 the Department of Justice filed an anti-trust suit against IBM without being aware that technology and the marketplace would bring Big Blue to its knees. As this had not been foreseen by anyone, its consequences were absolutely unpredictable. The continuing fall in microprocessor prices and their increased capacity have reduced the costs of production, inventory, and the transmission and analysis of data, which has led to an information explosion, during which the falling price of telecommunications has driven up the demand for computer connectivity. The new family of technologies, after having served to handle traditional tasks and functions better and faster (calculation, publication), created entire areas of new functions, leading in turn to new tasks, causing the development of new technologies.

[19] Survey cited in the *Economist*.

The information highway, the principal innovation of this *fin de siècle*, has developed without being made, or as might wrongly be inferred from its name, dependent on a large, costly and immobile infrastructure such as the railroads or freeways; the information highway comes out of decentralized networks, in the image of the society in which it was born.

There are many chain reactions that ensue.

2: Geopolitics and Institutions

It has been said that inventing does not suffice, one must still innovate: to move from the idea to the action, the scientific breakthrough to the technical application to the industrial process, and, it could be added, eventually to marketing and sales in order to encompass everything entailed by a leap into the unknown. The ability to perceive a new idea, analyze it, integrate into a setting where it will expand, in short, to make something requires innovation. Failing to find fertile ground, this [innovation] will fade away or seek a more propitious setting.

An entire society's perception of innovation can be placed in a larger context, that is, the process through which this society arrives at a decision, in the same way the visual apparatus, neurologically speaking, belongs to the larger category of general thought processes.

From this vantage point, the United States has an exceptionally rich number of decision-making sources. This study proposes then to analyze the way in which the American system has institutionalized this diversity.

Second, this section will examine how the system has responded to the new geopolitical situation, dating from the end of the 1980s.

2.1 Institutional Fluidity

2.1.1 Multiple constituencies

The word *supra* has been evoked to describe the role of the separation of powers in the United States. It is necessary to add the role of regional power, both in the sense of the extensive powers devolved to the state level and in the sense that history, traditions and practice have formed regional identities and geography: the South, Midwest, and West Coast are quite far from Washington (DC) and, in many ways, are little concerned about what happens in the capital.

This portrait also needs to touch on the multiple centers of power—economic, social, religious, and cultural—that exist in the United States.

Finances: if New York remains the leading financial metropolis, Boston, Chicago, Dallas, [and] San Francisco are also powerful financial centers. The Federal Reserve is a federation comprising 12 banks of the federal reserve, instead of 12 regional branches connected to a central bank. Economically, the United States lacks a center. The airline infrastructure makes the case: there is no center from which flight paths radiate, but multiple hubs with interconnections; accordingly, St. Louis, Chicago, Dallas, Washington-Baltimore are all locations of hub airports.

The nation has never had a state religion—the separation of church and state is a constitutional principle because the First Amendment states, "Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof"—nor does it have a religious center, but a disconcerting number of faiths ranging from major, worldwide religions to small, independent ones.

Even if metropolitan Boston, in particular, and New England, in general, offer quite a few excellent universities, New York, Washington, Chicago, California, and many other cities constitute centers attaining the best levels of research and teaching. There is even a university in Nevada's desert.

Socially, the country's wealth guarantees an explosion of power. Nations in which a few monopolize the wealth, most of the population is miserable, and only a tiny portion belong to the middle-class, are also

nations in which power is monopolistic, or at best, oligopolistic, with power shared among a few families. This is essentially the pre-democratic, pre-republican model that dominated history before the industrial revolution. To the contrary, a wealthy nation, blessed with a sizable middle class comprising the majority of the population and its wealth, will lead both to the growth of a powerful and diversified civil society and an even greater distribution of power, because all the types of associations that cover the United States represent pieces of political, social, religious, cultural, and other power.

This is not a unique model. The horizontal links and the vertical separation work together. It is the rule of multiplicity.

The intense movement from one geographic area to another, from one social or professional domain to another, and even, within certain limitations, from one social class to another, is the well-known American mobility. As has been discussed, these different types of mobility increase the number and variety of mutations, allowing for an improved mix.

The fluidity of movement, whether of goods, people or ideas, is therefore part and parcel of this society, whatever may be the inertias, which inevitably affect any of society's institutions, according to this principle: the older and more important an institution is, the more it provides inertia. Of course, the behaviors of a [royal] court can be found in the United States. But the absence of a unique court diminishes its influence.

2.1.2 Contradictory Debate

To repeat, the American nation results from a voluntary contract between parties; the concept of a social contract is not a noble metaphor, as it is in Europe, but a basic reality. *A fortiori* it is the same for the government (the state). In Europe and even more so in Asia, [government] administration originally played a major role in history, whether royal or imperial. Its procedures are still often marked by this genesis: secrecy, opacity, reserved areas, special laws reserved for it. The formation of large bureaucracies, using Weber's meaning, has certainly given the government its power, its efficacy, and often a measurable impartiality. But often, these have not overcome the lack of transparency, the monopolization of power that keeps the public and even representative bodies from partaking in decisions, or even knowing the facts and most elementary procedures: imagine Wilhelm's army, a corps completely estranged from and hostile to its society; think of the hidden world of Her Majesty's Service, the existence of which is still veiled under the official secrets act; consider finally the completely opaque procedures of the Italian government from which basic decisions about the nation emerge, Athena-like, without any contradictory debate.

Now, even guarding against praising the American model for nonexistent virtues, it is necessary to state the common-law notion of "contradictory debate in open court," which is largely applied to political decision-making: a well-informed debate occurs in the public arena, not through elaborate political machinations behind literally closed doors; it is an open-door debate.

Obviously, secrecy exists. The United States, for example, supports a secret aeronautical industry, the structure, location, budgets, and companies of which are classified and little information filters through to the even well-informed; this is where spy satellites, such as KH-11 and surveillance aircraft are built. But this discussion is examining how politics are structured, not the actual policies. Since the efforts of the Church Commission 20 years ago, the secret world of the CIA has shrunk. DIA and NSA continue to protect their classified information, barely. Here too, intelligence agencies are the means and not the ends. In short, if the political tools of the state sometimes operate in an opaque way, the means to develop policies have been gradually opening over the last two decades and the choices are essentially open to the public, or at least to interested parties.

In studying American defense strategy politics, what is striking is the number of people involved. Whether it is the list of witnesses testifying before the Senate or the House or the issues debated on op-ed pages, there is a deafening diversity of opinion, the antithesis of corporatism or of a monopoly on ideas:

(a) executive branch
- White House and National Security Council staff
- staff, and information and research agencies of the Pentagon, Planning Staff, Office of Net Assessment, etc.
- specialized federal agencies and departments: NASA, Arms Control & Disarmament Agency
- other governmental entities such as the Defense Science Board
- 600 national laboratories, for instance, Lawrence Livermore National Laboratory

(b) legislative branch
- numerous experts on representatives' personal staffs
- experts on committees staffs and other congressional agencies
- experts from congressional agencies such as the General Accounting Office (GAO), Congressional Budget Organization[sic] (CBO), Office of Technology Assessment (OTA), etc.

(c) armed services
- research staff of the Army, Air Force, Navy and Marine Corps
- war colleges: Naval War College, Air War College
- military academies: West Point and its famous military history department, Citadel, Annapolis
- armed services universities and quasi-universities: Air University
- doctrine institutions such as TRADOC
- various publications from the armed services: *Marine Gazette, Parameters, Airpower Journal, Joint Forces Quarterly, Naval War College Review*, etc. The U.S. Army alone sponsors or publishes at least 26 periodicals on military doctrine.

(d) semi-governmental bodies
- National Research Council
- research institutions linked to the Pentagon: Pacific Sierra Research Corp., IDA
- research institutions linked to a particular service branch: RAND, Center for Naval Analysis
- research institutes linked to the services: National Defense University, Defense Intelligence College
- private research institutions contracting with DoD: Systems Planning Corp, SAIC.

(e) semi-public and university research bodies
- public interest organizations: Brookings Institution, Carnegie Endowment for International Peace, Center for Strategic & International Studies, Aspen Institute, Hoover Institution
- numerous university entities: nearly every university has a department examining defense and strategy: Harvard's John Olin Institute for Strategic Studies and Kennedy School of Government, Johns Hopkins University School of Advanced International Studies, etc.
- specialized institutes at MIT, CalTech, Georgia Tech
- other research institutions: Hudson Institute, Foreign Policy Research Association

(f) partisan groups
- ideology-based organizations: Heritage Foundation, Progressive Policy Institute, American Enterprise Institute, or more modestly, the Center for Defense Information or the Center for Strategic Studies.

- research organizations linked to unions or businesses: Economic Policy Institute, Economic Strategy Institute

(g) civic organizations and charitable foundations who fund public interest projects
- foreign affairs: New York's Council on Foreign Relations, Chicago's Council on Foreign Relations, Council on World Affairs of San Francisco (each major city has one), Atlantic Council
- civic-minded private groups: Business Executives for National Security, Lawyers Alliance for World Security
- foundations: Rockefeller Foundation, Rockefeller Brothers Fund, Twentieth Century Fund, MacArthur Foundation, Ford Foundation

(h) the private and commercial sector
- for profit research institutes: Kissinger Associates
- consulting firms: Arthur D. Little
- innumerable Beltway consultants, including specialized budget consulting, such as the Center for Strategic & Budgetary Assessments

(i) industry
- legions of experts at major defense contractors and in the aerospace industry
- industry associations, worldwide ones such as the National Association of Manufacturers or the American Chambers of Commerce or an industry branch like the American Electronics Association. There are hundreds of such organizations, if not more, and most have well-qualified staff.

(j) the media
- directors and associates of the major international and strategic affairs journals: *Foreign Affairs, Foreign Policy, International Security*
- editors of defense publications: *Defense News, Aviation Week*, etc.
- specialized editors of daily papers: *New York Times, Boston Globe, Christian Science Monitor, Washington Post, Washington Times, Baltimore Sun, Chicago Tribune, San Francisco Chronicle, LA times, Seattle Examiner, Wall Street Journal*, etc.
- national weeklies: *Time, Newsweek, U.S. News & World Report*, or opinion: *New Republic, National Review*
- network television: ABC, CBS, NBC and CNN; press agencies such as the Associated Press; radio such as Voice of America, Radio Free Europe/Radio Liberty

(k) scientific organizations or scientists
- scientific organizations: American Association for the Advancement of Science American Academy of Arts & Sciences
- more active scientific associations: America Federation of Scientists, Concerned Scientists, etc.

(l) military lobbies
- veterans' organizations: American Legion, Veterans of Foreign Wars
- organizations established around a service such as the Association of the U.S. Army

This list, despite its length, is not comprehensive. It does underline the point that discussion and debate draw many varied participants. It also indicates the existence of a defense and strategic affairs community, comprising tens of thousands, perhaps hundreds of thousands of individuals who, to differing degrees, create an impact in this domain.

This is because each of the named institutions above produces studies and reports, in short, knowledge and recommendations. The members, directors and researchers participate in meetings, conferences and colloquia, are called to testify before Congress and sit on government commissions. The debates taking place within the national security community become part of the public domain, finding outlets in the press and specialty publications, for the informed and the general public.

A large number of people participate directly in the national discussion. An extraordinarily complex process of integration allows, in effect, the contributions of many people, groups and organizations to the discussion.

First, the participants are accustomed to interacting with each other through the many organizations that mix, match and work together in different arenas. A Pentagon special panel will bring together senior officers of one or more services, information specialists, scientists, defense industry personnel, strategists, military historians, members of Congress, congressional staffers, civilian bureaucrats from the Pentagon, academics... These actors learn to meet, to get to know one another, to finish a given task, whether it is to assist with deciding on future weapon systems—this could be, for example, a stealth technology defense review, led under the aegis of the U.S. Air Force—or organizational plans or evaluations (such as the Gulf War Air Power Study). Prolonged contact between academics and military personnel, for instance, tends to form a climate that encourages reciprocal exchanges of ideas and creativity. Those who work eight hours a day together twice a month, over one or two years as part of an advisory board or a technology review panel are going to hasten the spread and acceptance of ideas.

This practice is systematic and widespread. It does not, however, eliminate factions or differences. Rather it contributes to creating a setting.

Having many institutional centers also allows for many sources of suggestions. A rejected idea from one Pentagon decision-making node might find refuge in an Army or Marine research institute, which would refine the concept before once more placing it on the table. One domain reacts to another and its ideas or suggestions take hold. An idea, a plan, project, whether it is doctrinal or organizational or part of any other aspect of defense and strategy, no matter its value, can find refuge and institutional support in the wide range of pertinent organizations.

The diverse source of ideas and the many ways they can be filtered to the top guarantees they will have their day in the sun, or at least be debated and tested, before being quashed. The extraordinary public debate over the future of aviation in the 1920s (and which was capped by the “Billy Mitchell Affair”) is a significant example in which Congress fostered the vast, visionary designs rejected by the Army and Marine Corps, and allowed them to be developed in front of public opinion. Also to be remembered is the famous example of the Senate demanding, and obtaining from the U.S. Navy, Admiral Rickover’s name on the list of promotions.

The constitutional checks and balances prevent (to an extent) the abuse of power reflected here; the wealth of viewpoints and the institutionalization of different opinions, integrated in many cases, permits the checking and balancing. As a result, the legitimacy of similar views having been accepted, these viewpoints are integrated, whether in private or publicly, by the executive or legislative branch, all having contributed to the decision.

In the arsenal of institutional settings that integrate different opinions to put them into effect, there are presidential commissions; other entities created under permanent statutes such as a presidential foreign intelligence advisory board, which brings together experts, not in intelligence, but who are primarily from outside governmental bureaucracies; and blue ribbon commissions, a temporary entity limited to a question or particular mission. A good number of these are dedicated to defense issues: a congressional panel of investigation, which has the authority to call civilians, military chiefs, [and] all kinds of experts to testify [before Congress].

A similar function could also be filled by a private entity, of known nonpartisanship: this might be a research committee formed by the Council of Foreign Relations or the Carnegie Endowment or a bipartisan commission to pull together all the major points of view. This type of committee will meet one or two times a month over the course of a year, bringing in outside presenters and committee members to discuss the relevant issue. A report will be issued to concerned parties, distributed and published in book or monograph form. The major news outlets will mention the report, while the trade press will study it.

The fluid, professional circulation of people and careers functions similarly as a way of diffusing ideas: a fighter pilot may earn a Ph.D. in physics, go to DARPA before teaching at Georgetown University, do a stint in the Pentagon before researching strategy for CSIS or teaching at the Air Force War College. These plans for an extremely varied career—which do not demand boxing oneself in, but continue until retirement—form a powerful means of spreading new ideas. An idea never stays within its place of origin; its dissemination is virtually assured.

Let's return to the already formulated thesis, according to which the entire society, or the entire market, is the "tool of discovery" that permits the optimal use of resources. The above analysis on the integration process of defense politics holds to the same principle: a highly diverse community in which complex interactions allow for the best testing of proposed hypotheses on the debated subject and, despite the inherently flawed nature of manmade institutions, arrive at the best possible—even if imperfect—decisions for the here and now.

This, of course, guarantees nothing. As the respected defense scholar Richard Garwin explains, "The revolution in military affairs is above all a long struggle and victory against bureaucratic stupidity, inertia and lethargy."[20]

2.2 Strategic Innovation: Geopolitical upheaval

With the collapse of the Soviet Union, an essential part of the balance of power in the 20th century, more has changed than just the 23 million square kilometers lopped off the USSR. If geopolitics operates metaphorically like a magnetic field, then the sudden disappearance between 1989 and 1991 of one of the magnetic poles by necessity demands a redefinition and a reorientation of all the other parts of the system, beginning with the other pole, the victorious power.

Since its full entry into international affairs, first under the more or less limited form of McKinley's and Roosevelt's imperialism that was active in the Pacific and Latin America, then in full force with the American intervention into the First World War, the United States has been one of the key elements in the international system. In Mackinder's geopolitics, global equilibrium rested on the heartland, the center of the Eurasian world. The two axes were the Yenisey and the Missouri. Spykman corrected or, rather, adapted this view of the postwar world in underlining the importance of the *rimland*. A major maritime power would be important in this construct.

But, with the collapse of the great continental power of Eurasia, world geopolitics kept a significant surprise from the United States. In a no longer bipolar world, where there is no other superpower, in which potential candidates for superpower status are not exactly plentiful, at least not for the foreseeable future, the United States finds itself the lone superpower, as spokespersons at the end of the Bush Administration made known far and wide.

As the sole head of the world hierarchy, the United States alone possesses all the determinant active and passive criteria of power: territory, population, geographic position, natural resources, industrial might,

[20] Interview with author, June 6, 1997.

scientific and technological excellence, monetary influence, commercial and financial institutions, educational quality, military and strategic power, alliances, a preponderant presence in various spheres (land, air, sea, space), self-affirmed identity, a sense of its own importance... All the other countries might have at their disposition many of these criteria, but none could begin to master the entire list. A given nation might surpass, even to a large extent, the United States in a particular criterion, but the gulf which separates it from the United States in the other remaining categories is insurmountable.

It is never simple after a major shift to redefine the national interest, a corresponding strategy, the operational means to put it to work, and the doctrine to guide the strategy and means. Only the passage of time, which shortens and deforms perspectives, would lead one to believe that the Cold War strategy of containment came fully armed out of the heads of General Marshall, Paul Nitze and *Mr. X*…. of 1947. Visions of the post-Cold War world have been debated now for a decade in the United States. Francis Fukuyama, Samuel Huntington, Paul Kennedy, Robert Kaplan, the Tofflers, Edward Luttwak, and many others have tried with varying degrees of success. But without a doubt such a redefinition is never more arduous than when the source is uniquely positioned; there is no enemy against which the United States can judge and measure its strategy.

The United States was, at the time of its first doctrine of international relations—the refusal of foreign entanglements originated by George Washington—a new and weak nation, at the mercy of outside intervention, as shown by the War of 1812 when the British burned the capital, Washington.

The second doctrine, formulated in 1823 by James Monroe, badly rendered as "America for the Americans," and stated better as "the Americas for North and South Americans, others keep out," was to protect the Caribbean and Latin America from imperial European invasions. The United States henceforth dedicated itself to conquering and developing its interior. Its limited international power, however, allowed it to avoid European (French or British) intervention during the Civil War.

The third doctrine, promoted by McKinley, Teddy Roosevelt and imperialist ideologues such as Herbert Croly, sought an end to a tenacious isolationism by inspiring colonial policies in the name of America's *manifest destiny*. America becomes a power, able to intervene in China, to impose itself as a mediator between Russia and Japan. The America of 1918 already is a great power; it was behind the export of armaments. But lacking a domestic consensus, it returns to isolationism between the world wars.

Since the shock of December 17, 1941, the international politics of the United States is a global strategy. During the entire Cold War, the United States was one of two superpowers. And since the fall of the Berlin Wall, the United States "of the year 2000" is the unique world hegemon. Most analysts see the present as a strategic lull, haunted perhaps by the notion of a peer competitor appearing one day.

Much hesitation is the price of all this. The disappearance of the sworn enemy, and with him the list of sworn enemies which had constituted the thorns in American foreign policy: the kaiser and European emperors, Hitler, Mussolini and Admiral Tojo, Lenin, Stalin and Brezhnev, Mao… As for Saddam Hussein, he is but a shadow of the Great Tyrants. General Aidid was momentarily promoted to the rank of a shadow of a shadow; it was quickly realized, whatever CNN imagined, that there was no point in making a mountain out of a molehill. The remains of communism in Cuba and North Korea, although watched, have fallen far below the strategic threshold.

Thus, the entire view of the world had to be reinvented. What a shock! American public opinion is rarely suspected of exhibiting excessive interest in the rest of the world, having been exposed to the slogans such as "the peace dividend," "the end of history" or, better, "neo-isolationism," [which were] spontaneous reactions to a situation more than reflective visions. The slogan "New World Order," thrown in hastily by some speechwriter of Mr. Bush, did not last a season. The isolationist fringe is miniscule, limited to a small number of Patrick Buchanan supporters on the far right and Ralph Nader supporters on the far left of the electorate. Discussing "continentalism" is more suitable, which puts Americans in the

forefront without implying retreat from—impossible—the rest of the world. The Carter-Wilsonian multilateralism that enlivened a section of the Clinton Administration in the beginning gave way to the shock of reality.

Opinions have not yet crystallized into "hard" options. From the overall strategic viewpoint of the United States, the *Bottom Up Review* put forth by the former Secretary of Defense Les Aspin or the *QDR* of last May are mostly exercises in indecision. It is possible, however, to distinguish the outlines taken by various historical-geopolitical schools of thought, whose theses sometimes draw on each other and which are not always mutually exclusive. The major choices of the next years will undoubtedly reflect a synthesis of these ideas:

- the school identified with Francis Fukuyama: his hypothesis of the "end of history" marked by the clear triumph of democracy and the marketplace is quite damaged by developments in recent years. The very multilateral implications of this analysis, that is, involving the United Nations, has retreated before a more realistic political approach.

- Samuel Huntington's "clash of civilizations" thesis, object of fierce polemics, which seems to have covered more media than political terrain.

- the concentration on two great future enemies: radical Islam and China

- the *realpolitik* current, aimed primarily at preventing the rise of a Eurasian power, China being off in the distance; this geopolitical view is the basis of *From the Sea*, the official doctrine of the U.S. Navy.

- the concept that the main enemy is chaos—the central idea behind *Project 2025*, sponsored by Admiral Owens during his tenure as vice chief of the Joint Chiefs—"The threats below the threshold of danger for us, non-essential threats, could snowball and cross over the threshold," explains the project's director. In his [the director's] version à la Spengler or Toynbee, such an idea could feed the defeatism of an empire in decline. In the more generally held version, the ideas have more force and energy.

- the image of the United States as a world hegemon charged with the inherent responsibilities of the position.

The word "hegemon" does not imply "empire." In the traditional sense, logically and historically, it has the implication of power imposed arbitrarily, through force or threat, and which oppresses the peoples in its sphere. In contrast to the lazy usage of the term, premised on U.S. power and its often arrogant and invasive behavior which thoughtlessly rubs against other national sensibilities, it is important to distinguish and not conflate imperial politics on one hand—the Persians, the Middle Kingdom, Rome, Charles V, Queen Victoria—always accompanied by an imperial ideology (*Austria est imperare orbis universum*) and [on the other] a unique superpower toward which everyone else turns.

Cabanis the Ideologue believed at the end of the 18th century that the brain secreted thought like a gland. National interest is not spontaneously secreted by some strategic gland; a nation, were it a superpower, has no other interests than those it knows and recognizes; national interest and strategy must be grabbed, described, taken apart and codified.

American geopolitical thinking, finding itself at an exceptional juncture, has run into a technological and an economic revolution. It has been necessary, it is imperative, to reconstruct a vision of the world in which the puzzle pieces can be adjusted.

Already the telltale signs of this readjustment are discernable in the *dénouement* of the Cold War: after four decades of conflict, in the 1980s everything focuses on the Soviet perception that there was a "military technical revolution" underway in the United States. Marshal Nikolai Ogarkov and his team see in the future where conventional long-range precision strike is capable of inflicting damages along the lines of nuclear arms, while avoiding [the use of] nuclear force itself, the premise of a new strategic order. Military Soviet leaders were interpreting Air-Land Battle as a creation of the United States, thanks to precision technologies, electronics, automated C2 systems, and long range precision munitions, of a superior force in Europe that Soviet doctrine viewed as "complexes of information and assault."[21] Guided missiles, "new means of intelligence and radioelectronic combat" were going to change the face of a European war. The Gulf War was *post facto* going to confirm their fears of seeing western nations proceed to "incorporat[e] information sciences in the military sphere."[22]

The taking stock and interpretation of Ogarkov and company of a "military-technical revolution" underway in the United States was leading them to form a strong alliance with KGB reformers, headed by Yuri Andropov, and to support the new scientific, technological and managerial intelligentsia in order to prepare those reforms susceptible to permitting the USSR to counter the threat and maintain technological parity.

The subsequent wave of revolutionary innovation, in the form of the Strategic Defense Initiative, caught Moscow unprepared: the capacity to mount a Soviet techno-industrial counter-response was completely saturated. The ratio of the military economy to the civilian one was already unsupportable. The appeal to doctors, to Evgenii Velikhov, to Rudakov, to sociologists, to Zaslavskaya and her colleagues at Novosibirsk, could not compensate for the vast range of technologies put into SDI—the lasers and directed energy weapons, calculating power of computers, miniaturization, system integration, space, precision …

The hopeless efforts of the last years of the USSR to respond to the technological emergencies and to their military applications were underwriting the ill-conceived reforms and the regime's fall.

The meeting of geopolitics and a revolutionary innovation in military affairs has thus already happened.

[21] Cf. Mary C. FitzGerald, *Marshal Ogarkov & the New Revolution in Soviet Military Affairs,* Center for Naval Analyses, Alexandria, VA, 1987 [CRM 87-2].
[22] Mary C. FitzGerald, "The Soviet Image of Future War: Through the Prism of the Gulf War," in C*omparative Strategies,* vol. 10, no. 4. (October-December 1991), p. 398.

3: Civilian and Military Developments/Evolutions

War does not belong to the arts and sciences
but to society. It is a conflict between important interests
differing only from society in that it is resolved in blood.
It would be better, instead of comparing war to any
other art, to compare it to the competition among
businesses, which is similarly a conflict among human
interests and activities. Even more so, war resembles
politics, which can be thought of as business
competition on a higher level.

Karl von Clausewitz

Major changes in military affairs are traditionally linked to four main causes:[23]

In the first case, direct, external reasons: a defeat or worse, the crushing rout of a country's armed services. Such would be the Prussian armed forces crushed by Napoleon at Jena and Auerstedt in 1806. The former military elites are set aside, while the panicked political elites yield their place to new leaders who draw radical lessons learned from the defeat. New technologies and doctrines are useful for starting afresh. This is also the situation of the German army following 1918. And it is the case for the U.S. Army after the Vietnam mishap: there is a radical and overarching self-examination.

Second, indirect external causes: innovation in response to an enemy and the threats it brings to bear. The arms race of the Cold War is such a case, where each side is constantly trying to upset the technological balance to match the other side's perceived or actual superiority while protecting itself offensively and defensively. A geopolitical variant also occurs: the threat of a clearly designated enemy. Other arms races illustrate this concept. These include the decades before the First World War, as well as today's regional arms races between rivals, such as on the Indian subcontinent and in south Asia.

A third cause results from internal upheaval, a revolution that, overturning social and political relations, shakes up the military. This is the French Revolution: *levée en masse*, politization and nationalization of war, revolutionary ideological warfare, [and] the immense rise of the Third Estate; Carnot, Monge and Chaptal's application of science and scholars, shooters; innovative strategy, doctrine and tactics are only possible in such a setting. The Russian Revolution, which went from the "steam roller" Russian armies of 1914 to the Toukhatchevsky version of the blitzkrieg, is another example.

Fourth, especially during prolonged periods of peace,[24] when there is little opportunity for wartime experimentation, technological innovation may give birth to a major strategic innovation such as is realized in an RMA. The development of railroads, beginning in the 1820s, led to their first strategic application in the Prussian wars against Austria. Fifty years later, they were also used against France. The true tank revolution and combined operations with aviation took place in the interwar period.

When looking at the collection of facts and projects assembled under the term "RMA" in the United States, one first notices that the Vietnam War had a powerful impact on weapon systems and that the defeat had a measurable impact on military attitudes and doctrines.

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[23] Cf. Stephen Peter Rosen, *Winning the Next War: Innovation & the Modern Military*, Cornell University Press, Ithaca, NY 1991.

[24] Cf. James R. Fitzsimonds and Jan M. van Tol, "Revolutions in Military Affairs," *Joint Forces Quarterly,* Spring 1994, pp. 24-31.

Second, the Cold War arms race pushed the development of military technology considerably. Admiral William Owens notes in his discussion of the Gulf War and the beginning of the RMA, "The technology was already there, underwritten by the last two decades of investment during the Cold War."[25]

Third, even though the United States has not undergone a revolution in its classic political sense, the length and depth of U.S. economic and societal transformations over the last two decades certainly are worthy of the sobriquet "revolution." Fourth, the technological transformations during this period have not been any less revolutionary.

The "engines" of [this] RMA are thus all the traditional engines of a revolution in military affairs, except those caused by the existence of a sworn enemy, which today does not truly threaten the United States. Today, if one were naming a principal engine behind the RMA, it would definitely be societal and technological evolution. As Admiral Owens said, "The first reason for defense planning is no longer the threat but the capacity, it is no longer passive but an opportunity."[26]

Ryan Henry, a researcher for DARPA and CSIS, developed a theory of innovation, founded, he explains, on that of Friedrich Engels:

There are three types of innovation:

- **European**: technology helps improve what I have done before
- **East Asian**: to make an order of magnitude better
- to do that which I was unable to do before, that is to develop another degree of freedom.[27]

Here one can see the resonance and impact on military affairs that come out of the civilian economic and social evolutions discussed in the first part of this report.

3.1 Dematerialization

3.1.1 The least density

During the wars of Antiquity, writes former Army Chief of Staff General Gordon Sullivan, human density on a battlefield was about 100,000 people per square kilometer. During the Napoleonic era, the density established was around 4,000 people per square kilometer. During the First World War, there were no more than 404 people per kilometer squared. This number was further reduced to 36 during World War II and then to two to four people during the Gulf War.[28] RAND analysts, measuring the number of soldiers along a front, speak of soldiers stacked 2.5 to 5 per meter during the American Civil War, compared to the ten or so kilometers occupied by a division in World War I or the 30 kilometers occupied by one in 1986

[25] Cited by James Blaker, "Understanding the RMA: A Guide to America's 21st Century Defense," Progressive Policy Institute, Defense Working Paper #3, 1997, Washington, DC

[26] Admiral W. Owens, "The Emerging System of Systems," U.S. Naval Institute Proceedings in Military Review, May-June 1995, p. 15.

[27] Interview with author, May 29, 1997.

[28] Gen. Gordon Sullivan and Col. James Dubik, "Land Warfare in the 21st Century," in *Military Review*, vol. LXXIII, no. 9, September 1993, pp. 22-3 and 28-9.

in Europe.[29] The threat of nuclear weapons quickened the dispersal of ground troops, a trend that will only increase in the wake of the threats posed by long-range precision strike missiles.

How densely packed a battlefield should be depends in many ways on the economic and logistic arrangements brought to the battle. Fires can be brought to bear from beyond the line of sight. Ground occupation density falls [inversely] to greater lethality and the resulting vulnerability of the soldier and the platforms he uses. All the identifying signatures emitted by armored platforms—thermal, acoustic, seismic, chemical, electromagnetic—render them more and more costly to protect against their growing vulnerability to precision strikes: this queen of 20th century ground warfare is becoming obsolete. It is necessary to "increasingly seek protection through greater mobility as opposed to physical protection (e.g., armor, weight)" asserts one of the most innovative thinkers in the American military debate, Andrew Krepinevich.[30]

There are many reasons to think that unit and soldier dispersion will continue to grow, which is certainly the take of the U.S. Army in its main doctrinal documents such as *Joint Vision 2010, Force XXI,* TRADOC P-525 and FM 100-5. Secretary of the Army Togo West explains, "Units will be tied more through electronic connectivity than physical or geographical connectivity."[31]

By operating in small, dispersed units, soldiers will be linked electronically on this depopulated battlefield. For RMA thinker Michael Mazarr, "Combat is a reflection of a historical trend. Over the course of centuries war has been the sum of thousands of individual battles in which combatants fought face to face … in the future, war, more than large, compact units advancing the line of battle, will resemble a confused patchwork."[32] No longer will there be a front line of opposing forces. The Marine Corps has already altered the distance at which it engages forces from 1,000 to 10,000 meters. [33] Stephen Rosen, an analyst of military innovation, says, "This makes a significant difference in decisively going in and winning a conflict like the Gulf War with 50,000 men instead of 500,000. It's truly another dimension."[34]

The battlefield, where any "signature is deadly," becomes insupportable, because there are no safe distances from the fighting. The tank or combat vehicle is too expensive and too vulnerable to be able to defend itself against an adversary's long-range precision strikes; not worth risking on the battlefield, [the tank] will disappear. As the battlefield becomes more dispersed, maneuver will rise in importance. Combat will be between long-range strike units, not between corps and divisions along a front.

In sum: the increased ability to strike precisely allows for a growth in the ratio of fires to mass (the destructive power per unit of mass), which can be exploited either by increasing the amount of fire power generated by a unit of mass or by shrinking the mass needed to fire to enhance portability and/or speed. This principle has led to reductions in the logistics train, permitting units to increase their agility and speed as well as the dispersal of the "iron mountain" stockpiles. The relation between fires and strikes, historically 90 to 10 is reversing: successful strikes are almost assured.[35]

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[29] Samuel Gardiner & Daniel B. Fox et al., "Understanding RMAs," RAND Corp., NDRI, April 1995, DRR 1009 OSD, p. 44.
[30] Andrew Krepinevich, "The Military Revolution: Restructuring Defense for the 21st Century," testimony before the Senate Armed Services Subcommittee on Acquisition and Technology, May 5,1 995.
[31] Togo West, testimony to the House of Representatives, February 22, 1995.
[32] Michael Mazarr, "The RMA: A Framework for Defense Planning," 5th annual conference, *The RMA: Defining an Army for the 21st Century*, Army War College Strategic Studies Institute, April 1994. Published June 10, 1994 by AWC-SSI, p. 79.
[33] *Defense News*, March 15, 1996, p. 37.
[34] Interview with author, May 22, 1997.
[35] Seth Cropsey, "Omniscient, omnipresent, omnipotent: O^3," *National Defense,* April 1997, pp. 51-62.

We have moved from a regime in which military conflicts relied principally on manpower as its main material of consumption (i.e., wars of antiquity, 18th century wars) to one in which industrial products, munitions, etc., are the main materials of war: this is the industrialization of war which began in the 19th century and reached its culmination in World Wars I and II. Its principal hallmark is capital-intensive warfare in which capital is substituted for labor. This is similar to the distinction Alvin and Heidi Toffler make between the First and Second Wave wars. In simplified form, what they describe as the Third Wave features the replacement of heavy industry by information technologies. This is precisely the driving force behind the decentralization that we see in the civilian sector.

This evolution is not suddenly replacing one set of systems with another, but occurs in a series of adjustments, of partial replacements permitting different organizational paradigms to coexist for a long time. Modern warfare has not eliminated its predecessors any more than has "post modern" warfare. Information technologies have not replaced weapons based on principles of energy and mass; they have made the latter infinitely more effective.

Just as the commercial sector has learned, change, virtual reality, the development of symbolic language, and non-linear interaction predominate today. Similarly, *intelligence* is no longer the result of data gathered before combat for integration into plans; now it is obtained, interpreted and distributed in real time. Intelligence has become more and more a direct part of operations.

3.1.2 Smart Bombs

The central image is the Thanh Hoa bridge, which shows up as a *leitmotiv* not just in specialized literature but as part of the American political dialogue, [such] is the impact of this event.

It is known that the two railroad lines providing North Vietnam with military supplies from China converged near the Paul Doumer bridge over the Red River, and that the Haiphong line, the other major entry point for logistics joined the two lines at the Thanh Hoa bridge which crossed the Chu River. From this point, logistics could be transported toward Vinh to aid units in the south or toward Laos along the Ho Chi Minh trail. The entire logistical effort of the North Vietnamese crossed over these two bridges. The classic strategic bombardments by the Americans were complete disasters: beginning April 3, 1965 a sortie of 79 bombers, including 46 F-105s, attacked the Thanh Hoa bridge, releasing 120 750-pound bombs and 32 guided missiles. Little damage was inflicted and two planes were lost. The following day, 384 750-pound bombers were dropped; pilots confirmed that 300 failed. Three attackers were hit.

Certainly, French civil engineering played a role in the survival of the bridge. During 1967-68, 177 sorties and more than 300 tons[36] of bombs were required in order to put the bridge temporarily out of commission. But the cost in equipment and pilots forced an end to the attacks. The Americans waited another four years before finding a military solution to this problem. Even as wave after wave of B-52s in *Operation Linebacker* destroyed Hanoi without weakening the North's offensive capabilities, these two "cursed" bridges were finally destroyed in 1972: on April 27, a sortie of 12 F-4 Phantom, four of which used 2000 pound bombs, attacked the target and destroyed it. The difference this time was the use of a "smart" bomb. These bombs possessed electro-optical guidance: the bomb was equipped with a small television camera, and the co-pilot could use the information from his screen to pick the desired point of impact. Then it was fire and forget. This second bomb, the *Paveway*, had laser guidance.

Five bombs with electro-optical guidance were dropped on the Thanh Hoa bridge, hitting the target, and the bridge was put out of use. A new assault occurred May 13: 14 fighter-bombers dropped nine laser-

[36] The text does not specify whether these are English or metric tons.

guided bombs, 15 EO bombs and 48 conventional bombs. One arch was entirely pulverized and the rest rendered useless, without any American losses.

On May 10, 1972 the Paul Doumer bridge was also attacked. Eighteen F-4s carrying a variety of loads, released 29 bombs (22 LGBs and seven EOGBs). Twelve missed, four were likely hits, and 13 either missed or could not be verified hits. After a new attack the following day, the bridge was put out of commission until the end of the war. As analysts have noted, the first attack used 77 aircraft releasing 45 tons of bombs (and 144 tons the next day). The first attack in 1972 employed eight combat aircraft dropping five tons the first day and (28.5 tons in the next assault.)

More than twenty years after this incident, the official air power study for the Gulf War, *Air Power Survey* cited this episode.[37]

In order to assess how precision guided munitions have affected the quantity versus quality ratio, one would compare the number of 2000-pound bombs released from medium altitudes that destroyed an 18x30 meter target site, to the LGBs of *Desert Storm*.[38]

War	# of bombs	# aircraft	sorties	equipment	target size (meters)
WWII	9,070	3,024	1,500	B-17	990
Korea	1,100	550			300
Vietnam	176	44	84	F-4	120
Gulf	30	8		F-117	60

Experts figure that one PGM replaces about 30 dumb bombs. During the Gulf War, these munitions represented about 10.9 percent of the tonnage dropped and 7.6 percent of all *projectiles* used. A simple calculation, if overstating the case, shows that 17,162 PGMs, which were successfully released, could "replace" 514,000 bombs; without the PGMs, it would be necessary to triple the number of bombs and double the tonnage to achieve the same results. According to RAND analyst Benjamin Lambeth, LGBs "are already showing a thousand-fold growth in destructive capability when compared to non-guided bombs," consequently, "as western air forces come close to zero errors when using precision strike bombing, they can procure weaker munitions and keep fewer in stock."[39]

The official analysts of Desert Storm elsewhere state that mission planners thought not just in terms of target destruction, but in terms of the effect of intimidation effects. "Functional-effects thinking led planners to assign fewer aircraft and fewer bombs to many targets, which, in turn, meant that they could attack more targets simultaneously rather than a few repeatedly and in depth."

[37] Cf. *Gulf War Air Power summary Report*, GPO, 1993 and the source: Col Glenn Griffith et al., "The Tale of Two Bridges" in *The Tale of Two Bridges and the Battle for the Skies over North Vietnam*, ed., Cdt., AJC Lavalle, GPO, Washington, DC, 1976. Also, interview with Richard Garwin by author, June 6, 1997.
[38] A. Singer & Scott Rovell, "Information Warfare: An Old Operational Concept with New Applications," *Strategic Forum,* no. 99, December 1996, INSS/NDU, Washington, DC and John Hallion, *Storm over Iraq*.
[39] Benjamin Lambeth, "The Technological Revolution in Air Warfare," *Survival* (IISS), vol. 39, no. 1, Spring 1997, London, p. 69.

3.1.3 Electron flows directing energy flows

To work, precision munitions need the aid of off-board systems. This is provided by navigational systems such as GPS (global positioning system). In fact, the network of major systems underlying more and more the actions of American armed forces need such external systems. These external systems, without which nothing can be accomplished, include geopositioning and all the systems comprising C4ISR and space systems. All these are based on a triad of electronic, telecommunications and information technologies.

One of the main epistomological principles of the RMA as conceived by Richard Garwin is that "systems performance is much more important than the performance of platforms. One facilitates the other." In other words, the whole is greater than the sum of its parts: the strength comes from the multiplier effect of developing a system of systems architecture, not from the utility of individual elements, subsystems or systems.

The background of GPS is pertinent here: the United States launched a constellation of satellites (*Navstar)* during the 1980s, 16 of which were available during the Gulf War. Now, at the end some twelve years of putting the satellite system in place, there is no weapon system that is not connected to GPS guidance.[40] Technology has preceded doctrine.

In any case, the electronic emissions from satellites have become an essential part of operations. This architecture lies outside the traditional battlefield, unless one extends this notion to encompass the entire world, including space. Information gathering, transmitting, analyzing, interpreting, and distribution have become an integral part of military operations. Information has been transformed from playing a secondary role to becoming a force multiplier, a key element, to the point that several analysts consider information to be one of the dimensions of conflict along with land, sea, air, and space.

Thanks to GPS, munitions are able to strike targets more and more accurately at reduced mass and expense. Powerful calculations by off-board computers which allow TERCOM and DSMAC to guide cruise missiles, the information architectures which bring together real-time C4ISR, or numerical data provided by disparate sensors, demonstrate this fundamental change: an army's center of gravity has changed from a "solid" logistics system to one based on electronics and information.

Transporting gasoline and petroleum-based products to the front and moving munitions, food supplies and other goods to their final users were the centers of gravity of mechanically based forces on the ground (tanks, APCs, Jeeps) and in the air (combat aircraft and bombers). One division during the 1870 Franco-Prussian War consumed an average of 50 tons of food (for men and horses) and ammunition per day. During World War I, this amounted to 150 tons per day. At the start of the Second World War, the figure rose to 300 tons/day and reached 650 tons/day by the end of the war. During 1990, the figure increased to 3,000 tons/day.[41]

Just as gasoline and the combustion engine allowed one to move firepower to reach the adversary, this role is now played by information: operations depend on bandwidth. This underlies the dematerialization now at work. The next generation of PGMs could use and combine smart bombs and sensor-fuzed munitions. Benefiting from reconnaissance, target identification and acquisition, and battle damage assessment, these munitions could increase precision within centimeters, allowing a further reduction in the amount of explosives, and therefore the size of the munition, inverse to its capabilities. The destructive capacity of a unit of mass should increase tenfold over today's PGMs. This qualitative leap means that a target no longer has to be entirely destroyed but could be disabled through the exact application of the right amount of explosive energy.

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[40] Richard Perle, interview with author, May 27, 1997.

[41] George & Meredith Friedman, *The Future of War, Power, Technology and American World Dominance in the 21st Century*, Crown Publishers, New York (1996), p. 32.

3.2 Organizational changes

The observable transformations in the economy and civil society following the technological revolutions caused by progress in electronics, information and telecommunications have similar impacts on the military sphere.

3.2.1. Just-in-time stock deliveries

Business today moves its inventory of inputs according to the principle of *just-in-time delivery*, from the Japanese concept of *kanban*. Just-in-time delivery means accelerating the operating tempo. Instead of expending resources to stockpile raw materials and keep semi-finished products on the books, in trucks and in stores until they are ready for production, a producer reduces his overhead by applying just-in-time delivery to the ordering, arrival and use of inputs. In its Japanese factories, Toyota does not maintain more than four hours worth of inventory. Similarly, it is possible to meet market demand for a good, without having to stock up on unsold inventories. This is the process that two MIT researchers, James Womack and Daniel Roos, named *lean production* in their book, *The Machine That Changed the World*: much wasted effort is eliminated by assuring that deliveries and payments are synchronized. And, in order to improve this process, better information is needed.

One of the most important consequences to Japanese industries of just-in-time deliveries is *jointness*, to use the terminology of American generals and admirals, that is, delivered products must be of excellent quality and the coordination perfect. To guarantee this, major Japanese businesses send "supplier development teams" to work with the contractor to cement enduring relations between the supplier and buyer. This is certainly one aspect of jointness upon which General Shalikashvili has insisted.

The idea of just-in-time deliveries has been triumphantly received among America's military. RAND issued an important report at the request of OSD, *Understanding Revolutions in Military Affairs*,[42] in which the National Defense Research Institute ran a series of war games to test the ideas behind the RMA, with the cooperation of the five task forces formed by the Pentagon for this purpose. One of the basic conclusions drawn from this work is the importance of *pulse logistics*: instead of stockpiling munitions, provisions, materiel, and petroleum products in depots near conflicts, it is necessary to decentralize these stockpiles and reduce the quantities.

Joint Vision 2010, General Shalikashvili's principal legacy to his successors, has built these concepts into a doctrine, referred to as *focused logistics*:

> To optimize all three concepts [dominant maneuver, precision engagement, full-dimensional protection], logistics must be responsive, flexible, and precise. Focused logistics will be the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while in route, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations. It will be fully adaptive to the needs of our increasingly dispersed and mobile forces, providing support in hours or days versus weeks. Focused logistics will enable joint forces of the future to be more mobile, versatile, and can be brought in from anywhere in the world.
>
> Logistics functions will incorporate information technologies to transition from the rigid vertical organizations of the past. Modular and specifically tailored combat service support packages will evolve in response to wide-ranging contingency requirements.

[42] DRR-1009-OSD, April 1995.

> Service and Defense agencies will work jointly and integrate with the civilian sector, where required, to take advantage of advanced business practices, commercial economies, and global networks.[43]

Along with just-in-time delivery comes another logistics practice from the same source: *total asset visibility*, which is the ability to track a good en route at any point, allowing for instantaneous tracking of inventory so as to tie the entire logistics chain as closely as possible to the needs of combat forces.[44]

3.2.2 Virtual organization, networks and synergy

In his excellent work, *Understanding the Revolution in Military Affairs—A Guide to America's 21st Century Defense,* James Baker, who was the main adviser to Admiral Owens at the JCS, describes the armed forces of tomorrow. These include combat units, which are smaller, more agile and mission-based, that depend more and more on non-organic support and require fewer logistics. The chain of command is flattened, and rules over many small maneuver units, which receive tactical responsibilities. These are devoid of many extraneous functions: anti-air defense, medical support, accountants, and managers which have moved to specialized organizations, that is, outplacement. Freed of extraneous responsibilities, the unit can focus on its core competency: combat, maneuver.

The military is already spontaneously moving along this path, if one believes the official histories of Desert Storm: "One large organizational innovation that did occur—unforeseen and by force of circumstances—was the dispersion of much command and control activity outside the theaters. Officers in the basement of the Pentagon helped pick targets and plan attacks … Space Command provided warning of missile attacks against Israel and Saudi Arabia; meteorologists in the United States processed weather information for use within the theater."[45]

The consequences are enormous. Similarly, state the authors, as much civilian authority—the president and the defense secretary—as military authority—General Powell and the JCS—was clearly granted to the operational commander in the theater who had almost free rein over military operations. "The dependence of modern military organizations on vast amounts of information, and the relative ease with which communications technology could disseminate that information, meant that supporting authority would, in some measure, trickle out of the theater. Now, commanders could tap the expertise of large staffs and organizations thousands of miles away to formulate decisions on courses of action to take during the next few hours. The formal scheme of organization did not acknowledge this, but the command system soon depended on information arrangements and ad hoc groupings. The prevalence of such organizations may prove to be part of a broader trend, not merely an aberration."[46]

This, like a large corporation's intranet, is possible because of *network* technology. As General Gordon Sullivan has shown, digitization allows real-time sharing of information by all command areas at all useful levels, creating a common situational awareness.[47]

From this viewpoint, one could organize a "large number of infantry by company, companies by battalions, battalions by brigades, brigades by divisions, with fewer administrative personnel at each level"; the division, if it becomes the apparent organizational unit, could be a modular network. The

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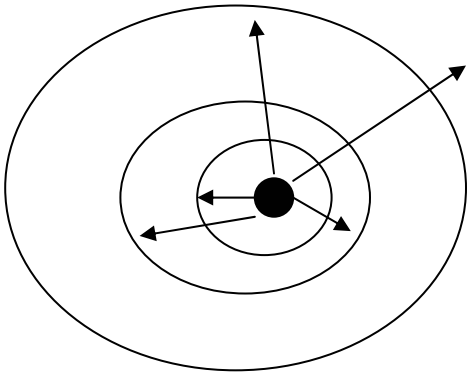
[43] General Shalikashvili, *Joint Vision 2010,* p. 24.
[44] See also Douglas A. Macgregor, *Breaking the Phalanx: A New Design for Landpower in the 21st Century*, Praeger, Westport, Conn., 1997, p. 230-1
[45] Thomas A. Keaney and Eliot A. Cohen, *Revolution in Warfare? Air Power in the Persian Gulf*, Naval Institute press, Annapolis, MD, 1995, p. 210.
[46] *ibid.,* 210-1.
[47] Gen. Gordon Sullivan, "A Vision for the Future," *Military Review,* 5-6 1995.

command structure hierarchy will not, however, disappear. As General Paul Van Riper forcefully argues, he has simply discovered that "the greenest Marine of the 21st century will need and use more information than a battalion chief has and uses today."[48]

Modular organization and the linking of these modules into networks "comes from a more and more decentralized society, an information society, from a global, interdependent economy, and from the spectacular rapport between civilian and military technologies." No one knows better than Michael Mazarr[49] how to draw this connection between civilian and military innovation. He has found some major consequences regarding the power of operational initiatives among lower level echelons, developing the notion of *powering down*, reviving the idea of *Auftragstaktik* of old Moltke.

Just as in the commercial sector, the military arena has its organizational structure. Traditionally this has been known as "irradiation."

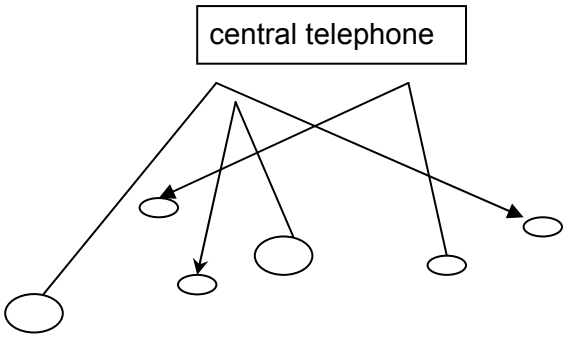
Figure 1: Transmission of message from a central node and from intermediaries in a hierarchy to other echelons, or direct distribution to customers, e.g., pyramid and administrative organizations, audio-visual media



The most complicated structure reflects the technological structure behind it, that of a telephone and similar types of communication devices. Instead of a vertical arrangement—leading to a pyramid—communication occurs between two people, which leads to longer and more fragmented development. Still, all of this communication must pass through a large infrastructure: the appropriately named central telephone system.

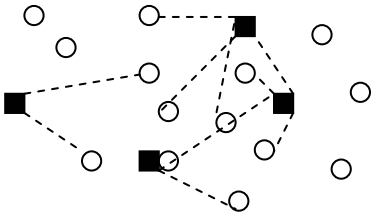
[48] Lt. General Paul K. Van Riper, "Information Superiority," *Marine Corps Gazette,* June 1977.
[49] M. Mazarr, *op.cit.*, p. 3.

Figure 2: Model of Communication Through a Central Network



Finally, the distributed network formed by the internet and similar modes of communication is the decentralized communication that goes through a great number of non-centralized notes in a lateral arrangement, like a spider web.

Figure 3: Transmission via Decentralized Networks



Distributed military organizations are assumed in *Joint Vision 2010* and in similar documents released by the four services to operate by amassing the effects instead of massing troops or equipment. One could interpret this doctrine as the realization of the Napoleonic or Clausewitzean ideal, indeed, the goal of all military history: to concentrate the appropriate number of resources at the location and time desired to have the optimal impact on the enemy's resources. But today's technology permits the achievement of this goal without requiring the actual physical concentration of forces: "In order to exploit the enormous potential offered by technology, we must systematically develop our ability to achieve the effects of mass: the necessary concentration of combat potential at the decisive moment and place while relying less than in the past on the physical concentration of our forces."[50] Further in the reading, "Toward the year 2010, we should be able to alter the way in which we conduct joint operations. Instead of depending on massed forces and sequential operations, we will produce massed effects in a different way," and simultaneously.[51]

Yet again, here one can see the impact of the "dematerialization" described above. Similar effects correspond to the same causes: the possibility of mobilizing forces and concentrating their effects on a

[50] *Joint Vision 2010*: http:// www. dtic.mil/doctrine/jv2010/jvpub.htm
[51] *ibid.,* p. 17.

given point oddly resembles the practice, developed over the last fifteen years at some multinationals, of specific methods. The business will mobilize around a directive given to a number of its profit centers that will work together toward this common goal, while retaining their autonomy in other areas of operation. Thus, the virtual business creates real results. This is what James Fitzsimonds, an officer attached to Andrew Marshall's office, refers to as temporal massing.[52] Experimental maneuvers such as the Army's *Louisiana Maneuvers* and the Marine Corps' *Hunter Warrior* appear to run marginally along these lines.

Pulling together a unit based on the specializations required to carry out a mission, from a menu of compatible units, is one of the bywords of new organizations. The synergy is a *leitmotiv* running through all the doctrinal texts. The ideas of a mission capability package developed in experimental texts such as *Shock and Awe: Achieving Rapid Dominance*, published in November 1996 by a team directed by several Desert Storm commanders,[53] has become the term used for these new types of organizations and their uses.

3.2.3 The Nature of work

These new organizational forms also reflect the changing nature of the work to be done. Just as with economic activity, military activity has moved from labor-intensive to skill-intensive and capital-intensive work. In response to an economy which is knowledge intensive, to once again use the Japanese concept, comes a corresponding idea of war. Education, technical competence and professional qualifications are not only indispensable, but it is inconceivable to have an army operate at the projected standards without its having a correspondingly qualified "workforce."

During the Second World War, one American division carried seven times more material than a German division comparably equipped—unlike his German equivalent, the average American soldier knew how to repair a car because his family had one. These knowledge-based skills have a contemporary analogy. The prevalence of computers in American homes, classrooms and offices create armed forces that are more exposed to and knowledgeable about information technologies than those of any other country.

The flattening of hierarchies, the increased autonomy of professional workers and the elimination of middle management are finding their counterparts in the military domain.

Out of 100 American one-star generals, 88 have done postgraduate work as compared to 19 percent of managers. At the outbreak of the Gulf War, 98 percent of soldiers had completed high school, the highest percentage in history for U.S. forces. "A soldier isn't a pack mule for transporting munitions," declared Marine Corps General Gregson to Alvin and Heidi Toffler.[54] "He knows infantry and mechanized forces tactics. He understands the operational capacities of helicopters and aircraft, which he often operates. Knowing aircraft, he understands anti-aircraft weapons. He is competent in geometry and navigation to direct mortar and artillery fires… Armored and anti-armored, mine and countermine, demolition, computers, motorized vehicles, laser designators, thermal visors, satellite communications and organizational logistics are all part of his baggage."

The authors of *Shock & Awe* recommend "major changes in the composition, the competencies and the authority of the heads of each military unit (in particular) perhaps reaching as far as the level of a combat unit or an individual soldier," and add, "The key to all of this, is to draw the entrepreneurial individual to the hidden potential of the technology."

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[52] James R. Fitzsimonds, "The Coming Military Revolution: Opportunities and Risks," *Parameters*, Summer 1995, p. 31.
[53] Harlan Ullman, James Wade, LA "Bud" Edney, Fred Franks, Charles Horner, Jonathan Howe, Keith Brendley, *Shock and Awe: Achieving Rapid Dominance,* ACT/NDU, Fort McNair, Washington, DC.
[54] Alvin & Heidi Toffler, *War and Anti-War*, Little, Brown, and Co., New York, 1993, p. 75.

A military doctrine that places speed and agility first, that posits using fewer soldiers in operational units that "are closer to special forces than to traditional infantry" operating high performance, complex weapons and platforms, demands high caliber people. The more one substitutes capital for labor, the greater the complexity of the work; and the more one substitutes electrons for solid matter, the more demands are made on intellectual capabilities. The more effective the technology, the less the soldier's exposure. "There could be very few people in a situation, the fewest possible. That is one of the good reasons to have UAVs—we need to get people out of attack systems," explains Richard Garwin, one of the heads of a military science complex.[55] He continues, "The value of one individual is such that we deploy huge field hospitals, which becomes part of the calculations of the cost of war."

This corresponds, by the way, to advanced industrialized and even post-industrial nations' demographics: an individual's life is worth much more than in earlier demographic regimes to the extent that the investment per child, by both society and the family, is much greater in families with one, two or three children than in those with 15 to 20. Low infant mortality rates and high life expectancy allow for considerable investment, including a long period of training (secondary and post secondary schooling).

This is the only rational for the otherwise unsupportable doctrine of zero-kill. An assault wave of thousands of interchangeable combatants without any particular qualification, who throw themselves against machine-gun fire or into mine fields, is the model of the Iran-Iraq war. During such a war of attrition, the results from an archaic demographic regime where individual lives, frail and vulnerable, are of little value. In a modern or post modern society, the risk to the individual combatant must be more carefully worked out. This picks up the views of a post-modern business, which does not need specialized workers for assembly line and other Fordist or Taylor industrial operations. The post-modern military unit needs individuals who offer high value-added. This is what General Paul Gorman is discussing when he describes the image of a super trooper, and this is the type of person the Army is thinking of when using the term "the soldier as a system."

The soldier is benefiting from significant technologies such as TEISS, HLEMID,[56] which allow him a much larger path of action. Weapons for firing beyond the line-of-sight, as well as weapon systems for seeking out the enemy beyond the horizon, enlarge the area of action, ranging from some 30 kilometers for the individual to maybe 80 kilometers for a combat unit. The productivity of a combat unit comprising 11 soldiers (chief, programmers and communication specialists, heavy weaponry and others) or 20 (a prototypical reconnaissance team) will extend themselves into zones up to 2,000-4,000 square kilometers.

3.3 America's Business is Business

President Coolidge, the originator of the phrase, "America's business is business," couldn't describe more accurately what is now evolving.

According to the authors of the huge *Project 2025*, "A sizable portion of tomorrow's armed forces could very well seem like today's Bechtel, a global construction company."[57]

In a work that has had a great impact among junior Army officers, and which was the subject of a long commentary by Army Colonel Douglas MacGregor goes even further. Recalling that General Krulak, commandant of the Marine Corps, sent his top officers to observe Wall Street in December 1995—traders are among the most aggressive decision-makers in the world, and, one could add, possess a honed killer

[55] Interview with author, June 6, 1997.
[56] Cf. "Infantry 2000" of the Army Infantry School, Ft. Benning and *Star 21: Strategic Technologies for the Army of the 21st Century*, National Research Council, Washington, DC 1992.
[57] Dr. Alvin H. Bernstein, Dr. Patrick M. Cronin et al., *Project 2025*, Institute for National Security Studies, NDU, 1992, p. 54.

instinct—MacGregor compares uncertainty and change in business with that of combat. Similarly he compares the organization of Microsoft—radical autonomy—with the way in which General Patton organized and commanded.

The era of fighting based on attrition warfare, the Lanchester equations reviewed by *Operations Research* and systems analysis, mass and quantity, is transforming. The revolution in military affairs is now underway.

4. The Revolution in Military Affairs

"Desert Storm wasn't the first war of the 21st century, but the last war of the 20th century. The Gulf War is the last war of the industrial era."[58]
Andrew W. Marshall

"The principal questions today are on the intellectual order."[59]
Andrew W. Marshall

In his memorandum titled "Several Ideas on Military Revolutions," dated August 1993, Andrew W. Marshall, who, since his nomination by Richard Nixon's Secretary of Defense James Schlesinger, directs the Office of Net Assessment, has written, "The Gulf War should be considered the equivalent of Cambrai," that is, the first break in the German front achieved by the first assault by British tanks. The image is strong: armored tanks broke the line, but neither the advantage nor the element of surprise created by the assault was exploited because there was no doctrine, no understanding of the situation and no analytical tools able to seize the new reality. Everyone was so accustomed to thinking in terms of meters that it became impossible to think in kilometers: so little was expected of the breakthrough that no one had considered what came after. All the same, despite the limitations of the Cambrai tank assault, it did announce the new military age which would be named the Second World War: the one of combustion engines on platforms and associated doctrines.

"We are in the beginning of [the RMA], maybe in 1922 if using the analogy of the 1920s and 1930s," adds Marshall. He emphasizes as strongly that "it would be better to discuss an *emerging* [his emphasis] military revolution than 'the' RMA, to the extent that the nature of the changes (underway) in the character of warfare has not been fully revealed."

In fact, the wide variety of attempts to define what is a (or the) RMA in current military affairs is worth further examination.

4.1 What does the RMA mean?

Without reviewing the technologies, the weapons or weapon systems as such, it is useful to listen to some important players in the American debate to attempt to grasp the ideas and objectives which are focused on by the players and institutions participating in the debate. We then will interrogate these players on a more general level.

One would glean from Andrew Krepinevich, who directs the Center for Strategic and Budgetary Assessments, the idea that a revolution in military affairs in general is:

[58] As told to author by Eliot Cohen in June 6, 1997 interview. Lawrence Korb, Brookings Institution reports the other version (interview with author, June 1, 1997).
[59] A.W. Marshall, "Memorandum for the Record," August 23, 1993; "Some Thoughts on Military Revolutions" (2nd version). Office of the Secretary of Defense, p. 7.

> a discontinuous leap in military effectiveness over a relatively short period of time, which gives rise to new military organizations, which are created to fill new roles and execute new missions.[60]

Eliot Cohen, for his part, thinks along similar lines:

> A quantum change affecting the ways of waging war and its outcomes, a change such that the very physiognomy of battle, its lethality, its rhythm and dimensions are transformed. In most cases, a revolution in war translates into the rise of a new military elite, new forms of organizations, and new dominant weapons."[61]

Martin Libicki, a scholar at the *National Defense University* also tries his hand, in a new paper,[62] at listing the possible definitions of an RMA.

1. an order of magnitude change in the effectiveness of conducting a war
2. a transformation so profound that the end [of a conflict] is basically independent of the quantity of military systems held by the other side
3. a change so fundamental that it relegates the preceding RMA to the annals of history
4. a change so elusive that it is necessary to start all over again
5. a change so profound that it fundamentally changes the understanding of what occurs on the battlefield
6. new operational capabilities that basically transform the relations between nations.

What really constitutes a transformation? The advantage of these slightly overcharged definitions, which try to focus on a large and ill-defined concept, is that they draw attention to the irritating and thorny problem of the future's definition and measure. They highlight the problem of how to grasp something today that is only in gestation, in any case at its beginning, and which has yet to show its full potential. In essence they ask how to measure the future. The problem is comparable to solving the allocation of resources in an economic system: while we don't know what the market will decide (or the millions of actors who participate in the market), we should take decisions all the same. Libicki concludes by suggesting that a "system of systems" integrating subsystems of sensors, weapons and communications, which he calls "inter-systems," is the basis for the RMA.

In his book on air power in the Gulf War, Eliot Cohen clarifies that the RMA underway is primarily information-based, but it is far from just a series of rapid calculations:

> The general absence of new operational concepts for the use of air power in the Gulf War suggests that if a revolutionary change in the conduct of war is underway, the harder parts of its implementation may still lie in the future… Similarly, in future warfare the struggle for information may play a central role, taking the place, perhaps, that the contest for geographical position has held in previous conflicts… The ingredients for a transformation of war may well have become visible in the Gulf War, but if a revolution is to occur, someone will have to make it.[63]

James Blaker, whom we will consult on the "genealogy" of the RMA, insists on the operational aspect and the integration factor: the RMA, for him, is the collection and analysis of information, communicated in real or near real-time to agile forces, equipped with new weapons, and capable of reacting swiftly and

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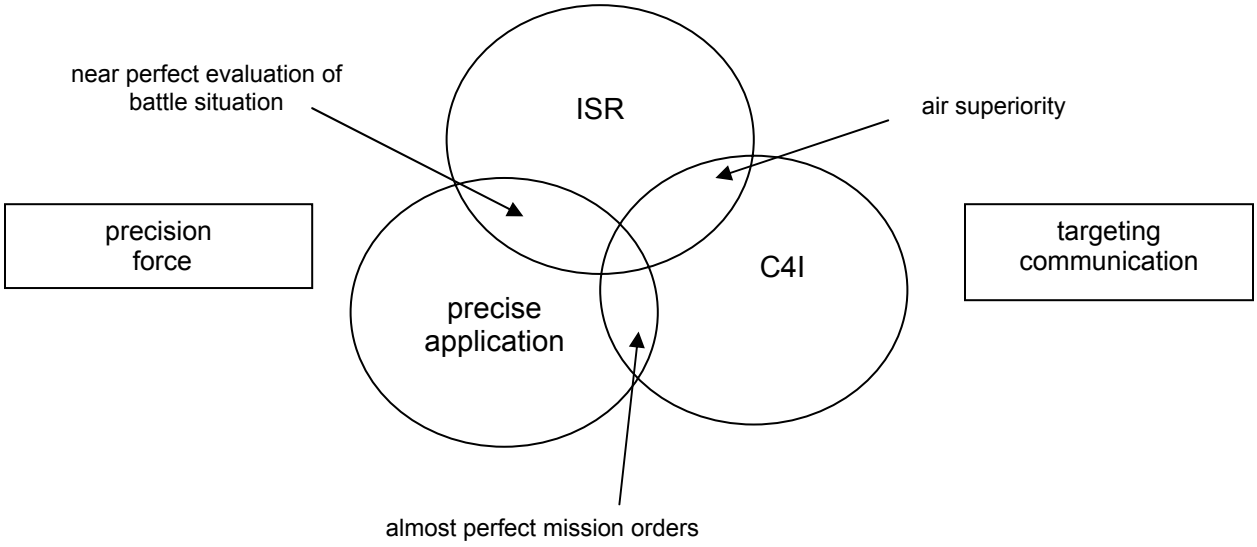
[60] Andrew Krepinevich, "The Military Revolution: Restructuring Defense for the 21st Century," testimony before the Senate Armed Forces subcommittee on acquisition and technology, May 5, 1995.
[61] Eliot Cohen, "On Revolutions in Military Affairs," Oct. 1994.
[62] Martin Libicki, *The Intersystems, or the RMA Reified*, Version 0.5, 1997, NDU.
[63] Eliot Cohen & Thos. Kearney, *op.cit.,* pp. 209, 211 and 212.

precisely to engage at great distances. He insists on the synergy of systems and of weapons. A military force operating from a system of systems foundation will thus be able to create "vast disparities" between it and any adversary: this is the capacity to rupture and cause disequilibrium, which remarkably quickens the operational tempo, thanks to the interaction and integration of its components. Blaker likewise insists that the RMA represents a new relationship between fire and maneuver … maneuver becoming essentially the means of directing fire on an enemy.[64]

Blaker borrows the schematic proposed by Admiral Owens in order to define his system of systems

Figure 4: Battlespace Awareness (Owens-Blaker schematic)



As for Admiral Owens, he considers the RMA to be a paradigm generator and the system of systems, the operational version. The latter depends on three essential technological keys, that is, digitization, information analysis and GPS. They will permit, according to the diagram reproduced above, the virtual dissipation of the fog of war. Returning to what William Perry has been predicting since 1978:

> [The United States] is rapidly approaching [the three following objectives]: being capable of seeing at any moment all high value targets on a battlefield, being capable of directly hitting any target we see, and being capable of destroying all the targets we can strike … [so that we] will make the presence of nearly any modern military force untenable on the battlefield. [65]

Owens creates the ideal of nearly perfect visibility:

> By 2005, we will be technically capable of sensing close to 90 percent of everything that is militarily important in an extended geographic area (for example, a square 320 kilometers on a side). By combining detection with the data analysis from our C4I, we can achieve dominant battle awareness. This new idea of war gives us an understanding of the correlation of forces based on the integrated perception of the locality, activity and

[64] James R. Blaker, *op.cit.*, *passim*, and also *1997 Strategic Assessment, Flashpoints and Force Structure,* chapter on "Force Structure," pp. 259-300.
[65] William J. Perry, quoted by Philip Morrison and Paul Walker, "A New Strategy for Military Spending," *Scientific American*, 239, 4 (October 1978), pp. 48-61.

> roles, and operational plans of friendly and enemy forces, including the precise prediction of the impact of short term intervention.[66]

During a conference on the RMA, organized by the Strategic Studies Institute of the Army War College, Michael Mazarr lists four pillars: information dominance, synergy, disengaged combat, [and] appeal to the civil sector. One must think of the RMA in terms of a world in which the best definition emerges and where order is generated less and less by structures or traditions. The schematic (Figure 4) is largely Admiral Owens': information equals infrastructure; rapid communications permit synergies between interoperable C2 systems; information is a force multiplier. This, plus precision, allows combat to take place at "a healthy distance" while at the same time reducing the role of heavy platforms. And in his conclusion, Mazarr avers one of the basic sociological aspects:

> The RMA marks the end of the road for totalitarian states' armed forces. This type of society and its accompanying military structures are weighted down by the effects of rigid, hierarchical and centralized command structures: slow and too predictable technological innovations, combined with an inability to foster innovative thinking and independence in officers. The armed forces of totalitarian states could never put an RMA into place.[67]

As evidence, the opposite image of this description is the very portrait of what the RMA authentically is. Note the insistence on the socio-political and institutional aspect as much as on the technological.

More recently, two U.S. Army War College analysts, Steven Metz and James Kievit, remarked, "It is rare in American history that military leaders and other defense decision-makers are as open to new ideas." One aspect of their work draws attention: the assembly of a hierarchy of RMA types. They distinguish minor RMAs as those formed by a unique technological change or a societal change. This type of change is translated onto the battlefield at the operational and tactical level. A major RMA, on the other hand, arises from multiple transformations that have combined effects which make themselves apparent at the strategic level. From this comes the concept that the silicon chip gave rise to a minor RMA, that other minor revolutions, such as robotics and psychotechnology, will come about shortly, and that the RMAs in the near term (several decades) are going to be so frequent that they will become a continuous revolution. The analysts conclude:

> The world is at the doorstep of a major RMA resulting from the interactions of economic, social and cultural changes driven by silicon, robotics, psychotechnology, and biotechnology.[68]

This especially interesting notion of a continuum of change, as outlined by the writers, is used by Eliot Cohen to define a limited series of very important changes that occur one after the other in the same paradigm. He defines the three phases of an RMA:

> First the one that is already completed, involving those technologies that have been around for a long time, including PGM, stealth, radar, simulation, among others.
>
> Second, a revolution that is going to take place over the upcoming 10 to 15 years: information processing, networking. These are the technologies that are largely percolating. Here the big question is on the cultural level; there are organizational and human consequences to networking power, centralization, decentralization, etc.

[66] Admiral W. Owens, testimony before the Senate Select Committee on Intelligence, September 20, 1995, pp. 2-3.
[67] M. Mazarr, *op.cit.*, p. 30.
[68] Steven Metz and James Kievit, *op.cit.,* p. 30.

> Third, weapons based on other physical, biological, biotechnological and directed energy principles.
>
> The Gulf War was the culmination of the old RMA, the one for PGM, radar and well-trained troops.[69]

RAND is concerned about responding to future uncertainty as shown in great intellectual suppleness and much practicality.

> We should think first about what we know today. We should consider above all two regional conflicts. We should think above all of historic threats and traditional combat. We cannot let ourselves court-martial the Billy Mitchells of our era, nor denigrate the idea of today's General Pattons. However, what must change are our institutional and budgetary propensities that focus on today or the near term. We should consciously invest in understanding the future, preparing for this future, for the next 20-30 years, and this will be a hard task. Vision is bothered by uncertainties, but perhaps it is time to develop measures that are more capable of limiting these uncertainties. We should evaluate the necessary choices involved in the allocation of defense material and equipment and the investment intended for understanding the changing nature of threats [to the U.S.]. We need to make sure that the systems which we are developing and which are consuming valuable defense resources aren't behind the curve or lack necessary flexibility by the time they are deployed.
>
> Idea: the ultimate significance of a revolution.
>
> A revolution in military affairs is transitory.
>
> The most important aspect of a revolution is in the process.[70]

The large number of definitions and concepts, of angles of approach and responses, the different levels of analysis that people wish to link together under the maladroit rubric, "the revolution in military affairs," is revealing: here is an expanding debate in which no one has the last word. We are in fact, as Andrew Marshall says, at the outset. But what is common to all the authors cited is the effort to think about change.

4.2 RMA: cause and effect

James Blaker, witness and active participant, sees the RMA as originating out of four causes:[71]

1. The rebound following the Vietnam War: "How to win without nuclear weapons?" at a time when the entire process defense planning was focused on the USSR, and all the leadership at TRADOC considered how to get from a war of attrition to one of maneuver.

2. The idea of an extended battlefield, defended in the 1970s by William Perry at DARPA: long-range precision weapons would break deep into Soviet lines thanks to technologies that allowed real-time targeting. This was the "assault breaker" doctrine before moving on to the "airland battle" doctrine. Perry was the one who developed the term "system of systems," a

[69] Interview with author, May 23, 1997.
[70] RAND Corp., *op.cit.*, pp. 52-3.
[71] Interview with author, May 27, 1997. *Strategic Assessment 1997* (NDU-INSS), op.cit., and *Understanding the RMA*, op.cit.

network able to oversee large areas of battle and to act in real time with precision on the basis of what has been "seen." The other aspect of this is to avoid being seen electromagnetically, that is, to apply stealth. In all, Perry hung out these force multipliers as advantages that could cancel out the superior size and mass of Soviet forces from whence came the notions of situational awareness, information dominance and systematic use of precision strike.

3. Andrew Marshall—economist by training and a statistician from RAND, one of the foremost analysts of USSR-Western military balance—and his group in the Office of Net Assessment, perceived the Soviet worry over American technological advances. He analyzed the Soviet conceptualization, among others, and the increasingly frenetic attempts of Marshal Ogarkov to overcome this apparently widening gap in technological advances. In his analysis Marshall drew a conclusion, that of the Soviet Union's decline,[72] and a new idea, the military-technical revolution. Upon reflection, this concept was rejected as too technical and eventually replaced by the "RMA," which is not a favorite of Marshall's: the latter has too many historical and sociological overtones, and is too frequently given doctrinal, organizational and operational consequences for his taste.

4. Admiral Owens, notably during his tenure as vice chairman of the Joint Chiefs (1994-1996), drew—from the image of weapon systems and equipment acquired by units without ever being made compatible across services—the conclusion that the synergy of people and institutions is like the synergy of equipment: integration yields systemic advantages. The admiral used the JROC to push for more integration. According to Owens, the technology for a revolution already exists and is the result of the last two decades of investment in the Cold War.

5. Admiral Owens' superior, General John Shalikashvili, was a forceful contributor to launching change by supporting Owen in his bureaucratic struggles within the Pentagon and in transforming the JROC and by intervening with Owens in the PPBS system, in addition to promulgating the *Joint Vision 2010* doctrine. This monograph, dated June 1996, carries all the authority of the head of the Joint Chiefs and basically sets out Owens' vision of an operational system of systems applied to combat.

If what has been outlined here captures the main idea behind the RMA, it has made its mark on numerous papers on doctrine, experimentation and transformation.

Force XXI with the progressive growth in ExFor, from the battalion to the division level, is the Army's expression of the RMA. Even if ExFor is often criticized, notably by junior officers, as "a vain attempt to digitize the Grand Battle in the central plains of Europe," it incorporates many of the [RMA's] elements, providing the potential to move toward a force based more on RMA-concepts. A similar vein is found in the Navy monograph *…From the Sea,* which is visibly influenced by Owen, and *New World Vistas*, the Air Force's doctrine. The Marine Corps appears to have made the most progress down this path, particularly with their battle lab, *Sea Dragon*.

A revolution in military affairs, for better or worse, is taking place in the United States and has made considerable progress recently. Using James Blaker again as proof, "For the last three years, part of the Pentagon at least has a draft of an RMA force."

[72] Department of Defense, "Commission on Integrated Long-Term Strategy: Report of the Future Security Environment Working Group," Washington, DC, Government Printing Office, October 1988.

4.3 Itinerary and Destination

The striking part about the American debate on the RMA is that it is led by those who use the terms conceived of and propagated by Andrew Marshall. The author of this study, in the course of several weeks worth of inquiry in the United States, met several dozen experts and officials, active participants in all the arenas involving defense. About half came from what might be jokingly referred to as the Marshall Legion—former colleagues in the Office of Net Assessment. They have gone on to positions in other Pentagon offices, to commands in the four armed services, to Congress, to Washington think tanks, and they can be found directing departments in major corporations and in research institutions. They are among the most prolific writers of articles in the defense media and journals.

The issue of the RMA belongs to Marshall. Benefiting from an extraordinary institutional longevity—he has been at his current position 24 years—Marshall has woven a complex fabric, placing or contributing to the promotion of these men into key or strategic posts. A close friend of Albert Wohlstetter—arguably one of the best strategic thinkers since Bernard Brodie—from their days at RAND, Marshall exemplifies the paradox of an institutional innovator, revealing the capacity of the American system to institutionalize change. Not involved in budgetary or political decisions, Marshall—"We must clone him!" exclaimed a former CIA director—does not participate in the open rivalries between the services, the bureaucracy, the cliques, and the cabals.

In the question of the RMA, if one will pardon the expression, there is a "Marshall Plan": an explanation of how to get there. The answers lie in part in the ideas contained in several of the Office of Net Assessment's papers and the general conformity of events to these ideas.

A notable study by Commander Jan van Tol, written at Marshall's behest, displays the tactical path taken by the latter and his heuristic principles applied to the progress of the military revolution: *Historical Innovation: Carrier Aviation Study* (1994):

The following summarizes the principles isolated by van Tol for preparing the way for a military revolution:

- It is necessary to create an institutional home for innovative officers and those one wants to encourage in innovative thinking; one needs to be able to offer them a career path that includes the new specializations they will want to take on as champions of experimental innovation; they need to slide up the career ladder; there should be an aura of glamour and adventure about them. In the way Admiral Rickover made nuclear powered turbines sexy, officers in critical positions need to appear to be innovators and supporters of innovation; a pool of junior enthusiasts needs to be created.

- This institutional safe harbor should be in charge of wargaming to test new technologies, tactics and operations, and organizational ideas and the connections between them; to be productive, the wargaming should be interactive, spanning a long time, and an institutional mechanism should be created to demonstrate the worth and utility of these concepts.

- Successful ideas are often driven by specific, concrete tactical problems; individuals with these ideas should be brought together to work; the credibility of such officers is reinforced by their longevity and steadfastness; institutional protection should be furnished to allay the risk to individuals' futures and careers; the institution should assume the risk and, of course, it should be tolerant of mistakes.

- The intellectual climate should be one of rigor; there needs to be a growing repetition of theoretical exploration, simulations, exercises, and tests at all levels. Another part is

developing the analytical tools to judge and measure the results of these activities. Finally, the various war colleges have a major role to play in this.

- This group of officers should also interact systematically with civilians in the different branches of the Pentagon; the institution should publicize high profile controversies to popularize the terms of the debate. It is necessary to create places for [these ideas] to land and be distributed in civilian and political society; it is essential to spread these ideas and to recruit important political actors to generate political support for them.

- Commercial technological developments in the inter-war period played a decisive role.

- To the extent that there are rival or opposing visions of the future, there should be an open competition among them.

At a higher conceptual level is Andrew Marshall's mid-1993 work, *Some Thoughts on Military Revolutions*, which summarizes his thinking at the same time as actual events, since its publication, have unfolded according to the order of battle he assembled.

Criticizing the use of "military-technical revolution" or "RMA," the author advises discussing an emerging or potential revolution. The essential aspect, according to Marshall, is not to acquire this or that technology, but to combine them into an organizational and operational concept. More than a revolution, we are discussing a particular time frame in which a major transition occurs among types of warfare, as has occurred several times in history, for example, during the interwar years.

> The most important competition is not the technological competition, although it is obviously preferable to have a superior technology if one can. The essential goal is not to be the first, but to be the best at solving an intellectual problem consisting of finding the most appropriate innovations in concepts of operations and to proceed with organizational changes before fully exploiting the technologies that are already available and those that will be available in the decade to come.

The author emphasizes, "Our biggest challenge is intellectual. We should not presently press to obtain new systems based on our current knowledge." Geopolitical uncertainties are sufficiently troubling, let's not add to them. Rather we should focus on the long term. Organizational and operational excellence is much more solid and durable, he contends, than technological advances in weapon systems, so that the former will contribute to the conception and development of working weapon systems because it is based on practical experience.

Now, there are two principal ways in which warfare may change. First, there is the fundamental importance of long-range precision strike, not only for large-scale ground and air combat, but also for force projection, naval and space warfare. Second is the emergence of information warfare: the dimensional, or the informational, aspect of war could take a more and more central place; strategy and tactics which permit the acquisition of informational superiority will become "one of the principal centers of gravity of operational art." Degrading an adversary's information while improving one's own will become a new dimension to be integrated into strategy and operations. This is a serious problem states Marshall as we do not have the metrics to analyze this new dimension: "The area about which we know the least is in the process of perhaps becoming the most important, central and decisive in warfare."

Hence the criticism which hits home in many places: most officials will acknowledge the RMA without doing anything about it.

In order to take advantage of the long strategic pause, continues Marshall, it is necessary "to actively launch the research and analysis that will allow us to understand the long-term transformation of doctrine,

operational concepts and organizational change" that took place in the 1920s and 1930s. The resulting ideas will allow us to develop the second and third generations of weapon systems that will incorporate these new concepts. And, to hasten all of this, we must change the acquisition process and the education program.

Ideally, this would take place under the auspices of the secretary of defense, chief of the Joint Chiefs of Staff, so that wargames and simulations would be conducted in this spirit.

Similarly, it is necessary to convince the services to assign the best of the best of their officers to the tasks defined earlier, to allow them to study at the war colleges, to have them participate in war games, to guarantee them careers. Creating a new mold like RAND would be useful—it is necessary to think in terms of the next 10, 30, 50 years. The secretary of defense should put together a group of officers to become some sort of think tank. And, concludes Marshall, it is in this spirit that future chiefs of staff should be chosen.

Less than a year after this paper's publication, five task forces were created by the Department of Defense for the purpose of examining the five underpinnings of the RMA: (1) forward presence, (2) maneuver warfare (3) deep strike (4) special operations and (5) organization. During the summer and fall of 1994, these task forces participated in a series of wargames organized by RAND that shared the common theme of incorporating these RMA elements.

If one were to ask him to estimate how far along we are in his plan, Marshall would respond, "Newer officers are very open to change. The obvious speed of technological changes clearly helps us a lot, that opens minds. Our joint venture with the services is going well. For the last five years our common interests have led them to put things into place themselves. But it's still for the majority of officers to find this out for themselves. All in all, things are going very well, but what I hope, is to be able to speed them along. At the top, the service commanders understand. Just below is where there is resistance: people who have invested their entire careers in pre-RMA things. The next level below are receptive junior officers. For these wargames we don't invite generals but only junior officers. In sum, a critical mass of people who think the same way is needed. I need several years. But really, I am surprised at how much progress has been achieved. I feared more resistance, but we have convinced several chiefs of staff sufficiently so…"[73]

Obviously Marshall is not just anyone, but is one of the principal agents of change. Bill Perry, John Deutch, Henry Rowen, Don Hicks, Paul Wolfowitz, many formerly at RAND, all are part of this "band of warriors" like Wohlstetter before his death. Lawrence Korb, formerly of the Pentagon and now at Brookings, sees an entire generation here. "… just as there was the generation of the Lincoln Brigade, there is the McNamara generation, the systems analysts such as Stansfield Turner etc., and now there is the Marshall generation."[74] And, according to Fred Downey of Senator Lieberman's (D-CT) staff, one of the congressional heavyweights on defense issues, "We are now in the third generation of 'former students of Andy Marshall' "[75]

One indication of the remarkable degree to which these ideas have penetrated is the following: an officer detailed to a study group specializing in the RMA received from one of his friends a senior honors thesis from Duke University's political science department. Tammy-Lynn Meyer, a 21-year old student and resident of North Carolina, will receive her degree with a thesis titled "Organizational Upheaval: the RMA, Zero Tolerance, and the U.S. Army." What today's American young women dream of!

[73] Interview with author, May 23, 1997.
[74] Interview with author, June 1, 1997.
[75] Interview with author, June 2, 1997.

4.4 Inertia, Problems, Discussions

At this stage of the inquiry, it is useful to have an outline of the types of resistance struggling against the strategic and military innovation of the RMA. Richard Garwin, promoter of military revolutions, is not tactful:

> The RMA? It comes so late and has to overcome so many difficulties! There are so many that are obvious. But clearly, the admirers are at risk of losing the game. Large-scale platforms are quite important to the extent that they represent significant resources. Precision strike is expensive. At a thousand dollars a shot, it is a colonel that issues them. At twenty dollars a shot, only a lieutenant is required.
>
> Revolutions are always hated and opposed. The U.S. Air Force was against developing laser-guided bombs, because it was not as glorious to need a designator. The Army fought all out against developing C2 for helicopters to improve their line-of-sight. During the Vietnam War, RAND wrote a report showing that the average bomb missed its target by 200 meters. We could have developed precision-guidance at that moment, we had them! The pilots bought their Sony televisions to have color T.V. in their cockpits. McNamara rejected this innovation; it was too long-term and did not correspond to the fiscal year.
>
> Corruption, legislative pressures and military personnel all have a say in what happens. It is very difficult to make such a radical transformation in this type of institution. Particularly in the Army. They need 18 years between deciding on a new system and deploying it.
>
> Institutional quirks and perversity, idiocy and sacred cows. People who are not accountable for their actions. "Never mind the facts—my mind is made up!"[76]

This vision addresses only the military-administrative American system and the relevant human and institutional obstacles, but what are the technological obstacles to the RMA?

Its most enthusiastic supporters complain that many people often just pay lip service to the concept of the RMA. The image that Americans have of themselves inhibits their ability to oppose technological progress: they believe in the self-congratulatory image of a champion of innovation, a man whom nothing stops such as Mark Twain's *Connecticut Yankee in King Arthur's Court*. But behind this flattering image, many people see high technology as an improvement, not a revolution. A technological varnish is painted over aging technology, microprocessors are attached to javelins and shields—that is, any type of traditional platform—but the improvement is deceptive. Hence, the many critiques of *Force XXI* that call the exercise nothing more than the digitization of a good old tank war.

Until now, RMA proponents add, the revolution has been driven by technology, but has yet to succeed in reorganizing the basic units of armed forces. In fact, to the extent that the innovator is encumbered with proving the validity of his ideas, the immense undertaking of creating a new structure in which divisions are no longer the basic unit of force structure is not the order of the day.

Henry Gaffney informed writers that the assimilation of RMA concepts through wargames is unsatisfactory:[77] many leaders are still intellectually committed to Cold War models, force-on-force, frontal assault, war of attrition, front lines, etc. Worse, in the wargaming that took place recently at Carlisle, center of the Army's military thought, the first concern of many of the teams, it has been reported, was the destruction of communication satellites that then allowed players to conduct a traditional war according to the old rules. It will require time, but with gradual assimilation through the

[76] Interview with author, June 6, 1997.
[77] Henry Gaffney, Center for Naval Analyses, interview with author, June 3, 1997.

participation of a good number of officers enlisted in exercises, maneuvers, and simulations, approaches should change, believes Marshall, Eliot Cohen and Andrew Krepinevich, who adds, "It's necessary to bring the revolution down to the individual soldier, the RMA needs to be incorporated at the tactical level."

A new generation will be necessary, concludes Stephen Rosen. "What is innovation? It comes from people whose behavior change, from change within the heart of large, hierarchical organizations. It occurs slowly, because once people work their way up to the top of an organizational ladder to the top, they do not easily relinquish what they have gained. Major evolutions often happen through the eventual need to pass the torch on to others for demographic and biological reasons—leaders age and retire. New blood enters at the bottom of the pyramid. The major difference from the business world is that the military offers no lateral access: people do not enlist in the Army as generals. They have to begin as lieutenants. Thus, to conduct war differently, it is necessary for one generation to succeed another."[78]

At the Center for Naval Analyses, Henry Gaffney shares similar thoughts, "Today, acceptance of the RMA falls according to age and rank, it is largely a generational divide. Senior leaders, those at the top of the pyramid, are decorated politicians. They are evolutionists, not revolutionaries. The intermediary generation, those who have 14-25 years of service, the subordinate officers, have a more revolutionary vision. They call this 'thinking outside the box.' In a number of Andrew Marshall's wargames, these are the ones who find solutions. The very young, the lieutenants and captains, are agnostic."[79]

As evidence, a new idea always has different approaches to gaining currency in different levels and places. In organizations with large numbers of people, a great deal of hierarchy, complexity and rankings like the American armed forces, different degrees of penetration necessarily emerge. The abundance of contradictory influences creates a multiplicity of conditions, traditions, and organizations, all of which inhibit transition. Because the price of an error for a military organization may be defeat or annihilation, military structures do not just leap into a reform.

Critics, and they make themselves heard, similarly accuse RMA supporters of exaggerating the performance, of displaying an outlandish optimism, of ignoring the human factor, of not taking into account Murphy's law, in short, of a beatific techno-optimism. In fact, this is one of the weaknesses—the Vietnam War proved it well—of American thinking: believing that technology can conquer all. General Paul Van Riper, who commands at Quantico, provides a vigorous rebuttal, "War is not a mechanical system that lends itself to precise, active controls, or to synchronized and centralized schemas. War has more in common with biological and ecological systems… It is an open system, interacting with the surrounding environment; it is marked by a feedback loop of nonlinear dynamics … information is not a dimension of warfare, it is a parameter." That said, the general is a partisan advocate of information technology: he sees info tech as reviving the potential of Napoleon's dominant battlefield awareness, the Marine Corps OODA loop (observation, orientation, decision, action). And despite their traditional rhetoric, the Marines seem closest to the mark in operational experimentation.[80]

A remarkable point of view is provided by David Chu, one of the directors of RAND, who defines himself as an incrementalist: "I don't believe that there is a revolution. I see a continual process of technological change. In military affairs, evolution is permanent. How should it be measured? The civilian sector measures it with GNP. There isn't an equivalent military GNP that allows us to measure military productivity. I don't see a major systemic transformation, even with sensors. The transformation of combat platforms? We are not yet there; maybe some day. The use of information in itself is not the principal idea, it is a way of refining and accelerating, of realizing old ambitions, but it does not change the nature of conflict. What I see is what can be discerned from the F-22 or in the new attack submarine;

[78] Interview with author, May 22, 1997.
[79] Interview with author, same reference.
[80] Gen. PK Van Riper, *op.cit*., and interview with author, May 27, 1997.

it is the implacable, irresistible technological progress, a type of formidable progress achieved by propulsion technology."[81] He concludes, "I see an evolution in military affairs, an EMA if you will."

The observer might ask if this argument is one of theology, but it should be remembered that theology takes on the more prosaic forms of liturgy—sermonizing and proselytizing.

Past investment plays a major role in the amount of inertia that slows down innovative movements. The enormous sunk costs of aircraft carriers and their battle groups, of the industries which build, equip, repair, and operate them, and of the 60-ton M1 Abrams tanks and their logistics trains, and of fighter aircraft, in addition to the long operational lifespan of current and aging generations of platforms, all of them lay claim to considerable budgetary resources needed for their upkeep and maintenance, while leaving other parts of the budget starved for resources. Moreover, these legacy forces represent powerful interests, doctrines and habits so ingrained that the eventual decision to disinvest in them is quite difficult to make. Bases, factories and arsenals cannot be simply swept away. A revolution is bit like a stock market crash—the stroke of a pen can eliminate certain stocks in favor of others.

People also have a lot to lose. And if too many have too much at risk of loss, there is an increased resistance to transformation. "It is difficult to ask the military to choose between the RMA and their career," explains Richard Perle, "because oftentimes, advancing the RMA means the end of a career." On a more ordinary level, but not without justification, Andrew Krepinevich commented that it is easier to pick up a pretty girl in a bar serving as a fighter pilot than piloting UAVs. In any case, there are certainly more substantial political and institutional barriers to change.

An essential aspect is discussed by Lawrence Korb. President Clinton, he explains, given his background and his disastrous beginning with the military, depended totally on General Powell. He was practically at his mercy, so much so that Clinton believed Powell would beat him in an election. The president's inexperience and ignorance in military matters added to his dependency on Powell, "and his deleterious influence: this burdened us with the Base Force and influenced Aspin's Bottom-Up Review. This *Powellism* is an unbelievable collection of hardware and personnel assembled before attacking an army of mice. The QDR, which was unable to make clear choices, was created to decide that it was urgent to do nothing, or to follow the path of least resistance. Now the debate turns on readiness." Not a few Republicans are primarily preoccupied with the actual state of the armed forces, in terms of quantity, not theory. The Democratic left is not interested in defense: this leaves moderate or conservative Democrats and Reagan Republicans as supporters of innovation. The QDR does not upset any apple carts; it may be necessary to await the fall report of the NDP for an opening volley to be fired.

Richard Perle's judgement is laconic: "The Pentagon dictated the text." In any case, all the indications show that Admiral Owens' frontal assault did not truly succeed in transforming the central bureaucracy. The JROC, which he did succeed in transforming—including forcing four-star generals to travel together for days, to work together without their staff aides, who had been sent by their respective services to protect corporate interests—seems to have fallen back on old ways. Despite the efforts taken under the name of jointness, which reinforces the Joint Chief, even General Shalikashvili and Bill Perry seem to have run into considerable resistance led by bureaucracies defending their turf.

This review finishes by looking at the opposing trains of thought in examining the interesting analysis of John Hillen, a young Special Forces officer now at the Council on Foreign Relations, "For the moment, there are two different spheres: on one side, the RMA as undertaken and conceived by Marshall, the defense industry, technology specialists, that is, marvelous new ways of using the forces at the disposition of the United States. On the other, the strategy, doctrine, budget sphere: for what purpose and why [are we] using American power? These two spheres are still disconnected: the military RMA and the RMA as politically conceived. It is necessary to bring them together."

[81] interview with author, May 30, 1997.

The U.S. Military Academy at West Point hosted a heated debate last year on the future of warfare, between Richard Perle and Martin van Creveld.

5. Missions, Doctrines, Means

What will be the missions of the American armed services transformed by the RMA? One of the most interesting responses comes out of the new areas of national security politics proposed by *Project 2025*, undertaken at the request and with the support of Admiral Owens.

This work recommends, in effect, throwing all the conceptual baggage of the post-Cold War and Cold War aside: containment, MAD, dissuasion, escalation, forward deployment, etc.

The new categories are thus:

- **core security**: defend the United States against weapons of mass destruction (NBC). Neutralize, disarm any potential aggressor who has ballistic missiles at his disposal. Develop appropriate defenses.

- **reassurance**: reassure key allies, notably before they launch a regional arms race or are tempted to transform themselves into military superpowers: to wit, Japan. Reassure less powerful allies, show them the United States will not let aggression go unpunished. Consequently, convince allies, large and small, to built complementary, rather than competitive and global, systems to those of the United States. The United States should have a substantial force projection capacity.

- **leverage**: American forces should be capable of influencing the outcome of a crisis or a conflict without having to risk many personnel. Indirect intervention, furnishing information and intelligence, providing anti-missile defenses, protecting friendly countries, air superiority, control of the seas and coastal waters: leverage favors allied interventions.

- **conflict containment**: contain escalation, both qualitatively and geopolitically. To do this, be capable of imposing a quarantine; creating safe transit and passage zones; selectively disarming or neutralizing a given country's C4I, its weapons of mass destruction, its conventional weapons systems; rapidly deploying control and containment forces; receiving massive amounts of intelligence about a great number of countries, personnel and forces.

- **punitive intrusion**: take measures to dissuade a potential aggressor or punish the instigator of actual trouble: brief missions, calibrated to cause real damage. The models: the 1986 bombing of Libya, the 1989 ousting of Noriega, Israeli operations in Entebbe in 1976 or against Osirak in 1981.

- **defend or liberate a territory**: in the wake of Desert Shield and Desert Storm, with limited objectives. It is necessary to have a capacity for rapidly reconstituting main forces (reserves).

- **support humanitarian missions**: operations other than war, protection of refugees, response to natural disasters, evacuation of populations at risk, controlling frontiers, anti-drug operations, infrastructure support, ecological protection, etc.[82]

This is quite a distance from the war of attrition, of body counts and of *Operations Research*.

[82] *Project 2025,* NDU, 1992, pp. 45-47.

5.1 Searching for Sun Tzu

If the MacNamara model of conducting war was repudiated a long time ago, under the influence particularly of TRADOC, its imprint has, however, its roots in American history; at its worst, this is the tradition of General McClellan, who, to Abraham Lincoln's detriment, would never do anything unless he was assured of victory. At its best, it is the idea of war as logistics, the trend a bit derogatorily called Jominian. As Arthur Schlesinger proposed in his cyclical theory of American political history, people achieving positions of power apply the theories and practices learned in their formative years. Twenty years after the Normandy invasion, the captains and commanders who now wore stars, or had become secretary of defense, surrounded themselves with systems analysts and quantification whiz kids: "For me, a strategy is a budget."

Given the maneuver warfare that it was, the doctrine of force conflict in Europe against the Warsaw Pact was a *force on force* war: a strike, often frontal, between heavy, mechanized, armored forces. Even with the developments tied to the airland battle doctrine—which focused on substituting quality for quantity, shifting the frontal assault, in short, on recreating the idea of flank attacks—there was no escaping a large tank battle. The enemy, landscape, circumstances, and means all seem to point in the same direction. The views put forth by General Powell and the methods that had his favor—which are found exposed and practiced in the *Base Force*—are there. American critics regretfully see it as "a heavy tendency of American thinking."

With the Soviet Union's collapse, the hypothetical has been elevated and the theoreticians and practicians are bent over operational plans, corresponding both to the extremely diverse palette of enemies and adversaries and to new technologies.

And it is essentially under Sun Tzu that strategic and operational research has found its patron saint.

Colonel John Warden (USAF) was among the first to think of a Sun Tzu-like doctrine arising from new technologies, which is his theory of strategic paralysis. A sufficiently complete expose of this "shock strategy" is found in an interesting work published within the last year under the direction of Harlan Ullman, a former Marine Corps officer who also was at CSIS and the Center for Naval Analyses, and James Wade, scientist and officer, former high-level Pentagon official. To get good results, they surrounded themselves with a highly qualified team that comprised former Atlantic CINC "Bud" Edney; Fred Franks, who commanded the 7th Corps in Desert Storm and headed TRADOC; Charles Horner, who commanded all the allied air forces during the Gulf War; and others.

The result, contained in a slim volume, *Shock & Awe—Achieving Rapid Dominance,* is a very interesting attempt to think about the future of warfare, but from a strongly operational point of view. To define the doctrine of shock strategy, the authors defined a typology of operational doctrines that allowed them to limit and define by exclusion. In short, they list:

1. **overwhelming force**: an enormous and costly quantity of personnel and material leads a war of attrition, force on force, platform versus platform, against an enemy. This force consumes a great deal of time to assemble and deploy. The problem with such a force today, writes the authors, is that there is no enemy to attack.

2. **Hiroshima and Nagasaki**: urban strikes that inflict massive, indiscriminate damages. Question: will non-nuclear weapons attain similar results? Problem: this type of strike can only be realized quickly without discussion.

3. **massive bombardment**: this crushes the enemy in striking military targets. It is an affair of endurance; who will give up first.

4. **transparent warfare**: this is the surgically precise application of highly focused forces in order to maximize productivity in profiting from economies of scale. To succeed, the blue forces must be commanded by a masterful hand and the enemy must exhibit great stupidity. The method is inappropriate to guerilla warfare.

5. **Sun Tzu**: the selective and instantaneous destruction of the enemy's key military and social targets in order to obtain the effect of assault and shock. This is a "selective Hiroshima," applying the most implacable brutality. The British special air force uses this method, that of the blind grenade: "a gigantic grenade on the scale of a battlefield."

6. **Potemkin village**: the combination of bluff and force demonstration to deceive the adversary.

7. **Roman legion**: a halo of invulnerability surrounding the force, the certainty of a superior and invincible force always finishing by taking the best—the authors consider the idea doubtful.

8. **Degeneration and privation**: resulting in the fall of the intended society, a long and cumulative process that uses embargoes, in other words, Chinese torture.

9. **Canadian Mounted Police**: "Never send people where they might be shot."

Although the writers do not avoid all the utility or application of the other cited methods, they favor the Sun Tzu method: it is less a question of engaging enemy forces and more one of battering an enemy's will to fight. This requires the application of RMA technologies—those that allow for the acquisition of near total awareness, knowledge and understanding of allied forces, enemy forces and the overall environment, converting this into precise and rapid action, all the while imposing a control and rigorous management of force signatures, "to impact the will, awareness, comprehension belonging to the adversary … and reduce it to powerlessness."[83] The desired result is also described: "Theoretically, the amplitude of the attack and shock that [the doctrine of] rapid domination wants to inflict is the non-nuclear equivalent of the impact of the atomic bombs dropped on Hiroshima and Nagasaki on Japan."[84]

It is necessary to strike an adversary by "immobilizing the state or blocking an organized enemy through the rapid and simultaneous application (or the threat of usage) of ground, naval, air, space, and special forces over the widest range of the adversary's power bases and centers of gravity and against the adversary's will and perception at a tactical and strategic level."[85]

What does the doctrine *rapid dominance* mean? "The radical difference in rapid dominance is the exhaustive increase in the systematic assembling and integration of numerous technological advances under development and of certain quite revolutionary changes in battlefield awareness and perception dominance—applications of new materials, sensors and signature controls, computers and bioengineering, application of enormous amounts of data, allowing the use of weapons simultaneously, with precision and lethality."[86] In brief, "Rapid dominance is fundamentally information war (IW) occurring on a large scale."[87]

The authors clarify, rightly, that their concept is still a work in progress and that it "needs to be operationalized." But it is strikingly obvious that they were forced to flesh out the questions formulated by Andrew Marshall in elaborating their strategic doctrine of a strike wave.

[83] Ullman, Wade *et.al.*, *op.cit.*, p. 10.
[84] *ibid.,* p. 12.
[85] *ibid.,* p. 35.
[86] *ibid*., p. 42.
[87] *ibid.,* p. 126.

The same reflection on the importance of timing and tempo as conditions for exploiting space and matter [is] found among many writers. The similarity to ideas of conserving velocity do not escape these authors. *Joint Vision 2010* is without any doubt an idea in which temporality plays a key role, across the complementary notions of simultaneous and parallel, rather than sequential, engagement: "the acceleration of time required for seeing, hearing, measuring, taking the temperature, recording magnetic properties, and testing the changes that happen at any spot ...";[88] the entry of the adversary's decision in the command loop, or better yet, the reduction of the command cycle which "should shrink from several weeks or days to several hours or minutes."[89] The priority given to time is the flip side of the least importance given to space: "The operational doctrine prescribes that RMA ground forces move away from the belief that ground forces should seize and control territory … or physically control large populations."[90] An attrition war or maneuver warfare have been replaced by nodal warfare which "operates in order to dismantle more than annihilate opposing military forces." The complementary concept is that of disparity, disequilibrium, rupture. New technologies allow for operational and strategic innovation to graduate from destruction to rupture, explains a RAND researcher; the disruptive use of energy allows for reaching objectives which would beforehand have required explosions and destruction.

This results in a system of systems that could have a very strong deterrent value—understood to be the deterrence of the strong against the weaker. This is, in any case, the hope of American theoreticians. A power which is no longer hunkered down at a distance, thanks to rapidity, precision and thus stand-off warfare, can dissuade. "Alleging that war over a distance will not stop an enemy who can progress in the mud when his routes are blocked is to forget at which point the mud, so to say, increases the costs, the length and the friction in operations," argues Martin Libicki. If deterrence fails, here is how the same author describes the battlefield:

> a dense net of millions—perhaps billions—of sensors and emitters which … illuminate, distinguish and target everything that is of sufficient value to be worth the bother of being destroyed by a plethora of PGMs that have become smaller, lighter, faster and less expensive, and which can be used to destroy anything which appears interesting ... a deadly firing field, virtually impenetrable by the other side, except by accepting a very high cost."[91]

The importance of small unit operations (SUO), the transformation of infantry along the lines of special forces/special operations, the weakening role of major platforms (combat aircraft, tank, aircraft carrier), the rise of drones and missiles constituting stand-off warfare, arsenal ships and mobile offshore bases, space warfare, and the essence of information warfare have, in any case, become almost axiomatic in the debate.

The doctrinal debates are intense, which the extent and the diversity of the transformations affecting the environment and the determinants of war suffice to explain. Just as the "new" geopolitical paradigm that has succeeded the wars of the 20th century and the Cold War—whose end is virtually concluded—has not been affirmed, the balance between new weapon systems and their respective capabilities has not yet settled into place. With *Joint Vision 2010* the doctrine has started to take and navigate certain paths. Concepts such as *Force XXI* seem to have intermediary value, and function as instruments for transitioning toward a revolutionary armed force. Gordon Sullivan recognizes this implicitly when he uses—in a quite revealing fashion—the following metaphor for describing FXXI: just as the Microsoft *Word* has seen a series of versions, *Word 1, Word 2,* etc., to *Word 6, Word 6.1a*, the American forces are at their version 12.0 since General Washington's army. FXXI is part of this evolutionary concept. In the plentiful output of military writers, the rudiments of this new doctrine are discernable.

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[88] J. Blaker, op.cit., p. 9.
[89] James R. FitzSimonds, *The Coming Military Revolution…, op.cit.*
[90] *ibid*., p. 16.
[91] Martin Libicki, *Silicon & Security in the 21st Century*, NDU, pp. 63-4.

5.2 Restructuring: industry R&D and COTS

Within the defense economy, new technologies surge in from all sides, as much from the National Labs as from commercial industry. The demand economy is not at rest, meaning that new strategic and tactical operational plans tested or adopted by military organizations have a pressing demand for new technologies. To take just one example, dispersing combat groups in small unit operations demands that sensors, transmissions and GPS within a dense situation be of an irreproachable quality and high level performance. Weapons technology, and organizational and operational developments begin to have a reciprocal influence on each other.

Military [procurement] budgets have fallen from $136 billion at their peak in FY 1985 to $42 billion in FY 1996, a 70 percent decline. They have fallen from 2.4 percent of GNP to 0.6 percent. The budget for research & development lost 28 percent compared to its peak. This has provoked a huge wave of defense industry consolidation, the mergers representing, on average, more than $10 billion a year since 1994. The number of jobs lost in the defense and aerospace industry reach 1.3 million. Downsizing has cruelly touched the industry.

The defense industry is in a universe of its own: around the thirty-some major industrial firms, called the primes, are about 40,000 suppliers, which in turn are supplied by thousands of businesses whose clientele is not limited to defense.

The industry has been restructured. If one examines the evolution of the number of American suppliers by major category, the size of the movement jumps out:

Figure 5: Number of American Defense Firms by Product

		1992	1996	2010
aviation	bombers	3	2	1
	fighter planes	5	4	2
	helicopters	4	4	2
related equip.	ballistic missile defense	6	4	3
	expendable launch vehicles	3	2	1
	satellites	5	4	3
	strategic missiles	1	1	1
	tactical missiles	8	8	8
armored vehicles	tanks	1	1	1
	armored personal carriers	8	8	4
munitions	small caliber ammo	5	5	3
	artillery	5	5	3
	explosives	2	2	1
	bombs	4	2	1
	mortars	4	2	1
	large mortars	4	4	2
	depth charges	2	2	1
	detonators	22	13	8
	cluster bombs	2	2	2
	torpedoes	1	1	1
	tank munitions	3	3	2
	demolition, grenades, mines	8	5	2
	fuzes	4	3	2

Source: *Defense Logistics Agency, Industrial Analysis Support Office,* December 1996

All the participants—industry, weapons engineers, Pentagon planners, legislators—had to reflect on the necessary changes at all stages: planning, R&D and acquisition.

Now the defense market is not like other markets. As Richard Garwin has studied, it is, traditionally at least, a monopsony—many sellers, a single buyer. And it is a very imperfect market: first, because the main consumers of products—wars—are not constantly happening and because it is a cyclical market, of irregular cycles varying in their frequency and amplitude; and second, because suppliers are more and more monopolistic in the wake of the industry's consolidation. Even if many of the technologies originating from commercial industries have a military usage, as does GPS, for example, the Pentagon remains the only potential buyer of artillery, guided bombs, fighters, bombers, aircraft carriers, or stealthy platforms.

For the first time the Pentagon is no longer the driving force behind electronics, information and telecommunications. At the beginning of the 1960s, 65 percent of all advanced electronics products were grabbed by the Pentagon. In 1994, this number had fallen to 4 percent. From 1985 to 1995, out of an annual average of $215 billion (in constant 1993 dollars) for the entire electronics industry, military electronics counted for $55 billion. The decline started at the beginning of the decade. In 1995, instead of a quarter, the Pentagon was buying no more than 17 percent ($38 billion). This decline is going to continue. The Pentagon foresees that 70 to 80 percent of its communication services will be acquired in the commercial market, which will facilitate a reduction in its costs, a shortening in the development cycle and the acquisition of state-of-the-art equipment. Just recently, though, *milspecs* were not fewer than 32,000 documents. Everything will change with the movement toward a commercial market.

The Carnegie Commission on Science, Technology and Government calculated that the Pentagon's regulation system, management and control increase the cost of acquisition by 40 percent, while in the commercial sector the same services cost between 5 and 15 percent. Another organization, Congress' Office of Technological [sic] Assessment gives a range of $15 billion to $75 billion per year for the indirect costs of this system. Still other sources estimate the surcharge as 30 percent.[92]

The Assistant Secretary of Defense John White does not fear stating, "We need a revolution in business affairs." He assumes as a given that the commercial sector is shaking up the Pentagon, by moving faster and better at less cost. Regulations are slowly dwindling. Pentagon negotiators now enjoy real freedom in negotiating with their suppliers; contractual procedures have been markedly simplified; and three new acronyms have made their appearance in Pentagon jargon: COTS, NDI and CMI.

Some do not hesitate to speak of the "revolution of COTS" (commercial off-the-shelf technologies). According to security technology expert Steve Bryen, "To the extent that we will be progressing in the RMA, the proportion of military technologies that will be from standard civil production and acquisition sources will increase to 98 percent."[93] The "civilianization" of the complete cycle of development and weapons system production is a completely logical consequence of the technological and economic revolutions already analyzed in this study. It is the realization of them.

Besides COTS, there is also the practice of NDI (non-developmental items): the Department of Defense may acquire products without having to participate in the financing of the design and development, and may pay a price that excludes these costs. Finally, there is CMI, commercial-military integration, based on dual-use technologies.

Certain firms, such as Lockheed Martin, have decided to use their core competencies to gain shares in related markets, such as systems designed for the information highway, real-time 3D graphics [and] medical imagery. The major system integrators have thrown themselves into supplying off-the-shelf

[92] Cf. Gordon Boezer, Ivars Gutmanis and Joseph E. Muckerman II, "The Defense Technology and Industrial Base: Key Components of National Power," *Parameters*, Summer 1997, pp. 26-51.
[93] Interview with author, May 27, 1997.

systems (satellites, missiles, ground systems). In the intervening mergers, there is an observable relation of capital stock of 0.65 to 1.35 in favor of electronics and information sciences, because the electronic-information share of the Pentagon budget is the only one not only to have stabilized, but which is projected to grow.

Others, such as William Anders, CEO of General Dynamics, the maker of the M1 tank, nuclear submarines and fighter planes, have vigorously opposed reconversion, hammering home the point that it will not work and should not: the vocation of arms producers is to make weaponry.[94] As is known, this attitude will not bring change to his company.

All the same, while the Aerospace Industries Association is enjoying the benefits of its COTS, NDI and CMI methods, major players such as ATT, Bell Helicopters, Oracle, U.S. Chambers of Commerce, or the Computer & Communications Industries Association are fully against it.

These shakeups have not come to a halt in the defense industry. Recently, Secretary of Defense William Cohen made it known to those interested in the Pentagon—and there are many—that whoever would enter or leave a senator's or representative's office with a wish list of acquisitions for a service, would be sent on his merry way. These horse-trading deals between legislators and Pentagon officials have the effect of adding a surcharge: a high ranking official related to the author a situation in which a legislator had succeeded the previous year in allocating not less than $3 million from military commands to businesses within his district, after having negotiated the arrangement with the functionaries of such and such service. Pork barrel politics plays its part.

If the partial privatization of the various services and functions of R&D, deregulation, "civilianization" continue to spread, what will be the role of DARPA? Although this study has not primarily focused on this subject, and the author does not have the necessary data and information for outlining his impression, many of the consulted sources seem to indicate that DARPA plays a completely qualitative role. "DARPA, which is one of the major bridgeheads to the RMA and is a crucial driver, is only allocated $325 million annually to do research on information systems," explains Dennis Gourmley, a respected member of the strategic community.[95]

It is useful to consult the testimony given last March before a Senate subcommittee by DARPA Director Larry Lynn, in which he outlined a precise picture of his department's projects. One will learn that DARPA funds many projects benefiting from the stability of public budgets, especially long and costly projects offering long-term and uncertain benefits. But at the same time, DARPA functions more and more by being inspired by the world of business, as its director underlines.

This is not the place to look at the fascinating list and superabundance of research and development projects involving DARPA. The reader will be able to compare the lists of priorities with those of other institutions, an instructive process.

William F. Ballhaus put together the following list last year:

- weapons operating at the speed of light, particularly antimissile defenses.
- UAVs and UCAVs, for reconnaissance missions, communication nodes and weapons platforms.
- C2 systems fully integrated with JSTARS, GPS and other subsystems.
- ultra precise missiles such as JASSM for striking high value targets (stealthy missiles employing advanced guidance and navigation systems and imagery).
- F-22 for aerial superiority.

[94] Speech given in St. Louis, October 31, 1991.
[95] Interview with author, May 18, 1997.

- new launch vehicles offering satellite access at a reasonable cost (i.e., reduction of 25 to 50 percent of today's cost).[96]

For Michael Mazarr, spokesman for the Army, his "priorities for defense investment in the 1990s," dated 1994, were as follows in regards to weapon systems (under the invocation *sub [sic] hoc signo vinces*[97] of "a new doctrine combining warfare based on information, disengaged and commercialized"):

- restrain the development of platforms in favor of powerful, long-range precision strike,
- nonlethal weaponry,
- stealthy aircraft,
- smaller and stealthier ships,
- UAVs and UCAVs.[98]

Others close to the Army have given voice to the following table of priorities:

Figure 6: Defense Priorities, Metz & Kievit[99]

Objective	*limit losses*	*focus efforts on*	*coordinate ops*	*organize operations*
1st stage	♦ long range platforms ♦ information dominance ♦ missile defense	centers of gravity	♦ improve C3I ♦ computers ♦ digitization	♦ synergy ♦ *ad hoc* coalitions
2nd stage	♦ robotic weaponry ♦ nonlethal weaponry ♦ psychotechnologies ♦ cyberdefense	interconnected systems	♦ nanotechnologies ♦ micro-robots ♦ smart systems	♦ abolition of distinct services or a nondivisive structure ♦ hyperflexibility

The authors of *Shock & Awe* are much more prolific; their detailed list:

- **knowledge**: automatic translators, interactive information simulation, tools for dynamic management of sensors, extraction tools, cracking, memory capacities, tools for exploiting information (filters, mergers, image comprehension), audible emissions.

[96] William F. Ballhaus, "The Revolutions in Military Affairs and Business Affairs," presentation at "Technology and The Future of National Security" symposium of the Hudson Institute in *Outlook* (Hudson Institute), March 1997, vol. 1, no. 3.
[97] *In hoc signo vinces:* by this sign you will conquer.
[98] Mazarr, *op.cit.*, p. 33.
[99] Steve Metz and James Kievit, *op.cit.*

- **crisis**: targeting tools, situational evaluation; acquisition of real-time information gathered by sensors; fusing space sensors, drones, and passive ground sensors; surveillance of the enemy's cyberspace.

- **merging information displays**: information imagery, graphics, virtual reality, advanced simulation.

- **speed**: planning based on modeling, machine intelligence, planning dynamic (feedback from new information brought to light), selectively automated assistance in decision-making.

- **general**: sensor technology, radars in all weather, acoustics, seismic, lidar, detectors of magnetic anomalies, hyperspectral visible and near infrared sensor, microelectromechanical systems. Soldier with implanted sensors.

- **materiel**: increasing the calculating power of workstations, image generators for a low price, massive parallel machines, compact displays, low cost memory (DRAM, RAID, optical juke boxes), client-server drivers reconfigurable simulation chambers, advanced human-computer interfacing, ultra light PCs.

- **software**: networked data drivers, object-oriented architectures to unify cybertraffic, advanced modeling and simulation, AI, tools for software engineering, operating architecture.

- **telecommunications**: GPS (30 Mbps), multi-terabyte databanks, connection to joint tactical internet under development, advanced relay platforms (UAVs, Iridium, etc.), multimedia communications.

- **platforms**: bombers and stealthy fighters, arsenal ships, submarines with cruise missiles, stealthy ground vehicles, attack and stealthy observation helicopters.

- **weapon systems**: smart bombs, cruise missiles, long-range guided missiles, smart long-range platforms for firing submunitions, smart mines, long- and short-range land attack missiles.

- **robotic systems**: dedicated programmable machines.

- **finally**: new materials, bioengineering, micro electronics.

Let's now look at the list of priorities established by Project 2025, which stipulates:

> In 1991, the victory brought by Desert Storm was based on 1980s equipment, developed in the 1970s, based on technologies conceptualized in the 1960s. Similarly, our defense system in 2025 will have been acquired during the second date of the 21st century, on the base of programs developed the prior decade, making concrete the technologies envisioned in the 1990s.[100]

The governing idea is that a

> long-term program should be consecrated to developing defense systems composed of dense networks of sensors, emitters, microrobots and miniprojectiles. To do this, five

[100] *Project 2025, op.cit.*, p. 55.

categories of technology are essential: electronics, nanotechnologies, energy, software, and manufacturing production.

- **electronics**: faster, smaller, more powerful microprocessors; memory; processors with digitized signals; emitters, sensors and specialized receivers for radio waves, magnetic fields, chemical substances, changes in atmospheric pressure, acoustical signals.

- **nanotechnologies**: engines produced in large quantities of miniaturized gears and equipment, nano devices capable of interacting with chemical substances at a microscopic level.

- **software**: artificial intelligence (logic processing and pattern recognition), distributed calculations.

- **energy**: more efficient and compact power sources, better batteries, photosensitive surfaces.

- **manufacturing:** to produce all of this.

The project's authors warn that the acquisition strategy should be prudent and hedging, to the extent that prodigious technological advances bring many surprises: it is better to have many prototypes on the drawing board than to buy great quantities of several models. Simulations, wargames, tactical simulations, and maneuvers should play a major role in directing acquisition.

6. What does this mean for France and Europe

6.1 And the allies

At the end of this tour through the American debate on innovation, and before attempting to draw conclusions or implications for France and Europe, it would undoubtedly be useful to summarize the views of RMA supporters on allies and alliances. The United States can be considered the pivot around which the world turns, and it is the relationship to this pivot that defines the rest of the system: independence exists, but not true autonomy. It appeared to be useful to outline the RMA thesis on alliances: if the United States is moving forward in the indicated direction, the problem of alliances will impact the attitudes and traditional practices of American strategic diplomacy.

The point of departure is straightforward: the United States is better positioned than any other competitor for exploiting the developing military revolution, writes Michael Vickers, one of the members of the NDP.[101] "There is a gulf between the U.S. and our allies in the development of the RMA," explains Dennis Gourmley. "Other countries develop and will develop this or that aspect or system, but we are, and we will probably remain, the only country to have an entire set of options," notes Eliot Cohen, adding, "We are spending so much more than all others combined, and our responsibilities are global—we are the only ones in this position."

The United States is developing a better and better force projection capability; between sealift, airlift, mobile offshore bases, and other artificial islands, it has less need of regional theater ground bases. Some worry about an oversimplified exclusivity. "Certainly, it is necessary to extend and maintain our influence in the world, but the status of hyperpower can, in situations of significant disequilibrium, lead to resentment, antagonism, suspicion. We need our allies," says James Blaker, "Particularly for OOTWs."

Then what is the role for allies? "We are going at such a quick rhythm … it is necessary or should be necessary to slow down and wait for our allies. We can maybe procure C2 systems for our allies, set up an informational infrastructure as we did in Bosnia," explains a senior Pentagon official, in reference to Bosnia Communication and Control Augmentation System (BC2A) that allowed exceptional, real-time coverage of Bosnia, including imagery, maps, video distribution, etc. As for the future? The Americans have to get their feet dirty, as the English would say. The idea that in each regional theater one or more U.S. allies would provide ground combat support, while a disengaged United States provides air, logistical and information support (as seductive as this idea appeared to Powellian adepts of zero-kill), would probably apply only to those small, self-contained regional conflicts that do not have extra-regional implications. It is apparent why thinkers in Washington are attracted to this type of scenario: a world super-theater with its decentralized sub-theaters that all connect back to the center borrows less from information models than from previous modes of organization. In order to participate it becomes necessary to be linked up to the central mainframe.

[101] Exact translation.

6.2. Some ideas for France and Europe.

6.2.1 Opening the debate

In noting the differences in traditions and culture, it nonetheless seems indispensable that we should be inspired by the United States. Minitel[102] should cede its place to the internet. And it is meaningless to reorganize the one to resemble the other as their purposes and uses are too dissimilar.

It is first important to recreate a permanent public debate about defense issues. Defense in France is not really in the public domain; we measure it in terms of the column-inches in the weeklies and newspapers and the minutes of coverage on the television. This is not because there still exists an enmity between the anti-military intelligentsia and the Army as an institution. Nor is the cause attributable to retired military personnel complaining about the civilian sector's lack of regard for their services. In fact, many historical wounds have healed into old scars, and resentments on both sides have mostly faded away.

6.2.2 Some Choices for France and Europe?

The absence of a large-scale conflict that might implicate France, shifts in geopolitics, and the major change wrought by the professionalization of the [French] armed forces appears to offer a window of opportunity, despite tight defense budgets and related difficulties.

First, there is the approach toward the United States: should France accept an American-centered plan and plug into its centralized network? What would the Americans offer in exchange? If France must make this choice, should it retain some specialty niches based on its excellent technology? Is it necessary to plunge into joint ventures with American defense firms, DARPA, etc., and bet on realizing a complementarity between a European or Euro-Mediterranean region and the United States?

A second issue is the geopolitics of the RMA. Setting aside the United States, the regions that have the requisite technology by rank are (1) Europe, (2) Japan, (3) Israel, (4) Canada, and Australia (5) by inclination, Taiwan, and (6) China, conditionally and within limits.

In the realm of the "Defense of Europe," should there be an alliance of European manufacturers, whether under the guise of the European Union or similar to the Airbus consortium, to form or enlarge technological niches? Or is it still necessary to work cooperatively with other actors that are likely to be key players in the field of technology? Or should one not mix strategies?

Whatever the responses may be, it seems urgent to promote the transfer of large sums of venture capital to cutting edge technology sectors, particularly ones relevant to the RMA. This touches financial, credit, legal, and stock market structures. The number of French working in Silicon Valley is growing rapidly, and is a worry for France: it represents a brain drain and a skill drain that is extremely damaging.

The first step must be to launch quickly a huge national debate on these hot topics.

Operationally, France has its own force projection capabilities. It can arm its forces with RMA weaponry: PGMs, converted Airbuses that carry ALCMs. This imposes some difficult choices for current and future platforms, the financing of which is uncertain. It is possible that the urgent need to reform the armed forces and restructure the defense industrial bases may offer opportunities at the same time it is the cause of present problems.

[102] French telecommunications company.

Given the long lead already taken by the United States, a significant amount of cooperation seems inevitable. The amount of investment and expenditure required does not permit a country to go it alone. “Beat it or join it” states the old adage. The developments emerging from the internet, from its technologies, tools and functions, reduce the realm of autonomous choices, as does the RMA. We cannot escape the new paradigm created by others, but we can move ourselves with strength and agility into the core of the new paradigm.